Long Island Sound Resource and Use Inventory

Report by the:
Long Island Sound Inventory and Science Subcommittee of the Blue Plan Advisory Committee

2018

LONG ISLAND SOUND
BLUE PLAN
Sustainable Ecosystems - Compatible Uses

Report by the:

Long Island Sound Inventory and Science Subcommittee
of the Blue Plan Advisory Committee

Version 1.3
December 2018

Long Island Sound Inventory and Science Subcommittee of the Blue Plan Advisory Committee. (2018). *Long Island Sound Resource and Use Inventory*. Groton, CT: University of Connecticut Avery Point.

Cover Photo by: Emily Hall

Acknowledgments

The Long Island Sound Inventory and Science Subcommittee of the Blue Plan Advisory Committee would like to thank the contributing authors, reviewers, and editors for their help in preparing this report.

Contributing Authors:
Bruce Beebe
David Blatt
David Carey
Sylvain De Guise
Catherine Finneran
Christian Fox
Nathan Frohling
Bill Gardella
Emily Hall
Hannah Hauptman
Sid Holbrook
Robert Klee
Corey Leamy
Evan Matthews
Kevin O'Brien
Tom Robben
Leah Schmaltz
Emily Shumchenia
Mike Theiler
Brian Thompson
Ian Yue

Reviewers:
Melanie Bachman
Brian Conte
Daniel Forrest
Donald Landers
David Leslie
Jerry "Captain" Morgan
Deb Pacileo
Mark Pappalardo
Christina Walsh

Editors and Copy Editors:
Emily Hall
Ian Yue

The Subcommittee would also like to recognize the following individuals and organizations, not already acknowledged above, who went above and beyond to provide data or help facilitate data review for the Inventory.

Other Contributors:
LTJG Shannon Andrew
Kathleen Atwood
Kathleen Burns
Bowen Chang
Jack Conway
DeWitt Davies
Bart DiFiore
Emily Farr Susan
Filipowich Anne
Hannan
Brian Jones
Eric Kretsch
Sarah Nahabedian
Ryan Patrylak
Valerie Pinkerton
Mike Pirri
Alan Rios
August Ruckdeschel
Susan Ryan
Geoffrey Steadman
Andrea Watson
Adam Wright

Connecticut State Historic Preservation Office staff
New London fishermen
New York State Historic Preservation Office staff
Southern New England Fishermen's and Lobstermen's Association

The Subcommittee would furthermore like to thank and recognize all ecological experts and stakeholders for their valuable contributions to this Resource and Use Inventory. This document

would not have been possible without their input, feedback, and support. For further information about stakeholder groups specifically engaged throughout the Inventory process, please see the appendices of each sector-specific Inventory chapter.

Funding Sources:

De Guise, S (PI), Frohling, N (co-PI). Using strategic engagement to achieve management and protection goals of the Long Island Sound Blue Plan. National Fish & Wildlife Foundation. $34,997. 10/1/16-12/31/17.

De Guise, S (PI), Frohling, N (co-PI). Support marine spatial planning in Long Island Sound: the Blue Plan. EPA Long Island Sound Study. $200,000. 10/1/17-9/30/19.

Frohling, N (PI). Initial planning steps towards development of a science-based marine spatial plan for Long Island Sound. Gordon and Betty Moore Foundation. $60,000. 2/1/17-2/28/18.

Summary Table of Contents

Acronyms and Abbreviations

Acronyms

AC	Alternating Current
AIS	Automatic Identification Systems
AMAPPS	Atlantic Marine Assessment Program for Protected Species
AMI	Association of Marina Industries
AWOIS	Automatic Wreck and Obstructions Information System
BEACON	Beach Advisory and Closing Online Notification
BOEM	Bureau of Ocean Energy Management
B.P.	Before Present
CAD	Confined Aquatic Disposal
CBC	Christmas Bird Counts
CCPBA	Connecticut Charter and Party Boat Association
CCMA	Connecticut Coastal Management Act
CCMP	Comprehensive Conservation and Management Plan
CFE	Connecticut Fund for the Environment
CFR	(U.S.) Code of Federal Regulations
CGS	Connecticut General Statutes
CLEAR	Center for Land Use Education and Research
CMC	Connecticut Maritime Coalition
CMTA	Connecticut Marine Trades Association
COA	Connecticut Ornithological Association
CPA	Connecticut Port Authority
CRESLI	Coastal Research and Education Society of Long Island
CRM	Coastal Relief Model
CSCC	Cross Sound Cable Company
CT	Connecticut
CT DA/BA	Connecticut Department of Agriculture Bureau of Aquaculture
CT DEEP	Connecticut Department of Energy and Environmental Protection
DAS	Day at Sea
DMMP	Dredged Material Management Plan
DO	Dissolved Oxygen
DSCRTP	Deep Sea Coral Research and Technology Program
EB	Electric Boat
EFH	Essential Fish Habitat
EMU	Ecological Marine Units
ENC	Electronic Navigational Chart
ENP	Ecologically Notable Place
EPA	(U.S.) Environmental Protection Agency
ESA	Ecologically Significant Area
ESI	Environmental Sensitivity Index
FERC	(U.S.) Federal Energy Regulatory Commission
FLAG	Fiber-optic Link Around the Globe
GIS	Geographic Information System
HVDC	High-Voltage Direct Current

IBA	Important Bird Area
LILCO	Long Island Lighting Company
LIPA	Long Island Power Authority
LIS	Long Island Sound
LISEA	Long Island Sound Ecological Assessment
LISFF	Long Island Sound Futures Fund
LISICOS	Long Island Sound Integrated Coastal Observing System
LISS	Long Island Sound Study
LISTS	Long Island Sound Trawl Survey
LNG	Liquefied Natural Gas
LNM	Local Notice to Mariners
MARCO	Mid-Atlantic Regional Council on the Ocean
MGEL	Marine Geospatial Ecology Lab
MOU	Memorandum of Understanding
NARWC	North Atlantic Right Whale Consortium
NCCA	National Coastal Condition Assessment
NCCOS	National Center for Coastal Ocean Science
NCR	Non-Consumptive Recreation
NE	Northeast
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NODP	Northeast Ocean Data Portal
NOEP	National Ocean Economics Program
NOS	National Ocean Service
NREL	National Renewable Energy Laboratory
NS&T	National Status and Trends
NUWC	Naval Undersea Warfare Center
NWI	National Wetlands Inventory
NY	New York
NYDOS	New York Department of State
NYGIG	New York Geographic Information Gateway
NYPA	New York Power Authority
NYS DEC	New York State Department of Environmental Conservation
OBIS-SEAMAP	Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations
OPM	Office of Policy and Management
OST	Office of Science and Technology
PSEG	Public Service Enterprise Group
RFP	Request for Proposals
RI	Rhode Island
RME	Research, Monitoring, and Education
RNC	Raster Navigational Chart
ROAP	Regional Ocean Action Plan
RPS ASA	Rural Planning Services Applied Science Associates
SAV	Submerged Aquatic Vegetation
SCUBA	Self-Contained Underwater Breathing Apparatus
SECONN	South East Connecticut

SHARP	Saltmarsh Habitat Avian Research Program
SHPO	State Historic Preservation Office
SGCN	Species of Greatest Conservation Need
SUP	Stand-Up Paddleboard
TMAUA	Temporary Marine Area Use Assignment
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
US (or U.S.)	United States
USA	United States of America
USACE	U.S. Army Corps of Engineers
U.S.C.	U.S. Code
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VMS	Vessel Monitoring System
VTR	Vessel Trip Report
WQ	Water Quality

Abbreviations

MassAudubon	Massachusetts Audubon Society
MYSound	Monitoring Your Sound
Sub Base	Naval Submarine Base New London
UConn	University of Connecticut

Introduction

Long Island Sound hosts diverse uses including recreation, aquaculture, commercial and recreational fishing and boating, marine trades and transportation, and habitats for fish, shellfish, birds, marine mammals, and plants. Protecting offshore and coastal resources, traditional uses, and community character while simultaneously considering changing environmental conditions and proposals for new offshore activities presents a complex set of challenges. Comprehensive, coordinated, and proactive planning is needed to improve the Sound's ability to support thriving habitats, abundant wildlife, and sustainable and resilient communities.

Agencies at federal, state, and local levels increasingly need to work together along with stakeholders to address these challenges. Decisions need to be informed by a consistent ecological and socioeconomic context and an understanding of the various interactions between offshore and coastal resources and activities. In the case of Long Island Sound, effective decision-making requires access to regional scale data and information, guidance for using the data, and opportunities for government agencies and stakeholders to improve collaboration around the use of data to inform management of coastal and offshore resources and activities.

In May of 2015, the CT legislature passed Public Act 15-66, the "Blue Plan" legislation - launching an official marine spatial planning process for Long Island Sound. Under existing authorities, the Blue Plan seeks to create a comprehensive, coordinated and proactive approach to help protect traditional uses, natural resources, and environmental quality relative to potential new uses that may or may not be compatible. Marine spatial planning is a science-based planning process that uses credible data and information along with public and stakeholder engagement to identify and sustain environmental resources and existing human uses recognized during the planning process. Marine spatial planning can also identify areas appropriate for new uses and resolve conflicts between uses among other management objectives. It is therefore not surprising that the Blue Plan legislation calls for the "completion of a Long Island Sound Resource and Use Inventory by a Long Island Sound Inventory and Science subcommittee", and that "such resource and use inventory shall be comprised of the best available information and data regarding the natural resources within Long Island Sound and the uses of Long Island Sound".

In order to fulfill this requirement, the Inventory and Science subcommittee secured some outside funding to mobilize some of the necessary capacity (cover some new staff time) and engage sector-relevant members of the Blue Plan Advisory Committee and staff members to gather and review relevant information. The Data and Information work group undertook efforts to identify existing potentially relevant datasets and map products, and undergo an initial review of those datasets to assure they met adequate technical standards. Criteria for adequate technical standards included spatial relation to the Blue Plan area, sufficient descriptive information/metadata in terms of the nature, source and format (symbology, use limitations and caveats) of the metadata, and how current the information is. For example, we would not have considered a dataset from unknown source to present as objective and factual. The datasets and map products that met adequate technical standards were then grouped by sector and used to engage sector-specific experts and stakeholders in a review of the accuracy, representativeness, and relevance of the existing map products for the Blue Plan. In other words, is the information presented is the information science-based and up-to-date, does the data reflect the sum of the collective hands-on knowledge of people involved first hand in the given sectors, and does the Inventory present trusted information on which to base the Blue Plan marine spatial planning process. Further, experts and stakeholders were asked to help identify significant data gaps, along with the existence of datasets not yet identified by the Blue Plan team that would help address such data gaps.

The Long Island Sound Resource and Use Inventory therefore aims to present objective and stakeholder/expert reviewed information summarized to the extent possible through a series of maps, along with a narrative, and a historical and socio-economic context, to "tell a story" about a given sector. The inventory is more than the handful of illustrative maps provided as examples of how important geospatial information can be represented, but rather the sum of the information that we drew from, and maybe most importantly the sources of geospatial data that this information was derived from (listed at the end of each chapter), and that that an individual can query to perform his/her own analysis and draw his/her own conclusions. So, simply put, we did not weed out information, but tried to be transparent and show our findings and the sources of data we drew it from. Further, each chapter presents an assessment of the data available, including how it meets adequate technical standards, as well as its overall accuracy, representativeness, and relevance to the Blue Plan, according to the stakeholders and experts who reviewed the information. Data gaps and potential source of additional data to address those gaps are also identified from input from experts and stakeholders. The information gathered is presented in this Inventory, which is divided into two major sections, the ecological characterization and human use characterization, each containing a series of chapters grouped by thematic relevance. A short introductory section will highlight the specifics of the approaches used for those sections.

It should be noted that the Inventory is focused on geospatial information. The experts and stakeholders actively engaged to identify and review the information in each of the chapters were selected from a large pool of potentially interested parties, with input from the Blue Plan Advisory Committee as well as the various sub-committees and work groups involved in the development of the Inventory. We recognize that a large number of potentially interested parties exist that would not necessarily have geospatial data to contribute directly to the inventory, but who will be interested in the use of those data in the development of the Blue Plan. These parties were not necessarily included in the chapter-focused Inventory efforts, but parallel engagement efforts were undertaken to reach out broadly via a series of public events focused on presenting the general concepts and approaches considered in the development of the Blue Plan.

It is important to understand what the Inventory is not. The Inventory is meant to focus on objective data, and we purposefully attempted to exclude what might be perceived as interpretations, opinions or judgements that could distract from objectivity. Instead, we focused on assessing the information in terms of its accuracy, representativeness, and relevance to the Blue Plan process. The Inventory is not a plan. It does not include judgement on some areas or uses relative to others. It does not contain new regulations, but may refer to existing regulations when relevant to spatial data or specific aspects of human uses.

This objective information, gathered across sectors, represents the initial attempt to collect, summarize and synthesize the best available information that will serve as the basis for the development of a forward looking plan. While improved over the previous versions based on public comments received through abroad, open and inclusive but informal review process, we recognize that this version of the Inventory is not perfect. Per the intent of the Blue Plan legislation, it is based on existing information, and is limited by the timing for the development of the plan, as well as capacity and funding available. The Blue Plan legislation clearly states that the development of the Blue Plan, including the Inventory, is to be performed "within existing resources", that is the task comes with no associated funding; we were however successful at securing modest funding from outside sources for the development of the inventory, which are acknowledged in a separate section. We recognize that the quantity and completeness of information varies across sectors. Further, the data gaps identified are sometimes significant, and there is not always existing data that would address such data gaps. However, the requirement for a Blue Plan to be delivered by March 2019 required an initial version of the Inventory on which to base the planning process. Further, if resources and capacity exist, we will continue to improve this initial version of the Inventory over time as new data become available.

Finally, just as there were opportunities to review and comment on the information included in each of the chapters, the Inventory as a whole will undergo another stage in the review process to identify inaccuracies and address suggestions for improvement. The Inventory will be shared broadly with parties who contributed to the discussions leading to the drafting of the chapters as well as with other parties with potential general interest in the Blue Plan process, including members of the general public.

Chapter 1

Ecological Characterization Process

According to the Blue Plan legislation (Public Act No. 15-66, Section 1(b)), the Long Island Sound (LIS) Resource and Use Inventory should be comprised of the best available information and data regarding "all plants, animals, habitats, and ecologically significant areas" in nearshore and offshore waters of Long Island Sound. This Inventory describes existing data and map products pertinent to plants, animals, and habitats, and will provide the basis for an Ecological Characterization and subsequent identification of Ecologically Significant Areas. Using this Inventory document as a starting point, the Ecological Characterization and Ecologically Significant Areas are to be developed by Blue Plan teams and an Ecological Experts group.

The first step in the Ecological Characterization was a Rapid Assessment. In early 2017, a Rapid Assessment of ecological data was conducted. All available (digital) datasets and map products pertaining to the plants, animals, and habitats of LIS were assembled in a database with example data templates. Data came from local and regional data portals, as well as existing databases and online publications belonging to various agencies, researchers, and other groups. The Rapid Assessment did not include archived, non-digital, non-spatial data, or an extensive literature review of scientific publications. For each ecological dataset, a "data template" was created which provided example maps and essential metadata that could be used to assess its relevance, representativeness, and accuracy.

The second step in the Ecological Characterization was to obtain expert feedback on the data templates produced for the Rapid Assessment. Data templates were organized by the three main data groups (plants, animals, and habitats), and a number of subgroups were identified and organized to more fully represent the variety of data and ecosystem components. Webinars that combined some subgroups into related topics were held to obtain expert/technical feedback (Table 1-1). Prior to each webinar, experts were given access to the data templates pertinent to each webinar topic in the form of a map book. At least 60 experts contributed across the five webinars, some joining multiple webinar sessions.

Table 1-1: Focal Topics of the Five Ecological Expert Webinars

Webinar topic	Date	Approximate number of participants
Birds	September 27, 2017	17
Marine Mammals and Sea Turtles	October 2, 2017	12
Benthic Physical Habitat • Bathymetry • Seafloor Complexity • Sediments and Geochemistry • Physical Oceanography • Water Quality • Meteorology	October 16, 2017	20
Benthic Biological Habitat • Water Quality • Phytoplankton • Macroalgae • Eelgrass and other Submerged Aquatic Vegetation • Coastal Wetlands • Benthic Invertebrates • Ecological Marine Units • Ecologically Notable Places	October 24, 2017	31
Fish • Fish and Invertebrates • Zooplankton • Shellfish	October 27, 2017	23

During each webinar, experts reviewed and discussed the data templates in the map book. Experts also suggested additional datasets and contributed their knowledge and experience on each topic. Expert feedback included recommendations to keep or discard datasets in the Rapid Assessment, as well as recommendations to include additional datasets.

The third step in the Ecological Characterization was to document and interpret the expert feedback. Each webinar was recorded and can be viewed or downloaded on the Blue Plan website (CT DEEP, 2017). The website also contains links to the map books for each webinar. Detailed expert feedback was captured in spreadsheets that noted the expert's name, the dataset they referred to, and any links or references they could provide for obtaining the data. This spreadsheet was used to prioritize data and map products to further describe in this Inventory.

The fourth step in the Ecological Characterization was to develop this Ecological Inventory. The purpose of this Inventory is to assemble datasets that are relevant, representative and accurate in conveying the ecology of Long Island Sound. This Inventory describes datasets within each of the three main data topics identified in the Blue Plan legislation. The “plants” topic is covered in one chapter. The “animals” topic is further subdivided into chapters for each major taxonomic group: Marine mammals, sea turtles, birds, fish and shellfish, and benthic invertebrates. The “habitats” topic is further subdivided into chapters for each major data category: coastal wetlands, bathymetry and seafloor complexity, sediments and geochemistry, physical oceanography including water quality and meteorology, and ecologically notable places and ecological marine units.

This Inventory represents datasets that have been obtained by the Blue Plan team (or are scheduled to be obtained in the immediate future) and are available to be used to support an Ecological Characterization process. Data from the Inventory that are carried forward to support the Ecological Characterization are potentially also applicable to identifying Ecologically Significant Areas (ESAs), depending on the approach chosen.

References

CT DEEP. (2017). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635

Chapter 2

Phytoplankton, Macroalgae, Eelgrass, and Submerged Aquatic Vegetation

Chapter Table of Contents

Chapter List of Figures and Tables

Figures

Tables

2.1 Key Data and Map Products

This chapter describes datasets relating to plants (e.g., submerged aquatic vegetation [SAV]) in Long Island Sound (LIS), as well as other photosynthetic organisms such as phytoplankton and macroalgae. Coastal wetland vegetation data are described in *Chapter 8 Coastal Wetlands*.

Phytoplankton

The spatial and temporal patterns of phytoplankton have been studied in LIS for decades (Lopez, et al., 2014). Chlorophyll-a concentrations are a proxy for phytoplankton biomass, and vary seasonally and over longer timescales. LIS has typically shown chlorophyll maxima occurring in spring, minima in summer, and smaller peaks in fall (Lopez, et al., 2014). Chlorophyll concentrations are linked with nutrient (dissolved inorganic nitrogen) concentrations in LIS, except between 2000 and 2007 when chlorophyll concentrations increased and remained high despite little change in nutrient concentrations (Lopez, et al., 2014). Presently, chlorophyll concentrations are measured every month year-round and biweekly in the summer at between 17 and 48 stations covering LIS. These stations are sampled as part of the Connecticut Department of Energy and Environmental Protection (CT DEEP) Long Island Sound Water Quality Monitoring Program (CT DEEP, 2017) (Figure 2-1; and see *Chapter 11 Physical Oceanography, Meteorology, and Water Quality* for more information about this program). Collaborations between CT DEEP, the National Oceanic and Atmospheric Administration (NOAA) Milford Lab (NOAA, 2017), and the University of Connecticut (UConn) (Lin, 2018) have been established to advance the analysis and interpretation of these phytoplankton data.

Chlorophyll-a concentrations are also measured by satellite, and the available datasets usually cover areas much broader than LIS. A few of these regional-scale datasets are available via the Northeast Ocean Data Portal (Northeast Ocean Data Working Group, 2018) and the Mid-Atlantic Ocean Data Portal (MARCO, 2018).

Macroalgae

A review of predominant macroalgae species and spatial patterns is provided in Long Island Sound: Prospects for the Urban Sea (Lopez, et al., 2014). This resource notes that perennial macroalgal species (e.g., brown fucoid algae) are primarily found in intertidal hard bottom areas of LIS. Kelps, which are found in deeper waters on hard bottoms, are biennial in LIS, and they begin to degenerate in August. There are warm-season peaks in abundance of hard bottom or floating red (e.g., Irish moss) and green algae (e.g., *Ulva* spp.) and also an influx of southern species that have been entrained in Gulf Stream waters. There are different macroalgae species associated with soft bottoms (e.g., *Polysiphonia subtilissima*), and some of these also epiphytize salt marsh grasses.

Eelgrass and Submerged Aquatic Vegetation (SAV)

Eelgrass (*Zostera marina*) and widgeon grass (*Ruppia maritima*) are the two SAV species present in LIS. The focus of most of the research and monitoring of SAV has been on eelgrass, which is the dominant species (Lopez, et al., 2014). While eelgrass was once found throughout LIS, it is now only observed in the eastern parts of the Sound (Lopez, et al., 2014). The most current eelgrass coverage dataset represents eelgrass coverage as of August of 2012 (Tiner, McGuckin, & MacLachlan, 2013) (Figure 2-2).

Figure 2-1: [Phytoplankton Data](). Station locations for the CT DEEP Long Island Sound Water Quality Monitoring Program, which measures phytoplankton biomass and community structure through proxies such as chlorophyll-a concentrations and phytopigments (CT DEEP, 2017).

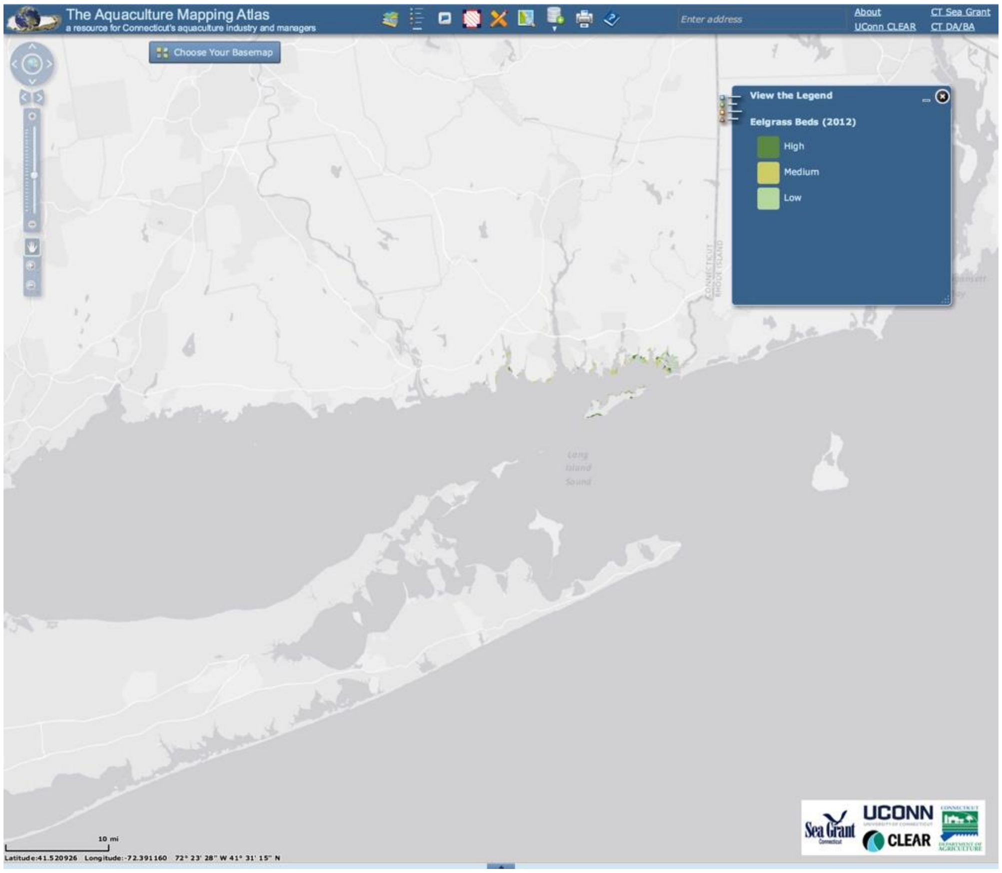


Figure 2-2: Eelgrass. The 2012 eelgrass coverage dataset from the U.S. Fish and Wildlife Service National Wetlands Inventory dataset (Tiner, McGuckin, & MacLachlan, 2013), as displayed in the Connecticut Aquaculture Mapping Atlas (UConn CLEAR, 2018).

2.2 Assessment of Data Quality

2.2.1 Sources of Data and Metadata

Phytoplankton

The CT DEEP Long Island Sound Water Quality Monitoring Program is an authoritative source for phytoplankton data at the scale of Long Island Sound. The data, methods, and map of stations are described on a CT DEEP website (CT DEEP, 2017). The website provides several example maps, analyses, fact sheets and reports using the data. Some of the raw data can be downloaded from the Long Island Sound Coastal Observatory (LISICOS, 2018).

Macroalgae

General patterns in macroalgae distribution and abundance in LIS are known by experts and recorded in decades of targeted research, as summarized by Lopez et al. (2014). Some of this research includes published papers with maps (Egan & Yarish, 1990; Kim, Kraemer, & Yarish, 2014; Kim, Kraemer, & Yarish, 2015; Pedersen, Kraemer, & Yarish, 2008), but to date, no digital spatial data are available. The most temporally extensive quantitative macroalgal dataset is held by the Millstone Environmental Laboratory as part of their monitoring of the effects of the nuclear power plant's thermal plume on the rocky intertidal ecosystem, eelgrass, lobster, benthic infauna, and fish in the area near the Dominion power plant (Millstone Environmental Laboratory, 2018).

Eelgrass and SAVs

The 2012 dataset was derived from aerial photography collected by the U.S. Fish and Wildlife Service (USFWS) as part of the National Wetlands Inventory in August of that year. Aerial photos were ground-truthed in October 2012. The methods and results of this survey are summarized in a technical report (Tiner, McGuckin, & MacLachlan, 2013). The map outputs describe eelgrass coverage as high, medium, or low (Figure 2-2). The spatial data and metadata are downloadable from the CT DEEP geographic information system (GIS) data website. Datasets representing the results of previous eelgrass surveys are also available for download (i.e., 2002, 2006, 2009). A web map of the 2012 data is accessible via the Connecticut Aquaculture Mapping Atlas (UConn CLEAR, 2018). As noted above under the Macroalgae section, the Millstone Environmental Laboratory also has data on eelgrass within the Millstone study area (Millstone Environmental Laboratory, 2018)

2.2.2 Accuracy, Representativeness, and Relevance of Map Products

All of the datasets discussed above are relevant to the Blue Plan effort. The accuracy and representativeness of the data depend on the scale of interpretation.

Phytoplankton

The CT DEEP Long Island Sound Water Quality Monitoring phytoplankton data are likely accurate and representative at the Sound-wide scale. Based on interpretation and discussion by Lopez et al. (2014), a high degree of inter-annual variability is expected in this dataset. Regardless, these data represent a relatively high spatial and temporal sampling frequency with even spatial coverage across the Sound.

Macroalgae

The only quantitative dataset for macroalgae is limited to a small area in eastern LIS near the Dominion power plant, in the rocky intertidal zone. Therefore, despite the accuracy of these data, they are not representative of LIS-wide patterns of macroalgae distribution and abundance.

Eelgrass and SAVs

The USFWS eelgrass data are likely accurate and representative at the Sound-wide scale. A relatively high degree of inter-annual variability is expected in each of these biological datasets, a characteristic that requires long-term records if trends are to be described.

2.2.3 Data Gaps and Availability of Data to Address Gaps

Phytoplankton

At the time of this draft, there are no apparent major gaps in phytoplankton data.

Macroalgae

Quantitative and comprehensive Sound-wide macroalgae distribution and abundance data represent a data gap in this chapter. Qualitative descriptions of expected macroalgal species distribution and abundance can be obtained from the resources noted in *Section 2.2.1 Source of Data and Metadata*. Expert knowledge and experience will be important for supplementing and interpreting these available data. Specifically, there is relatively little known about soft-sediment algal communities and drift algae species when compared with studies of rocky intertidal macroalgae communities. Expert judgment could also be used to inform Blue Plan efforts if qualitative data are insufficient or not specific enough (i.e., do not relate to a specific area or time period).

Eelgrass and SAVs

At the time of this draft, there are no apparent major gaps in eelgrass data. It is understood that eelgrass is currently limited in extent to eastern LIS, however, systematic surveys are only conducted in eastern LIS. Therefore, the research and/or conservation community would need to inform the team that conducts the surveys if it is suspected that eelgrass extent has expanded beyond eastern LIS at any point in the future. Since the USFWS has conducted eelgrass surveys in eastern LIS since 2002, it is assumed that surveys will continue in the future.

The lack of Sound-wide spatial data for widgeon grass (*Ruppia maritima*) or other SAV coverage is an existing data gap. Detecting widgeon grass or other SAV species in future surveys may require altering existing monitoring protocols.

2.3 Additional Context

Phytoplankton

Other phytoplankton datasets are available for subsets of LIS or are prepared at broader scales by other groups/institutions. For example, the Interstate Environmental Commission holds chlorophyll-a data for the western basin of LIS available via the Environmental Protection Agency (EPA) Storage and Retrieval database (US EPA, 2018). The NOAA Northeast Fisheries Science Center prepares seasonal chlorophyll-a concentration maps for the Northeast U.S. Continental Shelf Ecosystem, hosted by the Northeast Ocean Data Portal (Northeast Ocean Data Working Group, 2018).

Macroalgae

In recent years, interest in and implementation of kelp aquaculture in LIS has grown. The Connecticut Department of Agriculture Bureau of Aquaculture maintains records of where macroalgae is grown and harvested. Additional resources and publications of research conducted in LIS on patterns in macroalgae distribution and abundance are included in *Section 2.5.1 List of Maps Used to Inform the Chapter*.

Eelgrass and SAVs

There are several "historical" eelgrass datasets that may be used to assess change over time, or better understand the location of historical eelgrass beds. One recent analysis examined data from 2002, 2006, and 2009 (Tiner, et al., 2010). Other work to understand potential eelgrass habitat culminated in a habitat suitability index model for eelgrass in LIS, including factors such as minimum light requirements and nutrient levels (Vaudrey, Eddings, Pickerell, Brousseau, & Yarish, 2013). Additional eelgrass datasets are listed in *Section 2.5.1 List of Maps Used to Inform the Chapter*.

2.4 References

CT DEEP. (2017, May 2). *Long Island Sound Water Quality Monitoring Program and Information*. Retrieved Feb 5, 2018, from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://www.ct.gov/deep/cwp/view.asp?a=2719&q=325570&deepNav_GID=1635

CT DEEP. (2018, February). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635

Egan, B., & Yarish, C. (1990). Productivity and the life history of Laminaria longicruris at its southern limit in the Western Atlantic Ocean. *Marine Ecology Progress Series, 67*, 263-273.

Kim, J. K., Kraemer, G. P., & Yarish, C. (2014). Field scale evaluation of seaweed aquaculture as a nutrient bioextraction strategy in Long Island Sound and the Brox River Estuary. *Aquaculture, 443*, 148-156.

Kim, J. K., Kraemer, G. P., & Yarish, C. (2015). Use of sugar kelp aquaculture in Long Island Sound and the Bronx River Estuary for nutrient bioextraction. *Marine Ecology Progress Series, 531*, 155-166.

Lin, S. (2018, February). *Molecular Ecology of Phytoplankton: Long Island Sound Research*. Retrieved from University of Connecticut: https://phytoplankton.uconn.edu/long-island-sound-research/

LISICOS. (2018, February). *Long Island Sound Integrated Coastal Observing System (LISICOS)*. Retrieved from University of Connecticut: http://lisicos.uconn.edu/

Lopez, G., Carey, D., Carlton, J. T., Cerrato, R., Dam, H., DiGiovanni, R., . . . Shumway. (2014). Biology and Ecology of Long Island Sound. In J. S. Latimer, M. A. Tedesco, R. L. Swanson, C. Yarish, P. E. Stacey, & C. Garza, *Long Island Sound: Prospects for the Urban Sea* (p. 558). New York: Springer.

MARCO. (2018, February). *Mid-Atlantic Ocean Data Portal*. Retrieved from Mid-Atlantic Regional Council on the Ocean (MARCO): http://portal.midatlanticocean.org

Millstone Environmental Laboratory. (2018). *Executive Summary - 2017 Environmental Monitoring Annual Report.* Dominion Nuclear Connecticut, Millstone Environmental Laboratory. Washington DC: US Nuclear Regulatory Commission.

NOAA. (2017, December 7). *Milford Lab: Environmental Research*. Retrieved February 5, 2018, from National Ocean and Atmospheric Administration (NOAA) Northeast Fisheries Science Center: https://www.nefsc.noaa.gov/nefsc/Milford/environment.html

Northeast Ocean Data Working Group. (2018). *Northeast Ocean Data Portal*. Retrieved from www.northeastoceandata.org

NYS DOS OPD. (2018, February). *New York Geographic Information Gateway (NYGIG)*. Retrieved from New York State Department of State, Office of Planning and Development (NYS DOS OPD): http://opdgig.dos.ny.gov/

Pedersen, A., Kraemer, G., & Yarish, C. (2008). Seaweed of the littoral zone at Cove Island in Long Island Sound: annual variation and impact of environmental factors. *Journal of Applied Phycology, 20*(5), 869-882.

Tiner, R., McGuckin, K., & MacLachlan, A. (2013). *2012 Eelgrass Survey for Eastern Long Island Sound, Connecticut and New York.* National Wetlands Inventory Report. Hadley, MA: U.S. Fish and Wildlife Service.

Tiner, R., McGuckin, K., Fields, M., Fuhrman, N., Halavik, T., & MacLachlan, A. (2010). *2009 Eelgrass Survey for Eastern Long Island Sound, Connecticut and New York.* National Wetlands Inventory Report. Hadley, MA: U.S. Fish and Wildlife Service.

UConn CLEAR. (2018, February). *Connecticut Aquaculture Mapping Atlas*. Retrieved from University of Connecticut Center for Land Use Education and Research (CLEAR), Connecticut Sea Grant, and Connecticut Department of Agriculture Bureau of Aquaculture DA/BA: https://clear3.uconn.edu/aquaculture/

US EPA. (2018, February). *STORET Central Warehouse*. Retrieved from U.S. Environmental Protection Agency (US EPA): https://ofmpub.epa.gov/storpubl/dw_pages.querycriteria

Vaudrey, J. M., Eddings, J., Pickerell, C., Brousseau, L., & Yarish, C. (2013). *Development and application of a GIS-based Long Island Sound eelgrass habitat suitability index model.* New England Interstate Water Pollution Control Commission; Long Island Sound Study. http://digitalcommons.uconn.edu/marine_sci.

2.5 Appendices

2.5.1 List of Maps Used to Inform the Chapter

Data highlighted in grey are included in the Inventory and were discussed during expert webinars. In addition to the links provided below, each grey dataset is accompanied by a reference, citation, or link within the text in the Inventory.

The un-highlighted (white) data rows were also discussed during expert webinars. These data were either identified in the Rapid Assessment or mentioned by experts as credible sources of data that may not be relevant to the Blue Plan effort. Example reasons include the older age of the dataset, limited overall availability, lack of spatial data products, too limited or too broad spatial/temporal scope, or that other LIS datasets were preferred. Many of these un-highlighted datasets are described in *Section 2.3 Additional Context*, and most are described further in the Benthic Biological Habitat Map Book and Benthic Physical Habitat Map Books, which were used to for discussion purposes in the expert webinars (CT DEEP, 2018). Not all products showcased in the map book may be utilized to inform the final Blue Plan.

Table 2-1: Plant Datasets Used to Inform the Chapter or Discussed During Expert Webinars

CATEGORY	DATASET/LAYER	ADVANCED FROM RAPID ASSESSMENT TO INVENTORY	ADDED TO INVENTORY FROM EXPERT REVIEW
Phytoplankton	**Net primary productivity 2013, seasonal maximums, Mid-Atlantic Ocean Data Portal** (MARCO, 2018)	**X**	
Phytoplankton	**CT DEEP Water quality monitoring program, phytoplankton** (CT DEEP, 2017)	**X**	
Phytoplankton	**UConn phytoplankton analysis** (Lin, 2018)		**X**
Phytoplankton	**NOAA Milford lab phytoplankton data/analysis** (NOAA, 2017)		**X**
Phytoplankton	New York State Department of Environmental Conservation chlorophyll-a dataset		
Phytoplankton	Interstate Environmental Commission chlorophyll-a data in western basin		
Phytoplankton	Predicted concentration, chlorophyll-a (NYS DOS OPD, 2018)		
Phytoplankton	Chlorophyll-a seasonal medians (Northeast Ocean Data Working Group, 2018)		
Macroalgae	**LIS Prospects for the Urban Sea – macroalgae description** (Lopez, et al., 2014)		**X**
Macroalgae	Millstone Environmental Lab benthic seaweed community data, 2014-2016 reports		
Macroalgae	Productivity and the life history of Laminaria longicruris at its southern limit in the Western Atlantic Ocean (Egan & Yarish, 1990)		
Macroalgae	Field scale evaluation of seaweed aquaculture as a nutrient bioextraction strategy in Long Island Sound and the		

CATEGORY	DATASET/LAYER	ADVANCED FROM RAPID ASSESSMENT TO INVENTORY	ADDED TO INVENTORY FROM EXPERT REVIEW
	Bronx River Estuary (Kim, Kraemer, & Yarish, 2014)		
Macroalgae	Use of sugar kelp aquaculture in Long Island Sound and the Bronx River Estuary for nutrient bioextraction (Kim, Kraemer, & Yarish, 2015)		
Macroalgae	Seaweed of the littoral zone at Cove Island in Long Island Sound: annual variation and impact of environmental factors (Pedersen, Kraemer, & Yarish, 2008)		
Macroalgae	CT DEEP report on benthic algal communities		
Macroalgae	LIS cable fund kelp characterization – in progress		
Eelgrass and SAVs	**USFWS eelgrass (National Wetlands Inventory), 2012** (Tiner, McGuckin, & MacLachlan, 2013)	**X**	
Eelgrass and SAVs	Northeast regional eelgrass beds (Northeast Ocean Data Working Group, 2018)		
Eelgrass and SAVs	Historical eelgrass data (various sources)		
Eelgrass and SAVs	Long Island Sound Study eelgrass habitat suitability model		
Eelgrass and SAVs	Long Island Sound Ecological Assessment seagrass map, 2006 data		

2.5.2 Notes on Ecological Expert Input

Expert input was obtained on phytoplankton datasets during the “Benthic Physical Habitat” expert webinar, and input on macroalgae, eelgrass, and SAVs was obtained during the “Benthic Biological Habitat” expert webinar. The map books used for discussion in each webinar, and links to webinar recordings, can be found on the Long Island Sound Blue Plan website (CT DEEP, 2018).

Chapter 3

Marine Mammals

Chapter Table of Contents

Chapter List of Figures and Tables

Figures

Tables

3.1 Key Data and Map Products

Marine mammals in Long Island Sound (LIS) include whales, dolphins, and porpoises (together called cetaceans) and several seal species (pinnipeds).

Cetaceans

Cetacean data products and datasets in LIS come from several different sources. In mid-2018, the Marine Geospatial Ecology Lab (MGEL) at Duke University (MGEL, 2018) will release model results representing predicted cetacean density along the entire Atlantic coast, and including LIS for 10 individual species or species guilds (Table 3-1). Existing map products produced by this group do not include LIS (Figure 3-1). The new modeled outputs will integrate cetacean observations in LIS from the National Oceanic and Atmospheric Administration (NOAA) Atlantic Marine Assessment Program for Protected Species (AMAPPS) with local environmental predictors, but are also influenced by cetacean observations and environmental predictor variables throughout the entire Atlantic coast study area (NOAA NEFSC, 2018). These data products represent the most comprehensive estimates of cetacean distribution and abundance in LIS.

Other cetacean datasets include stranding data from the Mystic Aquarium (Smith, 2018), a limited number of cetacean sightings in the Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP) global scientific database (Halpin, et al., 2009), an interactive map of opportunistic sightings data of North Atlantic right whales maintained by the NOAA Northeast Fisheries Science Center and Protected Species Division (Figure 3-2) (NOAA NEFSC, 2018), and the marine mammal habitat layer within the NOAA Environmental Sensitivity Index (ESI) dataset (NOAA ORR, 2018).

Table 3-1: Species for Which Predicted Density Map Products with Coverage in Long Island Sound will be Released in Early 2018

Cetacean species or species guild
Fin whale
Humpback whale
Minke whale
North Atlantic right whale
Sei whale
Pilot whales (two species modeled as a guild)
Cuvier’s beaked whale
Mesoplodont beaked whales (all species modeled as a guild)
Unidentified beaked whales
Harbor porpoise

Pinnipeds

Pinniped species found on Long Island (including outside LIS) include Harbor, Grey, Harp, Hooded, and Ringed seals (CRESLI, 2018). The most extensive seal distribution and abundance data for seals consists of the locations of known haul-out areas on the coastline. Separate seal haul-out datasets are maintained by the Riverhead Foundation for Marine Research and Preservation (Riverhead, 2017), the Coastal Research and Education Society of Long Island (CRESLI) (CRESLI, 2018), and NOAA via the NOAA ESI dataset (NOAA ORR, 2018). The OBIS-SEAMAP repository also holds several additional seal occurrence observations in LIS (Figure 3-3) (Halpin, et al., 2009).

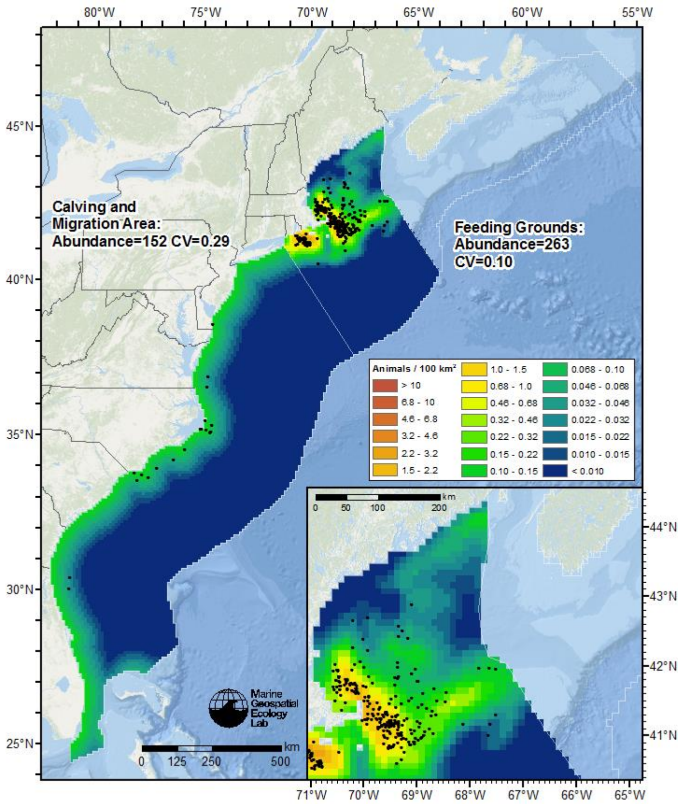


Figure 3-1: [Predicted Marine Mammal Density Map](). Example map of North Atlantic Right Whale predicted density from the Duke Marine Geospatial Ecology Lab's existing 2015 cetacean density model outputs (MGEL, 2018).

Figure 3-2: North Atlantic Right Whale Observations. Interactive map of opportunistic North Atlantic right whale sightings maintained by the NOAA Northeast Fisheries Science Center (NOAA NEFSC, 2018).

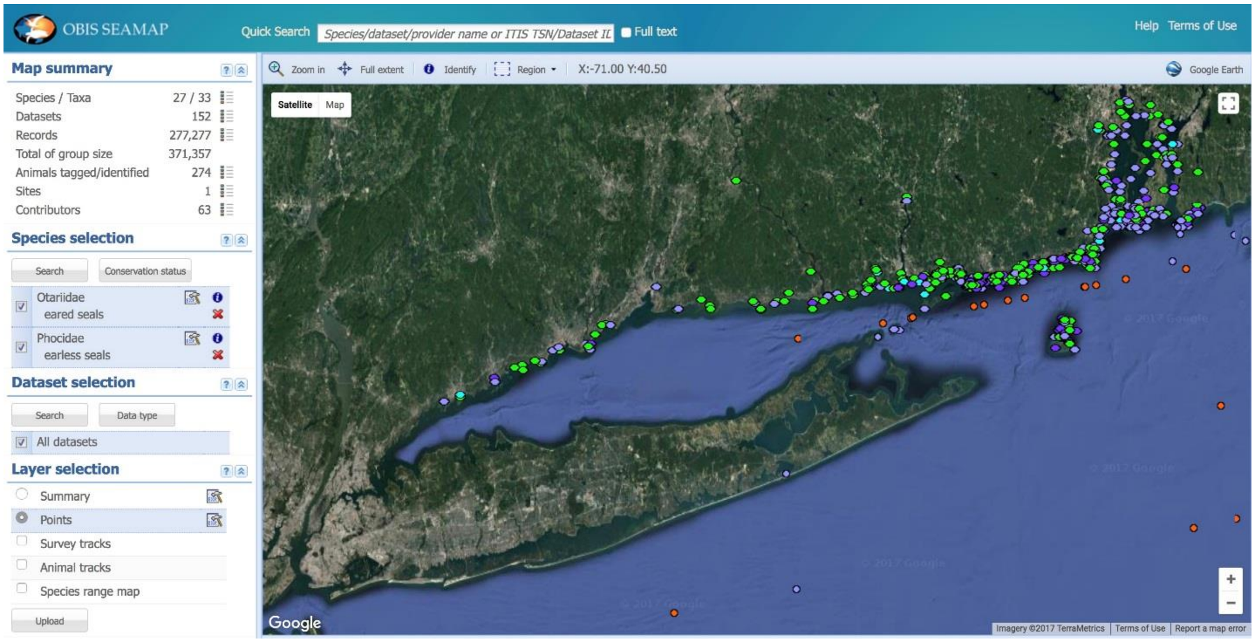


Figure 3-3: Seal Observations. Map showing observations of all seal species available in the OBIS-SEAMAP global database (Halpin, et al., 2009).

3.2 Assessment of Data Quality

3.2.1 Sources of Data and Metadata

Cetaceans

Modeled outputs of cetacean use of LIS will be available digitally, with metadata, through the Northeast Ocean Data Portal (Northeast Regional Planning Body, 2018) and Mid-Atlantic Ocean Data Portal (Mid-Atlantic Regional Planning Body, 2018) in mid-2018.

The Mystic Aquarium stranding data are currently available from the OBIS-SEAMAP repository, with metadata, but only for the years between 1976 and 2011 (Smith, 2018). Additional data/years can be requested from Mystic Aquarium directly.

The interactive map of North Atlantic right whale sightings (NOAA NEFSC, 2018) is derived from the North Atlantic Right Whale Consortium (NARWC) sightings database. These data can be requested from NARWC directly.

A map of the marine mammal habitat layer from the NOAA ESI (NOAA ORR, 2018) is available via the New York Geographic Information Gateway (New York Geographic Information Gateway, 2018). The underlying data are also downloadable via the ESI website.

Pinnipeds

Seal haul-out location information is maintained by the Riverhead Foundation (Riverhead, 2017) and CRESLI (CRESLI, 2018). Some of these data may have been contributed to the NOAA ESI database containing seal-haul out areas (NOAA ORR, 2018). OBIS-SEAMAP seal observations data are available digitally on the web (Halpin, et al., 2009).

3.2.2 Accuracy, Representativeness, and Relevance of Map Products

Cetaceans

The cetacean model outputs, stranding data, and opportunistic sightings data are all relevant to the Blue Plan effort. The degree of accuracy and representativeness differs depending on the dataset.

Each of the cetacean model outputs will be accompanied by multiple uncertainty layers (e.g., coefficient of variation, standard error) that will help the user to assess model performance and accuracy (for examples, see MGEL (2018)). Since these models generate predictions in LIS using a broader set of data (i.e., observations from along the entire Atlantic coast), their representativeness of LIS may not be optimal, but is still likely more robust than what could be produced with other datasets.

Stranding data collected by Mystic Aquarium can be considered accurate and likely representative of cetacean strandings, since the Aquarium is well-known in the area and is usually called upon to respond to these events. Stranding data alone, however, are obviously not representative of living cetacean distribution and abundance in LIS.

OBIS-SEAMAP sightings for cetaceans are likely accurate and accompanied by robust metadata. Consideration should be given to whether or not cetacean observations can be effort-corrected.

Pinnipeds

The seal haul-out datasets are likely accurate and representative of patterns in LIS, but expert knowledge and experience will be needed to interpret the data and assess representativeness. For example, it is currently unknown to what extent the three available seal haul-out datasets overlap (i.e., whether the NOAA ESI data already contain the observations and information from the other two locally-generated datasets).

The OBIS-SEAMAP seal observation data may contain some open-water observations of seals, in addition to coastal/land observations (Halpin, et al., 2009). These data should be interpreted with caution since it is difficult to identify seals in open water (see Marine Mammals and Sea Turtles Expert Webinar (CT DEEP, 2018)).

In general, the distribution and abundance of seals is a topic where expert knowledge and experience will be important for supplementing and interpreting the available data.

3.2.3 Data Gaps and Availability of Data to Address Gaps

Cetaceans

The available cetacean data are fairly comprehensive for Long Island Sound, although there are several (and growing) efforts to observe cetaceans in and near the Sound by local conservation groups, whale-watching businesses, and others. These observations are not captured in any of the datasets described in this chapter. The interactive map of North Atlantic right whale sightings (NOAA NEFSC, 2018) is one example of data that have not been effort corrected (i.e., see the disclaimer above the map).

Pinnipeds

Data gaps for pinnipeds relate to certain behaviors and times of year. For example, the majority of the data discussed in this chapter represents seals on the coast. There is very little if any dependable data representing seals in the open waters of LIS, due to the difficulty seeing and identifying individuals.

3.3 Additional Context

As with most marine life, change over time and responses to environmental change are important in understanding distribution and abundance of marine mammals. For example, the number of seals in LIS during the winter has increased from hundreds in the 1990s to thousands in 2011, and more animals are staying in the Sound year-round (Lopez, G et al., 2014). Experts described similar general patterns for cetaceans: sightings in LIS of whales, and dolphins and porpoises especially, have increased in the last few decades.

Exploratory modeling of seal distribution and abundance has been attempted by MGEL at Duke University, but final map products are not anticipated in 2018.

Because all marine mammal species are protected under the Marine Mammal Protection Act, the NOAA Protected Resources Division (NOAA GARFO, 2018) is a source of data for species presence information, maps of species ranges and critical habitats, and relevant mapping tools.

3.4 References

CRESLI. (2018, February 6). *Pinnipeds*. Retrieved from Coastal Research and Education Society of Long Island, Inc.: http://www.cresli.org/cresli/seals/pinnipeds.html

CT DEEP. (2018, February 5). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635

Halpin, P. N., Read, A. J., Fujioka, E., Best, B. D., Donnelly, B., Hazen, L. J., . . . Hyrenbach, K. D. (2009). OBIS-SEAMAP: The world data center for marine mammal, sea bird, and sea turtle distributions. *Oceanography, 22*(2), 104-115.

Lopez, G et al. (2014). Biology and Ecology of Long Island Sound. In J. S. Latimer, M. A. Tedesco, R. L. Swanson, C. Yarish, P. E. Stacey, & C. Garza, *Long Island Sound: Prospects for the Urban Sea* (p. 558). New York: Springer.
MGEL. (2018, February 6). *OBIS-SEAMAP Model Repository*. Retrieved from Duke University Marine Geospatial Ecology Lab: http://seamap.env.duke.edu/models/
Mid-Atlantic Regional Planning Body. (2018). *Mid-Atlantic Ocean Data Portal*. Retrieved from portal.midatlanticocean.org
New York Geographic Information Gateway. (2018). Retrieved from New York State: http://opdgig.dos.ny.gov
NOAA GARFO. (2018, February 6). *Protected Resources Division*. Retrieved from NOAA Greater Atlantic Region Fisheries Office: https://www.greateratlantic.fisheries.noaa.gov/protected/
NOAA NEFSC. (2018, February 6). *Atlantic Marine Assessment Program for Protected Species (AMAPPS)*. Retrieved from NOAA Northeast Fisheries Science Center: https://www.nefsc.noaa.gov/psb/AMAPPS/
NOAA NEFSC. (2018, February 6). *Interactive North Atlantic Right Whale Sightings Map*. Retrieved from NOAA Northeast Fisheries Science Center Protected Species Division: https://www.nefsc.noaa.gov/psb/surveys/
NOAA ORR. (2018, February 5). *Environmental Sensitivity Index (ESI) Maps*. Retrieved from NOAA Office of Response and Restoration: https://response.restoration.noaa.gov/maps-and-spatial-data/environmental-sensitivity-index-esi-maps.html
Northeast Regional Planning Body. (2018). *Northeast Ocean Data Portal*. Retrieved from www.northeastoceandata.org
Riverhead. (2017, December 31). *The Riverhead Foundation for Marine Research and Preservation*. Retrieved from Research - Tracking Maps: http://www.riverheadfoundation.org/
Smith, A. (2018, February 6). *Mystic Aquarium marine mammal and sea turtle stranding data 1976-2011*. Retrieved from Mystic Aquarium: http://seamap.env.duke.edu/dataset/945

3.5 Appendices

3.5.1 List of Maps Used to Inform the Chapter

Data highlighted in grey are included in the Inventory and were discussed during expert webinars. In addition to the links provided below, each grey dataset is accompanied by a reference, citation, or link within the text in the Inventory.

The un-highlighted (white) data rows were also discussed during expert webinars. These data were either identified in the Rapid Assessment or mentioned by experts as credible sources of data that may not be relevant to the Blue Plan effort. Example reasons include the older age of the dataset, limited overall availability, lack of spatial data products, too limited or too broad spatial/temporal scope, or that other LIS datasets were preferred. Many of these un-highlighted datasets are described in *Section 3.3 Additional Context*, and most are described further in the map books associated with the expert webinars (CT DEEP, 2018).

Table 3-2: Marine Mammal Datasets Used to Inform the Chapter or Discussed During Expert Webinars

CATEGORY	DATASET/LAYER	ADVANCED FROM RAPID ASSESSMENT TO INVENTORY	ADDED TO INVENTORY FROM EXPERT REVIEW
Marine mammals	**Cetacean predicted density models, forthcoming 2018 version** (MGEL, 2018; Mid-Atlantic Regional Planning Body, 2018; Northeast Regional Planning Body, 2018)	X	
Marine mammals	**Mystic Aquarium cetacean and pinniped stranding data** (Smith, 2018)		X
Marine mammals	**OBIS-SEAMAP cetacean and pinniped data** (Halpin, et al., 2009)		X
Marine mammals	**NOAA Northeast Fisheries Science Center opportunistic North Atlantic right whale sightings** (NOAA NEFSC, 2018)		X
Marine mammals	**NOAA ESI marine mammals habitat** (NOAA ORR, 2018)	X	
Marine mammals	**NOAA Protected Resources Division – maps and information** (NOAA GARFO, 2018)		X
Marine mammals	**Local databases of seal haul-out/concentration areas** (CRESLI, 2018; NOAA ORR, 2018; Riverhead, 2017)		X
Marine mammals	Analysis of Mystic Aquarium stranding data, 1990-2011; Smith Master's thesis, data in OBIS-SEAMAP		
Marine mammals	Unpublished draft pinniped models from Duke University		

3.5.2 Notes on Ecological Expert Input

Expert input was obtained on cetacean and pinniped datasets during the "Marine Mammals and Sea Turtles" expert webinar. Map books for each webinar and links to webinar recordings can be found on the Long Island Sound Blue Plan website (CT DEEP, 2018).

Chapter 4

Sea Turtles

Chapter Table of Contents

Chapter List of Figures and Tables

Figures

Tables

4.1 Key Data and Map Products

A partial picture of sea turtle use of Long Island Sound (LIS) can be obtained from the available data which include stranding records and opportunistic sightings. Three sea turtle species (Loggerhead, Kemp's ridley, and Atlantic green) use LIS as foraging grounds in the warmer months, and there are no known sea turtle nesting sites in LIS (Lopez G., et al., 2014). Limited recent tracking data suggest that sea turtles regularly use LIS waters (Lopez G., et al., 2014).

The primary source for stranding records is the Mystic Aquarium, which has collected these data since 1975 (Smith, 2018). Records of stranded/injured/dead animals may also be compiled in databases of opportunistic sightings. These databases also provide a way for mariners and citizens to report live animals. The Sea Turtle Sighting Hotline, established in 2002 and maintained by the Massachusetts Audubon Society (MassAudubon), is the primary sightings database that includes LIS (MassAudubon, 2018). This website displays a map of thousands of records that can be sorted by date, species, and status (i.e., alive or dead) throughout southern New England (Figure 4-1).

A smaller number of sea turtle sightings data are available via the Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP) database, a global scientific repository (Halpin, et al., 2009). Since the scope of that database is global, there are likely relatively few data relevant to LIS, but the accuracy of the data and associated documentation are robust.

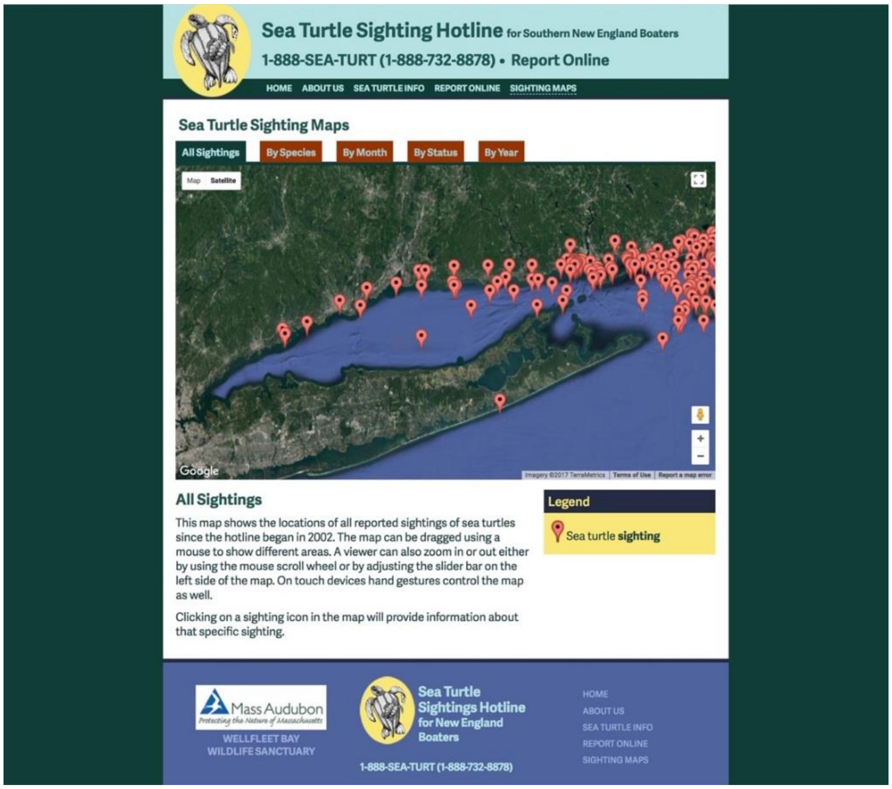


Figure 4-1: Sea Turtle Observations. Example map of sea turtle sightings data from the Sea Turtle Sighting Hotline (MassAudubon, 2018).

4.2 Assessment of Data Quality

4.2.1 Sources of Data and Metadata

The Mystic Aquarium stranding data are currently available from the OBIS-SEAMAP repository, with metadata, but only for the years between 1976 and 2011 (Smith, 2018). Additional data/years can be requested from Mystic Aquarium directly. Sea turtle observations data from the OBIS-SEAMAP repository are available digitally on the web (Halpin, et al., 2009).

The Sea Turtle Sighting Hotline website includes an interactive map, but the underlying data and metadata likely need to be requested from MassAudubon directly (MassAudubon, 2018).

4.2.2 Accuracy, Representativeness, and Relevance of Map Products

The stranding and sightings data are all relevant to the Blue Plan effort. However, the particular characteristics of each dataset may influence any assessments of accuracy and representativeness.

Stranding data collected by Mystic Aquarium can be considered accurate and likely representative of sea turtle strandings, since the Aquarium is well-known in the area and is usually called upon to respond to these events. Stranding data alone, however, are not representative of sea turtle distribution and abundance in LIS, especially since actively foraging turtles in LIS are not found on beaches. Instead, stranding data represent sick or cold-shocked animals. Sightings of live animals (e.g., from the Sea Turtle Sighting Hotline) could be used to fill this gap.

However, the Sea Turtle Sighting Hotline could include some inaccurate sea turtle identifications because sightings are reported by non-experts (MassAudubon, 2018). Additionally, these data are opportunistic (i.e., cannot be effort-corrected) and not focused solely on LIS. The quantity and quality of metadata accompanying each observation in the Sea Turtle Sighting Hotline is unknown.

Overall, the available data pertinent to healthy sea turtle distribution and abundance is of limited quality and quantity. Expert knowledge and experience will be important for supplementing and interpreting the available sea turtle data.

4.2.3 Data Gaps and Availability of Data to Address Gaps

Long Island Sound-wide spatial data derived from scientific surveys of live, healthy sea turtles represents a data gap. The opportunistic and non-expert sightings, combined with sea turtle stranding data provide an incomplete picture of sea turtle use of LIS.

4.3 Additional Context

Because all species of sea turtles are endangered or threatened, the National Oceanic and Atmospheric Administration (NOAA) Protected Resources Division (NOAA GARFO, 2018) is a source of data for species presence information, maps of species ranges and critical habitats, as well as relevant mapping tools.

The Army Corps of Engineers maintains some record of sea turtle observations, although at the time of this draft, the URL to their website was not functional.

4.4 References

CT DEEP. (2018, February 5). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635

Halpin, P. N., Read, A. J., Fujioka, E., Best, B. D., Donnelly, B., Hazen, L. J., . . . Hyrenbach, K. D. (2009). OBIS-SEAMAP: The world data center for marine mammal, sea bird, and sea turtle distributions. *Oceanography*, *22*(2), 104-115.

Lopez G., et al. (2014). Biology and Ecology of Long Island Sound. In J. S. Latimer, M. A. Tedesco, R. L. Swanson, C. Yarish, P. E. Stacey, & C. Garza, *Long Island Sound: Prospects for the Urban Sea* (p. 558). New York: Springer.

MassAudubon. (2018, February 6). *Sea Turtle Sighting Hotline for Southern New England Boaters*. Retrieved from MassAudubon Wellfleet Bay Wildlife Sanctuary: http://www.seaturtlesightings.org/index.html

NOAA GARFO. (2018, February 6). *Protected Resources Division*. Retrieved from NOAA Greater Atlantic Region Fisheries Office: https://www.greateratlantic.fisheries.noaa.gov/protected/

Smith, A. (2018, February 6). *Mystic Aquarium marine mammal and sea turtle stranding data 1976-2011*. Retrieved from Mystic Aquarium: http://seamap.env.duke.edu/dataset/945

4.5 Appendices

4.5.1 List of Maps Used to Inform the Chapter

Data highlighted in grey are included in the Inventory and were discussed during expert webinars. In addition to the links provided below, each grey dataset is accompanied by a reference, citation, or link within the text in the Inventory.

The un-highlighted (white) data rows were also discussed during expert webinars. These data were either identified in the Rapid Assessment or mentioned by experts as credible sources of data that may not be relevant to the Blue Plan effort. Example reasons include the older age of the dataset, limited overall availability, lack of spatial data products, too limited or too broad spatial/temporal scope, or that other LIS datasets were preferred. Many of these un-highlighted datasets are described in *Section 4.3 Additional Context*, and most are described further in the map books associated with the expert webinars (CT DEEP, 2018).

Table 4-1: Sea Turtle Datasets Used to Inform the Chapter or Discussed During Expert Webinars

CATEGORY	DATASET/LAYER	ADVANCED FROM RAPID ASSESSMENT TO INVENTORY	ADDED TO INVENTORY FROM EXPERT REVIEW
Sea turtles	**Mystic Aquarium sea turtle stranding data** (Smith, 2018)		X
Sea turtles	**Sea Turtle Sighting Hotline** (MassAudubon, 2018)		X
Sea turtles	**OBIS-SEAMAP sea turtle observations** (Halpin, et al., 2009)		X
Sea turtles	**NOAA Protected Resources Division – maps and information** (NOAA GARFO, 2018)		X
Sea turtles	Sea Turtle Sightings Per Unit Effort (leatherback, loggerhead, green), Northeast Ocean Data Portal		
Sea turtles	NOAA Atlantic Marine Assessment Program for Protected Species aerials surveys in LIS – also in OBIS-SEAMAP		
Sea turtles	Seaturtle.org observations – also in OBIS-SEAMAP		
Sea turtles	US Army Corps of Engineers sea turtle opportunistic sightings		
Sea turtles	Diamondback terrapin data		

4.5.2 Notes on Ecological Expert Input

Expert input was obtained on sea turtle datasets during the “Marine Mammals and Sea Turtles” expert webinar. Map books for each webinar and links to webinar recordings can be found on the Long Island Sound Blue Plan website (CT DEEP, 2018).

Chapter 5

Birds

Chapter Table of Contents

Chapter List of Figures and Tables

Figures

Tables

5.1 Key Data and Map Products

There are three available data products that each describe areas that are important to birds and one dataset that provides quantitative information about the distribution and abundance of individuals.

Each of the three “important area” data products integrate information from a variety of sources, including scientific surveys and expert knowledge, to identify these areas. In other words, experts used scientific observations and experience to highlight areas on a map important to birds for different life stages and behaviors. This inventory acknowledges and leverages the existence of those underlying data by incorporating the three integrative datasets (described in detail below).

First, the Connecticut Department of Energy and Environmental Protection (CT DEEP) maintains a dataset of migratory waterfowl concentration areas for approximately 20 species (e.g., including bufflehead, mallard, common scoter) derived from a report on significant coastal habitats in Southern New England (Figure 5-1) (CT DEEP, 2017; USFWS, 1991).

Second, the National Oceanic and Atmospheric Administration (NOAA) Environmental Sensitivity Index (ESI) delineates "special use areas", including migratory or wintering areas, nesting sites, concentration areas, roosting areas, and vulnerable occurrences for many types of birds (e.g., alcids, diving birds, gulls, terns, passerines, pelagic birds, raptors, shorebirds, wading birds, and waterfowl) (NOAA ORR, 2018). Each of these two datasets were developed specifically to support oil spill response or other coastal disasters.

Lastly, Audubon Important Bird Areas (IBAs) is the third data product that describes whole areas relevant to a variety of bird species (Audubon, 2018). IBAs are identified by one or more criteria developed by BirdLife International: (1) the site is known or thought to regularly hold significant numbers of a globally threatened species; (2) the site is known or thought to hold a significant component of a group of species whose breeding distributions define an Endemic Bird Area or Secondary Area; (3) the site is known or thought to hold a significant component of the group of species whose distributions are largely or wholly confined to one biome (4) the site is known or thought to hold congregations of ≥ 1% of the global population of one or more species on a regular or predictable basis. There are several state- and global-scale IBAs on both shores of Long Island Sound (LIS).

The distribution and abundance of individual birds and bird species within LIS can be described from an online citizen-based repository, eBird (Figure 5-2) (Sullivan, et al., 2009). The eBird database includes thousands of opportunistic (i.e., not effort-corrected) observations of birds, including the species, the numbers of individuals, the location, and the timing of each sighting. eBird contains discrete observations from many individual scientists/birders as well as from coordinated local survey efforts in LIS such as Super Seawatch. There is likely overlap between data contained in eBird and the individual datasets noted in the expert webinar map books and discussion (some of which are also listed in *Section 5.5.1 List of Maps Used to Inform the Chapter*), since many of the data collectors routinely enter their data into eBird (CT DEEP, 2018). By using eBird to access these and other data, sightings can be compiled, filtered, and analyzed holistically.

Finally, state-maintained lists of Species of Greatest Conservation Need (SGCN) for Connecticut and New York, endangered species, threatened species, and other species of concern also provide additional qualitative information about bird species in LIS with conservation, management, or regulatory relevance (CT DEEP, 2015; NYDEC, 2015a). These lists can be used to prioritize the acquisition and/or development of individual species maps.

The Connecticut Ornithological Association (COA) has developed qualified lists of LIS-dependent birds for offshore and onshore species (Tables 5-1 and 5-2). These lists are representative of the Sound as a whole geospatially and throughout all seasons, with species appearing in both CT and NY. The offshore list is meant to be fully inclusive of all species depending on LIS offshore waters for food and survival. The onshore list is limited to conservation at-risk species that depend upon LIS and can be found near the intertidal of both states. Note that this list excludes common waterfowl and shorebirds that depend upon beaches and tidal marshes but are not considered by the COA to be at conservation risk if offshore conditions change.

Table 5-1: Offshore Birds of Long Island Sound

Brant	Red-breasted Merganser	Little Gull!
Canada Goose	Red-throated Loon	Laughing Gull
American Black Duck	Pacific Loon!	Ring-billed Gull
Canvasback	Common Loon	Herring Gull
Redhead	Horned Grebe**	Iceland Gull
Tufted Duck!	Red-necked Grebe	Lesser Black-backed Gull
Greater Scaup	Eared Grebe!	Glaucous Gull
Lesser Scaup	Wilson's Storm-Petrel	Great Black-backed Gull
King Eider!	Northern Gannet	Least Tern*
Common Eider**	Great Cormorant	Caspian Tern!
Harlequin Duck!	Double-crested Cormorant	Black Tern!
Surf Scoter	Bald Eagle*	Roseate Tern**
White-winged Scoter	Osprey	Common Tern*
Black Scoter	Common Murre!	Forster's Tern
Long-tailed Duck**	Razorbill**	Royal Tern!
Bufflehead	Black-legged Kittiwake!	Black Skimmer
Common Goldeneye	Bonaparte's Gull	Snowy Owl**
Barrow's Goldeneye!	Black-headed Gull!	Peregrine Falcon
! = Uncommon in LIS; * = Species of conservation concern; ** = Species of great conservation concern		

The species listed in Table 5-1 feed offshore and are dependent on LIS. This list was compiled by the COA, with conservation and rarity evaluations provided by the list authors. Common names only are given.

Table 5-2: Onshore Birds of Long Island Sound

American Bittern*	American Oystercatcher**
Least Bittern*	Piping Plover**
Great Egret*	Red Knot**
Snowy Egret*	Sanderling*
Little Blue Heron*	Semipalmated Sandpiper**
Tricolored Heron*	Willet*
Yellow-crowned Night-Heron*	Nelson's Sparrow**
Glossy Ibis**	Saltmarsh Sparrow**
Northern Harrier*	Seaside Sparrow**
Clapper Rail*	
* = Species of conservation concern; ** = Species of great conservation concern	

The species listed in Table 5-2 are conservation at-risk species that depend upon LIS and can be found around its perimeter. Note that this list excludes common waterfowl and shorebirds that depend upon beaches and tidal marshes but are not at conservation risk if offshore conditions change. This list was compiled by the COA, with conservation and rarity evaluations provided by the list authors. Common names only are given.

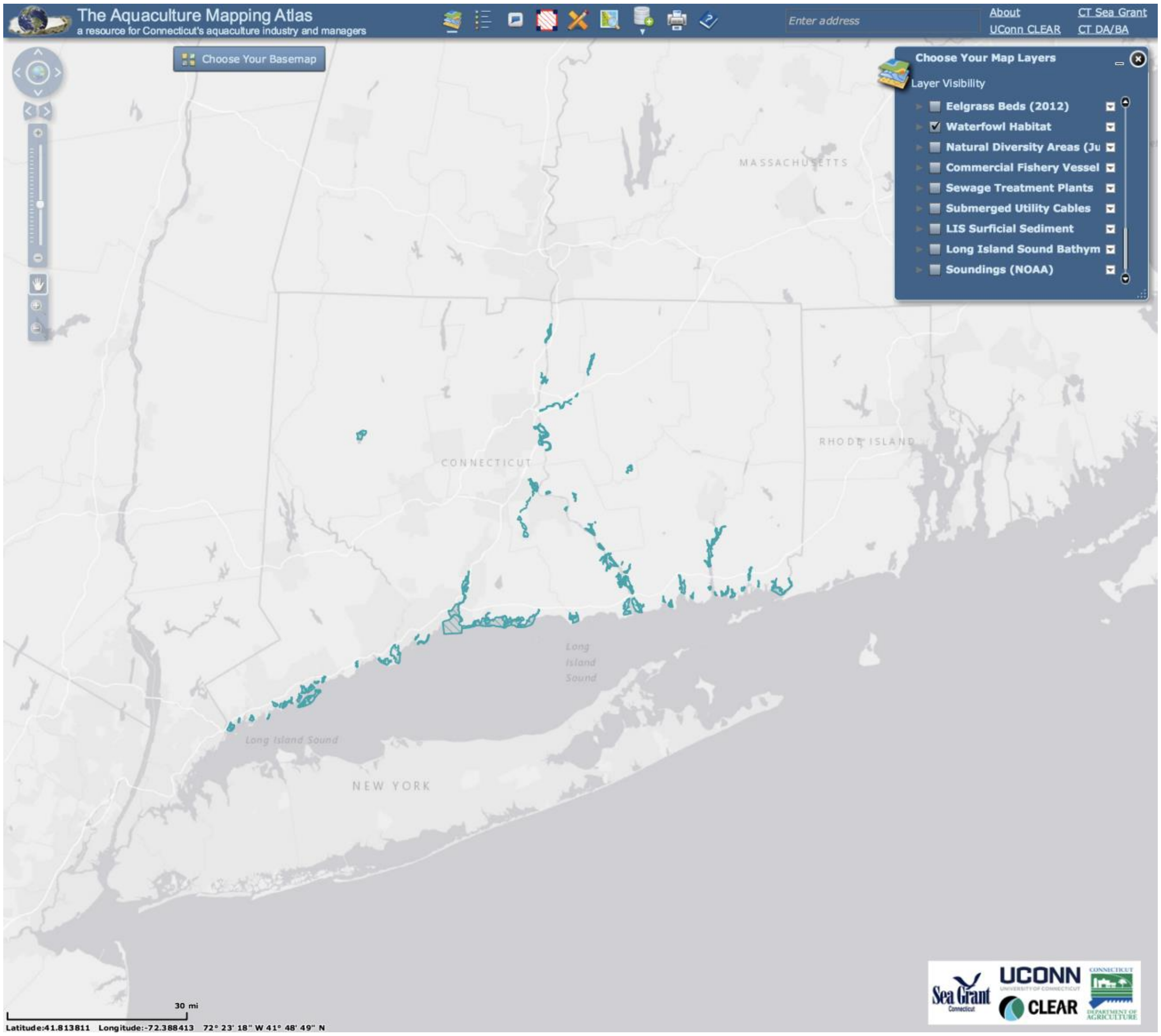


Figure 5-1: Migratory Waterfowl Concentration Areas. A map of waterfowl concentration areas (USFWS, 1991). Access available via the Connecticut Aquaculture Mapping Atlas (Aquaculture Mapping Atlas, 2017).

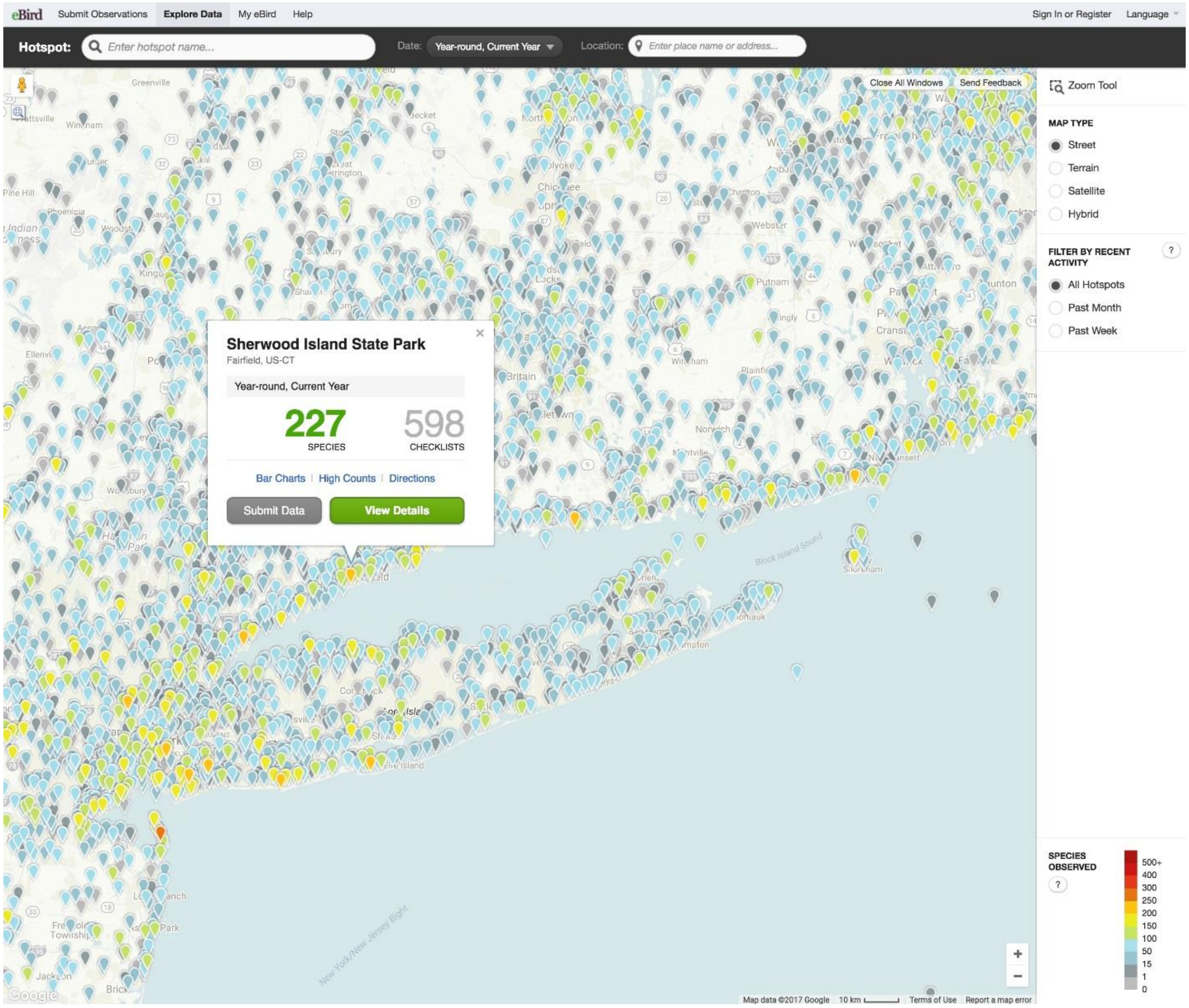


Figure 5-2: [Bird Observation Data](). A map showing the number of species observed at each location, according to the observations cataloged in the eBird database (Sullivan, et al., 2009).

5.2 Assessment of Data Quality

5.2.1 Sources of Data and Metadata

The CT DEEP migratory waterfowl concentration areas and NOAA ESI bird special use areas are maintained by a state and federal agency, respectively (NOAA ORR, 2018; USFWS, 1991). Each of these data products and their metadata are downloadable from agency websites.

A map of Audubon IBAs is publicly available on Audubon's website (Audubon, 2018) and is also displayed on the Northeast Ocean Data Portal (Northeast Regional Planning Body, 2018). The Northeast Ocean Data Portal map includes a link to metadata.

The eBird website displays a map of raw species observations and a map of bird "hotspots" (Sullivan, et al., 2009). The eBird database can be queried by state and county, and all raw observations can be obtained digitally, in a spreadsheet format. Maps can then be developed using the geospatial information tied to each observation. For application in the Blue Plan effort, queries would need to be conducted for both Connecticut and New York coastal counties and filtered by proximity to the coastline or open water.

Lists of SGCN are both maintained by state agencies. The most updated reports and resources are available on the web (CT DEEP, 2015; NYDEC, 2015a).

5.2.2 Accuracy, Representativeness, and Relevance of Map Products

The CT DEEP waterfowl concentration areas (USFWS, 1991), NOAA ESI birds special use areas (NOAA ORR, 2018), and Audubon IBAs (Audubon, 2018) are accurate, representative, and relevant to the Blue Plan. These three datasets also overlap thematically, and may highlight the same or similar areas. The age of the underlying information supporting these data products (e.g., scientific surveys, other sightings) is of some concern – in some cases (e.g., waterfowl concentration areas), the data are many decades old.

A consortium, led by the Cornell Lab of Ornithology and Audubon, maintains the eBird database, but any user can enter bird observations into the database. Some of the observations in eBird have more documentation and metadata than others. Although eBird data encompass a much broader area than LIS, the data can be easily subset to LIS, and so they are extremely relevant. The accuracy and representativeness of the eBird data can be assessed through exploratory data analyses, and by seeking expert guidance and input.

5.2.3 Data Gaps and Availability of Data to Address Gaps

Open-water areas of LIS are not as well represented as coastal areas in the suite of bird datasets described here. Systematic bird surveys of offshore and open-water species are "largely lacking", with a few exceptions (Lopez, G., et al., 2014). For this reason, information on pelagic seabird species is lacking relative to the information available for waterfowl and other coastal birds.

Pelagic and open-water seabird species distribution and abundance have been mapped at the regional scale by a few recent efforts, including through NOAA's Atlantic Marine Assessment Program for Protected Species (AMAPPS) (NOAA NEFSC, 2018). These and other data have been integrated into Atlantic-scale map products by the NOAA National Center for Coastal Ocean Science (NCCOS) (Kinlan, Winship, White, & Christensen, 2016). However, neither of these efforts has produced map products for seabirds that cover LIS, to-date. A previous NCCOS effort to map seabirds in the NY Bight (Menza, Kinlan, Dorfman, Poti, & Caldow, 2012) produced products with LIS coverage, but experts advised against using these maps for the Blue Plan effort, as they included few underlying observations within LIS.

The available bird datasets may also characterize certain species adequately, but less completely for other species. For these cases and in general, there is an abundance of expert knowledge and experience that can be used to supplement and assist in interpreting the available data for birds in LIS.

5.3 Additional Context

There are several other bird datasets relevant to LIS that are limited in scope, extent, or availability. These datasets were discussed during the expert webinars (CT DEEP, 2018), and many are also noted in *Section 5.5.1 List of Maps Used to Inform the Chapter*. Some of these datasets are also in the eBird database. Notable examples include the broad-scale Christmas Bird Counts (Audubon, 2018), datasets targeting individual threatened or endangered species (e.g., piping plover nesting data maintained by CT DEEP (CT CEQ, 2011)), ongoing shorebird and seabird tracking data collected by the U.S. Fish and Wildlife Service (USFWS) and Bureau of Ocean Energy Management (BOEM) (USFWS and BOEM, 2018), and ongoing research and data product development for salt marsh birds (the Saltmarsh Habitat Avian Research Program (SHARP) (SHARP, 2018)).

In addition to SGCN lists, the states of Connecticut and New York each maintain lists of endangered species, threatened species, and species of concern (CT DEEP, 2017; NYDEC, 2015a). These lists can be used together to prioritize future data development and identify data gaps.

The bird datasets reviewed for this inventory indicate that environmental change over time is an important factor in understanding bird distribution, abundance, and use of LIS. These changes include habitat loss due to coastal development (historical and recent), as well as climate change effects such as flooding of nesting sites and wading habitat due to sea level rise (Lopez, G., et al., 2014).

For more information on human involvement in waterfowl hunting in Connecticut, as it relates to bird distribution, see the *Chapter 23 Waterfowl Hunting*.

5.4 References

Aquaculture Mapping Atlas. (2017). Retrieved from Aquaculture Mapping Atlas : https://clear3.uconn.edu/aquaculture/

Audubon. (2018, February 6). *Audubon Christmas Bird Count Results*. Retrieved from Audubon Christmas Bird Count: http://netapp.audubon.org/CBCObservation/

Audubon. (2018, February 6). *Important Bird Areas*. Retrieved from Audubon: http://www.audubon.org/important-bird-areas

CT CEQ. (2011). *Piping Plovers on the Beach*. Retrieved February 6, 2018, from Environmental Quality in Connecticut: http://www.ct.gov/ceq/cwp/view.asp?a=4050&q=473846

CT DEEP. (2015). *Connecticut's Wildlife Action Plan, 2015 Revision.* Connecticut Department of Energy and Environmental Protection. State of Connecticut.

CT DEEP. (2017, June 27). *Endangered, Threatened and Special Concern Species in Connecticut*. Retrieved from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2702&q=323486

CT DEEP. (2017). *GIS Data*. Retrieved from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2698&q=322898&deepNav_GID=1707

CT DEEP. (2018, February 5). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635

Kinlan, B. P., Winship, A. J., White, T. P., & Christensen, J. (2016). *Modeling at-sea occurrence and abundance of marine birds to support Atlantic marine renewable energy planning: Phase 1 report.* Sterling, VA: OCS Study BOEM 2016-039.

Lopez, G., et al. (2014). Biology and Ecology of Long Island Sound. In J. S. Latimer, M. A. Tedesco, R. L. Swanson, C. Yarish, P. E. Stacey, & C. Garza, *Long Island Sound: Prospects for the Urban Sea* (p. 558). New York: Springer.

Menza, C., Kinlan, B. P., Dorfman, D. S., Poti, M., & Caldow, C. (2012). *A Biogeographic Assessment of Seabirds, Deep Sea Corals, and Ocean Habitats of the New York Bight: Science to Support Offshore Spatial Planning.* Silver Spring: NOAA Technical Memorandum NOS NCCOS 141.

NOAA NEFSC. (2018, February 6). *Atlantic Marine Assessment Program for Protected Species (AMAPPS)*. Retrieved from NOAA Northeast Fisheries Science Center: https://www.nefsc.noaa.gov/psb/AMAPPS/

NOAA ORR. (2018, February 5). *Environmental Sensitivity Index (ESI) Maps*. Retrieved from NOAA Office of Response and Restoration: https://response.restoration.noaa.gov/maps-and-spatial-data/environmental-sensitivity-index-esi-maps.html

Northeast Regional Planning Body. (2018). *Northeast Ocean Data Portal*. Retrieved from www.northeastoceandata.org

NYDEC. (2015a, May 4). *List of Endangered, Threatened and Special Concern Fish & Wildlife Species of New York State*. Retrieved from New York State Department of Environmental Conservation: http://www.dec.ny.gov/animals/7494.html

NYDEC. (2015b). *New York State Wildlife Action Plan.* New York Department of Environmental Conservation. State of New York.

SHARP. (2018, February 6). *Saltmarsh Habitat & Avian Research Program*. Retrieved from https://www.tidalmarshbirds.org/

Sullivan, B. L., Wood, C. L., Iliff, M. J., Bonney, R. E., Fink, D., & Kelling, S. (2009). eBird: a citizen-based bird observation network in the biological sciences. *Biological Conservation, 142*, 2282-2292.

USFWS. (1991). *Northeast Coastal Areas Study: Significant Coastal Habitats of Southern New England and Portions of Long Island, New York.* US Fish and Wildlife Service, Southern New England - Long Island Sound Coastal and Estuary Office. Charlestown RI: USFWS.

USFWS and BOEM. (2018). *Pilot study tracking offshore occurrence of Common Terns and American Oystercatchers with VHF - extended to include Roseate Terns and Piping Plovers.* US Fish and Wildlife Service. BOEM.

5.5 Appendices

5.5.1 List of Maps Used to Inform the Chapter

Data highlighted in grey are included in the Inventory and were discussed during expert webinars. In addition to the links provided below, each grey dataset is accompanied by a reference, citation, or link within the text in the Inventory.

The un-highlighted (white) data rows were also discussed during expert webinars. These data were either identified in the Rapid Assessment or mentioned by experts as credible sources of data that may not be relevant to the Blue Plan effort. Example reasons include the older age of the dataset, limited overall availability, lack of spatial data products, too limited or too broad spatial/temporal scope, or that other LIS datasets were preferred. Many of these un-highlighted datasets are described in *Section 5.3 Additional Context*, and most are described further in the map books associated with the expert webinars (CT DEEP, 2018).

Table 5-3: Bird Datasets Used to Inform the Chapter or Discussed During Expert Webinars

CATEGORY	DATASET/LAYER	ADVANCED FROM RAPID ASSESSMENT TO INVENTORY	ADDED TO INVENTORY FROM EXPERT REVIEW
Birds	**CT DEEP migratory waterfowl concentration areas** (USFWS, 1991)	**X**	
Birds	**NOAA Environmental Sensitivity Index bird habitat, nest sites, concentration areas** (NOAA ORR, 2018)	**X**	
Birds	**Audubon Important Bird Areas** (Audubon, 2018)		**X**
Birds	**eBird** (Sullivan, et al., 2009)		**X**
Birds	**State lists – Species of Greatest Conservation Need; Endangered, Threatened, Species of Concern** (CT DEEP, 2015; CT DEEP, 2017; NYDEC, 2015a; NYDEC, 2015b)		**X**
Birds	LIS SuperSeaWatch (included in eBird)		
Birds	Predicted abundance of seabird species, NY offshore biogeographic assessment, New York Geographic Information Gateway (NYGIG)		
Birds	Atlantic Offshore Seabird Dataset Catalog		
Birds	CT DEEP Piping Plover data		

CATEGORY	DATASET/LAYER	ADVANCED FROM RAPID ASSESSMENT TO INVENTORY	ADDED TO INVENTORY FROM EXPERT REVIEW
Birds	CT DEEP or Rhode Island Department of Environmental Management Roseate tern foraging areas		
Birds	Audubon American oystercatcher nesting areas		
Birds	Christmas Bird Count Data (some in eBird)		
Birds	Theses and USFWS work on endangered shorebirds, Loring, Spendelow		
Birds	CT Ornithological Association summer bird count data		
Birds	SHARP spatial data, Elphick at UConn and others		
Birds	North Atlantic Landscape Conservation Cooperative datasets		
Birds	NYC Aubudon wading bird nesting data		
Birds	NYC Parks winter waterfowl data		
Birds	Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP) bird observations		

5.5.2 Notes on Ecological Expert Input

Expert input was obtained on bird datasets during the "Birds" expert webinar. Map books for each webinar and links to webinar recordings can be found on the Long Island Sound Blue Plan website (CT DEEP, 2018).

Chapter 6

Fish, Pelagic Invertebrates, Shellfish, and Zooplankton

Chapter Table of Contents

Chapter List of Figures and Tables

Figures

Tables

6.1 Key Data and Map Products

This inventory category encompasses vertebrate and invertebrate animals living in the water column or in close association with the seafloor. Information pertinent to fish, pelagic invertebrates, shellfish, and zooplankton is available in three basic forms: (1) raw survey data, (2) indices, other syntheses, or tools integrating various data, and (3) places or areas relevant to these species or their management.

Raw Survey Data

The Connecticut Department of Energy and Environmental Protection (CT DEEP) Marine Fisheries Division has conducted the Long Island Sound Trawl Survey (LISTS) since 1984

(Gottschall, Johnson, & Simpson, 2000). The LISTS data are pertinent to fish, pelagic invertebrates, and some benthic invertebrates (Table 6-1). It is a stratified random survey with 12 combinations of three bottom types and four depth intervals conducted in spring and fall. Biomass has been recorded since 1992. The survey has resulted in a robust Sound-wide database that can be represented a number of ways: tow-level data can be mapped by individual species (see Table 6-1), by season, by year, and for species groups of interest (e.g., benthic and pelagic, commercial and recreational). For some species, age and length are also recorded (e.g., scup, flounder, tautog, bluefish, and weakfish). In addition to LISTS, CT DEEP Marine Fisheries Division also conducts an estuarine seine survey in Long Island Sound (LIS) (CT DEEP, 2016).

Although spatially restricted, there are three relatively long-term fish trawl survey datasets: one held by the Norwalk Aquarium (Maritime Aquarium, 2018), one by Harbor Watch in the Norwalk River Estuary (Harris, Fraboni, Cantatore, & Cooper, 2014), and one by the Millstone Environmental Laboratory. The Millstone dataset is an output of the Laboratory's ongoing monitoring of the effects of the Dominion nuclear power plant's thermal plume on eelgrass, lobster, benthic infauna, and fish in the surrounding rocky intertidal ecosystem (Millstone Environmental Laboratory, 2018).

A nearshore fish trawl has been coordinated by Project Oceanology since 1972 from coastal Connecticut and Eastern Long Island Sound. These data were recently entered into a digital database, along with benthic invertebrate, pH, oxygen, and temperature conditions, and stored on the Long Island Sound Integrated Coastal Observing System (LISICOS) server (LISICOS, 2018). A recent Master's thesis assembled these data and explored decadal shifts in species abundance, diversity, and richness in relation to shifts in abiotic parameters and large-scale climate indices (Snyder, 2017).

The New York State (NYS) Department of Environmental Conservation (DEC) maintains horseshoe crab survey data (Cornell Cooperative Extension, 2018).

Zooplankton abundance or biomass data are held by the CT DEEP Water Quality Monitoring Program (CT DEEP, 2017) and by researchers at the University of Connecticut (e.g., Rice, Dam, & Stewart (2014); Tamura, Katz, & McManus (2011)).

Table 6-1: Fish and Invertebrate Species Caught in More Than 5 Fall Tows (1992-2014) in the CT DEEP Long Island Sound Trawl Survey

Species common name		
Alewife	Gizzard shad	Round herring
American lobster**	Glasseye snapper	Round scad
American shad	Hickory shad	Scup
Atlantic croaker	Hogchoker	Short bigeye
Atlantic herring	Horseshoe crab**	Silver hake
Atlantic mackerel	Inshore lizardfish	Smallmouth flounder
Atlantic menhaden	Little skate	Smooth dogfish
Atlantic sturgeon	Longfin squid*	Spanish mackerel
Bay anchovy	Mackerel shad	Spiny dogfish
Bigeye scad	Moonfish	Spot
Black sea bass	Northern kingfish	Spotted hake
Blue runner	Northern pipefish	Striped anchovy
Blueback herring	Northern puffer	Striped bass
Bluefish	Northern searobin	Striped sea robin
Butterfish	Northern sennet	Summer flounder
Clearnose skate	Oyster toadfish	Tautog
Conger eel	Planehead filefish	Weakfish
Crevalle jack	Red goatfish	Windowpane
Cunner	Red hake	Winter flounder
Fourbeard rockling	Rough scad	Winter skate
Fourspot flounder	Roughtail stingray	Yellow jack

*pelagic invertebrate; **benthic invertebrate

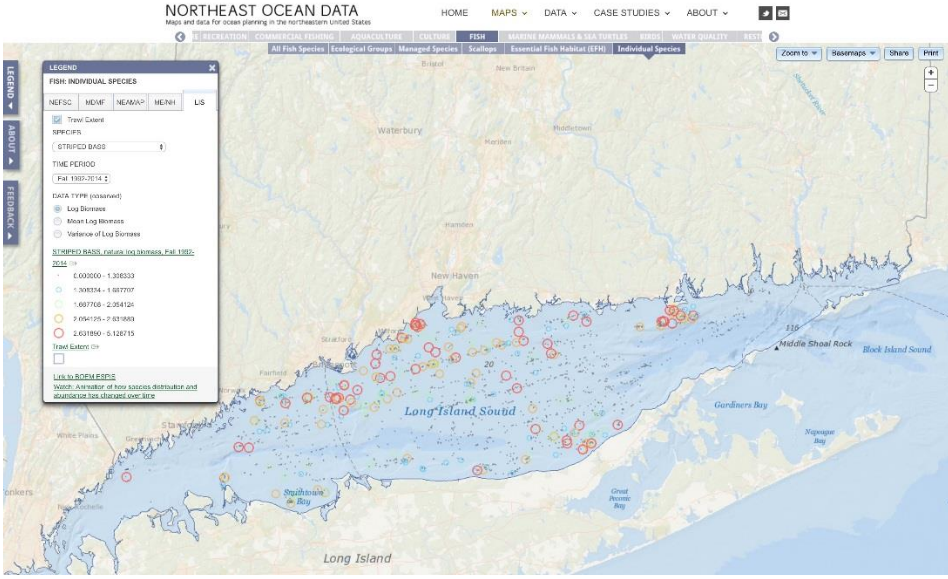


Figure 6-1: [Fish Biomass Data](). A map from the Northeast Ocean Data Portal showing the biomass of fish species from the CT DEEP Long Island Sound Trawl Survey (Gottschall, Johnson, & Simpson, 2000).

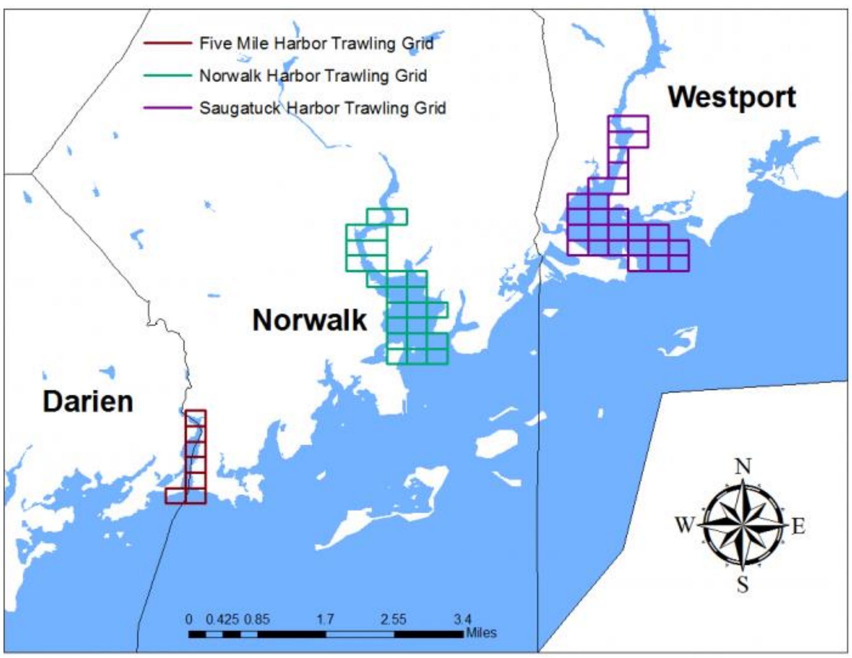


Figure 6-2: [Coastal Fish Trawl Footprints](). A map showing the grids used for fish trawl surveys conducted by Harbor Watch (Harris, Fraboni, Cantatore, & Cooper, 2014).

Indices, Other Syntheses, and Integrative Tools

Several individual efforts have taken raw datasets mentioned above (or other sources) and developed interpretive products, syntheses, or tools to make the data useful for various purposes. Examples include some of the indices developed for the Long Island Sound Study (LISS), such as the warm water/cold water fish index and the open water forage fish index (LISS, 2018).

CT DEEP has also developed several Saltwater Fishing Resource Maps that can provide additional information about fish distribution and abundance (CT DEEP, 2017).

Using beach characteristics and horseshoe crab abundance data, researchers at UConn and CT DEEP mapped predicted spawning sites for horseshoe crabs on the CT coast of LIS (Landi, Vokoun, Howell, & Auster, 2014).

The Nature Conservancy's Long Island Sound Ecological Assessment (LISEA) used the LISTS data to develop a series of maps representing individual species persistence, weighted persistence, persistence areas, and total species richness (Anderson & Frohling, 2015). The maps produced relate to individual species, species groups, and functional groups (e.g., Atlantic cod demersal fish, Gaddids), as well as macroinvertebrate species caught in the trawl (e.g., American lobster, blue crab, bobtail squid). Other details about this project are discussed in *Chapter 12 Ecologically Notable Places and Ecological Marine Units*.

The Stevens Institute of Technology, in partnership with CT DEEP and the National Oceanic and Atmospheric Administration (NOAA), recently modeled past and future bottom temperatures in LIS on the same sampling grid used by the LISTS survey (Stevens Institute, 2018). The resulting maps examine changes in the distribution and abundance of warm- or cold-water adapted species.

A recent project used LIS and winter flounder as a pilot study for modeling estuarine fish habitat (Clingerman, Petty, & Boettner, 2015). The project used CT DEEP LISTS data for winter flounder and produced a Fish Habitat Decision Support Tool (NALCC, 2016).

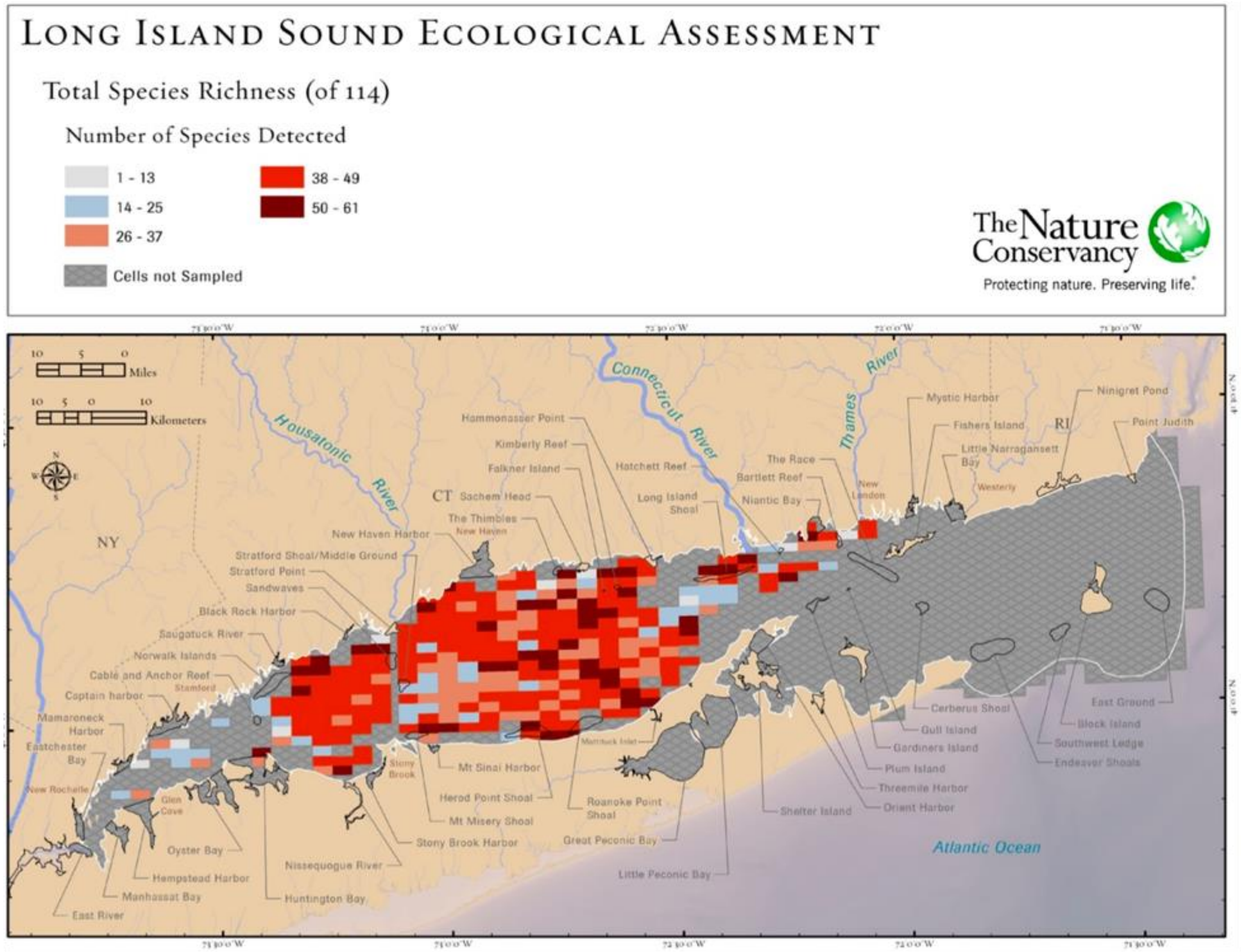


Figure 6-3: [Fish Species Richness](). This map was derived from the CT DEEP Long Island Sound Trawl Survey data and compiled in the Long Island Sound Ecological Assessment (Anderson & Frohling, 2015).

Places or Areas

Datasets representing places or areas integrate information from a variety of sources, including scientific surveys and expert knowledge. In some cases, areas are based on management schemes or designations. These data include:

- NOAA Environmental Sensitivity Index (NOAA ORR, 2018)
- NOAA Essential Fish Habitat (NOAA NMFS, 2018)
- NOAA groundfish management areas, available via the Northeast Ocean Data Portal (Northeast Regional Planning Body, 2018)
- NOAA scallop management areas, available via the Northeast Ocean Data Portal (Northeast Ocean Data Working Group, 2018)
- Designated natural shellfish beds, available via the CT Aquaculture Atlas (UConn CLEAR, 2018)

6.2 Assessment of Data Quality

6.2.1 Sources of Data and Metadata

<u>Raw Survey Data</u>

The LISTS data, estuarine seine data, and zooplankton data collected as part of the Water Quality Monitoring Program are both held by CT DEEP. Some of the LISTS data are also displayed on the Northeast Ocean Data Portal (Figure 6-1) (Northeast Regional Planning Body, 2018). Metadata descriptions are available via the Northeast Ocean Data Portal as well.

Maps, reports, and some data for the Norwalk-area fish trawls are available on the Norwalk Aquarium (Maritime Aquarium, 2018) and Harbor Watch (Harris, Fraboni, Cantatore, & Cooper, 2014) websites.

A map of horseshoe crab monitoring sites and reports are available on the New York Horseshoe Crab Monitoring Network website (Cornell Cooperative Extension, 2018).

<u>Indices, Other Syntheses, and Integrative Tools</u>

All of the data in this category are readily available, either on the web or by partner entities. The predicted horseshoe crab spawning sites data (Landi, Vokoun, Howell, & Auster, 2014) is held by CT DEEP.

<u>Places or Areas</u>

All of the data in this category are readily available, either on the web or by partner entities. Data are housed on federal agency websites and regional data portals, such as the Northeast Ocean Data Portal (Northeast Regional Planning Body, 2018). If housed on the Northeast Ocean Data Portal, metadata descriptions are available.

6.2.2 Accuracy, Representativeness, and Relevance of Map Products

<u>Raw Survey Data</u>

All raw survey data described above are relevant to LIS, and since they are derived from existing and ongoing programs at state agencies and by local scientific groups, their results can be considered to be accurate as well.

In term of representativeness, bottom trawl datasets are limited in their ability to represent the complete fish community in an area. Certain species are more well-caught than others (e.g., demersal fish), and trawl gear cannot be towed over certain habitat types. For example, the LISTS data does not adequately survey shoals, reefs, trenches, and areas like The Race. For other datasets, more exploratory work needs to be done in order to assess representativeness.

Indices, Other Syntheses, and Integrative Tools

All of these more synthesized datasets focus on LIS and so they are relevant to the Blue Plan effort. The accuracy and representativeness of each of these outputs depends on the input data and the methods used to product the products. For efforts where the data collectors have provided input on the methods and outputs, those outputs will be more likely to be accepted as accurate and representative. Outputs that are derived from predictions, interpolations, or models may require additional consideration and interpretation prior to use – ideally in consultation with data collectors, analysts, and other experts.

Places or Areas

Since all of these data come from federal and state agencies, they can be considered to be accurate. Because each dataset has coverage in LIS, they are relevant to the Blue Plan effort. Each likely differs in its representativeness, however, since the NOAA datasets pertain to a much broader area than LIS.

Each dataset is also derived for a specific management purpose, and so the products should be interpreted in that context. For example, the NOAA Environmental Sensitivity Index data were developed to support oil spill response, and so these data may focus on coastal and nearshore species. The NOAA Essential Fish Habitat (EFH) maps are very broad scale and coarse resolution. The EFH spatial units would be inadequate for mapping related to the Blue Plan, but information imbedded in this dataset (e.g., species habitat preferences, life stage information) may be extremely pertinent. The two management areas datasets pertain only to areas sensitive to a subset of species and only for sensitive life history stages.

The CT designated natural shellfish beds data represent beds that are used for the purposes of providing seed for aquaculture, and do not necessarily represent all natural shellfish beds in LIS.

6.2.3 Data Gaps and Availability of Data to Address Gaps

Overall, data gaps exist for any species not well caught in bottom trawl surveys, and for species with affinities for complex and rocky habitats. The LISTS survey also does not cover the entire Sound; trawl coverage is sparser in the eastern and western ends of LIS. The estuarine seine data and other nearshore trawls (Harris, Fraboni, Cantatore, & Cooper, 2014; Maritime Aquarium, 2018) could be used to help partially fill these gaps.

There is also relatively little data describing pelagic invertebrates, shellfish, and zooplankton, when compared with vertebrate fish (and especially commercially important species).

6.3 Additional Context

The NOAA Protected Resources Division maintains maps and information on endangered species presence and critical habitat (NOAA GARFO, 2018). The Atlantic Sturgeon is an endangered fish species found in LIS. Atlantic Sturgeon critical habitat maps are available on the NOAA Protected Resources Division Atlantic Sturgeon Recovery Program website (NOAA GARFO, 2018).

In addition to LISTS and the seine survey, CT DEEP Marine Fisheries Division also conducts various other targeted surveys for specific species or purposes at different times of year or in response to particular events. Finally, research concerning lobster development and macroalgae growth, including work on the breakdown of plastics in Long Island Sound (e.g., Bisphenol A and other chemicals) and such plastics' effects on lobsters and other organisms, has been conducted at the Department of Molecular and Cell Biology at the University of Connecticut for nearly 20 years (Jacobs, Laufer, Stuart, Chen, & Pan, 2012; Laufer, et al., 2013).

6.4 References

Anderson, M., & Frohling, N. (2015). *The Long Island Sound Ecological Assessment.* The Nature Conservancy.

Clingerman, J., Petty, T., & Boettner, F. (2015). *Estuarine Fish Habitat Assessment: A general framework and winter flounder pilot studies.* Downstream Strategies, West Virginia University. North Atlantic LCC.

Cornell Cooperative Extension. (2018). *New York Horseshoe Crab Monitoring Network*. Retrieved from Cornell University Cooperative Extension of Suffolk County: http://nyhorseshoecrab.org/NY_Horseshoe_Crab/Home.html

CT DEEP. (2016). *A study of marine recreational fisheries in Connecticut.* Connecticut Department of Energy and Environmental Protection, Marine Fisheries Program.

CT DEEP. (2017, May 2). *Long Island Sound Water Quality Monitoring Program and Information*. Retrieved Feb 5, 2018, from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2719&q=325570&deepNav_GID=1635

CT DEEP. (2017, March 17). *Saltwater (Marine) Fishing*. Retrieved from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2696&q=322744&deepNav_GID=1647

CT DEEP. (2018, February 5). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635

Gottschall, K. F., Johnson, M. W., & Simpson, D. G. (2000). *The Distribution and Size Composition of Finfish, American Lobster, and Long-Finned Squid in Long Island Sound Based on the Connecticut Fisheries Division Bottom Trawl Survey, 1984–1994.* NOAA National Marine Fisheries Service. Seattle, WA: NOAA Technical Report NMFS 148.

Harris, R., Fraboni, P., Cantatore, N., & Cooper, J. (2014). *Harbor Watch, a Program of Earthplace Report on Norwalk Harbor Juvenile Benthic Marine Fish May through October 2014.* Harbor Watch.

Jacobs, M., Laufer, H., Stuart, J., Chen, M., & Pan, X. (2012). Endocrine disrupting alkylphenols are widespread in the blood of lobsters from Southern New England and adjacent offshore areas. *Journal of Shellfish Research, 31*(2), pp. 53-71.

Landi, A. A., Vokoun, J. C., Howell, P., & Auster, P. (2014). Predicting use of habitat patches by spawning horseshoe crabs (Limulus polyphemus) along a complex coastline with field surveys and geospatial analyses. *Aquatic Conservation: Marine and Freshwater Ecosystems, 25*, 380-395.

Laufer, H., Chen, M., Baclaski, B., Bobbitt, J. M., Stuart, J. D., Zuo, Y., & Jacobs, M. W. (2013). Multiple factors in marine environments affecting lobster survival, development, and growth, with emphasis on alkylphenols: a perspective. *Canadian Journal of Fisheries and Aquatic Sciences, 70*(11), pp. 1588-1600.

LISICOS. (2018, February). *Long Island Sound Integrated Coastal Observing System (LISICOS)*. Retrieved from University of Connecticut: http://lisicos.uconn.edu/

LISS. (2018). *Status and Trends: LISS Environmental Indicators*. Retrieved from Long Island Sound Study: http://longislandsoundstudy.net/?indicator_categories=marine-and-coastal-animals

Maritime Aquarium. (2018). *The Long Island Sound Biodiversity Database*. Retrieved from The Maritime Aquarium: https://www.maritimeaquarium.org/biodiversity

Millstone Environmental Laboratory. (2018). *Executive Summary - 2017 Environmental Monitoring Annual Report.* Dominion Nuclear Connecticut, Millstone Environmental Laboratory. Washington DC: US Nuclear Regulatory Commission.

NALCC. (2016). *Fish Habitat Decision Support Tool*. Retrieved from http://www.fishhabitattool.org/home.html

NOAA GARFO. (2018). *Atlantic Sturgeon Recovery Program*. Retrieved from NOAA Greater Atlantic Region Fisheries Office: https://www.greateratlantic.fisheries.noaa.gov/protected/atlsturgeon/index.html

NOAA GARFO. (2018, February 6). *Protected Resources Division*. Retrieved from NOAA Greater Atlantic Region Fisheries Office: https://www.greateratlantic.fisheries.noaa.gov/protected/

NOAA NMFS. (2018, February 6). *Essential Fish Habitat Mapper*. Retrieved from NOAA National Marine Fisheries Service, Habitat Conservation, Habitat Protection: https://www.habitat.noaa.gov/protection/efh/efhmapper/

NOAA ORR. (2018, February 5). *Environmental Sensitivity Index (ESI) Maps*. Retrieved from NOAA Office of Response and Restoration: https://response.restoration.noaa.gov/maps-and-spatial-data/environmental-sensitivity-index-esi-maps.html

Northeast Ocean Data Working Group. (2018). *Northeast Ocean Data Portal*. Retrieved from www.northeastoceandata.org

Northeast Regional Planning Body. (2018). *Northeast Ocean Data Portal*. Retrieved from www.northeastoceandata.org

Rice, E., Dam, H. G., & Stewart, G. (2014). Impact of climate change on estuarine zooplankton: Surface water warming in Long Island Sound is associated with changes in copepod size and community structure. *Estuaries and Coasts, 38*, 13-23.

Snyder, J. (2017). *Analysis of a Newly Digitized Long-Term Dataset of Environmental Observations from Long Island Sound.* Retrieved from University of Connecticut, Master's Thesis: https://opencommons.uconn.edu/gs_theses/1170

Stevens Institute. (2018). *Analyzing history to project and manage the future: Simulating the effects of climate on Long Island Sound's physical environment and living marine resources*. Retrieved from Ocean Climate Reconstruction for Fisheries:

https://www.stevens.edu/research-entrepreneurship/research-centers-labs/davidson-laboratory/research-projects/ocean-climate-reconstruction-fisheries
Tamura, M., Katz, L. A., & McManus, G. B. (2011). Distribution and diversity of Oligotrich and Choreotrich ciliates in a large temperate estuary. *Aquatic Microbial Ecology, 64*, 51-67.
UConn CLEAR. (2018, February 5). *Connecticut Aquaculture Mapping Atlas*. Retrieved from UConn CLEAR, CT Sea Grant, CT DA/BA: https://clear3.uconn.edu/aquaculture/

6.5 Appendices

6.5.1 List of Maps Used to Inform the Chapter

Data highlighted in grey are included in the Inventory and were discussed during expert webinars. In addition to the links provided below, each grey dataset is accompanied by a reference, citation, or link within the text in the Inventory.

The un-highlighted (white) data rows were also discussed during expert webinars. These data were either identified in the Rapid Assessment or mentioned by experts as credible sources of data that may not be relevant to the Blue Plan effort. Example reasons include the older age of the dataset, limited overall availability, lack of spatial data products, too limited or too broad spatial/temporal scope, or that other LIS datasets were preferred. Many of these un-highlighted datasets are described in *Section 6.3 Additional Context*, and most are described further in the map books associated with the expert webinars (CT DEEP, 2018).

Table 6-2: Fish, Pelagic Invertebrate, Shellfish, and Zooplankton Datasets Used to Inform the Chapter or Discussed During Expert Webinars

CATEGORY	DATASET/LAYER	ADVANCED FROM RAPID ASSESSMENT TO INVENTORY	ADDED TO INVENTORY FROM EXPERT REVIEW
Fish	**CT DEEP Marine Fisheries Division Long Island Sound Trawl Survey data and derivatives including tow-level counts and biomass, species groups, relative abundance of age classes, length-mode groups** (Gottschall, Johnson, & Simpson, 2000)	**X**	
Fish	**CT DEEP Marine Fisheries Division estuarine seine survey data** (CT DEEP, 2016)	**X**	
Fish	**Millstone Environmental Laboratory fish data** (Millstone Environmental Laboratory, 2018)		**X**

CATEGORY	DATASET/LAYER	ADVANCED FROM RAPID ASSESSMENT TO INVENTORY	ADDED TO INVENTORY FROM EXPERT REVIEW
Fish	**Project Oceanology fish trawl database** (Snyder, 2017)		**X**
Fish	**Long Island Sound Study indicators** (LISS, 2018)		**X**
Fish	**LISEA fish data products including individual species persistence, weighted persistence, persistence areas, total species richness** (Anderson & Frohling, 2015)	**X**	
Fish	**NOAA Environmental Sensitivity Index, nearshore/coastal areas** (NOAA ORR, 2018)		**X**
Fish	**NOAA Protected Resources Division endangered species presence, critical habitat maps and information** (NOAA GARFO, 2018)		**X**
Fish	**CT Aquaculture Atlas, including designated natural shellfish beds** (UConn CLEAR, 2018)	**X**	
Fish	**Predicted horseshoe crab spawning beaches** (Landi, Vokoun, Howell, & Auster, 2014)		**X**
Fish	**NYS DEC horseshoe crab data** (Cornell Cooperative Extension, 2018)		**X**
Fish	**CT DEEP Saltwater Fishing Resource Maps** (CT DEEP, 2017)		**X**
Fish	**Stevens Institute of Technology climate change impacts on fish habitats** (Stevens Institute, 2018)		**X**
Fish	**Norwalk Aquarium** (Maritime Aquarium, 2018) **and Harbor Watch** (Harris, Fraboni, Cantatore, & Cooper, 2014) **trawl datasets**		**X**
Fish	**U.S. Fish and Wildlife Service/North Atlantic Landscape Conservation Cooperative/The Nature Conservancy Winter flounder habitat decision tool** (Clingerman, Petty, & Boettner, 2015)		**X**
Fish	**NOAA Essential Fish Habitat Mapper** (NOAA NMFS, 2018)		**X**

CATEGORY	DATASET/LAYER	ADVANCED FROM RAPID ASSESSMENT TO INVENTORY	ADDED TO INVENTORY FROM EXPERT REVIEW
Fish	**NOAA Groundfish management areas, Northeast Ocean Data Portal** (Northeast Regional Planning Body, Northeast Ocean Data Portal, 2018)	**X**	
Fish	**Scallop management areas, Northeast Ocean Data Portal** (Northeast Regional Planning Body, Northeast Ocean Data Portal, 2018)	**X**	
Fish	**CT DEEP Water Quality Monitoring Program, zooplankton**	**X**	
Fish	**UConn zooplankton research** (Tamura, Katz, & McManus, 2011) (Rice, Dam, & Stewart, 2014)		**X**
Fish	Zooplankton predicted biomass, seasons, NYGIG		
Fish	US Atlantic Coast Fishing Atlas (NMFS)		
Fish	NOAA Milford lab surf clam data		
Fish	CT Department of Agriculture Bureau of Aquaculture landings data		
Fish	Cedar Island Marina trawling data		
Fish	Coast Guard Academy Thames River trawling data		
Fish	CT DEEP Marine Fisheries Division short-term surveys including summer surveys, lobster mortality event tows, etc.		
Fish	NYS DEC Western LIS annual striped bass survey		
Fish	New York City Parks/New York & New Jersey Baykeeper/Hudson River Foundation/The School shellfish and invertebrate data		

6.5.2 Notes on Ecological Expert Input

Expert input was obtained on fish, pelagic invertebrate, shellfish, and zooplankton datasets during the "Fish" expert webinar. Map books for each webinar and links to webinar recordings can be found on the Long Island Sound Blue Plan website (CT DEEP, 2018).

Chapter 7

Benthic Invertebrates

Chapter Table of Contents

Chapter List of Figures and Tables

Figures

Tables

7.1 Key Data and Map Products

Benthic invertebrates include benthic epifauna and infauna (i.e., macrofauna). Datasets pertinent to mega-invertebrates like American lobster, Horseshoe crab, and other shellfish are described in *Chapter 6 Fish, Pelagic Invertebrates, Shellfish, and Zooplankton*.

There are no recent Sound-wide datasets describing the distribution and abundance of benthic invertebrates using uniform methods (Anderson & Frohling, 2015). The most recent data (2012, 2013) are derived from the Long Island Sound Mapping and Research Collaborative ("Cable Fund"), which has focused on collecting data at a few targeted locations within Long Island Sound (LIS) (Long Island Sound Cable Fund Steering Committee, 2015). The data collected and mapped were thematically extensive and included epifaunal and infaunal species richness, diversity (see Figure 7-1), and community clusters. Branching sponges, cold-water coral, and other structural epifauna were observed at Stratford Shoal as a part of this project (Stefaniak, Auster, & Babb, 2014).

The most recent and closest data product to a Sound-wide characterization of benthic invertebrates was produced for the Long Island Sound Ecological Assessment (LISEA) (Anderson & Frohling, 2015). The LISEA effort integrated data from Reid and coauthors collected in 1972 (Reid, Frame, & Draxler, 1979), Pelligrino and Hubbard collected in 1981-1982 (see Figure 7-1) (Pelligrino & Hubbard, 1983), National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service data collected between the 1950s and 1990s, and Cerrato and coauthors collected between 2001-2008 (Theroux & Wigley, 1998; Wigley & Theroux, 1981). Zajac et al. provide a detailed overview and some synthesis of many of these datasets and their relationship to other benthic data in all of LIS (2000). The LISEA project used the benthic invertebrate communities identified in these datasets to define ecologically-meaningful (i.e., statistically defined) thresholds in depth, sediment type, and seabed forms. The resulting map of Ecological Marine Units represents physical habitats that are likely to have distinct biota, but it is not a map of individual benthic communities. More detail on Ecological Marine Units and example maps are included in *Chapter 12 Ecologically Notable Places and Ecological Marine Units*.

Lastly, cold-water or "deep sea" (i.e., non-reef-building) corals are known to be found in LIS (e.g., Stefaniak, Auster, & Babb, 2014). Although the NOAA Deep Sea Coral Research and Technology Program (DSCRTP) maintains a dataset of known coral and sponge observations nationwide, including LIS (NOAA DSCRTP, 2018), the data are principally for deep sea corals – defined as species with principal distributions deeper than 50m so are not particularly useful for LIS. The New England and Mid-Atlantic Fishery Management Councils are using a data set constructed with NOAA and other more recent data to develop management alternatives. This and other efforts may present greater opportunities for data and information on LIS-related corals.

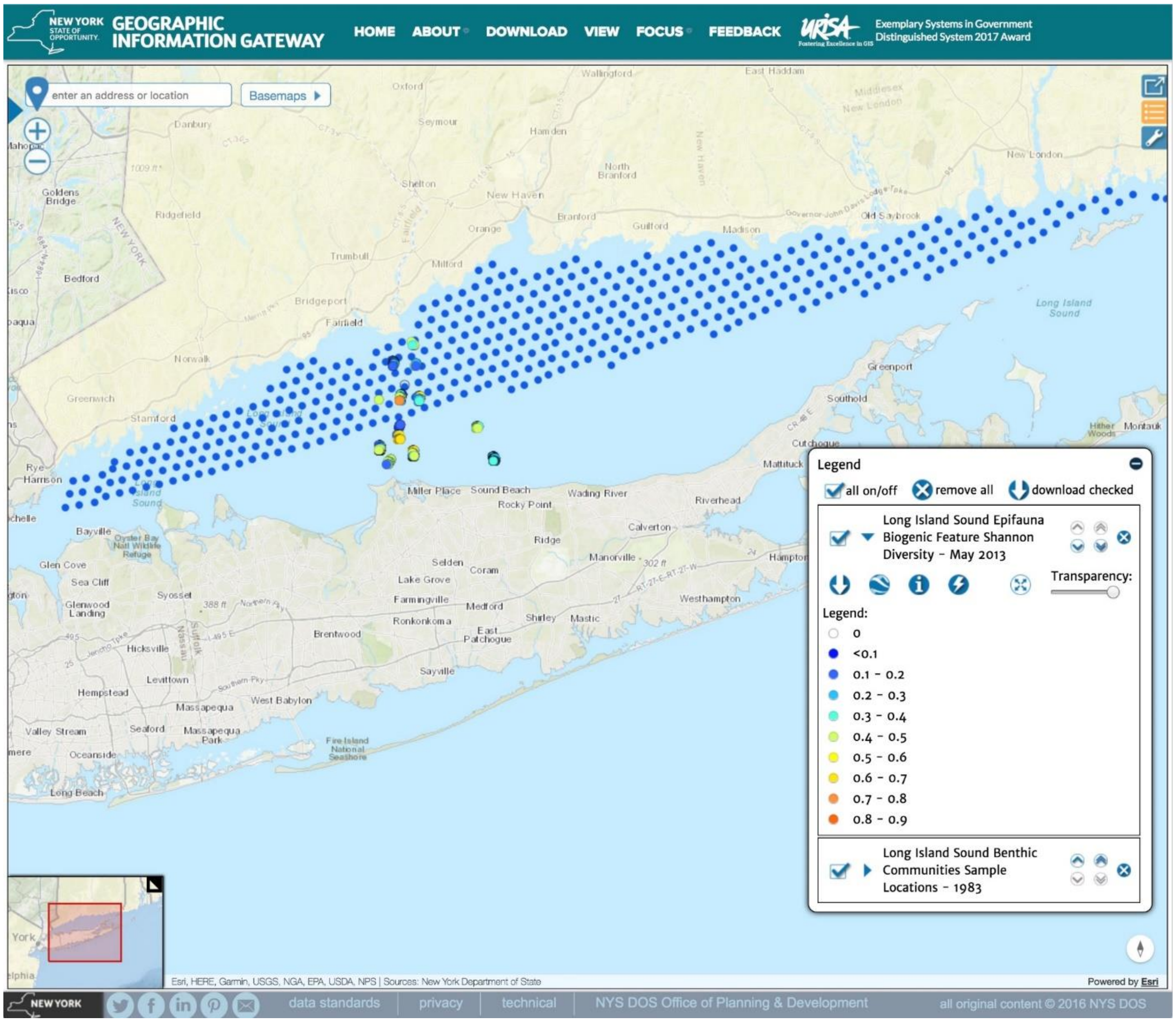


Figure 7-1: Benthic Communities Sample Locations and Epifauna Biogenic Feature Shannon Diversity. Sample locations are denoted by blue dots; Shannon diversity values are denoted as multi-colored circles. Two example benthic invertebrate data layers pertinent to benthic invertebrates that are available on the NY Geographic Information Gateway (NYDOS, 2018).

7.2 Assessment of Data Quality

7.2.1 Sources of Data and Metadata

All of the data layers derived from the Cable Fund project are available for download, with metadata, on the Long Island Sound Study online repository (MGDS, 2018). Maps of some of these data products are available on the New York Geographic Information Gateway (NYDOS, 2018). The Long Island Sound Study maintains a website with resources related to this project, including the Phase I final report (Long Island Sound Cable Fund Steering Committee, 2015).

All of the Long Island Sound Ecological Assessment (LISEA) data and map products are available via the report and the GIS dataset is available from The Nature Conservancy via the web link above (Anderson & Frohling, 2015).

Observations of cold-water corals in the NOAA Deep Sea Coral Research and Technology Program (DSCRTP) database are viewable online through the DSCRTP portal (NOAA DSCRTP, 2018) and the Mid-Atlantic Ocean Data Portal (Mid-Atlantic Regional Planning Body, 2018).

7.2.2 Accuracy, Representativeness, and Relevance of Map Products

All of the benthic invertebrate datasets described above are relevant to LIS. A typical problem in assembling benthic invertebrate data is limited spatial coverage and temporal mismatch, and LIS datasets are no exception. In combining datasets to achieve broader spatial and temporal coverage, different collection and/or analysis methods often complicate the interpretation. The Cable Fund data were collected and analyzed with consistent methods, but for a geographically small area – including Stratford Shoal and Bridgeport (Long Island Sound Cable Fund Steering Committee, 2015). Therefore, the Cable Fund data are likely accurate but perhaps not representative of the variety of benthic invertebrate communities in LIS. Conversely, the LISEA maps have better spatial coverage (i.e., are perhaps more representative) but are limited in their ability to clearly convey benthic community information because the methods used to collect each of the underlying invertebrate datasets were different.

The NOAA DSCRTP database presently contains one observation in LIS, and one in nearby Block Island Sound (NOAA DSCRTP, 2018). Very recent (within the last 5 years) coral and sponge observations in Southern New England are not yet reflected in this database.

7.2.3 Data Gaps and Availability of Data to Address Gaps

There are spatial and temporal gaps in benthic invertebrate data. Benthic invertebrate communities are heterogeneous, and the datasets described above likely do not capture the finest scales of that heterogeneity. Similarly, benthic communities fluctuate seasonally, with disturbances, and naturally on longer time scales. According to Lopez et al., "there have been no studies of…benthic communities [in LIS] that have assessed seasonal and year to year changes for periods greater than 2 years, nor studies that have assessed recovery following disturbance for more than that time span" (Lopez, G., et al., 2014).

Corals, sponges, and their habitats are a notable data gap for LIS. As noted above, the national dataset only contains a few observations of corals in LIS. Observations of these organisms recorded in the Cable Fund data can be used to fill this gap but only for the areas around the Stratford Shoal.

For this category of data – especially the distribution and abundance of corals and sponges – expert experience and judgement could be used to supplement the available datasets.

7.3 Additional Context

Notable additional datasets that were discussed on the expert webinars (CT DEEP, 2018) include the U.S. Geological Survey's (USGS) work in LIS (USGS, 2014), which has been integrated with other habitat characterization efforts, and the Environmental Protection Agency (EPA) National Coastal Condition Assessment 2010, 2005/2006, and its precursors, which characterizes benthic habitat quality at the national scale (with coverage in LIS) using benthic invertebrate community measures (US EPA, 2015).

It should also be noted that there have been a range of approaches used to map benthic biological resources in the Northeast region, including LIS. The Northeast Ocean Data Portal includes a comprehensive resource, Habitat mapping and classification in the Northeast USA, that explains the various methods and tools used by different mapping entities in New England (Northeast Regional Planning Body, 2018). Some of the issues discussed include how to integrate biological and geological (e.g., sediment) data to create an integrated map (e.g., Zajac, 2008) and efforts to apply the national NOAA Coastal and Marine Ecological Classification Scheme to data in the Northeast Region (FGDC, 2012). Finally, as noted in other chapters in this Inventory, the Millstone Environmental Laboratory has valuable benthic infauna data from their long-term datasets for areas surrounding the Dominion power plant (Millstone Environmental Laboratory, 2018).

7.4 References

Anderson, M., & Frohling, N. (2015). *The Long Island Sound Ecological Assessment.* The Nature Conservancy.

CT DEEP. (2018, February 5). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635

FGDC. (2012). *Coastal and Marine Ecological Classification Standard.* Federal Geographic Data Committee, Marine and Coastal Spatial Data Subcommittee. FGDC-STD-018-2012.

Long Island Sound Cable Fund Steering Committee. (2015). *Seafloor mapping of Long Island Sound - Final report: Phase 1 Pilot Project.* Stamford, CT: US Environmental Protection Agency Long Island Sound Study.

Long Island Sound Cable Fund Steering Committee. (2015). *Seafloor mapping of Long Island Sound - Final report: Phase 1 Pilot Project.* Stamford, CT: US Environmental Protection Agency Long Island Sound Study.

Lopez, G., et al. (2014). Biology and Ecology of Long Island Sound. In J. S. Latimer, M. A. Tedesco, R. L. Swanson, C. Yarish, P. E. Stacey, & C. Garza, *Long Island Sound: Prospects for the Urban Sea* (p. 558). New York: Springer.

MGDS. (2018). *Long Island Sound Study Funded/Related Data*. Retrieved from Marine Geoscience Data System: http://www.marine-geo.org/tools/new_search/index.php?&a=1&funding=LISS&output_info_all=on

Mid-Atlantic Regional Planning Body. (2018). *Mid-Atlantic Ocean Data Portal*. Retrieved from portal.midatlanticocean.org

Millstone Environmental Laboratory. (2018). *Annual Report 2017. Monitoring the Marine Environment of Long Island Sound at Millstone Power Station Waterford, Connecticut.* Waterford, CT : Dominion Energy Nuclear Connecticut.

NOAA DSCRTP. (2018, February 7). *NOAA Deep Sea Coral Data Portal*. Retrieved from NOAA Deep Sea Coral Data: https://deepseacoraldata.noaa.gov/

Northeast Regional Planning Body. (2018). *Northeast Ocean Data Portal*. Retrieved from www.northeastoceandata.org

NYDOS. (2018). *New York Geographic Information Gateway*. Retrieved from New York Department of State Office of Planning and Development: http://opdgig.dos.ny.gov/#/home

Pelligrino, P., & Hubbard, W. (1983). *Baseline shellfish data for the assessment of potential environmental impacts associated with energy activities in Connecticut's coastal zone: volumes I & II.* Hartford, CT: Report to the State of Connecticut. Department of Agriculture, Aquaculture Division.

Reid, R. N., Frame, A. B., & Draxler, A. F. (1979). *Environmental baselines in Long Island Sound. 1972-1973.* NOAA Technical Report. NMFS-SSRF738.

Stefaniak, L. M., Auster, P. J., & Babb, I. G. (2014). Loss of an erect sponge on a rock reef in Long Island Sound (north-west Atlantic). *Marine Biodiversity Records, 7*, e115.

Theroux, R. B., & Wigley, R. L. (1998). *Quantitative composition and distribution of the macrobenthic invertebrate fauna of the continental shelf ecosystems of the northeastern United States.* US Dept of Commerce. NOAA Technical Report NMFS 140.

US EPA. (2015). *National Coastal Condition Assessment 2010.* US Environmental Protection Agency, Office of Water and Office of Research and Development. Washington, DC: EPA 841-R-15-006.

USGS. (2014, December 10). *US Geological Survey Studies in Long Island Sound: Geology, Contaminants, and Environmental Issues*. Retrieved from Woods Hole Coastal and Marine Science Center: https://woodshole.er.usgs.gov/project-pages/longislandsound/

Wigley, R. L., & Theroux, R. B. (1981). *Atlantic continental shelf and slope of faunal composition and quantitative distribution.* US Geological Survey Professional Paper 529-N.

Zajac, R. N., Lewis, R. S., Poppe, L. J., Twichell, D. C., Vozarik, J., & DiGiacomo-Cohen, M. L. (2000). Relationships among sea-floor structure and benthic communities in Long Island Sound at regional and benthoscape scales. *Journal of Coastal Research, 16*, 627-640.

7.5 Appendices

7.5.1 List of Maps Used to Inform the Chapter

Data highlighted in grey are included in the Inventory and were discussed during expert webinars. In addition to the links provided below, each grey dataset is accompanied by a reference, citation, or link within the text in the Inventory.

The un-highlighted (white) data rows were also discussed during expert webinars. These data were either identified in the Rapid Assessment or mentioned by experts as credible sources of data that may not be relevant to the Blue Plan effort. Example reasons include the older age of the dataset, limited overall availability, lack of spatial data products, too limited or too broad spatial/temporal scope, or that other LIS datasets were preferred. Many of these un-highlighted datasets are described in *Section 7.3 Additional Context*, and most are described further in the map books associated with the expert webinars (CT DEEP, 2018).

Table 7-1: Benthic Invertebrate Datasets Used to Inform the Chapter or Discussed During Expert Webinars

CATEGORY	DATASET/LAYER	ADVANCED FROM RAPID ASSESSMENT TO INVENTORY	ADDED TO INVENTORY FROM EXPERT REVIEW
Benthic invertebrates	**Long Island Sound Cable Fund epifauna and infauna data and maps** (Long Island Sound Cable Fund Steering Committee, 2015)	X	
Benthic invertebrates	**LISEA invertebrate species richness, weighted persistence, persistence areas** (Anderson & Frohling, 2015)	X	
Benthic invertebrates	**Observed cold water corals** (Mid-Atlantic Regional Planning Body, 2018)	X	
Benthic invertebrates	NOAA Milford lab infaunal community clusters data		
Benthic invertebrates	Benthic community data layers for LIS: Zajac, Lewis, Poppe (USGS pub and maps) (USGS, 2014)		
Benthic invertebrates	EPA National Coastal Condition Assessment data (US EPA, 2015)		
Benthic invertebrates	New York State Department of Environmental Conservation macroinvertebrate data (e.g., lobster trap contents)		
Benthic invertebrates	LIS Integrated Coastal Observing System: 45 year time series analysis of benthic invertebrate (and other) data; UConn Snyder thesis		

7.5.2 Notes on Ecological Expert Input

Expert input was obtained on benthic invertebrate datasets primarily during the “Benthic Biological Habitat” expert webinar, but also during the “Benthic Physical Habitat” expert webinar. Map books for each webinar and links to webinar recordings can be found on the Long Island Sound Blue Plan website (CT DEEP, 2018).

Chapter 8

Coastal Wetlands

Chapter Table of Contents

Chapter List of Figures and Tables

Figures

Tables

8.1 Key Data and Map Products

Because of their proximity to land, historical delineation on topographic maps, and visibility in aerial photos, coastal wetlands have been mapped in Long Island Sound (LIS) repeatedly through the years. According to the first 130-year assessment of tidal wetland change for the entire Long Island Sound area, there has been an overall 31% loss of tidal wetlands, 27% in Connecticut and 48% in New York (Basso, O'Brien, Albino Hegeman, & O'Neill, 2015). Coastal wetland loss can be attributed to many factors, including coastal development, invasive species, pollution, and sea level rise.

Coastal wetlands data relate to estuarine and marine marsh or wetland vegetation, and in some cases, sensitive species found in those habitats. The datasets described below pertain to intertidal and subtidal habitats, but may also relate to freshwater wetlands; coastal wetlands are delineated by two national datasets, a Connecticut dataset, and a New York dataset:

The National Oceanic and Atmospheric Administration (NOAA) Environmental Sensitivity Index (ESI) includes delineations of "intermittent coastal wetlands", and "rare/terrestrial/native" plants along all shorelines (NOAA ORR, 2018).

The U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) maps estuarine and marine wetlands (USFWS, 2018).

The Connecticut critical habitats dataset includes delineations of a subset of important wildlife habitats identified in the Connecticut Comprehensive Wildlife Conservation Strategy, including intertidal marsh (CT DEEP, 2009).

The New York State Department of Environmental Conservation (NYS DEC) tidal wetland areas data are derived from aerial infrared vertical photographs obtained in 1974 (NYS DEC, 1974).

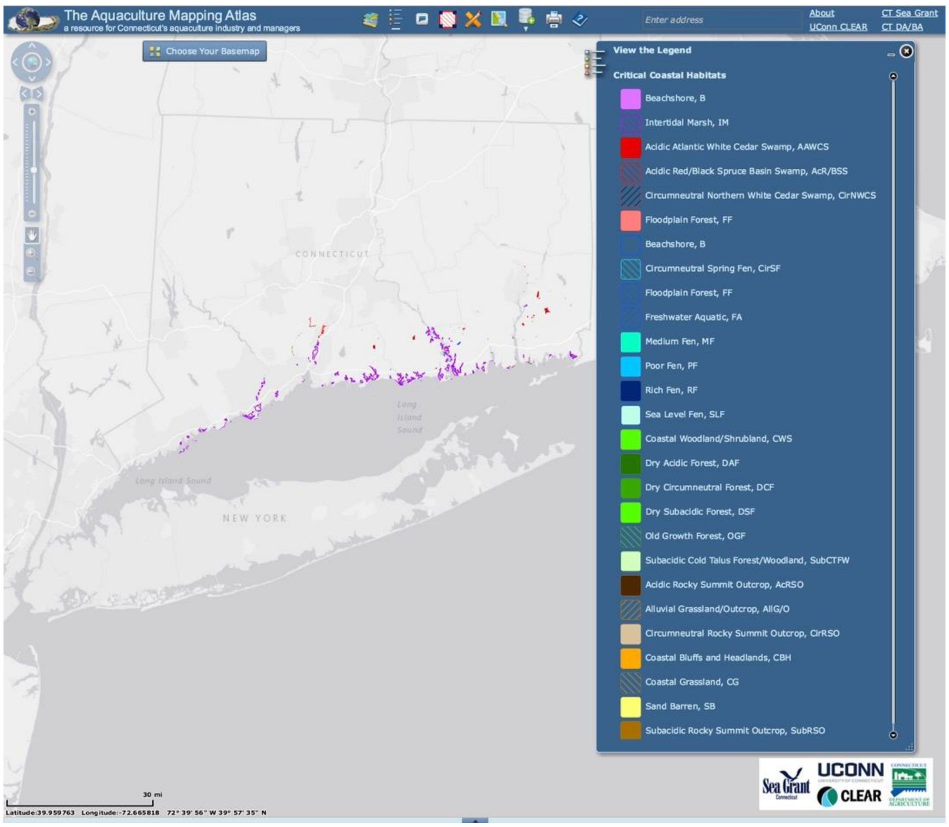


Figure 8-1: Connecticut Critical Habitats. Map showing Connecticut critical habitats data, including intertidal marsh, available in the Connecticut Aquaculture Mapping Atlas (CT DEEP, 2009; UConn CLEAR, 2018).

8.2 Assessment of Data Quality

8.2.1 Sources of Data and Metadata

All of the coastal wetlands data and metadata can be accessed via the Connecticut Aquaculture Mapping Atlas (UConn CLEAR, 2018), with the exception of the New York tidal wetlands area data, which can be accessed and downloaded via the New York Geographic Information Gateway (NYDOS, 2018).

The ESI and NWI data and metadata can also be downloaded directly from each project's website (NOAA ORR, 2018; USFWS, 2018). The Connecticut critical coastal habitats data and metadata can be downloaded from the Connecticut Department of Energy and Environmental Protection (CT DEEP) geographic information systems page (CT DEEP, 2009).

8.2.2 Accuracy, Representativeness, and Relevance of Map Products

For example, the ESI data were developed specifically to support oil spill/disaster response, and it and the NWI datasets pertain to areas larger than LIS (NOAA ORR, 2018; USFWS, 2018). Therefore, those national datasets may not adequately represent the spatial and temporal scale/variability within LIS. Furthermore, the ESI maps show areas where the most sensitive species/habitats exist, and don't necessarily show the entire area where a species/habitat exists (NOAA ORR, 2018).

The metadata for the Connecticut critical habitats layer notes that there is variation in the accuracy and completeness of each community type presented in the data (CT DEEP, 2009).

Lastly, the primary concern with accuracy and representativeness for the New York tidal wetlands data is its age (i.e., > 40 years). Tidal wetland area has likely changed since this survey.

8.2.3 Data Gaps and Availability of Data to Address Gaps

There do not appear to be significant data gaps for coastal wetlands in the Long Island Sound area.

8.3 Additional Context

The recent report on tidal marsh change in the Long Island Sound area provides excellent additional context for this topic (Basso, O'Brien, Albino Hegeman, & O'Neill, 2015). This report takes a historical perspective and uses maps of wetlands dating to the 1880s to analyze change over time. There is also an extensive discussion of the strengths and weaknesses of each wetlands dataset examined, for example, which areas of LIS may have been excluded in certain surveys, and differences in thematic resolution between datasets (Basso, O'Brien, Albino Hegeman, & O'Neill, 2015).

8.4 References

Basso, G., O'Brien, K., Albino Hegeman, M., & O'Neill, V. (2015). *Status and trends of wetlands in the Long Island Sound Area: 130 year assessment.* US Department of the Interior, Fish and Wildlife Service.

CT DEEP. (2009). *Connecticut Critical Habitats*. (D. o. State of Connecticut, Producer) Retrieved from http://www.cteco.uconn.edu/metadata/dep/document/CRITICAL_HABITAT_POLY_FGDC_Plus.htm

CT DEEP. (2018, February 5). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635

NOAA ORR. (2018, February 5). *Environmental Sensitivity Index (ESI) Maps*. Retrieved from NOAA Office of Response and Restoration: https://response.restoration.noaa.gov/maps-and-spatial-data/environmental-sensitivity-index-esi-maps.html

NYDOS. (2018). *New York Geographic Information Gateway*. Retrieved from New York Department of State Office of Planning and Development: http://opdgig.dos.ny.gov/#/home

NYS DEC. (1974). *DEC Tidal Wetland Areas*. (N. Y. Conservation, Producer) Retrieved from http://opdgig.dos.ny.gov/geoportal/catalog/search/resource/detailsnoheader.page?uuid=%7bE8B21766-F7F6-49B0-8346-58E71A8B3DF8%7d

UConn CLEAR. (2018, February 5). *Connecticut Aquaculture Mapping Atlas*. Retrieved from UConn CLEAR, CT Sea Grant, CT DA/BA: https://clear3.uconn.edu/aquaculture/

USFWS. (2018, February 1). *National Wetlands Inventory*. Retrieved from US Fish and Wildlife Service: https://www.fws.gov/wetlands/

8.5 Appendices

8.5.1 List of Maps Used to Inform the Chapter

Data highlighted in grey are included in the Inventory and were discussed during expert webinars. In addition to the links provided below, each grey dataset is accompanied by a reference, citation, or link within the text in the Inventory.

The un-highlighted (white) data rows were also discussed during expert webinars. These data were either identified in the Rapid Assessment or mentioned by experts as credible sources of data that may not be relevant to the Blue Plan effort. Example reasons include the older age of the dataset, limited overall availability, lack of spatial data products, too limited or too broad spatial/temporal scope, or that other LIS datasets were preferred. Many of these un-highlighted datasets are described in *Section 8.3 Additional Context*, and most are described further in the map books associated with the expert webinars (CT DEEP, 2018).

Table 8-1: Coastal Wetland Datasets Used to Inform the Chapter or Discussed During Expert Webinars

CATEGORY	DATASET/LAYER	ADVANCED FROM RAPID ASSESSMENT TO INVENTORY	ADDED TO INVENTORY FROM EXPERT REVIEW
Coastal wetlands	**NOAA ESI** (NOAA ORR, 2018)	**X**	
Coastal wetlands	**Connecticut critical habitats** (CT DEEP, 2009)	**X**	
Coastal wetlands	**NYS DEC tidal wetland areas** (NYS DEC, 1974)	**X**	
Coastal wetlands	**USFWS NWI** (USFWS, 2018)	**X**	
Coastal wetlands	Northeast coastal wetlands, Northeast Ocean Data Portal		
Coastal wetlands	NYS DEC Regulatory tidal wetland map index		

8.5.2 Notes on Ecological Expert Input

Expert input was obtained on coastal wetlands data during the "Benthic Biological Habitat" expert webinar. Map books for each webinar and links to webinar recordings can be found on the Long Island Sound Blue Plan website (CT DEEP, 2018).

Chapter 9

Bathymetry and Seafloor Complexity

<u>Chapter Table of Contents</u>

<u>Chapter List of Figures and Tables</u>

Figures

Tables

9.1 Key Data and Map Products

Bathymetry and seafloor complexity data provide information about the structure and shape of subtidal habitats. Seafloor complexity metrics are often derived from bathymetry data, so these datasets contain similar or overlapping information. Important factors to consider are spatial coverage and resolution, which can present a trade-off: broad spatial coverage is usually available at a coarser resolution than smaller patches of high-resolution data. Regardless, seafloor complexity metrics (including measures like slope and ruggedness) are relatively straightforward to generate from any existing bathymetry datasets. The following datasets relate to bathymetry and seafloor complexity in Long Island Sound (LIS):

Table 9-1: Available Data and Metadata for Characterizing Bathymetry and Seafloor Complexity

Dataset	**LIS coverage, resolution or type**
National Oceanic and Atmospheric Administration (NOAA) National Ocean Service (NOS) hydrographic survey data (NOAA NCEI, 2016)	Patchy, 0.5 – 2 m resolution
Mid-Atlantic region bathymetry (Mid-Atlantic Regional Planning Body, 2018)	Full coverage, approx. 100 m resolution
Long Island Sound Ecological Assessment (LISEA) products (Anderson & Frohling, 2015) • Depth classes • Landscape Position Index • Slope • Standard deviation of slope ("bathymetric complexity")	Full coverage, 83 m resolution
Long Island Sound Cable fund bathymetry (Long Island Sound Cable Fund Steering Committee, 2015)	Stratford Shoal and Bridgeport, 1 m resolution
Artificial reefs (Mid-Atlantic Regional Planning Body, 2018)	Point data

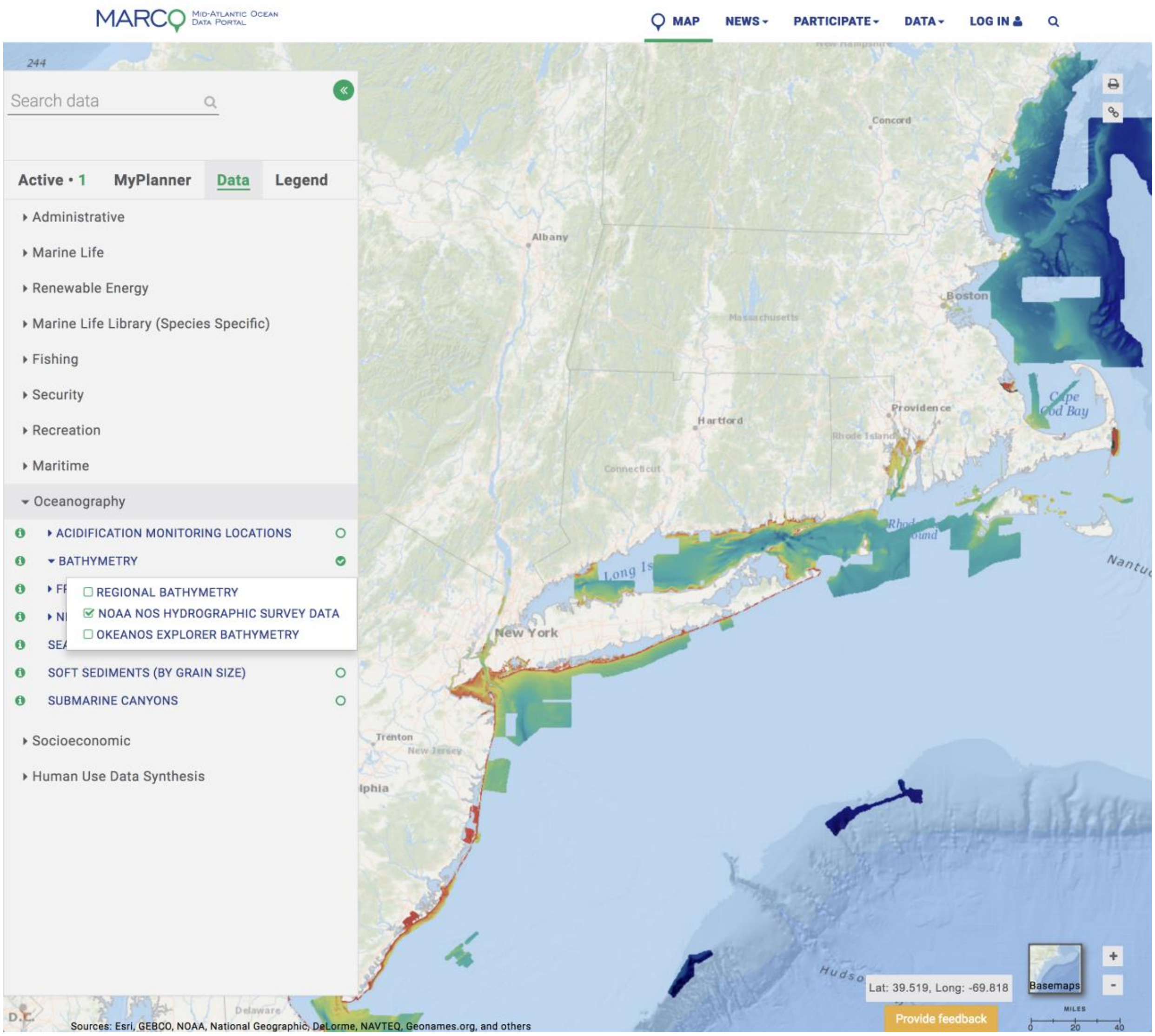


Figure 9-1: [High-Resolution Bathymetry Data](). NOAA NOS hydrographic survey data that ranges between 0.5-2.0 m resolution, but is not full coverage in LIS (NOAA NCEI, 2016), as viewed on the Mid-Atlantic Ocean Data Portal (Mid-Atlantic Regional Planning Body, 2018).

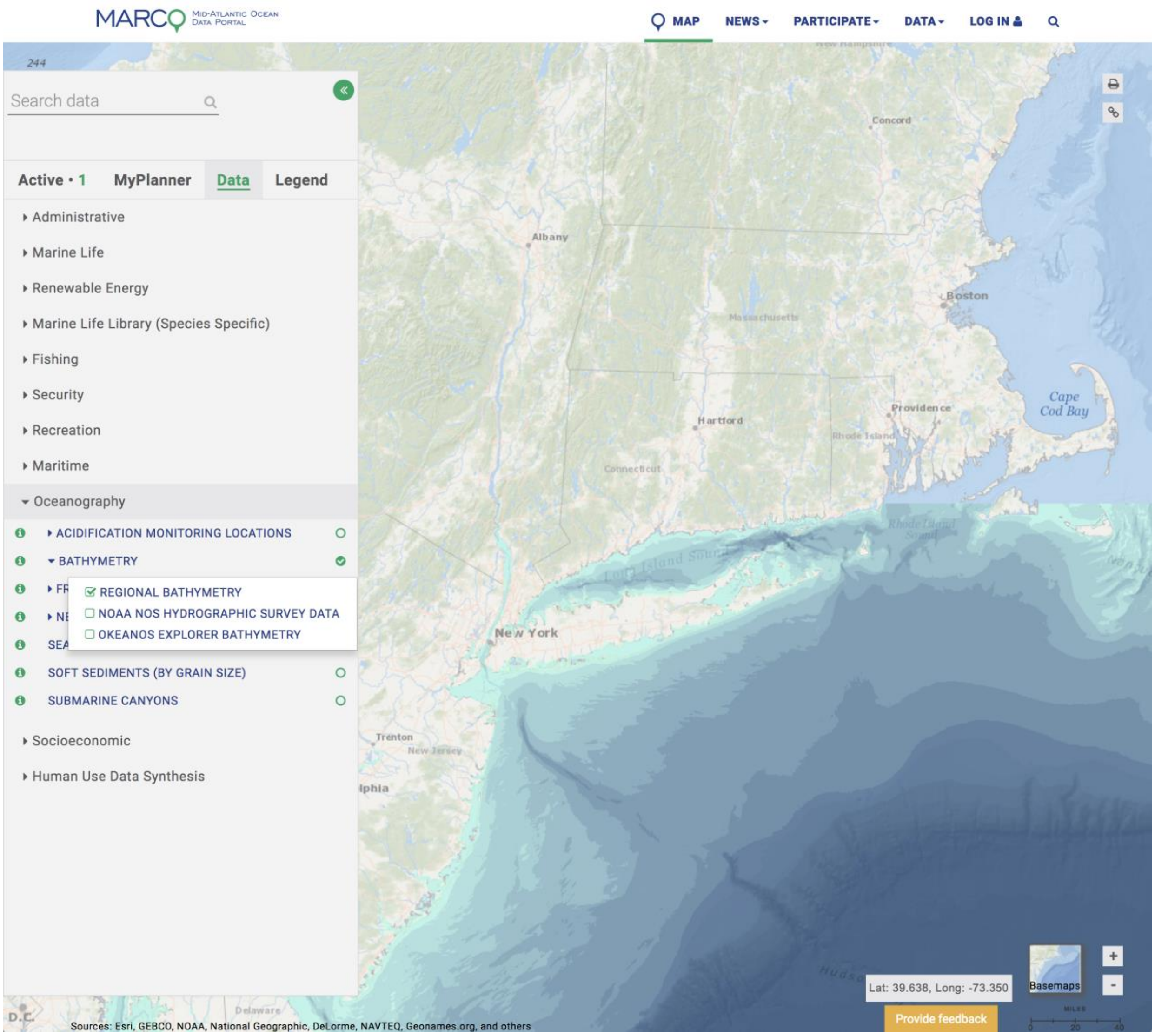


Figure 9-2: Lower-Resolution Bathymetry Data. Mid-Atlantic regional bathymetry data with ~100 m resolution and full coverage in LIS, as viewed on the Mid-Atlantic Ocean Data Portal (Mid-Atlantic Regional Planning Body, 2018).

9.2 Assessment of Data Quality

9.2.1 Sources of Data and Metadata

The NOAA NOS hydrographic survey data, Mid-Atlantic region bathymetry data, and artificial reefs data are all available, with metadata, on the Mid-Atlantic Ocean Data Portal (Mid-Atlantic Regional Planning Body, 2018).

All of the Long Island Sound Ecological Assessment (LISEA) data and map products are available via the report and the geographic information systems dataset is available from The Nature Conservancy via the web link above (Anderson & Frohling, 2015).

9.2.2 Accuracy, Representativeness, and Relevance of Map Products

All of the bathymetry and seafloor complexity datasets described above are relevant to the Blue Plan effort. The primary considerations for accuracy and representativeness for these datasets relate to resolution, coverage, and scale. In general, bathymetry metadata include robust estimates of instrumental and methodological accuracy, and each dataset's documentation should be consulted for that detailed information.

The finest resolution data are the NOAA NOS data (NOAA NCEI, 2016). Because the coverage is patchy, these data aren't representative of the entire LIS, but they are high-quality data.

The Cable Fund data are also very high resolution (1 m), but cover only very small parts of LIS (Long Island Sound Cable Fund Steering Committee, 2015).

Both the Mid-Atlantic regional bathymetry data and the LISEA products are derived from the NOAA Coastal Relief Model (CRM) and present full-coverage of LIS (NOAA NCEI, 1999). The Mid-Atlantic regional bathymetry data integrates additional datasets in the region, and used a lower overall resolution for the final product.

The LISEA products used the NOAA CRM data to develop derived products, all of which are simple mathematical calculations based on a spatial assessment window. For example, the Landscape Position Index search radius was 100 cells, or 8,300 m (Anderson & Frohling, 2015). Users should be aware of the analytical steps and choices applied to the development of these types of derived products.

9.2.3 Data Gaps and Availability of Data to Address Gaps

For the coarsest resolution datasets, there are no gaps in Long Island Sound. However, for the finest resolution datasets, several gaps exist (see Figure 9-2). If an area of interest overlaps with one of the gaps in high-resolution data, the lower resolution data could be used.

9.3 Additional Context

Depending on the intended use of bathymetry dataset, the age of the data should be considered. For example, high resolution data will often reveal dynamic seafloor features that can be located elsewhere or gone completely in subsequent surveys.

9.4 References

Anderson, M., & Frohling, N. (2015). *The Long Island Sound Ecological Assessment.* The Nature Conservancy.

CT DEEP. (2018, February 5). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635

Long Island Sound Cable Fund Steering Committee. (2015). *Seafloor mapping of Long Island Sound - Final report: Phase 1 Pilot Project.* Stamford, CT: US Environmental Protection Agency Long Island Sound Study.

MARCO. (2018, February). *Mid-Atlantic Ocean Data Portal*. Retrieved from Mid-Atlantic Regional Council on the Ocean (MARCO): http://portal.midatlanticocean.org

Mid-Atlantic Regional Planning Body. (2018). *Mid-Atlantic Ocean Data Portal*. Retrieved from portal.midatlanticocean.org

NOAA NCEI. (1999). *US Coastal Relief Model - Northeast Atlantic*. Retrieved from NOAA National Centers for Environmental Information: https://www.ngdc.noaa.gov/mgg/coastal/grddas01/grddas01.htm

NOAA NCEI. (2016). *NOS Hydrographic Surveys Collection*. Retrieved from NOAA National Centers for Environmental Information: https://www.ngdc.noaa.gov/docucomp/page?xml=NOAA/NESDIS/NGDC/Collection/iso/xml/NOS_Hydrographic_Survey_Collection.xml&view=xml2text/xml-to-text-ISO

9.5 Appendices

9.5.1 List of Maps Used to Inform the Chapter

Data highlighted in grey are included in the Inventory and were discussed during expert webinars. In addition to the links provided below, each grey dataset is accompanied by a reference, citation, or link within the text in the Inventory.

The un-highlighted (white) data rows were also discussed during expert webinars. These data were either identified in the Rapid Assessment or mentioned by experts as credible sources of data that may not be relevant to the Blue Plan effort. Example reasons include the older age of the dataset, limited overall availability, lack of spatial data products, too limited or too broad spatial/temporal scope, or that other LIS datasets were preferred. Many of these un-highlighted datasets are described in *Section 9.3 Additional Context*, and most are described further in the map books associated with the expert webinars (CT DEEP, 2018).

Table 9-2: Bathymetry and Seafloor Complexity Datasets Used to Inform the Chapter or Discussed During Expert Webinars

CATEGORY	DATASET/LAYER	ADVANCED FROM RAPID ASSESSMENT TO INVENTORY	ADDED TO INVENTORY FROM EXPERT REVIEW
Bathymetry and seafloor complexity	**NOAA National Ocean Service (NOS) hydrographic survey data** (NOAA NCEI, 2016)	X	
Bathymetry and seafloor complexity	**Mid-Atlantic region bathymetry** (Mid-Atlantic Regional Planning Body, 2018)	X	
Bathymetry and seafloor complexity	**LISEA depth classes, seafloor complexity, hard bottom areas, seafloor complexity components, slope, seabed forms, seafloor structure** (Anderson & Frohling, 2015)	X	
Bathymetry and seafloor complexity	**Artificial reefs** (Mid-Atlantic Regional Planning Body, 2018)	X	
Bathymetry and seafloor complexity	**High resolution bathymetry from LIS cable fund studies** (Long Island Sound Cable Fund Steering Committee, 2015)		X

9.5.2 Notes on Ecological Expert Input

Expert input was obtained on bathymetry and seafloor complexity datasets during the "Benthic Physical Habitat" expert webinar. Map books for each webinar and links to webinar recordings can be found on the Long Island Sound Blue Plan website (CT DEEP, 2018).

Chapter 10

Sediments and Geochemistry

Chapter Table of Contents

Chapter List of Figures and Tables

Figures

Tables

10.1 Key Data and Map Products

Datasets relevant to sediment and geochemistry include raw data from sampling points as well as some interpreted map products (i.e., polygons) in Long Island Sound (LIS). The sediments and geochemistry of LIS are well-studied and there is data available for most of the entire Sound.

Because of the quantity of data, each source is described in Table 10-1. Briefly, two types of data are listed: sediment grain size data and geochemistry data. Sediment grain size data include sediment classifications for point data and interpreted polygons depicting the composition of sediments. There is also a U.S. Geological Survey (USGS) foraminifera dataset included because these data are obtained from sediment samples, and their distribution and abundance in sediments indicates environmental conditions (Thomas, Gapotchenko, Varekamp, Mecray, & Buchholtz ten Brink, 2000). Geochemical parameters include naturally occurring and contaminant compounds. For example, most projects measure total organic carbon and metals concentrations together as a way to assess contaminant bioavailability. In addition, the Natural Resource Conservation Service did a sub-aqueous soil survey in Branford, CT, along with other sites (e.g., Little Narragansett Bay), which may provide more detailed sediment and seafloor information for particular areas that may be important for the Blue Plan (USDA Natural Resource Conservation Service, 2018).

Table 10-1: Available Data and Metadata for Characterizing Sediment Grain Size and Geochemistry

Dataset	LIS coverage, resolution or type
SEDIMENT GRAIN SIZE DATA	
National Oceanic and Atmospheric Administration (NOAA) Environmental Sensitivity Index (ESI) shoreline type (NOAA ORR, 2018) e.g., exposed rocky shore, gravel beach, sheltered tidal flat	Connecticut and New York shore, polygon geographic information system (GIS) data
LIS Cable Fund samples (Long Island Sound Cable Fund Steering Committee, 2015) • % gravel • % mud • % sand • sediment matrix density • Texture – Folk classification • Texture – Shepard classification	Stratford Shoal
USGS post glacial deposit sediment thickness (DiGiacomo-Cohen & Lewis, 2000)	Full coverage
USGS foraminifera samples (Thomas, Gapotchenko, Varekamp, Mecray, & Buchholtz ten Brink, 2000)	Transects, point GIS data
USGS sediment samples (Poppe, Knebel, Seekins, & Hastings, 2000)	Full coverage, point GIS data
USGS sediment polygon maps (Poppe, Knebel, Seekins, & Hastings, 2000)	Full coverage, polygon GIS data
Long Island Sound Ecological Assessment (LISEA) (Anderson & Frohling, 2015) • Sediment thresholds – determined by benthic community structure • Hard bottom locations • Soft sediment maps • Seabed forms	Full coverage

Dataset	LIS coverage, resolution or type
SEDIMENT GRAIN SIZE DATA (cont.)	
USGS/NOAA backscatter interpretations (USGS, 2014)	Patchy
LIS Cable Fund ecognition acoustic patches (Long Island Sound Cable Fund Steering Committee, 2015)	Stratford Shoal
GEOCHEMISTRY	
LIS Cable Fund samples (Long Island Sound Cable Fund Steering Committee, 2015) % carbon % nitrogen Copper concentration Zinc concentration Lead concentration	Stratford Shoal
USGS chemical and contaminant data (Mecray, Buchholz ten Brink, & Shah, 2000) Total organic carbon, trace metals (Ag, Ba, Cd, Cr, Cu, Hg, Ni, Pb, V, Zn and Zr), major metals (Al, Fe, Mn, Ca, and Ti), mercury	Full coverage, point GIS data
Environmental Protection Agency (EPA) National Coastal Condition Assessment (NCCA) –1999-2001/2004-2006, 2010 (US EPA, 2015) Total organic carbon Metals concentration Mercury concentration PAHs concentration PCBs concentration Organochlorine pesticides concentration Sediment toxicity (survival of amphipods) Sediment quality index	National coverage, point GIS data
NOAA National Status and Trends (NS&T) sediment toxicity data (amphipods, clam larvae, microbial bioluminescence) (Wolfe, Bricker, Long, John Scott, & Thursby, 1994) Heavy metals PAHs PCBs Chlorinated pesticides	Primarily coastal bays of LIS, point GIS data (most recent data is 1996)
Metals, organic compounds, and nutrients in Long Island Sound: Sources, magnitudes, trends, and impacts. In: Long Island Sound: Prospects for the Urban Sea (Varekamp, McElroy, Mullaney, & Breslin, 2014)	Full coverage, includes maps and analyses of USGS, NCCA, NS&T, and other datasets

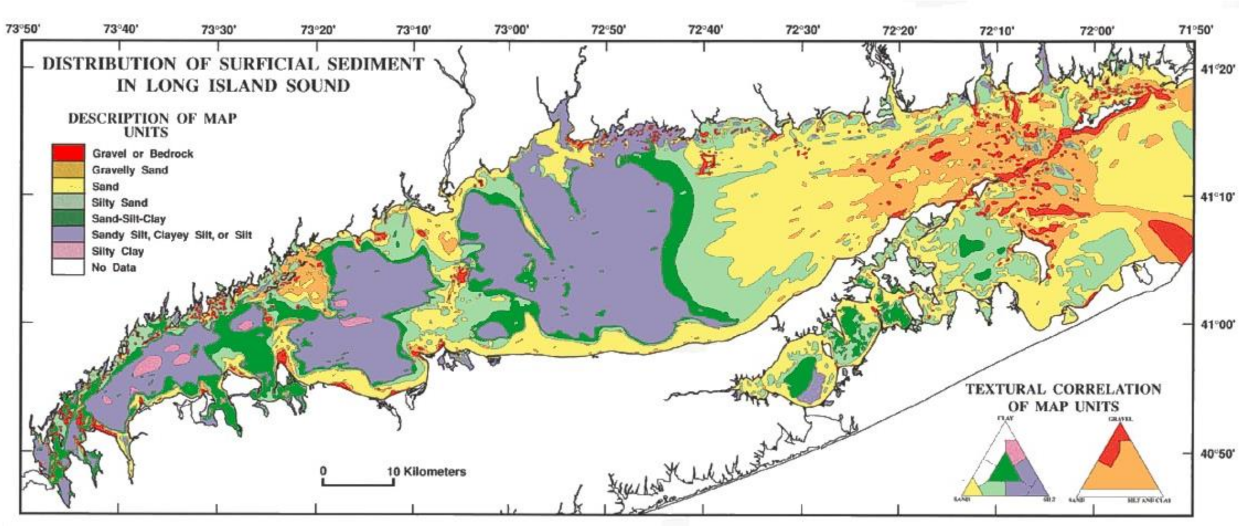


Figure 10-1: [Surficial Sediments of Long Island Sound](). This map appears in (Poppe, Knebel, Seekins, & Hastings, 2000) and in the Long Island Sound Thematic Section of the Journal of Coastal Research (Poppe, Knebel, Mlodzinska, Hastings, & Seekins, 2000).

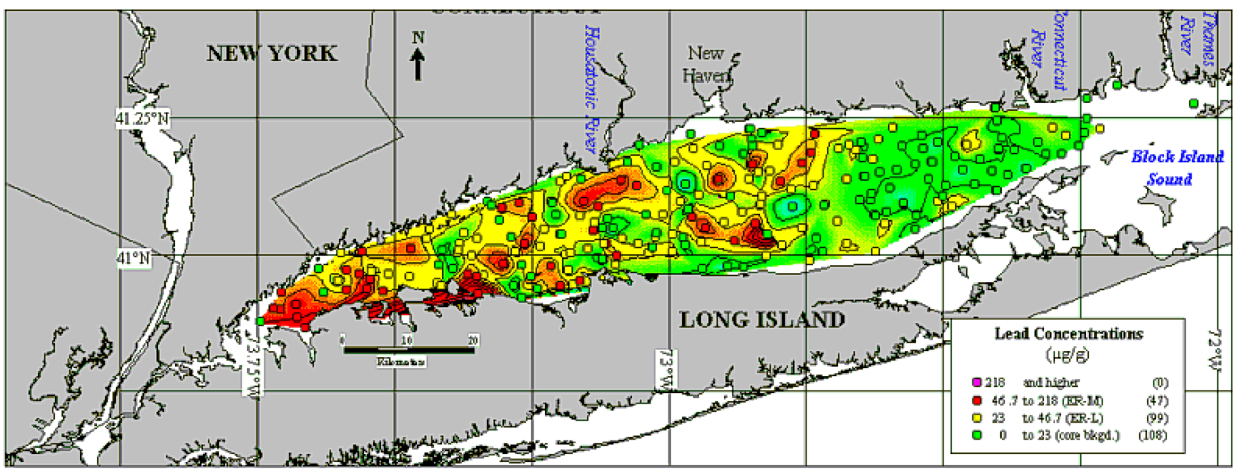


Figure 10-2: [Lead Concentrations in the Sediments of Long Island Sound](). This map appears in (Mecray, Buchholz ten Brink, & Shah, 2000) and in the Long Island Sound Thematic Section of the Journal of Coastal Research (Mecray & Buchholz ten Brink, 2000).

10.2 Assessment of Data Quality

10.2.1 Sources of Data and Metadata

All of the data in Table 10-1 are available on the web for download, viewing, or both.

NOAA ESI data are downloadable from the [ESI website]() and viewable on the [CT Aquaculture Mapping Atlas]() (UConn CLEAR, 2018).

The LIS Cable Fund sediment data are downloadable from the Long Island Sound Study repository (Long Island Sound Cable Fund Steering Committee, 2015).

All USGS data are available for download from their Studies in Long Island Sound page (USGS, 2014), and many are visible as maps in the New York Geographic Information Gateway (NYDOS, 2018).

EPA NCCA and NOAA NS&T data are each downloadable from the web. The EPA NCCA data can be downloaded by survey ("coastal") and by indicator ("sediment chemistry" and "sediment toxicity"). The NOAA NS&T data can be downloaded by geographic location, specific to Long Island Sound (Wolfe, Bricker, Long, John Scott, & Thursby, 1994).

All of the LISEA data and map products are available via the report and the GIS dataset is available from The Nature Conservancy via the web link above (Anderson & Frohling, 2015).

10.2.2 Accuracy, Representativeness, and Relevance of Map Products

All of the sediment and geochemistry data described above are relevant to LIS. Because many of these data and products are comprehensive in their coverage of LIS, they can be considered to be representative as well. Exceptions would be the Cable Fund data which are only pertinent to the Stratford Shoal area.

Two additional considerations for accuracy and representativeness of these data would be age and scale. Some of the geochemistry data are on the order of decades old, and the concentration and/or bioavailability of some contaminants may have changed since they were last measured. Relative to scale, some of these data (e.g., USGS sediment polygon maps, Figure 10-1) may have been drawn at scales broader than the finest scales of sediment heterogeneity, and so do not adequately represent very fine-scale features.

10.2.3 Data Gaps and Availability of Data to Address Gaps

Overall there are no comprehensive data gaps in sediment and geochemistry data for Long Island Sound. If an area of interest overlaps with one of the gaps in the finest-resolution data, the lower resolution data could be used.

10.3 Additional Context

The full coverage, "interpretive" maps were developed using different approaches to extrapolate point data and other information into broad-scale features covering LIS. For example, the USGS sediment polygons were interpreted using a combination of geophysical data (e.g., bathymetry, backscatter) and grain size samples, whereas the thresholds between sediment types in the LISEA data were determined from benthic community analysis of 1,321 benthic grab samples (see *Chapter 12 Ecologically Notable Places and Ecological Marine Units* for more information). These differences in methodology could affect interpretation and application, and so they should be understood and considered by potential users.

10.4 References

Anderson, M., & Frohling, N. (2015). *The Long Island Sound Ecological Assessment.* The Nature Conservancy.

CT DEEP. (2018, February 5). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635

DiGiacomo-Cohen, M. L., & Lewis, R. S. (2000). Maps Showing the Shape of the Marine Transgressive Surface and the Thickness of Postglacial Sediments in Long Island Sound. In V. F. Paskevich, & L. J. Poppe, *Georeferenced seafloor mapping and bottom photography in Long Island Sound.* Woods Hole, MA: USGS Open ile Report 00-304. Retrieved from https://pubs.usgs.gov/of/2000/of00-304/htmldocs/toc.htm

Long Island Sound Cable Fund Steering Committee. (2015). *Seafloor mapping of Long Island Sound - Final report: Phase 1 Pilot Project.* Stamford, CT: US Environmental Protection Agency Long Island Sound Study.

Mecray, E. L., & Buchholz ten Brink, M. R. (2000). Contaminant distribution and accumulation in the surface sediments of Long Island Sound. *Journal of Coastal Research, 16*(3), 575-590.

Mecray, E. L., Buchholz ten Brink, M. R., & Shah, S. (2000). Metals in the Surface Sediments of Long Island Sound. In V. F. Paskevich, & L. J. Poppe, *Georeferenced seafloor mapping and bottom photography in Long Island Sound.* Woods Hole, MA: USGS Open File Report 00-304. Retrieved from https://pubs.usgs.gov/of/2000/of00-304/htmldocs/toc.htm

NOAA ORR. (2018, February 5). *Environmental Sensitivity Index (ESI) Maps*. Retrieved from NOAA Office of Response and Restoration: https://response.restoration.noaa.gov/maps-and-spatial-data/environmental-sensitivity-index-esi-maps.html

NYDOS. (2018). *New York Geographic Information Gateway*. Retrieved from New York Department of State Office of Planning and Development: http://opdgig.dos.ny.gov/#/home

Poppe, L. J., Knebel, H. J., Mlodzinska, Z. J., Hastings, M. E., & Seekins, B. A. (2000). Distribution of surficial sediment in Long Island Sound and adjacent waters: Texture and total organic carbon. *Journal of Coastal Research, 16*(3), 567-574.

Poppe, L. J., Knebel, H. J., Seekins, B. A., & Hastings, M. E. (2000). MAP SHOWING THE DISTRIBUTION OF SURFICIAL SEDIMENTS IN LONG ISLAND SOUND. In V. F. Paskevich, & L. J. Poppe, *Georeferenced seafloor mapping and bottom photography in Long Island Sound.* Woods Hole, MA: USGS Open File Report 00-304.

Thomas, E., Gapotchenko, T., Varekamp, J. C., Mecray, E. L., & Buchholtz ten Brink, M. R. (2000). Maps of Benthic Foraminifera Distribution and Environmental Changes in Long Island Sound Between the 1940s and the 1990s. In V. F. Paskevich, & L. J. Poppe, *Georeferenced seafloor mapping and bottom photography in Long Island Sound.* Woods Hole, MA: USGS Open File Report 00-304. Retrieved from https://pubs.usgs.gov/of/2000/of00-304/htmldocs/toc.htm

UConn CLEAR. (2018, February 5). *Connecticut Aquaculture Mapping Atlas*. Retrieved from UConn CLEAR, CT Sea Grant, CT DA/BA: https://clear3.uconn.edu/aquaculture/

US EPA. (2015). *National Coastal Condition Assessment 2010.* US Environmental Protection Agency, Office of Water and Office of Research and Development. Washington, DC: EPA 841-R-15-006.

USDA Natural Resource Conservation Service. (2018). *SoilWeb*. Retrieved from NRCS ArcGIS Online: http://nrcs.maps.arcgis.com/apps/MapSeries/index.html?appid=57b5679ef42d4cdeabb91be4b491e965

USGS. (2014, December 10). *US Geological Survey Studies in Long Island Sound: Geology, Contaminants, and Environmental Issues*. Retrieved from Woods Hole Coastal and Marine Science Center: https://woodshole.er.usgs.gov/project-pages/longislandsound/

Varekamp, J. C., McElroy, A. E., Mullaney, J. R., & Breslin, V. T. (2014). Metals, organic compounds, and nutrients in Long Island Sound: Sources, magnitudes, trends, and impacts. In J. S. Latimer, M. A. Tedesco, R. Lawrence Swanson, C. Yarish, P. E. Stacey, & C. Garza, *Long Island Sound: Prospects for the urban sea* (p. 558). New York: Springer.

Visel, T. (2017). *Blue Crabs and Marine Soil Habitat Histories.* New Haven, CT: The Sound School.

Visel, T. C. (2017). *The Mapping of Coastal Sapropels for Marine Habitat Chemistry.* New Haven, CT: The Sound School.

Visel, T. C. (2018). *Climate Seasons and our Fisheries, Marine Soils and Seafood, Part 1: Temperature and Energy Cycles – The Case History of Sapropel & Part 2: The Case History of Eelgrass.* New Haven, CT: The Sound School.

Wolfe, D. A., Bricker, S. B., Long, E. R., John Scott, K., & Thursby, G. B. (1994). *Biological effects of toxic contaminants in sediments from Long Island Sound and environs.* Silver Spring: NOAA Technical Memorandum NOS ORCA 80.

10.5 Appendices

10.5.1 List of Maps Used to Inform the Chapter

Data highlighted in grey are included in the Inventory and were discussed during expert webinars. In addition to the links provided below, each grey dataset is accompanied by a reference, citation, or link within the text in the Inventory.

The un-highlighted (white) data rows were also discussed during expert webinars. These data were either identified in the Rapid Assessment or mentioned by experts as credible sources of data that may not be relevant to the Blue Plan effort. Example reasons include the older age of the dataset, limited overall availability, lack of spatial data products, too limited or too broad spatial/temporal scope, or that other LIS datasets were preferred. Many of these un-highlighted datasets are described in *Section 10.3 Additional Context*, and most are described further in the map books associated with the expert webinars (CT DEEP, 2018).

Table 10-2: Sediment and Geochemistry Datasets Used to Inform the Chapter or Discussed During Expert Webinars

CATEGORY	DATASET/LAYER	ADVANCED FROM RAPID ASSESSMENT TO INVENTORY	ADDED TO INVENTORY FROM EXPERT REVIEW
Sediments and geochemistry	**NOAA ESI shoreline type** (NOAA ORR, 2018)	X	
Sediments and geochemistry	**LIS Cable Fund samples** (Long Island Sound Cable Fund Steering Committee, 2015)	X	
Sediments and geochemistry	**USGS post glacial deposit sediment thickness** (DiGiacomo-Cohen & Lewis, 2000)	X	
Sediments and geochemistry	**USGS foraminifera samples** (Thomas, Gapotchenko, Varekamp, Mecray, & Buchholtz ten Brink, 2000)	X	
Sediments and geochemistry	**USGS sediment samples** (Poppe, Knebel, Seekins, & Hastings, 2000)	X	
Sediments and geochemistry	**USGS sediment polygon maps** (Poppe, Knebel, Seekins, & Hastings, 2000)	X	
Sediments and geochemistry	**LISEA sediment thresholds, hard bottom locations soft sediment maps, seabed forms** (Anderson & Frohling, 2015)	X	
Sediments and geochemistry	**LIS Cable Fund ecognition acoustic patches** (Long Island Sound Cable Fund Steering Committee, 2015)	X	
Sediments and geochemistry	**USGS/NOAA backscatter interpretations** (USGS, 2014)		X
Sediments and geochemistry	**EPA NCCA** (US EPA, 2015)		X
Sediments and geochemistry	**NOAA NS&T** (Wolfe, Bricker, Long, John Scott, & Thursby, 1994)		X
Sediments and geochemistry	**LIS Prospects for the Urban Sea – chapter on organic contaminants** (Varekamp, McElroy, Mullaney, & Breslin, 2014)		X
Sediments and geochemistry	Journal of Coastal Research special volume on LIS, organic contaminants		
Sediments and geochemistry	U.S. Department of Agriculture Natural Resources Conservation Service subaqueous soils dataset		

CATEGORY	DATASET/LAYER	ADVANCED FROM RAPID ASSESSMENT TO INVENTORY	ADDED TO INVENTORY FROM EXPERT REVIEW
Sediments and geochemistry	usSEABED Atlantic Coast Offshore Surficial Sediment database		
Sediments and geochemistry	The Nature Conservancy Northwest Atlantic Marine Ecoregional Assessment, soft sediments by grain size, seafloor habitats		

10.5.2 Notes on Ecological Expert Input

Expert input was obtained on sediments and geochemistry datasets primarily during the "Benthic Physical Habitat" expert webinar. Map books for each webinar and links to webinar recordings can be found on the Long Island Sound Blue Plan website (CT DEEP, 2018). Additional input was submitted for consideration regarding Eelgrass sapropels and LIS geochemistry (Visel T. , 2017; Visel T. C., 2017; Visel T. C., 2018).

Chapter 11

Physical Oceanography, Meteorology, and Water Quality

Chapter Table of Contents

Chapter List of Figures and Tables

Figures

Tables

11.1 Key Data and Map Products

Physical processes in Long Island Sound (LIS) influence water quality, geochemistry, and ecology. Chapter 3 in *Long Island Sound: Prospects for the Urban Sea*, "The physical oceanography of Long Island Sound", provides a comprehensive overview, including several maps, of physical oceanographic processes in LIS (O'Donnell, et al., 2014).

In this chapter, three main data types are discussed: (1) continuous maps of oceanographic/ meteorological variables; (2) water quality monitoring data; and (3) water quality management units or areas.

Oceanographic/Meteorological Variables

There are several existing continuous maps of oceanography and meteorological variables with coverage in LIS that are derived from regional- or broader-scale datasets (e.g., satellite data) and/or models. Many of these products represent long-term averages of seasonal patterns, annual patterns, or longer. One exception is for sea surface temperature front products that represent a single season of data in a single year (Rutgers University, 2016). Various datasets are listed below:

- Sea surface temperature – long-term average (spring, summer, fall, winter) (NOAA NCCOS, 2014a)
- Water column stratification – long-term average (spring, summer, fall, winter) (NOAA NCCOS, 2014c)
- Turbidity – long-term average (spring, summer, fall, winter) (NOAA NCCOS, 2014b)
- Sea surface temperature fronts – 2012, 2013 maximum (spring, summer, fall winter) (Rutgers University, 2016)
- Surface and bottom current speed – long-term average (Northeast Ocean Data Portal, 2016)
- Ocean wave resource potential (Electric Power Resource Institute, 2014)
- Tidal stream resource potential – mean current and mean power density (USDOE, 2014)
- Annual mean offshore wind speed – long-term average (Schwartz, Heimiller, Haymes, & Musial, 2010)

Water Quality Monitoring Data

The authoritative source for water quality monitoring data in the Sound is the Connecticut Department of Energy and Environmental Protection (CT DEEP) Long Island Sound Water Quality Monitoring Program (CT DEEP, 2017). The program was established in 1994 with 48 permanent sampling stations to monitor hypoxia during the summer months of June, July, August, and September. There are currently 47 active stations. Seventeen stations are also sampled year-round as part of the monthly water quality monitoring program. Originally sampling was aimed at evaluating the effects of dissolved oxygen concentrations on fish abundance and determining the temporal and spatial extent of hypoxia (Figure 11-1). Sampling stations were selected randomly with more sites concentrated in the western Sound where hypoxia was generally more severe. Variables measured as a part of this program are listed in Table 11-1.

Table 11-1: Variables Measured as Part of the CT DEEP Long Island Sound Water Quality Monitoring Program

Variable type	Measurement
In-situ	Dissolved oxygen (% saturation)*
	Temperature*
	Salinity*
	Conductivity
	Depth
	Photosynthetic Active Radiation
Chemical	Dissolved silica*
	Particulate silica*
	Particulate carbon
	Dissolved inorganic carbon
	Dissolved nitrogen*
	Particulate nitrogen*
	Ammonia
	Nitrate
	Nitrite
	Particulate phosphorus
	Total dissolved phosphorus
	Orthophosphate
	Chlorophyll-a*
	Total suspended solids*
	Winkler DO
Biological	Biological Oxygen Demand
	Zooplankton
	Phytoplankton
	Phytoplankton photopigments via HPLC

* = surface and bottom measurements

The Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS, 2018) and the University of Connecticut maintains the Long Island Sound Integrated Coastal Observing System (LISICOS) buoy network to provide meteorological, oceanographic, and water quality observations from Long Island Sound, including the CT DEEP Long Island Sound Water Quality Monitoring Program data described above (LISICOS, 2018).

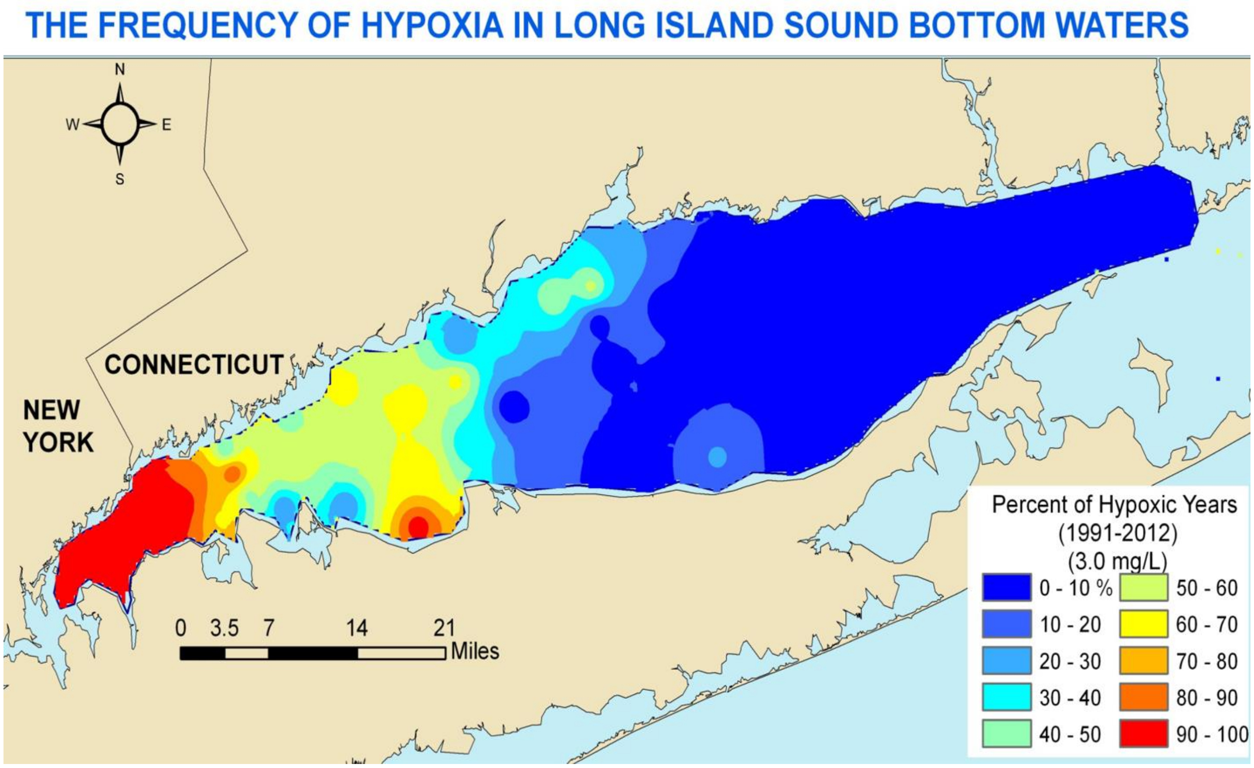


Figure 11-1: Frequency of Hypoxia in Long Island Sound over 21-Year Span. This map was developed from CT DEEP Long Island Sound Water Quality Monitoring Program data (CT DEEP, 2017).

Water Quality Management Units and Areas

The third type of water quality information is conveyed via maps of management units or areas. This information is developed and maintained by the U.S. Environmental Protection Agency (EPA) and includes impaired rivers or coastline, impaired water bodies, Total Maximum Daily Load (TMDL) rivers or coastline, TMDL water bodies, and wastewater discharges (USEPA Office of Water, 2015). An additional layer showing no discharge zones in the Northeast region was developed and is maintained by the Northeast Ocean Data Portal (Northeast Regional Planning Body, 2014).

11.2 Assessment of Data Quality

11.2.1 Sources of Data and Metadata

Oceanographic/Meteorological Variables

All of the Oceanographic/meteorological variables are available for viewing and as web services on the New York Geographic Information Gateway (NYDOS, 2018), the Northeast Ocean Data Portal (Northeast Regional Planning Body, 2018), and the Mid-Atlantic Ocean Data Portal (Mid-

Atlantic Regional Planning Body, 2018). Each hyperlink above opens a map of all variables available on each portal.

Meteorological, oceanographic, and water quality observations from Long Island Sound, including the CT DEEP Long Island Sound Water Quality Monitoring Program data are available on the LISICOS website (LISICOS, 2018).

Additional maps of oceanographic and meteorological data and information (e.g., wind speed and direction, wave heights, currents, water temperature) for eastern Long Island Sound are contained within descriptions of the affected environment in the Supplemental EIS for the Designation of Dredged Material Disposal Site(s) in Eastern LIS (Louis Berger and University of Connecticut, 2016).

Water Quality Monitoring Data

Water quality data are available directly from CT DEEP (CT DEEP, 2017). On the CT DEEP Long Island Sound Water Quality Monitoring Program and Information website, several data products are viewable, including a map of sampling stations, summer hypoxia maps for each year from 1991-2017, and graphs of surface/bottom temperature. The website also contains fact sheets on water quality monitoring, hypoxia, zooplankton, and phytoplankton.

Water Quality Management Units and Areas

All of the water quality management units and areas datasets are visible on the Northeast Ocean Data Portal (Northeast Ocean Data Working Group, 2018).

11.2.2 Accuracy, Representativeness, and Relevance of Map Products

All of the datasets described above are relevant to the Blue Plan effort. The accuracy and representativeness of each dataset differs depending on the purpose of the data collection and analysis efforts. It is important to understand the underlying scale of each set of observations because these datasets inherently vary on multiple spatial and temporal scales.

Spatial representation is good, with all products having full coverage of LIS. However, several of the datasets pertain to areas larger than LIS (e.g., the oceanographic and meteorological data), and may not accurately represent the spatial variability within LIS. For some of these variables (e.g., stratification), more representative maps could be developed using the local-scale data available on the LISICOS website (LISICOS, 2018).

Temporal representation is also good in the underlying raw data, e.g., there are multi-decade records of water quality variables readily available. However, some of the existing map products represent discrete time periods in the form of seasonal or annual long-term averages. These products may not accurately represent the temporal variability within LIS.

Lastly, some of the available maps use underlying datasets that do not represent or integrate the most current information available (e.g., the hypoxia map shown in Figure 11-1 is 5 years old).

11.2.3 Data Gaps and Availability of Data to Address Gaps

Experts have indicated that there are major gaps in the coverage and extent of some physical oceanography and water quality data in Long Island Sound. One important example are turbidity or suspended sediment data. The total suspended solids data collected by the CT DEEP Long Island Sound Water Quality Monitoring Program may be inadequate for particular uses including the establishment of a baseline range of total suspended solids in LIS.

In addition, there may be gaps within the suite of existing completed map products that use these data. The existing map products have been developed for specific purposes (e.g., to support monitoring and management of hypoxia conditions), and may not reflect all of the needs of the Blue Plan effort. For example, the maps of oceanographic variables are regional in scale (i.e., broader than LIS) and do not adequately represent fine-scale patterns in LIS. Experts indicated that they would prefer maps scaled-down to LIS. To address these types of gaps, the CT DEEP Long Island Sound Water Quality Monitoring data could be used to map these variables (e.g., temperature) on spatial and temporal scales more appropriate to LIS and the Blue Plan effort.

11.3 Additional Context

Water quality characteristics drive patterns in LIS habitats, organisms, and their variability in space and time. It could be useful to examine spatial and temporal patterns in the biology and habitats of LIS to determine the scale(s) useful for portraying physical oceanography, meteorology, and water quality parameters.

Long-term records in oceanographic, meteorological, and water quality data likely reflect the changing climate. These patterns, and climate in general as a driver, should also be considered when interpreting the available data or developing new map products.

11.4 References

Capriulo, G. M., Smith, G., Troy, R., Wikfors, G. H., Pellet, J., & Yarish, C. (2002, May). The planktonic food web structure of a temperate zone estuary, and its alteration due to eutrophication. *Hydrobiologia, 475*(1), 263–333.

CT DEEP. (2017, May 2). *Long Island Sound Water Quality Monitoring Program and Information*. Retrieved Feb 5, 2018, from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2719&q=325570&deepNav_GID=1635

CT DEEP. (2018, February 5). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635

Electric Power Resource Institute. (2014). *Ocean wave resource potential*. Retrieved from NYGIG metadata: http://opdgig.dos.ny.gov/geoportal/catalog/search/resource/detailsnoheader.page?uuid=%7b052C3538-9155-4095-9975-C06B5550093C%7d

LISICOS. (2018, February). *Long Island Sound Integrated Coastal Observing System (LISICOS)*. Retrieved from University of Connecticut: http://lisicos.uconn.edu/

Louis Berger and University of Connecticut. (2016, November). *Supplemental Environmental Impact Statement for the Designation of Dredged Material Disposal Site(s) in Eastern Long Island Sound, Connecticut, and New York.* Retrieved from https://www.epa.gov/sites/production/files/2016-11/documents/elis_fseis_-_full_report_with_appendices_submitted_04nov16.pdf

Mid-Atlantic Regional Planning Body. (2018). *Mid-Atlantic Ocean Data Portal*. Retrieved from portal.midatlanticocean.org

NERACOOS. (2018). *Homepage*. Retrieved from Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS): http://www.neracoos.org

NOAA NCCOS. (2014a). *Sea surface temperature - long-term average*. Retrieved from NYGIG metadata: http://opdgig.dos.ny.gov/geoportal/catalog/search/resource/detailsnoheader.page?uuid=%7b4B45E078-63D1-478D-A165-CBE3DCB14ED9%7d

NOAA NCCOS. (2014b). *Turbidity - Long-term average*. Retrieved from NYGIG metadata: http://opdgig.dos.ny.gov/geoportal/catalog/search/resource/detailsnoheader.page?uuid={07288051-B16F-4CE9-A6EA-76F9D276DB8C}

NOAA NCCOS. (2014c). *Water column stratification - Long-term average*. Retrieved from NYGIG metadata: http://opdgig.dos.ny.gov/geoportal/catalog/search/resource/detailsnoheader.page?uuid=%7b3646B9FF-5F1E-407A-89C7-412740C1B3D8%7d

Northeast Ocean Data Portal. (2016). *FVCOM Annual Climatology for Temperature, Stratification, and Currents (1978-2013) Northeast United States*. Retrieved from Northeast Ocean Data Portal metadata: http://www.northeastoceandata.org/files/metadata/Themes/Habitat/FVCOMAnnualClimatology.pdf

Northeast Ocean Data Working Group. (2018). *Northeast Ocean Data Portal*. Retrieved from www.northeastoceandata.org

Northeast Regional Planning Body. (2014). *No Discharge Zones*. Retrieved from Northeast Ocean Data Portal metadata: http://www.northeastoceandata.org/files/metadata/Themes/WaterQuality/NoDischargeZones.pdf

Northeast Regional Planning Body. (2018). *Northeast Ocean Data Portal*. Retrieved from www.northeastoceandata.org

NYDOS. (2018). *New York Geographic Information Gateway*. Retrieved from New York Department of State Office of Planning and Development: http://opdgig.dos.ny.gov/#/home

O'Donnell, J., Wilson, R. E., Lwiza, K., Whitney, M., Frank Bohlen, W., Codiga, D., . . . Varekamp, J. (2014). The physical oceanography of Long Island Sound. In J. S. Latimer, M. A. Tedesco, R. Lawrence Swanson, C. Yarish, P. E. Stacey, & C. Garza, *Long Island Sound: Prospects for the urban sea* (p. 558). New York: Springer.

Rutgers University. (2016). *Fronts: Seasonal max values*. Retrieved from Mid-Atlantic Ocean Data Portal Metadata: http://portal.midatlanticocean.org/static/data_manager/metadata/html/Fronts_SeasonalMax.html

Schwartz, M., Heimiller, D., Haymes, S., & Musial, W. (2010). *Assessment of offshore wind energy resources for the United States.* NREL Technical Report TP-500-45889.

USDOE. (2014). *Tidal stream resource potential - mean current*. Retrieved from NYGIG metadata: http://opdgig.dos.ny.gov/geoportal/catalog/search/resource/detailsnoheader.page?uuid=%7b286FAA27-CF09-475A-A608-9AABA22D80C7%7d

USEPA Office of Water. (2015). *TMDLs on impaired waters NHDPlus indexed dataset; 303(d) Listed impaired waters NHDPlus indexed dataset; Wastewater discharges*. Retrieved from EPA EDG: https://edg.epa.gov/metadata/catalog/search/resource/details.page?uuid=%7B88E53742-CF0D-443C-94AF-8139C09471F9%7D

11.5 Appendices

11.5.1 List of Maps Used to Inform the Chapter

Data highlighted in grey are included in the Inventory and were discussed during expert webinars. In addition to the links provided below, each grey dataset is accompanied by a reference, citation, or link within the text in the Inventory.

The un-highlighted (white) data rows were also discussed during expert webinars. These data were either identified in the Rapid Assessment or mentioned by experts as credible sources of data that may not be relevant to the Blue Plan effort. Example reasons include the older age of the dataset, limited overall availability, lack of spatial data products, too limited or too broad spatial/temporal scope, or that other LIS datasets were preferred. Many of these un-highlighted datasets are described in *Section 11.3 Additional Context*, and most are described further in the map books associated with the expert webinars (CT DEEP, 2018).

Table 11-2: Physical Oceanography, Meteorology, and Water Quality Datasets Used to Inform the Chapter or Discussed During Expert Webinars

CATEGORY	DATASET/LAYER	ADVANCED FROM RAPID ASSESSMENT TO INVENTORY	ADDED TO INVENTORY FROM EXPERT REVIEW
Physical oceanography, including water quality and meteorology	**CT DEEP Water Quality Monitoring Program data** (CT DEEP, 2017)	**X**	
Physical oceanography, including water quality and meteorology	**CT DEEP hypoxia frequency 1991-2012** (CT DEEP, 2017)	**X**	
Physical oceanography, including water quality and meteorology	**Sea surface temperature, stratification, and turbidity: long-term average (spring, summer, fall, winter)** (NOAA NCCOS, 2014a; NOAA NCCOS, 2014b; NOAA NCCOS, 2014c)	**X**	
Physical oceanography, including water quality and meteorology	**Sea surface temperature fronts, season max** (Rutgers University, 2016)	**X**	
Physical oceanography, including water quality and meteorology	**Surface and bottom current speed, long-term average** (Northeast Ocean Data Portal, 2016)	**X**	
Physical oceanography, including water quality and meteorology	**Ocean wave resource potential** (Electric Power Resource Institute, 2014)	**X**	
Physical oceanography, including water quality and meteorology	**Tidal stream resource potential, mean current and mean power density** (USDOE, 2014)	**X**	

CATEGORY	DATASET/LAYER	ADVANCED FROM RAPID ASSESSMENT TO INVENTORY	ADDED TO INVENTORY FROM EXPERT REVIEW
Physical oceanography, including water quality and meteorology	**Annual mean offshore wind speed** (Schwartz, Heimiller, Haymes, & Musial, 2010)	**X**	
Physical oceanography, including water quality and meteorology	**Impaired rivers or coastline, Impaired water bodies, TMDL rivers or coastline, TMDL water bodies, and Wastewater discharges datasets** (USEPA Office of Water, 2015)	**X**	
Physical oceanography, including water quality and meteorology	**No discharge zones** (Northeast Regional Planning Body, 2014)		
Physical oceanography, including water quality and meteorology	**LISICOS buoy data** (LISICOS, 2018)		**X**
Physical oceanography, including water quality and meteorology	**Supplemental Environmental Impact Statement for the Designation of Dredged Material Disposal Site(s) in Eastern Long Island Sound, Connecticut, and New York** (Louis Berger and University of Connecticut, 2016)		**X**
Physical oceanography, including water quality and meteorology	**CT DEEP water quality and hypoxia maps** (CT DEEP, 2017)		**X**
Physical oceanography, including water quality and meteorology	**CT DEEP water quality summary in LIS Prospects for the Urban Sea** (O'Donnell, et al., 2014)		**X**

CATEGORY	DATASET/LAYER	ADVANCED FROM RAPID ASSESSMENT TO INVENTORY	ADDED TO INVENTORY FROM EXPERT REVIEW
Physical oceanography, including water quality and meteorology	Bottom stress: UConn, O'Donnell		
Physical oceanography, including water quality and meteorology	The planktonic food web structure of a temperate zone estuary, and its alteration due to eutrophication (Capriulo, et al., 2002)		

11.5.2 Notes on Ecological Expert Input

Because of the importance of this topic to both physical and biological processes in LIS, expert input was obtained on physical oceanography, meteorology, and water quality datasets during the "Benthic Physical Habitat" and "Benthic Biological Habitat" expert webinars. Map books for each webinar and links to webinar recordings can be found on the Long Island Sound Blue Plan website (CT DEEP, 2018).

Chapter 12

Ecologically Notable Places and Ecological Marine Units

Chapter Table of Contents

Chapter List of Figures and Tables

Figures

Tables

12.1 Key Data and Map Products

The data described in this chapter are somewhat different from datasets described in other chapters of the Ecological Inventory in that these data and map products represent syntheses of many different types of ecological data, some previously discussed.

The map products discussed here were assembled and integrated by a team at The Nature Conservancy (TNC) for a project called the Long Island Sound Ecological Assessment (LISEA) (Anderson & Frohling, 2015). The TNC team worked with scientists in the region to obtain and understand datasets relating to the ecology of Long Island Sound (LIS). The purpose of LISEA was to enhance the understanding of ecologically notable places in LIS and the surrounding waters of Block Island Sound and the Peconic Estuary, to support the conservation of ecologically and biological significant resources in LIS, and to contribute to the growing body of methods and approaches for identifying ecologically significant resources within estuaries. The major outputs of LISEA are summarized below, but the full report should be consulted for detail about the methods and underlying data (Anderson & Frohling, 2015).

Ecologically Notable Places (ENPs) are defined by TNC according to four criteria, any number of which may be met in order to be considered an ENP: (1) geographic areas with sustained levels of marine diversity (species persistence); (2) geographic areas of diverse and complex bottom habitat types (seafloor complexity); (3) geographic areas that perform or serve notable ecological functions (e.g., seagrass); (4) geographic areas with usual or rare species and/or habitats.

LISEA had two major results. The first was the identification of ENPs, through the assessment of biological data (fisheries, using Connecticut Department of Energy and Environmental Protection (CT DEEP) survey data, 1984-2009) plus areas of seafloor complexity. LISEA adopted the 1x2 minute rectangle assessment units used by CT DEEP for their analysis of species persistence. Data were grouped into 8- or 9-year intervals and corrected for survey effort and catchability. For each species, each rectangle was scored based on persistence for each time interval. A metric of weighted persistence was developed to describe persistence while accounting for the relative level of detection not explained by survey effort. There were 114 species examined in this way. Maps of weighted persistence were developed and interpreted by groups for demersal fish, pelagic fish, diadromous fish, and invertebrates to identify ENPs. ENPs were rectangles where the number of species in a group with high weighted persistence relative to other rectangles were 1 standard deviation above the mean or greater. Pelagic and diadromous fish ENPs (“water column portfolio”) were overlaid with delineations of seafloor complexity, seagrass, and demersal and invertebrate ENPs (“seafloor portfolio”) to create an integrated portfolio of ENPs in LIS (Figure 12-1).

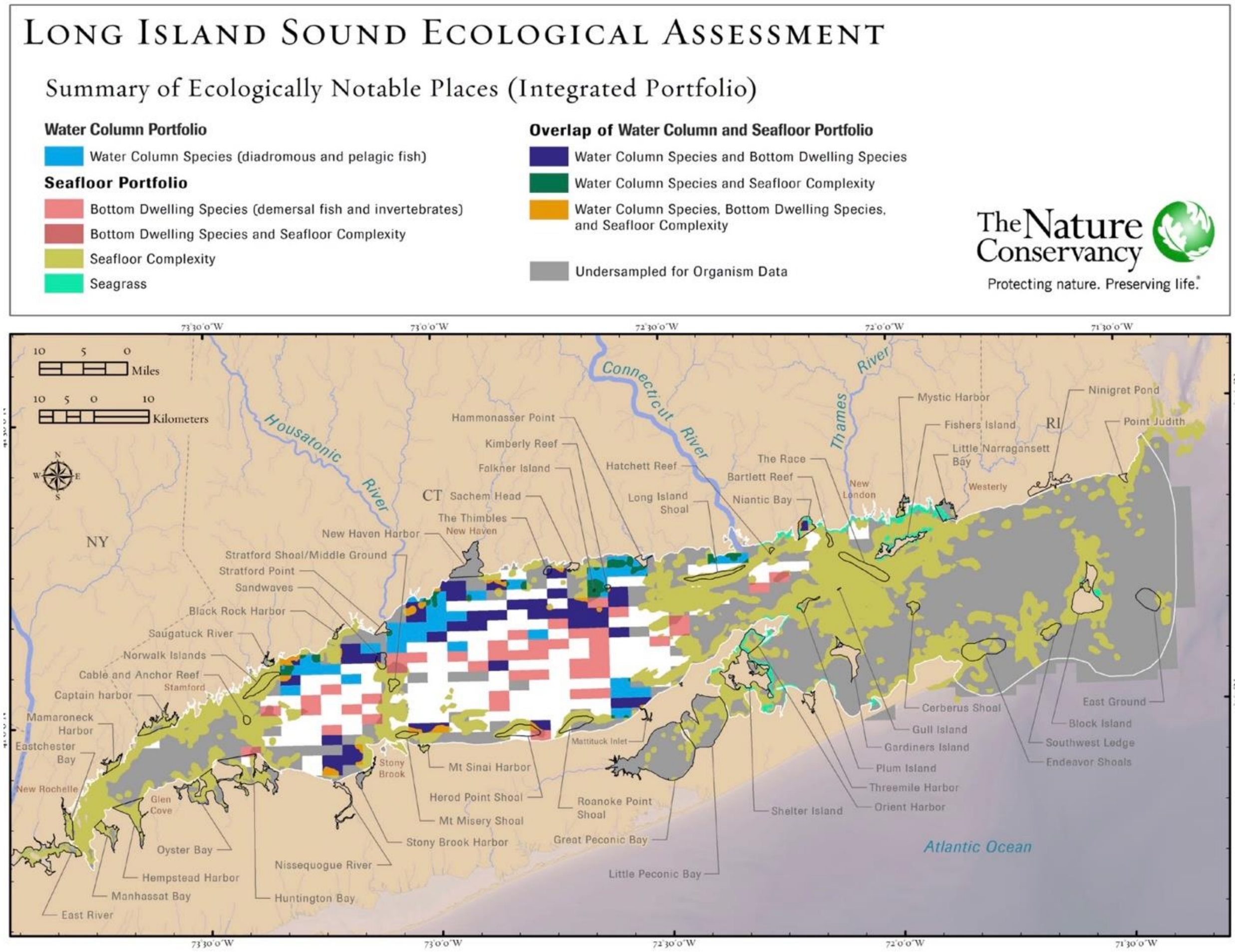


Figure 12-1: Ecologically Notable Places in Long Island Sound. This map from the LISEA report shows persistence areas for pelagic and diadromous fish species ("water column portfolio") with delineations of seafloor complexity, seagrass, and demersal and invertebrate ENPs ("seafloor portfolio") (Anderson & Frohling, 2015).

The second major result of LISEA was the identification of seafloor habitats described as Ecological Marine Units (EMUs). EMUs are a combination of depth (National Oceanic and Atmospheric Administration (NOAA) Coastal Relief Model (CRM), 83 m resolution), sediment type (U.S. Geological Survey and Stony Brook University data) and seabed forms. Depth and sediment thresholds were defined by benthic community analysis of 1,321 benthic grab samples (Anderson & Frohling, 2015; Cerrato, Flood, & Holt, 2009; Cerrato, Flood, & Holt, 2010; Cerrato & Maher, 2007; Pelligrino & Hubbard, 1983; Theroux & Wigley, 1998). Seabed forms were delineated using the Landscape Position Index and slope of the NOAA CRM. The final EMU map shows 14 classes. With the EMU layer, TNC overlaid sediment types (silt, sand, and gravel), areas of known hard bottom, and areas of predicted hard bottom (Figure 12-2).

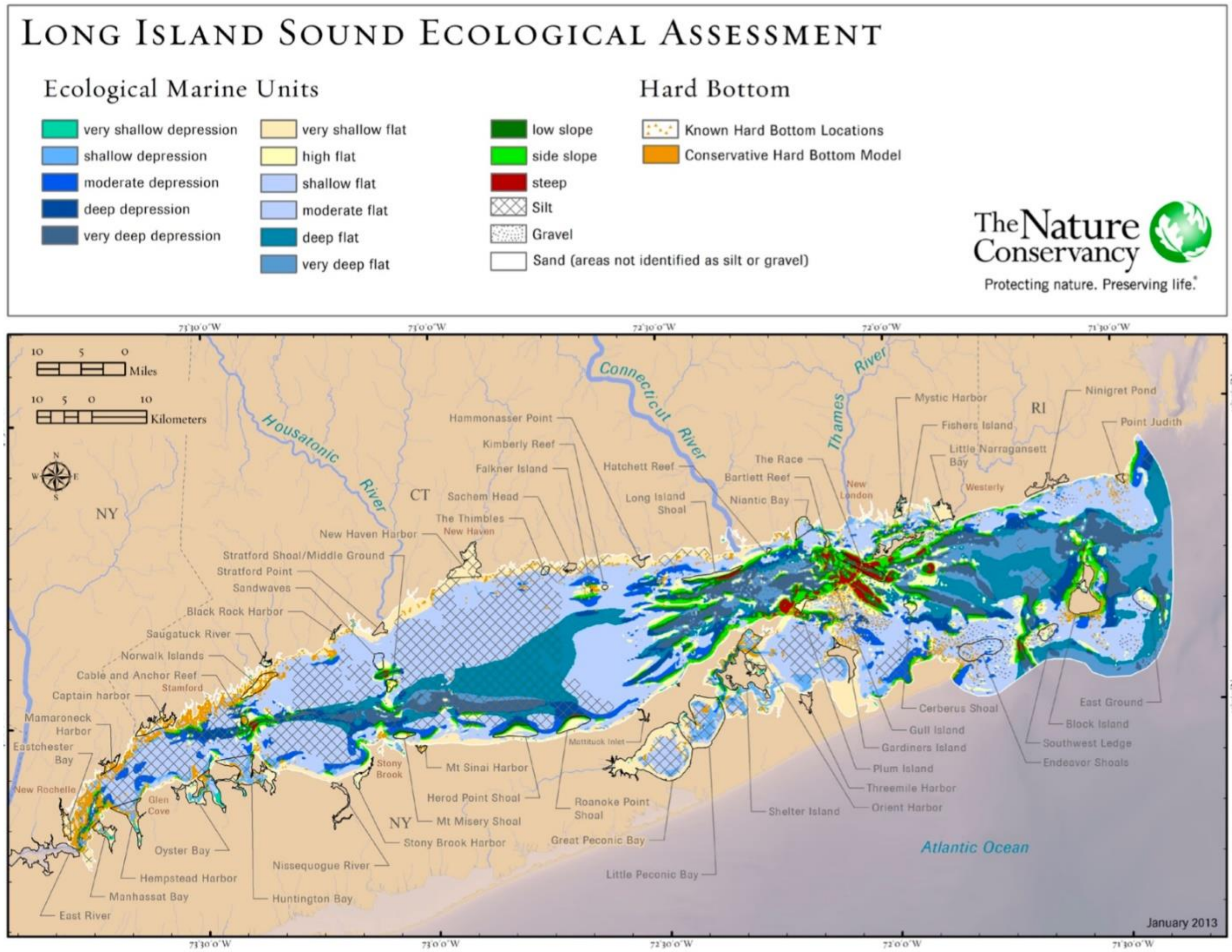


Figure 12-2: [Ecological Marine Units in Long Island Sound](). The 14 types of EMUs are combinations of depth and sediment type (with threshold defined by benthic communities), and seabed forms. Sediment types and hard bottom locations are also shown (Anderson & Frohling, 2015).

12.2 Assessment of Data Quality

12.2.1 Sources of Data and Metadata

All of the [LISEA]() data, metadata, and map products are available via the report and the GIS dataset is available from The Nature Conservancy via the web link above (Anderson & Frohling, 2015). The report describes the methods used to develop the map products in detail.

12.2.2 Accuracy, Representativeness, and Relevance of Map Products

The LISEA datasets described above are relevant to the Blue Plan effort. The LISEA outputs are completed map products that integrate multiple individual datasets in an interpretive way for a specific purpose. As such, these products should also be examined to understand the underlying source data and methods that may influence the assessment of their accuracy and representativeness. In addition, some of these syntheses use underlying datasets that do not represent the most current information available (e.g., LISEA uses 2006 eelgrass data).

12.2.3 Data Gaps and Availability of Data to Address Gaps

Some of high-level data gaps in the LISEA outputs are described in the report. For example, nearshore marine life in general, but also plankton, salt marsh, migratory or diving birds, marine mammals, shellfish and other habitat-forming species, and migratory corridors were not included in the assessment and delineation of ENPs (Anderson & Frohling, 2015). Other datasets in this inventory could be used to complement the LISEA products and at least partly address these gaps.

The gaps and limitations of the Long Island Sound Trawl Survey dataset used in the identification of ENPs are described in *Chapter 6 Fish, Pelagic Invertebrates, Shellfish, and Zooplankton*. Briefly, that survey does not sample the entire LIS and especially does not adequately sample complex habitat and some pelagic species, so the resulting ENPs can be considered to reflect gaps in those species/habitats as well. Estuarine seine data and coastal trawls could be used to help fill these gaps (CT DEEP, 2016; Harris, Fraboni, Cantatore, & Cooper, 2014; Maritime Aquarium, 2018).

Finally, LISEA was not able to include at least 4 rare species in their analyses (Anderson & Frohling, 2015).

12.3 Additional Context

LISEA data products were also discussed in *Chapter 6 Fish, Pelagic Invertebrates, Shellfish, and Zooplankton*; *Chapter 7 Benthic Invertebrates*; *Chapter 9 Bathymetry and Seafloor Complexity*; and *Chapter 10 Sediments and Geochemistry*.

The LISEA effort was modeled after the methods and approaches of the TNC Northwest Atlantic Marine Ecological Assessment (Greene, Anderson, Odell, & Steinberg, 2010). Both of these projects represent one way to integrate a variety of physical and biological information into a set of ecological map products. As discussed in other chapters (e.g., *Chapter 7 Benthic Invertebrates),* there have been several different approaches used in the Northeast region to integrate ecological data to represent habitats or areas spatially. The Habitat mapping and classification in the Northeast USA story map on the Northeast Ocean Data Portal provides a broad overview of the approaches in the region (Northeast Regional Planning Body, 2018).

12.4 References

Anderson, M., & Frohling, N. (2015). The Long Island Sound Ecological Assessment. The Nature Conservancy.

Cerrato, R. M., & Maher, N. P. (2007). *Benthic mapping for habitat classification in the Peconic Estuary: Phase I.* Marine Sciences Research Center Special Report No. 134. Stony Brook: Stony Brook University.

Cerrato, R. M., Flood, R. D., & Holt, L. C. (2009). *Benthic mapping for habitat classification in the Peconic Estuary: Phase II ground truth studies.* Final Report to Suffolk County Office of Ecology. Marine Sciences Research Center Special Report No. 136. Stony Brook: Stony Brook University.

Cerrato, R. M., Flood, R. D., & Holt, L. C. (2010). *Benthic mapping for habitat classification in the Peconic Estuary: Phase III ground truth studies.* Final Report to Suffolk County Office of Ecology. Marine Sciences Research Center Special Report No. 137. Stony Brook: Stony Brook University.

CT DEEP. (2016). *A study of marine recreational fisheries in Connecticut.* Connecticut Department of Energy and Environmental Protection, Marine Fisheries Program.

CT DEEP. (2018, February 5). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635

Greene, J. K., Anderson, M. G., Odell, J., & Steinberg, N. (2010). *The Northwest Atlantic Marine Ecoregional Assessment: Species, Habitats and Ecosystems. Phase One.* . Boston, MA: The Nature Conservancy, Eastern Division.

Harris, R., Fraboni, P., Cantatore, N., & Cooper, J. (2014). *Harbor Watch, a Program of Earthplace Report on Norwalk Harbor Juvenile Benthic Marine Fish May through October 2014.* Harbor Watch.

Maritime Aquarium. (2018). *The Long Island Sound Biodiversity Database*. Retrieved from The Maritime Aquarium: https://www.maritimeaquarium.org/biodiversity

Northeast Regional Planning Body. (2018). *Northeast Ocean Data Portal*. Retrieved from www.northeastoceandata.org

Pelligrino, P., & Hubbard, W. (1983). *Baseline shellfish data for the assessment of potential environmental impacts associated with energy activities in Connecticut's coastal zone: volumes I & II.* Hartford, CT: Report to the State of Connecticut. Department of Agriculture, Aquaculture Division.

Theroux, R. B., & Wigley, R. L. (1998). *Quantitative composition and distribution of the macrobenthic invertebrate fauna of the continental shelf ecosystems of the northeastern United States.* US Dept of Commerce. NOAA Technical Report NMFS 140.

12.5 Appendices

12.5.1 List of Maps Used to Inform the Chapter

Data highlighted in grey are included in the Inventory and were discussed during expert webinars. In addition to the links provided below, each grey dataset is accompanied by a reference, citation, or link within the text in the Inventory.

The un-highlighted (white) data rows were also discussed during expert webinars. These data were either identified in the Rapid Assessment or mentioned by experts as credible sources of data that may not be relevant to the Blue Plan effort. Example reasons include the older age of the dataset, limited overall availability, lack of spatial data products, too limited or too broad spatial/temporal scope, or that other LIS datasets were preferred. Many of these un-highlighted datasets are described in *Section 12.3 Additional Context*, and most are described further in the map books associated with the expert webinars (CT DEEP, 2018).

Table 12-1: Ecologically Notable Places and Ecological Marine Units Datasets Used to Inform the Chapter or Discussed During Expert Webinars

CATEGORY	DATASET/LAYER	ADVANCED FROM RAPID ASSESSMENT TO INVENTORY	ADDED TO INVENTORY FROM EXPERT REVIEW
Ecologically Notable Places	**LISEA ENPs: water column portfolio, seafloor portfolio, integrated portfolio**	**X**	
Ecological Marine Units	**LISEA EMUs**	**X**	

12.5.2 Notes on Ecological Expert Input

Expert input was obtained on Ecologically Notable Places and Ecological Marine Units during the “Benthic Physical Habitat” and “Benthic Biological Habitat” expert webinars. Elements of LISEA outputs (e.g., fish persistence products) were also discussed in the “Fish” expert webinar. Map books for each webinar and links to webinar recordings can be found on the Long Island Sound Blue Plan website (CT DEEP, 2018).

Chapter 13

Ecologically Significant Areas

<u>Chapter List of Figures and Tables</u>

Figures

The fourth category of natural resources listed in the Blue Plan legislation (Public Act No. 15-66, Section 1(b)), is “ecologically significant areas”. This inventory represents the data that was used – or built on – to define the Ecologically Significant Areas (ESAs). Final ESAs and their supporting documentation will be include in the Blue Plan, Chapter 3 Section 3.4.

The Blue Plan Ecological Characterization Work Team and technical experts agree that a collaborative, technical, and science-based approach to characterizing ESAs was needed. The process could begin by considering the data described in this Ecological Inventory. An Ecological Experts group would review the Inventory and potentially recommend any data development tasks that would be needed to improve existing map products, or generate new map products from existing data, that would enable a more complete Long Island Sound Ecological Characterization.

Considering the results of the Ecological Characterization, the Ecological Characterization Work Team and the Ecological Experts group could then work together to develop a definition of Ecologically Significant Areas. Next, a number of approaches for characterizing ESAs could be considered, with continued guidance from the Ecological Experts group. For example, a Delphic or more informal process could be established with the Ecological Experts where spatial information is produced directly from the experts (e.g., via participatory mapping exercises) about what they consider to be “ecologically significant” in LIS. Once ESAs are identified, their descriptions and methods used to characterize them can be added to the Ecological Inventory (Figure 13-1).

Several of the maps and data products discussed in this inventory are already the result of expert- and data-driven collaborative processes. For example, NOAA Environmental Sensitivity Index (ESI) maps were developed by assembling many different data sources and experts’ input to products that “show where…most sensitive species, life stages, and locations exist (NOAA ORR, 2018).” The resulting maps identify areas that are generally vulnerable to oil spills and other coastal hazards. ESI map products are discussed throughout this inventory, as they pertain to multiple ecosystem components. Another example is the Audubon Important Bird Areas (IBAs) dataset, the development of which was guided by and IBA Technical Committee who developed the four IBA criteria and provide technical guidance on the identification of IBAs (Audubon, 2018). The criteria focus on species’ conservation status, range, and vulnerabilities due to habitat needs or behaviors. The IBA dataset and criteria are further discussed in Chapter 5

Birds. A final example of an expert- and data-driven process to delineate important areas is the NOAA Essential Fish Habitat (EFH) dataset (NOAA NMFS, 2018). The EFH delineation process used several sources of data on fish presence/absence, density, growth, reproduction, survival, and production, in addition to expert judgment and experience. The result is a series of areas important to various species and life stages of fish, which can be used for fishery management and conservation (NOAA NMFS, 2018). EFH maps are included in the discussion of fish dataset in Chapter 6 Fish, Pelagic Invertebrates, Shellfish, and Zooplankton. These examples demonstrate the usefulness of a process that combines data with expert knowledge and experience to develop spatial products and tools.

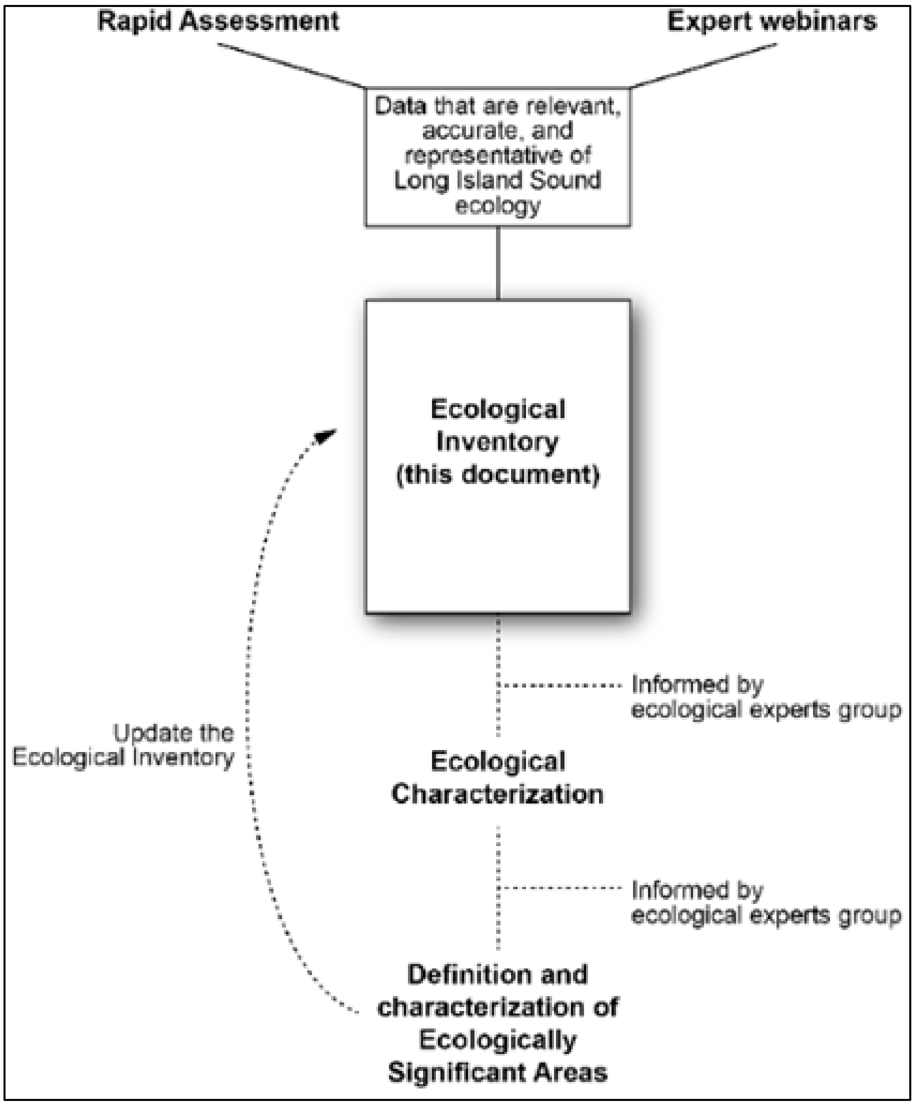


Figure 13-1: Ecological Characterization and Ecologically Significant Areas Determination Workflow Diagram. This diagram illustrates the process by which ecological information has been and could continue to be integrated into the Ecological Inventory and the process by which Ecologically Significant Areas could be included.

References

Audubon. (2018, February 6). *Important Bird Areas*. Retrieved from Audubon: http://www.audubon.org/important-bird-areas

NOAA NMFS. (2018, February 6). *Essential Fish Habitat Mapper*. Retrieved from NOAA National Marine Fisheries Service, Habitat Conservation, Habitat Protection: https://www.habitat.noaa.gov/protection/efh/efhmapper/

NOAA ORR. (2018, February 5). *Environmental Sensitivity Index (ESI) Maps*. Retrieved from NOAA Office of Response and Restoration: https://response.restoration.noaa.gov/maps-and-spatial-data/environmental-sensitivity-index-esi-maps.html

Chapter 14

Human Use Characterization Process

Regardless of its ecological attributes, Long Island Sound would not need a Blue Plan if it were not heavily used by humans. The Sound's coastal communities are also home to more than 4 million people, and the Sound's watershed includes nearly 9 million people. The Sound is used by ferries, ships, and barges to transport people and goods into deep water harbors. Commercial and recreational fishers and shellfishers are active throughout the Sound, as are boaters, birdwatchers and many other use sectors. All human activities in the Sound generate about $9.4 billion annually (adjusted for inflation in 2015 dollars) in the regional economy. With the uses it serves and the recreational opportunities it provides, Long Island Sound is among the most important and valuable estuaries in the nation. In 1987, Congress designated Long Island Sound an Estuary of National Significance.

Accordingly, the Blue Plan legislation (Public Act No. 15-66, Section 1(b)), required the resource and use inventory to be comprised of the best available information and data regarding "uses of [Long Island Sound] waters and substrates, including, but not limited to: (i) Recreational and commercial boating, (ii) recreational and commercial fishing, (iii) waterfowl hunting, (iv) shellfish beds, (v) aquaculture facilities, (vi) shipping corridors, (vii) energy facilities, and (viii) electric power line, gas pipeline and telecommunications crossings."

While considerable Human Use data is available from sources such as the Northeast Ocean Data Portal and the CT Aquaculture Atlas, the data tend not to be as organized or accessible as the more scientific ecological data, and much information resides within the personal knowledge of users and stakeholders. As a first step in accessing this knowledge base, Sea Grant intern Ariana Spawn coordinated a compilation of contacts for a wide variety of use sectors, groups and organizations. This master list of contacts included over 600 names or points of contact, making it somewhat unwieldy as a tool for data gathering. However, further development of such a large list would be difficult.

As such, the Human Use Characterization Work Team applied its sector-based knowledge and experience to refine the master list into a priority list of users, grouped according to sector. Each sector or group of sectors was assigned to a member of the Blue Plan Advisory Committee who represented or was familiar with that sector, supported by staff from one of the Blue Plan partner organizations. Rather than scheduling a series of webinars from the outset, each sector was engaged through a targeted approach based on the numbers of participants, the nature and sensitivity of the issues associated with each group. For some sectors with larger numbers of participants, such as recreational fishing, webinars were employed and supplemented with more direct contacts; but other sectors with smaller numbers of participants such as shipping and national security relied on in-person meetings and direct communications.

For each use sector, a "data template" was created which provided example maps and essential metadata that could be used to assess its relevance, representativeness, and accuracy. Unlike the ecological data, human use data is more likely to be developed according to political boundaries, so that many data sources are specific to Connecticut or New York. This situation has created some inconsistencies and data gaps which are discussed in each chapter.

For purposes of the Inventory, the primary human use sectors were grouped into five main topics. As shown below, stakeholder and user feedback was obtained via webinars and other methods (Table 14-1). At least 60 experts contributed across the five webinars, some being contacted for multiple sectors.

Table 14-1: Human Use Sector Topic Areas, Outreach Methods, and Stakeholders Engaged

Human Use Sector Topic Area	Outreach Methods	Approximate Number of Stakeholders Who Reviewed Spatial Data
Fish and Shellfish Activities • Aquaculture • Commercial Fishing • Recreational Fishing • Charter/Party Boat Fishing	Personal interviews, meetings, webinar, newsletter notice	45
Recreation and Tourism • Recreational Boating and Sailing • Harbors and Marinas • Non-Consumptive Recreation • Waterfowl Hunting	Personal interviews, meetings, webinars	82
Cultural Resources and Education • Historic and Archaeological Marine and Coastal Cultural Resources • Research and Education	Personal interviews, meetings, webinar, conferences, emails	18
Marine Transportation, Infrastructure, and Security • Marine Transportation, Navigation, and Infrastructure • Energy and Telecommunications • National Security	Personal interviews, meetings, webinars, emails	53

Users and stakeholders reviewed and discussed the data templates that were prepared and distributed as Map Books prior to the applicable webinar or meeting. Sector experts also suggested additional spatial and non-spatial datasets and contributed their knowledge and experience on each topic.

The purpose of this Inventory is to assemble datasets that are relevant, representative and accurate in conveying the human uses of Long Island Sound. The Inventory represents datasets that have been obtained by the Blue Plan team (or are scheduled to be obtained in the immediate future), and are available to be used to support a Human Use Characterization process. Data from the inventory that are carried forward to support the Human Use Characterization are potentially also applicable to identifying Significant Use Areas, depending on the approach chosen.

Chapter 15

Aquaculture

Chapter Table of Contents

Chapter List of Figures and Tables

Figures

Tables

None

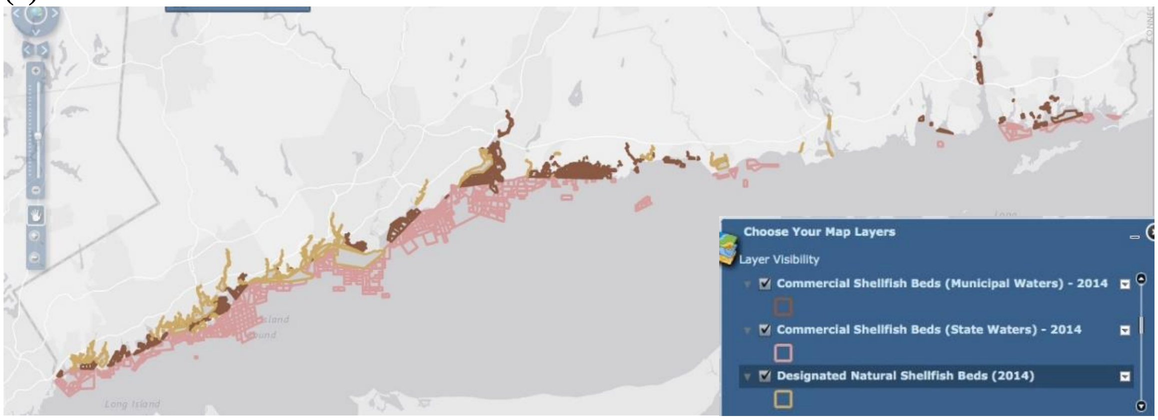
15.1 Key Data and Map Products

Shellfish have been harvested from Long Island Sound (LIS) since pre-colonial periods, and their culture now constitute an important economic and cultural sector in LIS. The following sections will document geospatial information and tools important to the sectors and its management.

The Aquaculture Mapping Atlas seems to capture most of the relevant geospatial information on shellfish aquaculture in CT, including state and town commercial leases, aquaculture gear sites, shellfish classifications areas, water quality sampling sites for classification, summarizing on one site the information relevant to the shellfish aquaculture (UConn CLEAR, 2018). The latest revision of the Aquaculture Mapping Atlas also added information on aquaculture operations, including the location of hatcheries, upwellers, cages and trays. Some examples of relevant maps are presented in Figures 15-1 and 15-2.

In 1881 a line was established, referred to as the Commissioners line that divides the waters of the state into a northern and southern section. All beds south of this line are State beds and most beds north of this line are town beds (Figure 15-3). The Connecticut Department of Agriculture Bureau of Aquaculture (CT DA/BA) still controls all the licensing and regulations north and south of this line, for example CT DA/BA determines when an area will be closed to shellfishing due to a change in water quality and what licenses are need to do certain work. All the beds under state jurisdiction were mapped using longitude/latitude data from a CT DA/BA access database (Figure 15-1). These coordinates were taken from converted sextant angles.

(a)



(b)

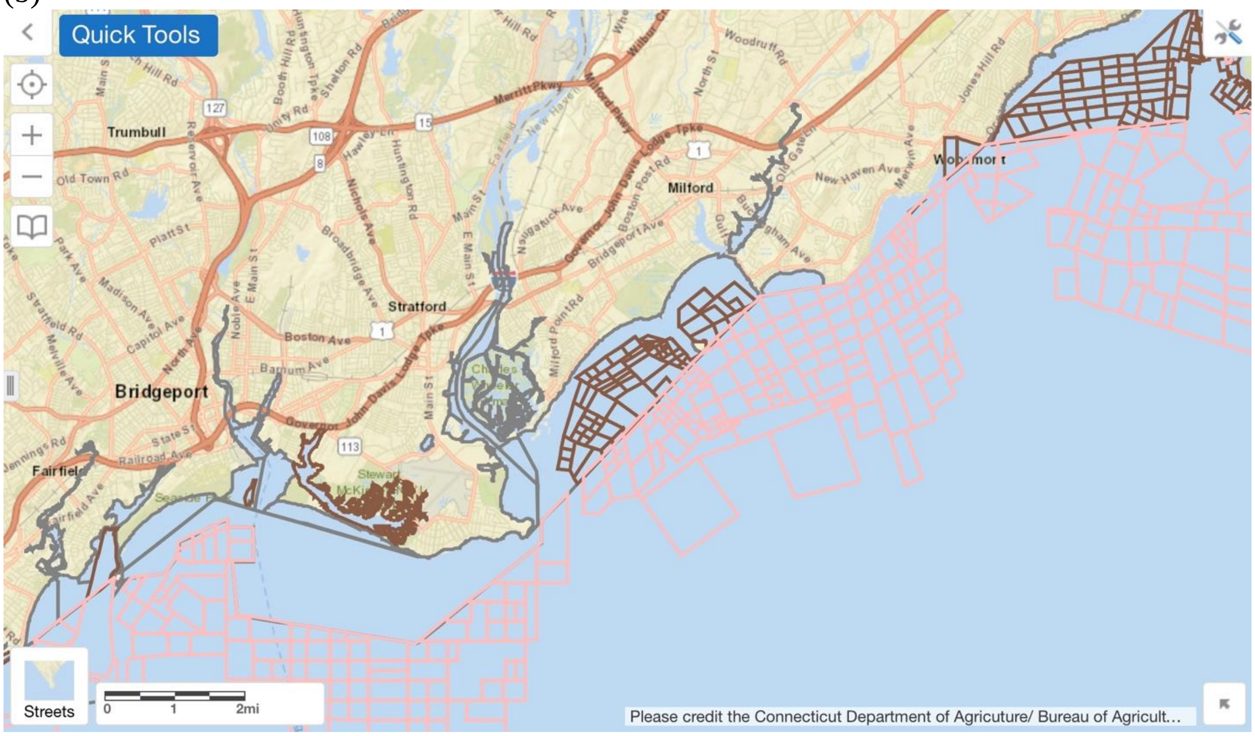
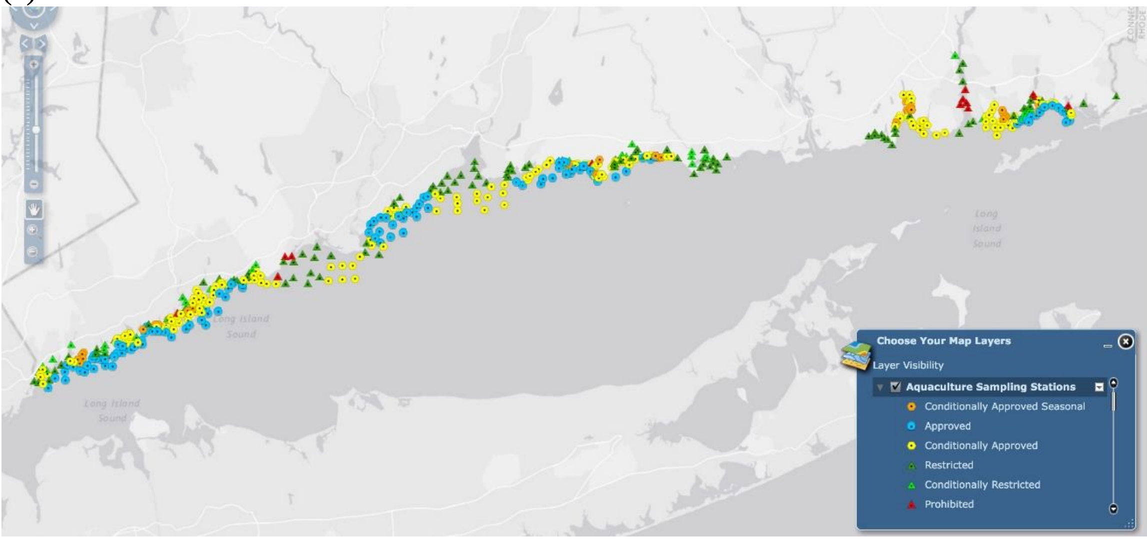


Figure 15-1: [Connecticut Commercial Shellfish Beds (Municipal and State Waters) and Designated Natural Shellfish Beds](). The map of these shellfish beds is shown at (a) the whole state scale, and (b) a zoomed-scale at the mouth of the Housatonic River. Access available via the Aquaculture Mapping Atlas. (UConn CLEAR, 2018).

(a)



(b)

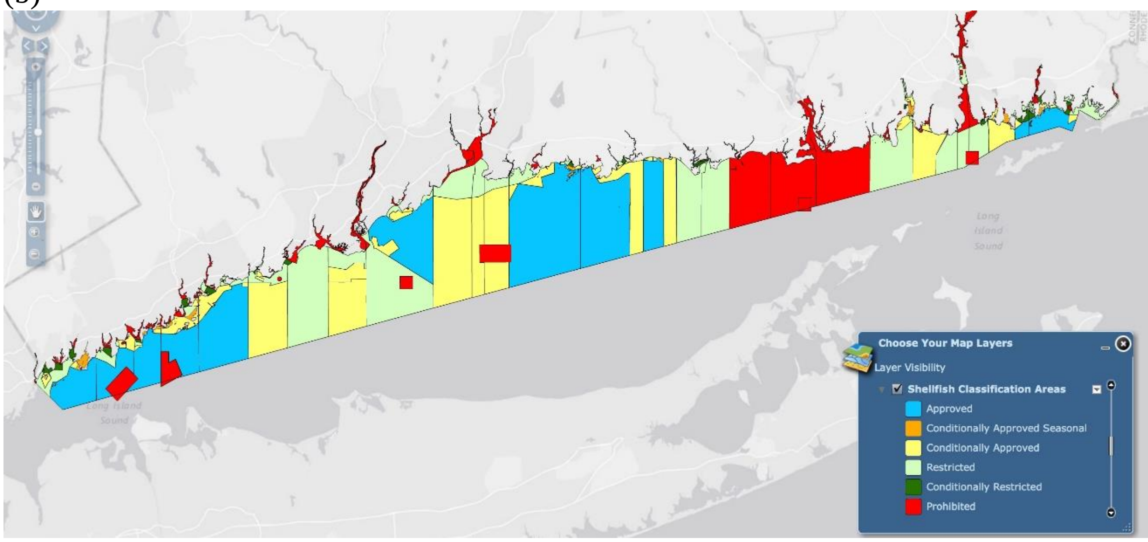


Figure 15-2: [Connecticut Water Quality Sampling Stations and Shellfish Harvest Classification Areas](). Sampling stations, illustrated in (a), help determine the classification designations for the shellfish harvest areas in municipal and state waters, illustrated in (b). Access available via the Aquaculture Mapping Atlas (UConn CLEAR, 2018).

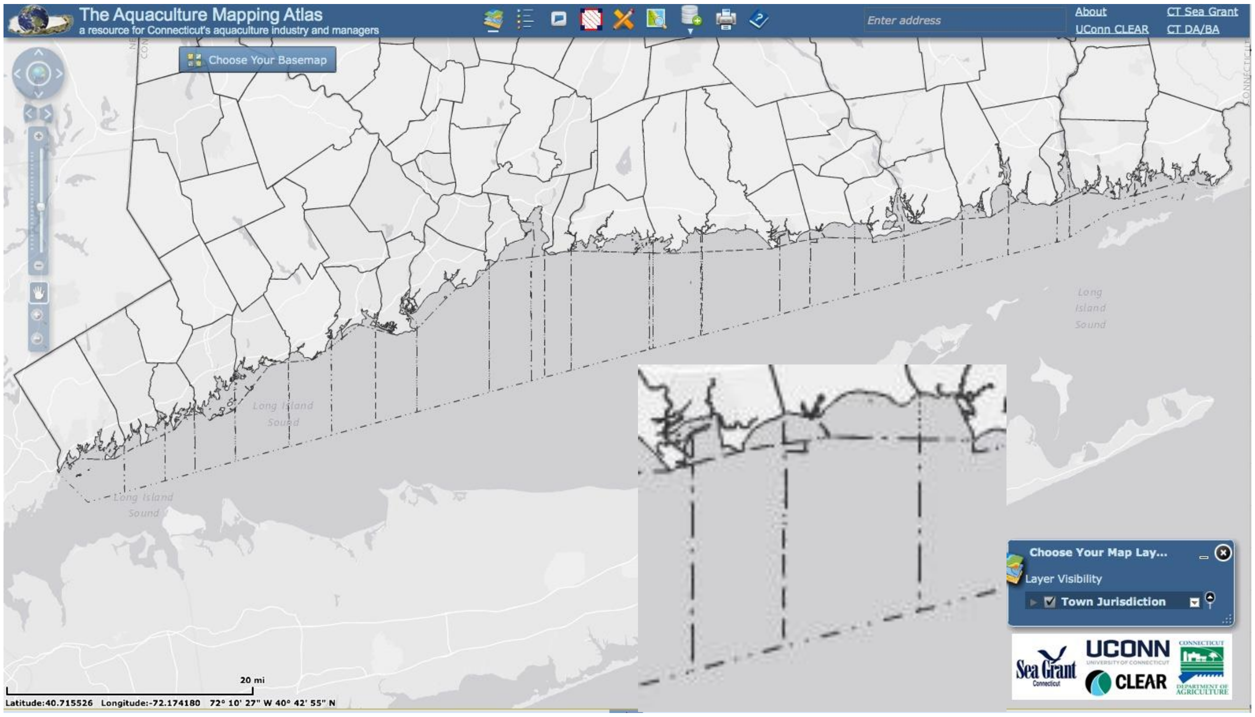


Figure 15-3: [The 1881 East-West "Commissioners Line" Separating Jurisdiction between Municipal and State Shellfish Beds in Connecticut](). Municipal beds lie north of the line while state beds lie south of the line. The inset demonstrates how the "Commissioners Line" joins adjacent ends of bays to delineate bays into municipal beds. Access available via the Aquaculture Mapping Atlas (UConn CLEAR, 2018).

Town beds are simply leased, owned or managed through the local shellfish commission. Towns may require additional local permits to work in waters under local jurisdiction. The beds north of the line in Westport, Milford, West Haven, and New Haven are exceptions to this as they are under state control. The sources of data for the town managed beds layer were quite varied. The sources included longitude/latitude data and maps from CT DA/BA, maps and longitude/latitude provided by local shellfish commissions and longitude/latitude data and maps obtained from private operations. Additionally, a few towns provided maps of their beds in an electronic format such as a CAD file or shapefile.

Natural beds get their name from the fact that shellfish, especially oyster, naturally inhabited the area. These areas tend to be closer to shore and more often than not are at the mouth of a river. Natural beds have specific regulations concerning their use, including licensing and harvesting methods. They are predominately seed beds that cannot be mechanically harvested. Use of the natural beds requires a Relay/Transplant License I or II and/or Seed Oyster Harvesting License. Any person assisting in the harvesting of seed oysters must have a Helper's License. These beds cannot be leased or subdivided; they are to remain open to any properly licensed shellfisherman. A complete listing of regulations is available from CT DA/BA, and the latest update of the Aquaculture Mapping Atlas includes new natural beds such as those in the Housatonic River (Figure 15-1(b)).

State natural beds are simply natural beds south of the Commissioners line. Descriptions of these beds can be found in section 3295 of the Connecticut General Statutes (CGS), revision of 1918. Not all of the beds listed in section 3295 were mapped. Many of the natural beds in state waters off of Greenwich are now covered with leases. The town natural beds were defined by law under section 2326 of the CGS of 1888. Each town had the opportunity to map areas that they wanted to be considered natural bed. The documents, written descriptions and maps, were submitted to the Superior Court that had jurisdiction for that town. Several towns did not avail themselves of this opportunity. Some areas such as in Westport have been changed in recent court decisions. There are some areas that may have been declared natural bed that now have leases on them. Since a significant proportion of the shellfish aquaculture industry relies on sets in natural beds, the Atlas includes information on natural shellfish beds, information is also available for the location of natural shellfish beds (Figure 15-1). It should be noted that “natural beds” in Connecticut are a unique classification of seafloor set aside for natural recruitment of Eastern Oyster, and should not be confused with wild beds that may exist outside of natural bed designated areas.

There are generally two forms of shellfish lot ownership, a lease and a franchise. They are distinct types of ownership with different rights and assigned under different statutes. As a leaseholder, one’s interest is governed by terms of the lease (which has changed in 2014 to include things like imminent domain provisions) and as a franchise owner, one’s rights are more akin to fee simple ownership, i.e. the rights are transferable, inheritable, and run in perpetuity. Franchises exist in town and state waters and are taxed like real estate with taxes being paid to the town or state respectively. There are some towns that lease as well though sometimes rights are given in towns under what is called a co-management agreement. Currently the Aquaculture Mapping Atlas does not differentiate between leases and franchises though the CT DA/BA has published lists with this data in the past. In addition, the CT DA/BA has recently created a new category in Branford's jurisdictional waters on the formerly private Lang franchises purchased by the state. This new category is a very limited state issued license to conduct shellfishing within Branford's jurisdictional waters with no lease rights or franchise rights given to the shellfishermen or by the town.

CT DA/BA water quality monitoring station locations are used for the purpose of shellfish growing area classification (Figure 15-2). CT DA/BA classifies all tidal waters of Long Island Sound located along the coast of Connecticut. All shellfish growing areas are classified in accordance with the National Shellfish Sanitation Program Model Ordinance. These classifications, established to minimize health risks, may restrict the taking and use of shellfish from some areas. No fresh water areas are classified for the harvesting of shellfish. Any shellfish area, regardless of classification, may be temporarily closed to all activities when a potential public health emergency exists as a result of a storm event, flooding, sewage, chemical, or petroleum discharges, or a hazardous algal bloom. Classifications are briefly summarized below:

- APPROVED AREA: Is a classification used to identify a growing area that is safe for the direct marketing or consumption of shellfish.
- CONDITIONALLY APPROVED AREA: Is a classification used to identify a growing area that is safe for the direct marketing or consumption of shellfish when the area is in the open status. The area must meet the criteria for Approved classification when the area

is in the open status, and meets the criteria for the restricted classification in the closed status.

- CONDITIONALLY APPROVED SEASONAL AREA: same as above, but may be closed under certain seasonal conditions.
- CONDITIONALLY RESTRICTED: Is a classification used to identify a growing area where a sanitary survey has found that the area meets the criteria for Restricted classification when the area is in the open status and meets the criteria for Prohibited classification when the area is in the closed status. Shellfish may only be harvested from Conditionally Restricted areas by special license, and may not be directly harvested for market or consumption.
- PROHIBITED: Is a classification used to identify a growing area where there has been no current sanitary survey or where a sanitary survey has found that the area is adjacent to a sewage treatment plant or other point source outfall with public health significance; pollution sources may unpredictably contaminate the growing area; the growing area is contaminated with fecal waste so that the shellfish may be vectors for disease microorganisms; and/or that the concentration of biotoxin is sufficient to cause a public health risk. Shellfish may not be harvested from Prohibited areas except for seed oystering or depletion of the areas.

The Aquaculture Mapping Atlas also includes information on recreational shellfish beds (Figure 15-4, more detailed information is also provided in *Chapter 18 Recreational Fishing*), as well as other relevant and complementary layers of information such as aids to navigation, coastal access sites, bathymetry, and anchorage areas.

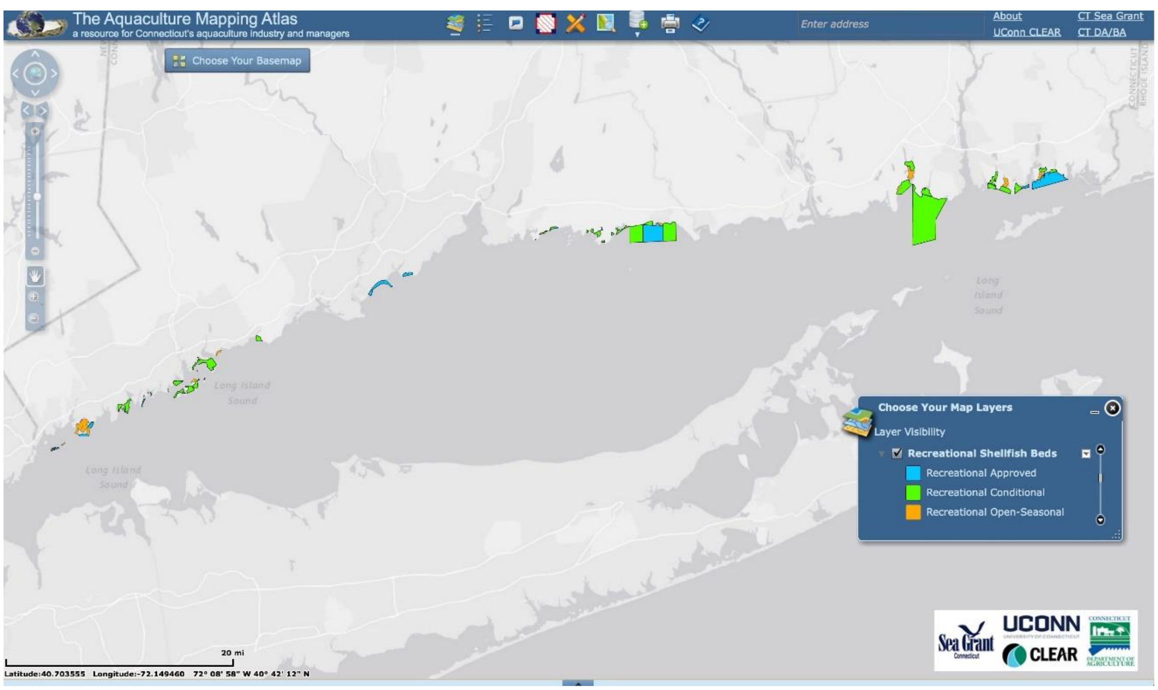


Figure 15-4: [Connecticut Recreational Shellfish Beds.](#) Access available via the Aquaculture Mapping Atlas (UConn CLEAR, 2018).

Comparatively, there is relatively little spatially explicit information on shellfish aquaculture in New York. However, it should be noted that commercial shellfish activity in New York is mostly focused on wild harvest, with only a small percentage of grounds cultivated under leases. One notable exception is a large lease-based aquaculture company that operates in Oyster Bay, located in New York LIS state waters. Publically available maps documenting the spatial location of these leases were not found.

While not prevalent, there are temporary leases located in New York LIS state waters that permit off-bottom aquaculture, called Temporary Marine Area Use Assignments (TMAUAs). We were able to secure information on the location of these TMAUAs from New York State Department of Environmental Conservation (NYS DEC) (Figure 15-5). At this point we have not been able to verify if these are the only leased or deeded areas of seafloor in New York LIS state waters.

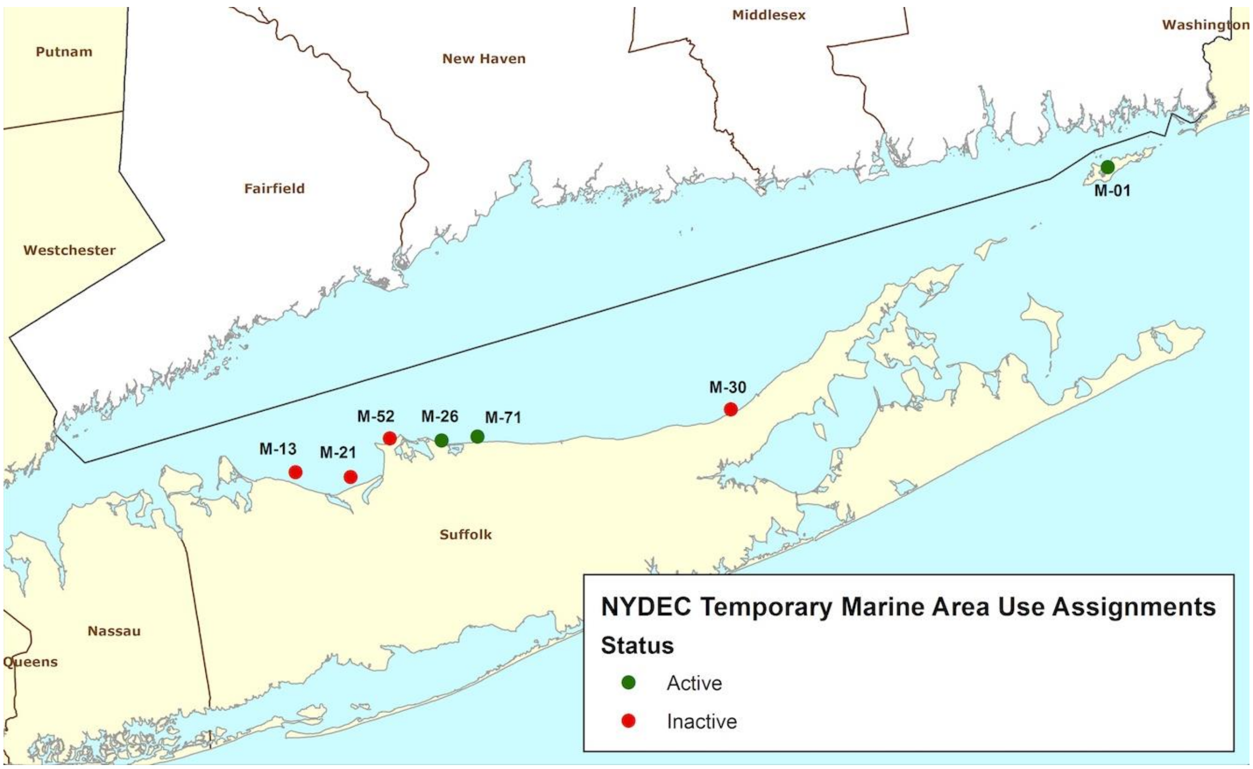


Figure 15-5: Map of New York Temporary Marine Area Use Assignments in Long Island Sound. The dots represent the center point of 5-acre circular assignments. A radius of 250' defines the outer boundary of each site. The map was created using data provided by NYS DEC.

We also found evidence of spatially explicit data held by individual townships along the north shore of Long Island. NYS DEC does not control lease areas in town waters, and maps are kept by the individual towns. It appears that these lease maps have not been systematically digitized, and it appears that they are managed town by town. The Town of Brookhaven is currently in the process of developing its own aquaculture leasing program. The Town of Huntington describes its shellfish activities for both water quality and seeding for later harvest on its website (Town of Huntington, 2018). Cornell Cooperative Extension runs a county-wide program that trains amateur oyster farmers with their own private water access (usually dockside) to seed local waters in the Town of Southold (Cornell Cooperative Extension of Suffolk County, 2018). While activities are focused at the town level, it was confirmed that all aquaculture operations must have a culture permit from the NYS DEC.

Interviews identified the existence of a series of maps that delineate the shellfish classification for each township on Long Island, based on data held by NYS DEC. These maps delineate areas that are uncertified (similar to Connecticut's "prohibited" classification), certified, seasonally certified, or subject to holiday closures (for example, Figure 15-6).

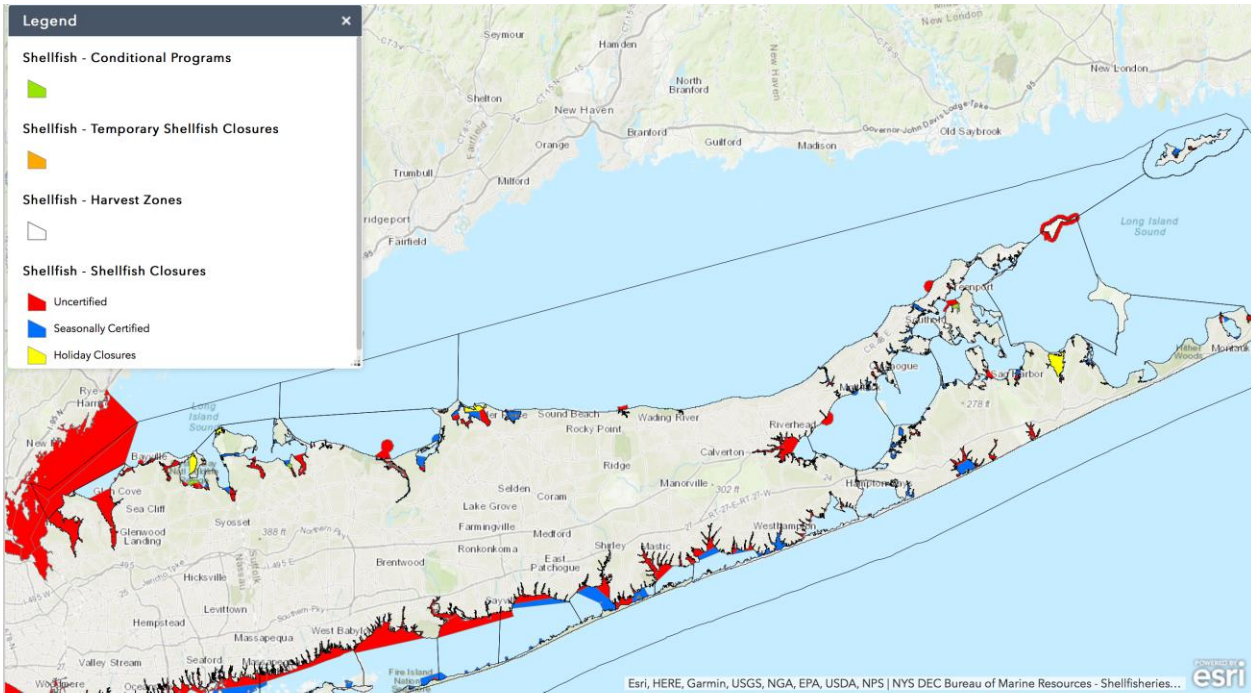


Figure 15-6: [Shellfish Closures for Northport Bay, Northport Harbor, and Centerport Harbor](). Access available via the NYS DEC Public Shellfish Mapper (NYS DEC, 2017).

Since wild harvesters in New York are required to document the harvest areas where they captured shellfish, we used NYS DEC spatially explicit information on landings by shellfish species and year to construct a new shapefile that represents mean and total shellfish landings in New York LIS waters by species and summed across species (Figure 15-7). The total aquaculture and commercial harvest in New York is approximately $40M per year. While not necessarily precise and strictly related to aquaculture (NYS DEC's shellfish landings include all shellfish, wild and cultured, from each harvest area), such a map may provide useful spatial information on the relative intensity of activities related to shellfish in the New York waters of LIS, which seem to mostly take place in the western portion of the Sound. It should be noted that Figure 15-7 shows full harvest areas but many areas are closed and shellfish harvest is prohibited, particularly in western Long Island Sound. For example, in the harvest area west of Oyster Bay, the only area actually open for harvest is outer Hempstead Harbor.

New York Shellfish Landings by Value

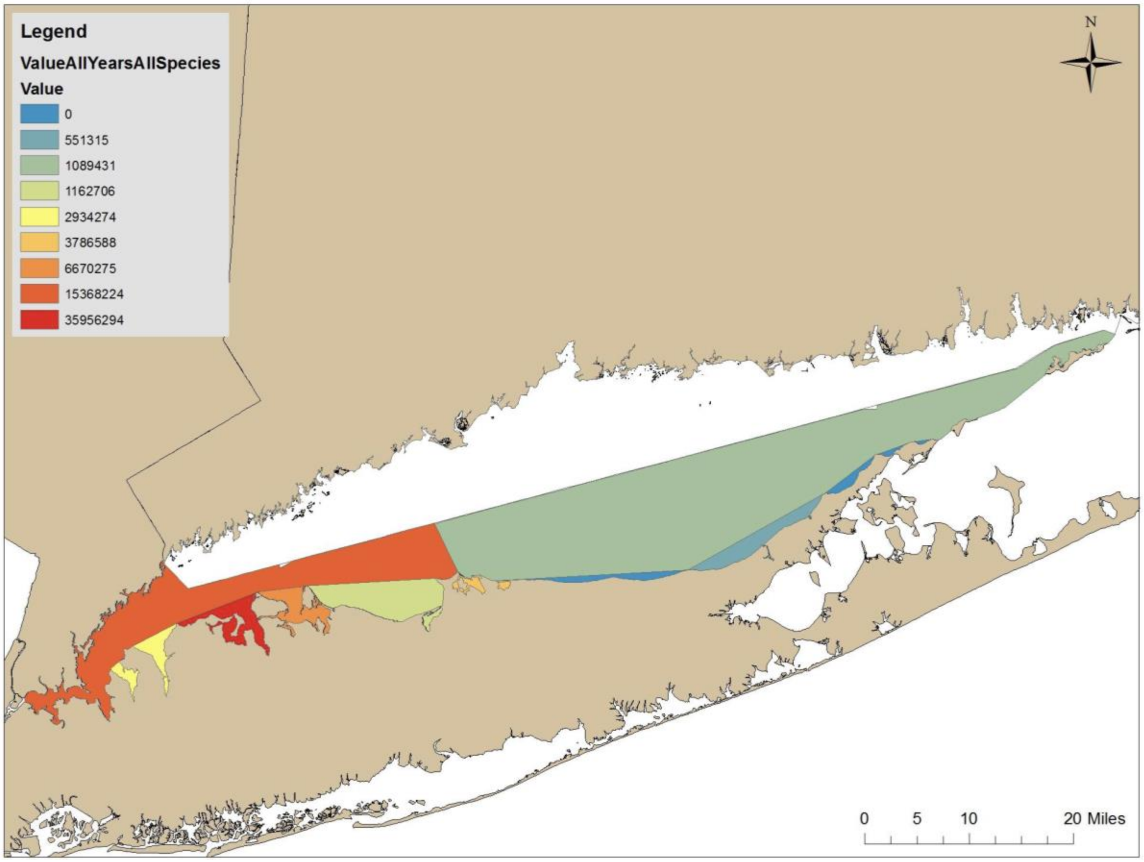


Figure 15-7: Total Shellfish Landings by Value from 2011-2015, Delineated by NYS DEC Shellfish Harvest Areas. The total aquaculture and commercial harvest in New York is approximately $40 million per year. The map was created using data provided by NYS DEC.

While shellfish is the largest aquaculture sector in Long Island Sound, it should be noted that there is a new and growing seaweed aquaculture industry that is developing in CT, using long lines. A compilation of locations for kelp aquaculture activities authorized by the Connecticut Department of Energy and Environmental Protection (CT DEEP), Land and Water Resources Division as of November 2017 provides spatial information based on data taken from approved permit documents. Points were used to generally represent area-based locations. Currently, data represents 12 distinct locations spanning 8 different authorizations. Locations are Sound-wide, with concentrations in Norwalk, Branford, and Groton/Stonington. All activities are long-line based, with various lengths and groupings. A map of the currently permitted sites is presented in Figure 15-8. The latest revision of the Aquaculture Mapping Atlas includes information on aquaculture gear area, including for kelp, in addition to the location of kelp long lines as part of aquaculture operations, and seaweed licenses, a prerequisite for securing a gear permit. It should be noted that seaweed aquaculture is often associated with shellfish aquaculture efforts (in terms of location and individuals), and that it is a seasonal effort, with kelp mostly grown over winter, and to a lesser extent *Gracillaria* grown over the summer season.

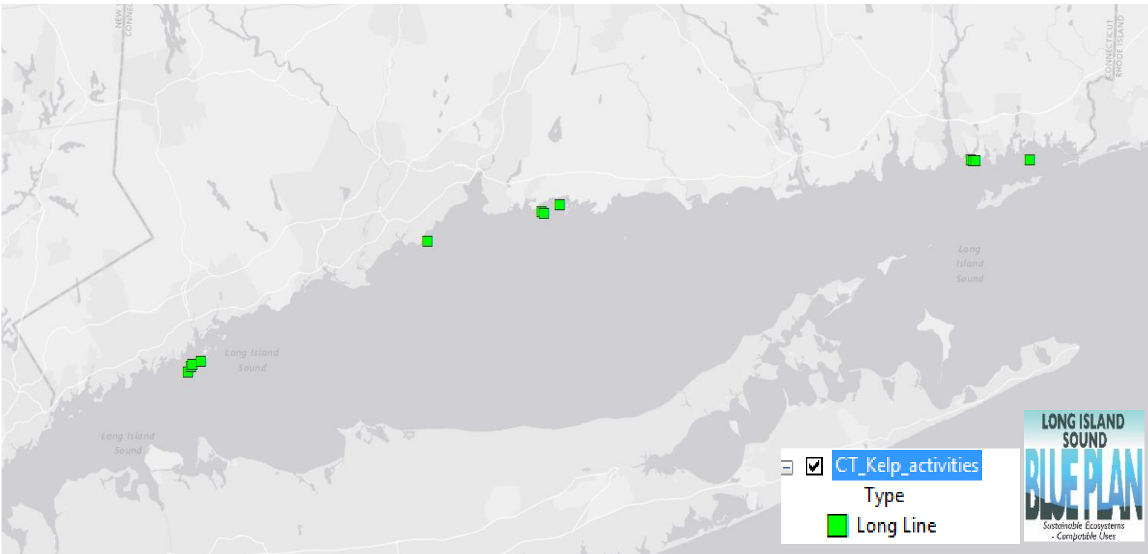


Figure 15-8: Connecticut Kelp Aquaculture Activity. Locations are based on CT DEEP permitting data, as of November 2017. Data are not currently publicly available, but can be obtained from CT DEEP.

To the best of our knowledge, there is no significant marine fish aquaculture in Long Island Sound. It should however be noted that there is a new land-based company, Great American Aquaculture LLC, growing marine fish in Waterbury, CT.

15.2 Assessment of Data Quality

15.2.1 Sources of Data and Metadata

While some map products from other portals document pieces of information sometimes relevant to aquaculture in Long Island Sound, it appeared clear that the Aquaculture Mapping Atlas represents the most comprehensive and authoritative source of information relevant to the aquaculture industry in Connecticut (UConn CLEAR, 2018). The source of data is clearly described in the accompanying user guide, along with a link to the original datasets (UConn CLEAR, 2014). Further, a link to the technical characteristics of the datasets is provided in the viewer that allows the user to select data layers. The project includes representation from entities knowledgeable and respected in the aquaculture field as well as technical geographic information systems expertise, resulting appropriately vetted and relevant data and meta-data, displayed in a user-friendly interface.

Interviews identified the existence state and individual Long Island north shore townships leases for the culture of shellfish, along with a series of maps that delineate the shellfish classification for each township on Long Island, based on data held by NYS DEC. It is uncertain if these maps have been digitized, and if they have, we were unable to locate the shape files that compose these maps, along with associated metadata, and therefore unable to assess the technical quality of the data.

A compilation of locations for kelp aquaculture activities authorized by CT DEEP, Land and Water Resources Division as of November 2017 provides spatial information based on data taken from approved permit documents. Points were used to generally represent area-based locations.

15.2.2 Accuracy, Representativeness, and Relevance of Map Products

CT stakeholders generally responded positively to maps that included information of lease boundaries, shellfish classifications, and natural oyster bed areas, adding that they regularly use the Atlas (and its data) in their day to day operations. This is not surprising since the Atlas was created for use by the aquaculture industry and allows users to overlay lease boundaries with shellfish area classifications. This suggests that the data served through the Aquaculture Mapping Atlas provided data that are accurate and representative of the hands on knowledge of the industry. The data accessed from the Atlas also seemed relevant to the Blue Plan planning process, with particular relevance associated with state and municipal commercial shellfish beds (leased, franchised, and deeded ground), natural beds, shellfish classification areas, recreational beds and town jurisdiction lines. There was also interest in the relevance of inclusion of relevant data layers associated with estuarine habitat (particularly salt marshes, discussed further in *Chapter 8 Coastal Wetlands*), eelgrass beds (discussed further in *Chapter 2 Phytoplankton, Macroalgae, Eelgrass, and Submerged Aquatic Vegetation*), sewage treatment plants (addressed in *Chapter 26 Marine Transportation, Navigation, and Infrastructure*), and underwater cables and pipelines (discussed further in *Chapter 27 Energy and Telecommunications*). However, growers generally resisted the idea of sharing information about their practices that they deemed proprietary, including how shellfish are moved within a leased area, to help support planning purposes. It was agreed that such data would not be requested for the purpose of the inventory, and that objective information at the level of documented leases would be sufficient for the needs of the Blue Plan.

Since we have not yet been able to obtain the data, metadata and series of maps that document state and individual Long Island north shore townships leases for the culture of shellfish, along with maps that delineate the shellfish classification for each township on Long Island, based on data held by NYS DEC, we were unable to obtain stakeholder vetting of those maps. However, the accuracy of those maps should be trusted as they are issued by the state agency and townships with relevant authority and jurisdiction. Landing maps such as the one depicted in Figure 15-7 may carry some inaccuracy based on the availability of data. Further, they are not necessarily precise and strictly related to aquaculture, but may provide useful spatial information on relative shellfish-related activity. We were unable to discuss representativeness and relevance with stakeholders since we did not have those maps to present for discussions.

Data on the locations for kelp aquaculture activities in Connecticut is deemed reliable as it is extracted from the permits authorized by CT DEEP, Land and Water Resources Division. It should however be noted that there is a rapid expansion of this novel industry, and that the data shown in Figure 15-8 are subject to frequent changes as new permit applications are approved.

15.2.3 Data Gaps and Availability of Data to Address Gaps

Perhaps the most significant data gap is the absence of systematic and comprehensive spatially explicit data documenting shellfish aquaculture activities in New York waters. We understand that maps exist that document state and individual Long Island north shore townships leases for the culture of shellfish, along with maps that delineate the shellfish classification for each township on Long Island. Locating the shape files for those maps, if they have been digitized, along with associated metadata, would allow to fill an important gap relevant to the Blue Plan, and complement similar datasets in CT.

Also, since there are still possibilities to prospect for new leases, there would be value in getting good maps of shellfish habitats to inform the suitability and potential productivity of new lease grounds. Additional relevant information can be found in sections *Chapter 6 Fish, Pelagic Invertebrates, Shellfish, and Zooplankton*; *Chapter 9 Bathymetry and Geochemistry*; and *Chapter 10 Sediments and Geochemistry*, focusing on characterization of natural resources. It should be noted that research efforts have been undertaken to adapt models of shellfish aquaculture such as the farm aquaculture resource management model to give indications of how well shellfish would grow in a region, and try to inform site selection processes for new and expanding shellfish farms (Bricker, Getchis, Chadwick, Rose, & Rose, 2016).

15.3 Relevance

15.3.1 Relative Historical Importance

Shellfish aquaculture is central to the economy, culture, and ecosystems of Long Island Sound. There is evidence that shellfish harvesting is in fact a pre-colonial activity in Long Island Sound, and records of transplanting shellfish seeds (small shellfish) from natural beds in Connecticut or Virginia to cultivated bay bottoms that became oyster farms as early as the 1830s (Weigold & Pillsbury, 2014).

15.3.2 Socio-Economic Context

Shellfish, including oysters and hard clams, generate over $30 million in farm-gate sales between New York and Connecticut (Figure 15-9). In Connecticut, the shellfish industry employs more than 300 individuals and more than 70,000 acres of seafloor are under cultivation (Connecticut Department of Agriculture, 2017). Not only are shellfish a critical economic resource, they are essential to the LIS ecosystem. Shellfish, particularly the Eastern Oyster, *Crassostrea virginica*, provide biogenic habitat that supports diverse marine communities and filters pollutants and sediments from the water column, cleansing the waters of LIS.

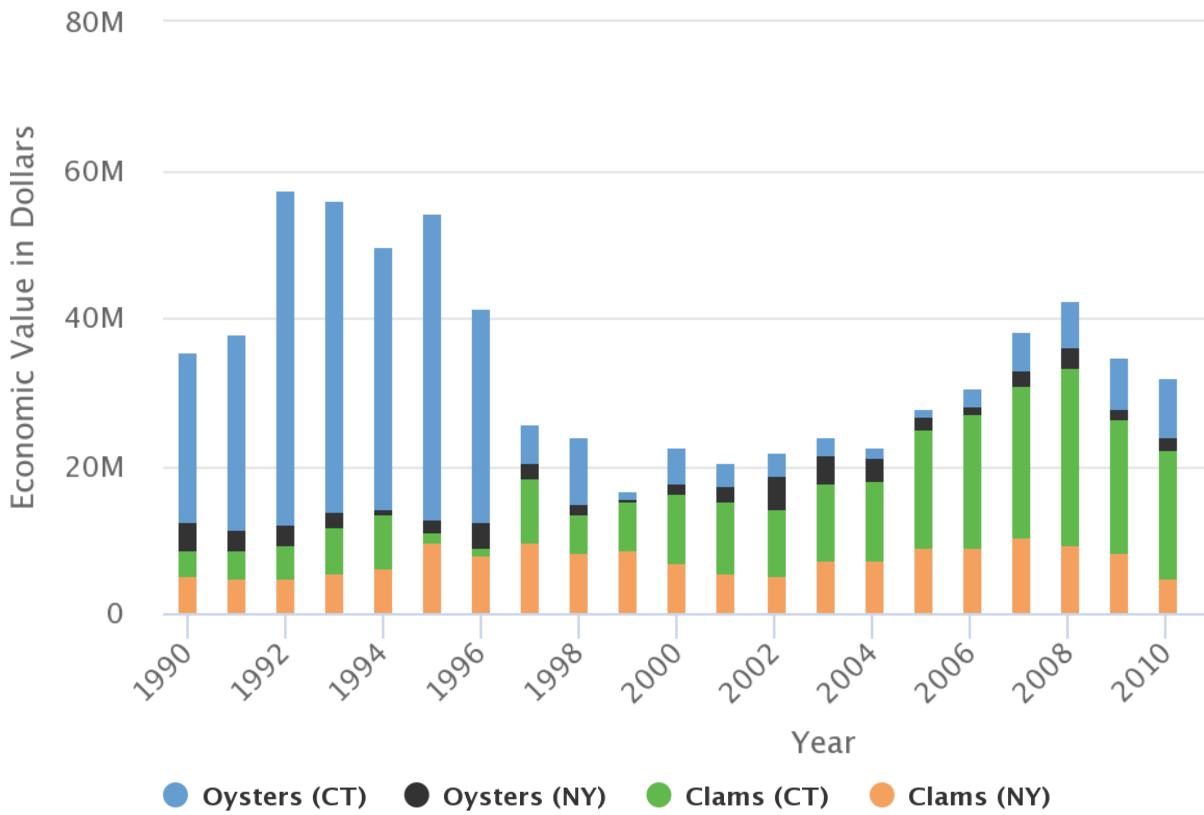


Figure 15-9: [Economic Value of Oyster and Hard Clam Landings in Connecticut and New York from 1990-2010](). There was a significant natural oyster die-off due to disease that occurred in 1998-1999. The largest cultivated acreage producer failed to report harvest statistics from 2008 to 2010. As a result, the overall average harvest growth rate was factored into the last reported figures by the company to obtain an estimate for 2010 harvest numbers. However, no growth rate was factored for 2008 harvest numbers. Data from CT DA/BA and the Long Island Sound Study (LISS, 2018).

15.3.3 Other Notes

Regulations and management according to classification are important factors in the management of shellfish aquaculture. Natural beds (which may be in rivers) are important as a source of seed shellfish for use in aquaculture. Some stakeholders argued that current classifications are necessary to maintain sustainable stocks. In particular they believed that prohibited areas were crucial to promoting sustainable harvest. Other growers argued for downgrading classifications from prohibited to conditionally approved or conditionally approved to approved in particular areas, due to perceptions of improved water quality.

The State designations cited in this section (e.g. approved, restricted, etc.) are for commercial/recreational purposes, reflecting the health/hygiene considerations for consumption. They are not, alone, mandates. In other words, even in an area approved, there may be conditions that would limit shellfishing, including ecological and environmental conditions of a specific area and, of course, other possibly conflicting uses.

15.4 References

Bricker, S. B., Getchis, T. L., Chadwick, C. B., Rose, C. M., & Rose, J. M. (2016). Integration of ecosystem-based models into an existing interactive web-based tool for improved aquaculture decision-making. *Aquaculture, 453*, 135-146.

Connecticut Department of Agriculture. (2017, April 1). *Shellfish Industry Profile and Economic Impact*. Retrieved from http://www.ct.gov/doag/cwp/view.asp?a=3768&q=458588

Cornell Cooperative Extension of Suffolk County. (2018, January 22). *Suffolk Project in Aquaculture Training*. Retrieved from Cornell Cooperative Extension of Suffolk County: http://ccesuffolk.org/marine/aquaculture/spat-program

CT DEEP. (2017). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635

LISS. (2018). *Shellfish Harvested - Economic Value (CT & NY)*. Retrieved from Long Island Sound Study (LISS): http://longislandsoundstudy.net/ecosystem-target-indicators/shellfish-harvested/

NYS DEC. (2017, 13 December). *NYS DEC Public Shellfish Mapper*. Retrieved from New York State Department of Environmental Conservation (NYS DEC): https://nysdec.maps.arcgis.com/apps/webappviewer/index.html?id=d98abc91849f4ccf8c38dbb70f8a0042

Town of Huntington. (2018). *Aquaculture Restoration Projects*. Retrieved from Town of Huntington, Long Island, New York: http://www.huntingtonny.gov/content/13749/16439/16577/99657/43423/43673.aspx

UConn CLEAR. (2014). *The Aquaculture Mapping Atlas User's Guide.* Haddam: University of Connecticut Center for Land Use Education and Research (UConn CLEAR). Retrieved from http://clear.uconn.edu/geospatial/shellfish/UsersGuide_Nov2014.pdf

UConn CLEAR. (2018, February). *Connecticut Aquaculture Mapping Atlas*. Retrieved from University of Connecticut Center for Land Use Education and Research (UConn CLEAR), Connecticut Sea Grant, and Connecticut Department of Agriculture Bureau of Aquaculture: https://clear3.uconn.edu/aquaculture/

Weigold, M. E., & Pillsbury, E. (2014). Long Island Sound: A Socioeconomic Perspective. In J. T. Latimer, *Long Island Sound: Prospects for the Urban Sea* (pp. 1-46). New York, NY: Springer.

15.5 Appendices

15.5.1 List of Maps Used to Inform the Chapter

Below is a list of all maps used to inform this chapter, including maps presented above in the narrative and additional maps used to support chapter findings. Maps listed below are organized by the online data portal on which they are hosted (URL links to data portals are noted in *Section 15.4 References* above). Map products not accessible by online data portal are also noted below.

The Aquaculture Mapping Atlas

- Aquaculture Gear Sites
- Commercial Shellfish Beds (Municipal Waters) 2014
- Commercial Shellfish Beds (State Waters) 2014
- Recreational Shellfish Beds
- Designated Natural Shellfish Beds 2014
- Shellfish Area Jurisdiction Line
- Shellfish Classification Lines
- Shellfish Classification Areas
- Town Jurisdiction

Northeast Ocean Data Portal

- Commercial Shellfish Beds (Municipal Waters) 2014
- Commercial Shellfish Beds (State Waters) 2014
- Recreational Shellfish Beds

NYS DEC Public Shellfish Mapper

- Shellfish Closures for Northport Bay, Northport Harbor, and Centerport Harbor

Non-Portal Map Products

- New York Temporary Marine Area Use Assignments in Long Island Sound (created using data provided by NYS DEC)
- Total Shellfish Landings by Value from 2011-2015, Delineated by NYS DEC Shellfish Harvest Areas (created using data provided by NYS DEC)
- Connecticut Kelp Aquaculture Activity (created using data provided by CT DEEP as of November 2017)

More information on some of the map products presented in this chapter, including URL links to data and metadata, can be found in the Aquaculture Map Book (CT DEEP, 2017). Not all products showcased in the map book may be addressed in this chapter or utilized to inform the final Blue Plan.

15.5.2 Notes on Stakeholder Engagement

The stakeholder community engaged includes commercial and recreational harvesters, producers, aquaculturists, industry experts, biologists, ecologists, and regulators.

In addition to engaging relevant regulators and other sector experts, we had individual in person or phone interviews to seven shellfishermen in Connecticut and eight shellfishermen in New York. Some groups are not represented, however, including small scale leaseholders in Connecticut, and large-scale aquaculturists in New York. We gained the stakeholders' contact information mostly through referral from experts and, later on, through referral by the shellfishermen themselves. This process may magnify a certain subset of views and neglect others, as stakeholders may preferentially refer people with similar opinions and interests. Our stakeholder engagement in New York differed markedly from Connecticut. Compared with Connecticut, New York has very little spatially explicit information related to shellfish. This is largely a function of the differences in the shellfish industries between the two states. In the New York waters of LIS, shellfish are harvested through both wild fisheries and cultivation on leased grounds. The vast majority of seafloor is open to wild-harvest with only a small percentage of grounds cultivated under leases. Due to this discrepancy, we engaged stakeholders using nautical charts and asked them to discuss productive areas, compared to discussing data layers mostly from the Aquaculture Mapping Atlas in Connecticut. We were unable to meet with representatives from the main lease-based aquaculture company in New York LIS waters.

Stakeholders were engaged starting with background questions about the nature of each individual's shellfishing activities before speaking more specifically about the Blue Plan. Participants were provided with information about the goals and implications of the Blue Plan. At what we deemed an appropriate moment in the conversation, we brought out printed nautical maps of the Sound, as well as maps depicting lease boundaries and shellfish classifications from the Connecticut Shellfish Atlas to redirect the conversation to questions of a spatial nature. The conversations were designed to be informal in nature and generally free-flowing, we did try to steer the topics around several key topics and broad themes, including questions such as:

- What type of shellfishing are you engaged in?
- Do existing map products match your view and knowledge of shellfishing grounds?
- What spatial information would you like to see considered in the Blue Plan?
- Are there additional sources of spatial data that you use?
- What are your concerns about the Blue Plan process?
- How would you prefer to engage with the Blue Plan process?

Outreach that informed this chapter occurred in the spring of 2017. While engaging a likely representative cross-section of stakeholders, not all potential interested parties were engaged in the review of relevant data, although the Connecticut shellfish has been briefed about the overall Blue Plan process by De Guise at a mandatory meeting of the Connecticut Shellfish Harvesters convened by CT DA/BA on May 30, 2017. We will further present the content of this chapter of the Inventory at upcoming relevant industry meetings.

Chapter 16

Commercial Fishing

<u>Chapter Table of Contents</u>

<u>Chapter List of Figures and Tables</u>

Figures

Tables

None

16.1 Key Data and Map Products

Commercial fishing is a hallmark of the social and cultural fabric of New England It is important in terms of sustaining a traditional livelihood in communities, in addition to creating significant economic impact through sales of seafood and supporting direct and indirect employment. Commercial fishing is closely regulated by federal and state agencies, directly affecting fishing activities in different locations. The following sections will document geospatial information and tools important to the commercial fishing and its management in Long Island Sound (LIS).

While several maps document commercial fishing activities at the regional scale, National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) landing estimates may be the best estimate of fishing efforts in Long Island Sound, although the scale is coarse and less that adequate for planning purposes.

Fishing Effort

The Northeast Ocean Data Portal includes abundant map products that document commercial fishing at the Northeast scale (Northeast Regional Planning Body, 2017). An example is provided in Figure 16-1. The data can be displayed as clustered, multi-species activity or broken down into individual species and can be refined to display vessels operating at less than 4 kn (as shown in Figure 16-1, to reduce the likelihood of misinterpreting a vessel underway to fishing grounds for one actually fishing. These map products are also served by the New York Geographic Information Gateway (NY Geographic Information Gateway, 2017).

It should be noted that most of the data on fishing effort served through the Northeast Ocean Data Portal are based on the Vessel Monitoring System (VMS). In general, vessels holding permits in certain fisheries are required to use VMS (see *Section 16.3.1 Source of Data and Metadata* for more details). The National Marine Fisheries Service (NMFS) describes VMS as "a satellite surveillance system primarily used to monitor the location and movement of commercial fishing vessels in the U.S." (NOAA Fisheries, 2017b). These data are from vessels operating in certain fishery management plans and certain programs within those plans. The maps do not distinguish between fishing activity, vessel transit, or other vessel activities (although efforts to distinguish between vessels underway to fishing grounds and vessels actually fishing are made by including the potential to sort the data by vessels operating at a speed below 4 kn, suggesting actual fishing). The most accurate interpretation of these maps is that they indicate relative levels of vessel presence. For most of the VMS-based map products displayed through the Northeast Ocean Data Portal, there appears to be little to no commercial fishing activity in Long Island Sound. It should be noted that these maps do not discriminate between no data and no fishing. It is also important to note that there are many New England fisheries not described through any VMS-derived maps.

Operators of the NOAA Fisheries Greater Atlantic Region permitted vessels are required to submit a vessel trip report (VTR) for every fishing trip regardless of where the fishing occurs or what species are targeted, with the exception of those vessels that possess only a lobster permit. VTRs are required in order to provide information on when and where catch occurred. Operators of all federally permitted vessels must complete a VTR prior to landing. Communities-at-Sea maps link fishing communities to specific resource areas in the ocean. They are developed by linking VTR data to vessel permit data, and represent diverse map products by gear type in the Mid-Atlantic and Northeast, served by the New York Geographic Information Gateway (NY Geographic Information Gateway, 2017). These include maps of fishing activities for ground fish (for vessels less than 65 ft and more than 65 ft), gillnet, dredge, long line and lobster. The data can be displayed for individual types of fishing activity or sectors can be grouped. A map of all sectors combined is presented in Figure 16-2. Once again, for most of the Communities-at-Sea VTR-based map products displayed, there appears to be little to no commercial fishing activity in Long Island Sound. It should be noted that these maps do not discriminate between no data and no fishing.

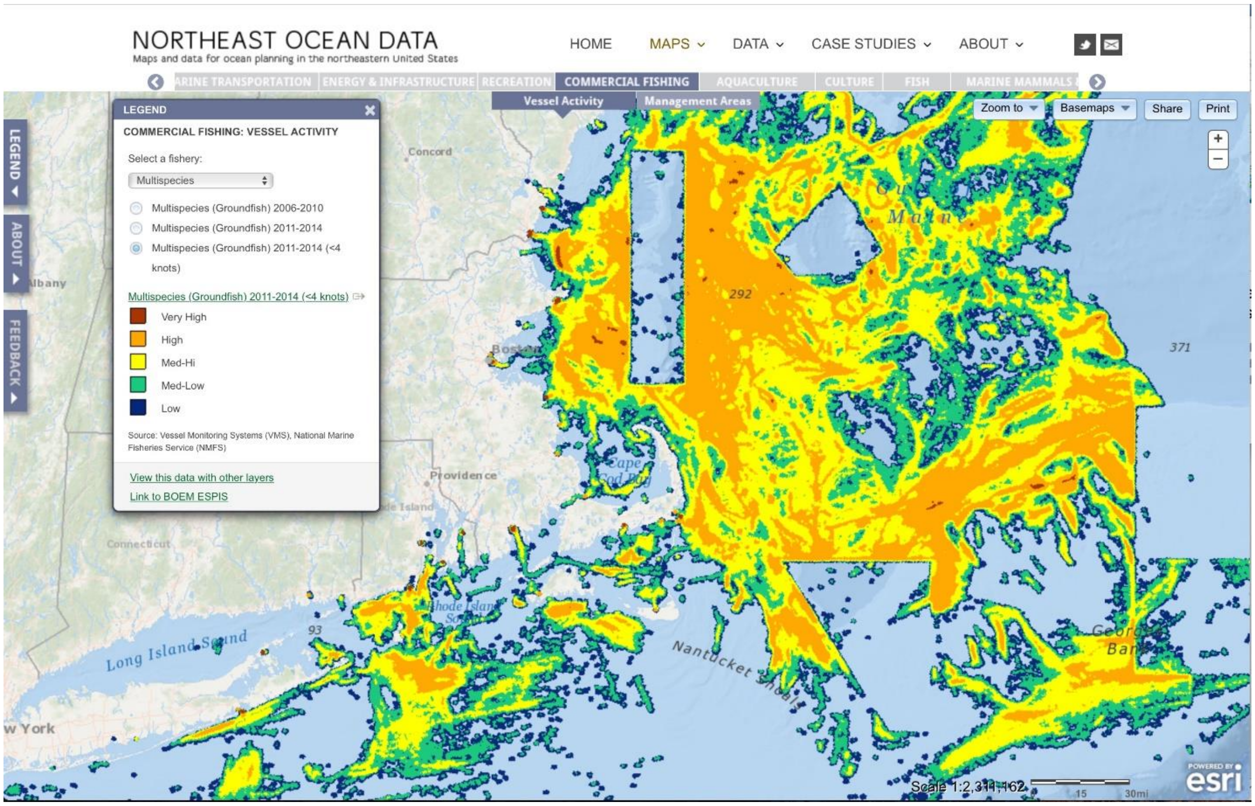


Figure 16-1: Commercial Fishing: Vessel Activity. Commercial fishing at the Northeast scale. The data are based on the VMS. In general, vessels holding permits in certain fisheries are required to use VMS (see Section 16.3.1 Source of Data and Metadata for more details). The relative amount of vessel activity is indicated qualitatively from high (red) to low (blue), and can be refined to display vessels operating at less than 4 kn (as shown here), to reduce the likelihood of misinterpreting a vessel underway to fishing grounds for one actually fishing. Access available via the Northeast Ocean Data Portal (Northeast Regional Planning Body, 2017).

Landings

VTR data provided by the National Marine Fisheries Service were also used to quantify the total amount of fish landed (measured in pounds) by federally permitted commercial fishing vessels using different gear type between 2001 and 2010. Map products document landings using traps/pots fishing gear (Figure 16-3), otter trawl fishing gear (Figure 16-4), gillnet fishing gear (Figure 16-5), and seine fishing gear (Figure 16-6). Map products are also available to document total effort (measured in days) made by federally permitted commercial fishing vessels using otter trawl fishing gear between 2001 and 2010 (Figure 16-7). Atlantic fishing revenue intensity between 2007 and 2012 was estimated by the Bureau of Ocean Energy Management (BOEM) using VTR data, with map products served through the [Marine Cadastre National Viewer](#) (NOAA, 2017). Figure 16-8 displays a map product that includes Long Island Sound. Overall, landings data generally suggest that catches in Long Island Sound are less abundant than in waters outside of Long Island Sound, with generally more abundant catches in the eastern portion of the Sound that in the western portion. However, it should be noted that the scale of these datasets is very coarse and may not be adequate for planning purposes.

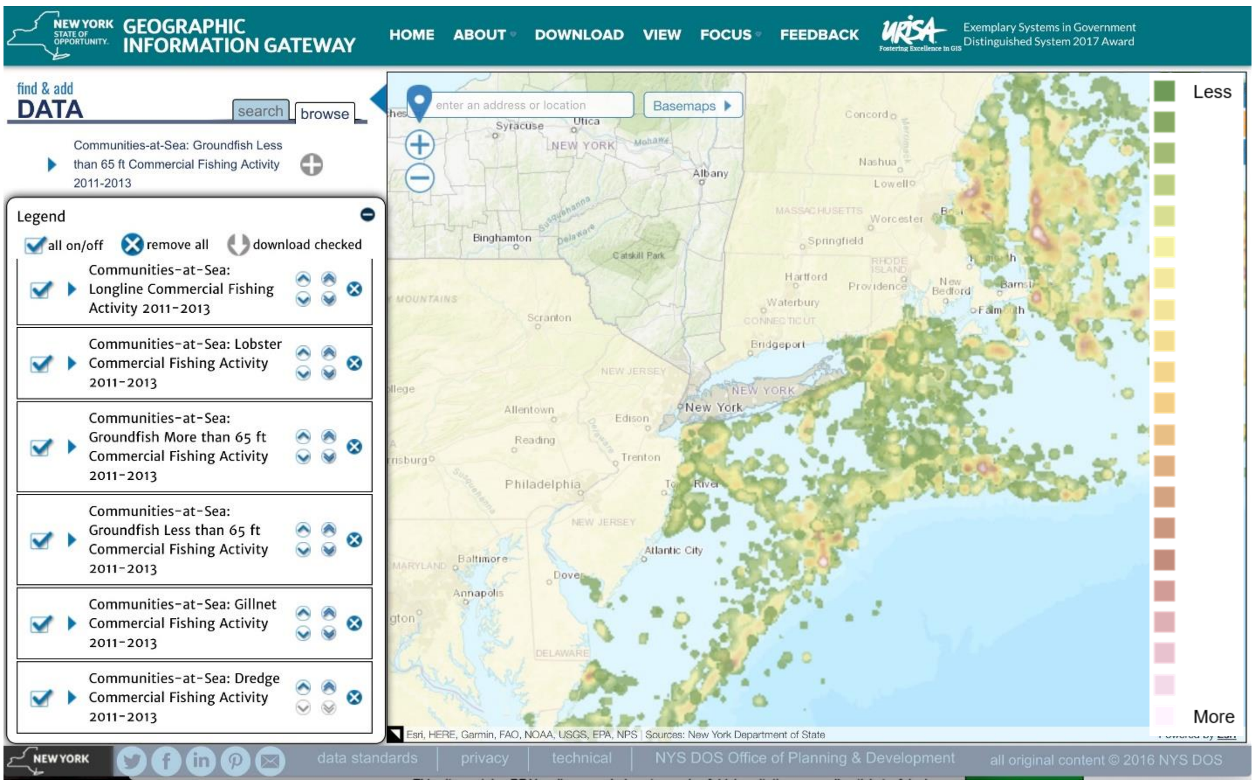


Figure 16-2: [Communities-at-Sea: Commercial Fishing Activity 2011-2013](#). Representation of various commercial fishing activities in the Northeast and Mid-Atlantic. The data are based on VTR through Communities-at-Sea maps that link VTR data to vessel permit data, and represent diverse map products by gear type in the Mid-Atlantic and Northeast. The figure above groups activities across all sectors. Access available via New York Geographic Information Gateway (NY Geographic Information Gateway, 2017).

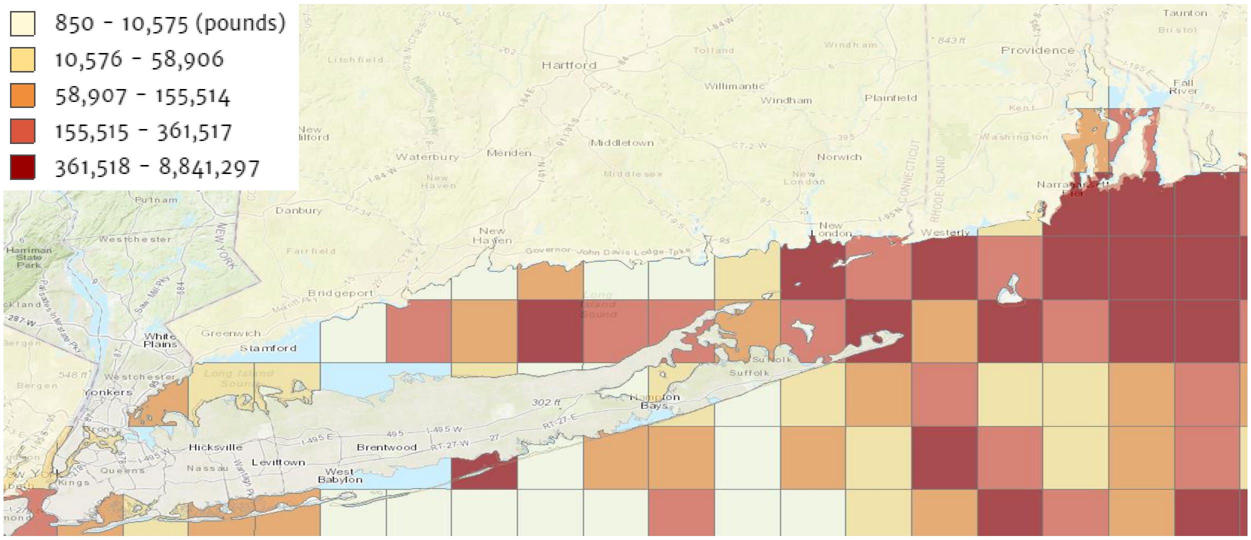


Figure 16-3: [Pot Gear – Regional, Landings [lbs], 2001-2010](). Total commercial fishing landings between 2001 and 2010 using traps/pots. Data is based VTR summaries provided by the NMFS. Access available via New York Geographic Information Gateway (NY Geographic Information Gateway, 2017).

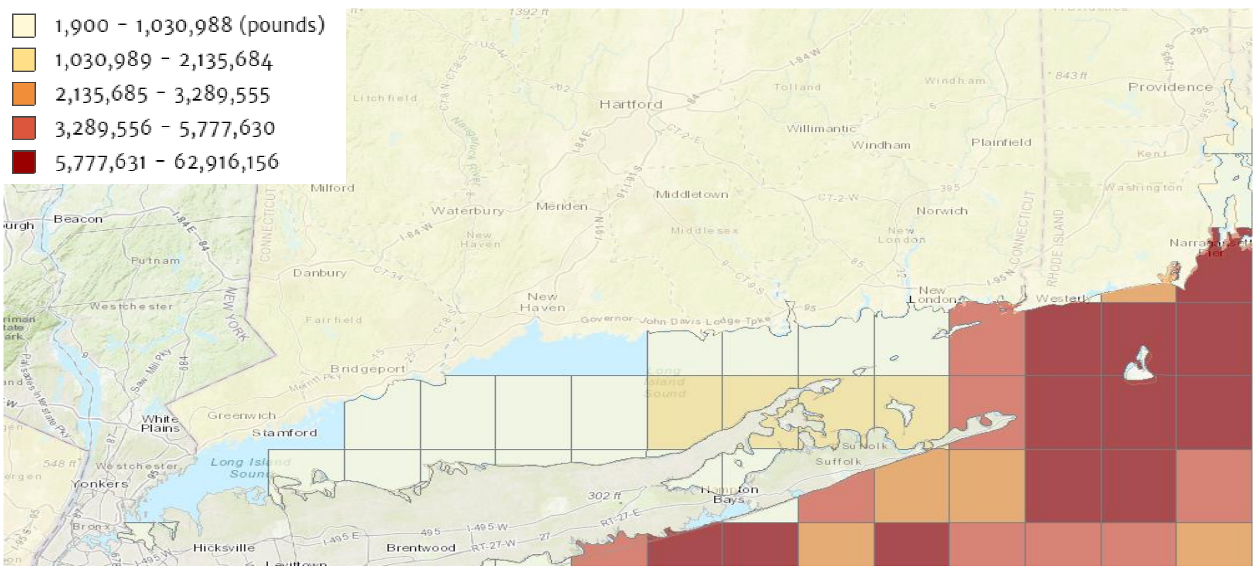


Figure 16-4: [Trawl Gear – Regional, Landings [lbs], 2001-2010](). Total commercial fishing landings between 2001 and 2010 using otter trawl gear. Data based on annual VTR summaries provided by the NMFS. Access available via New York Geographic Information Gateway (NY Geographic Information Gateway, 2017).

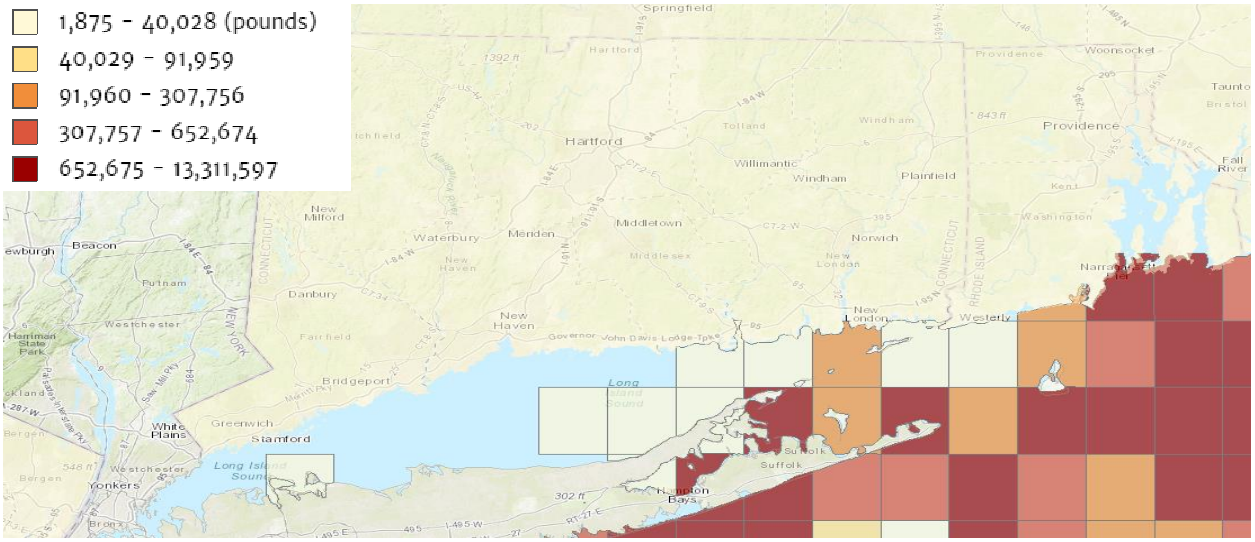


Figure 16-5: [Gillnet Gear – Regional, Landings [lbs], 2001-2010](). Total commercial fishing landings between 2001 and 2010 using gillnet fishing gear. Data based on annual VTR summaries provided by the NMFS. Access available via the New York Geographic Information Gateway (NY Geographic Information Gateway, 2017).

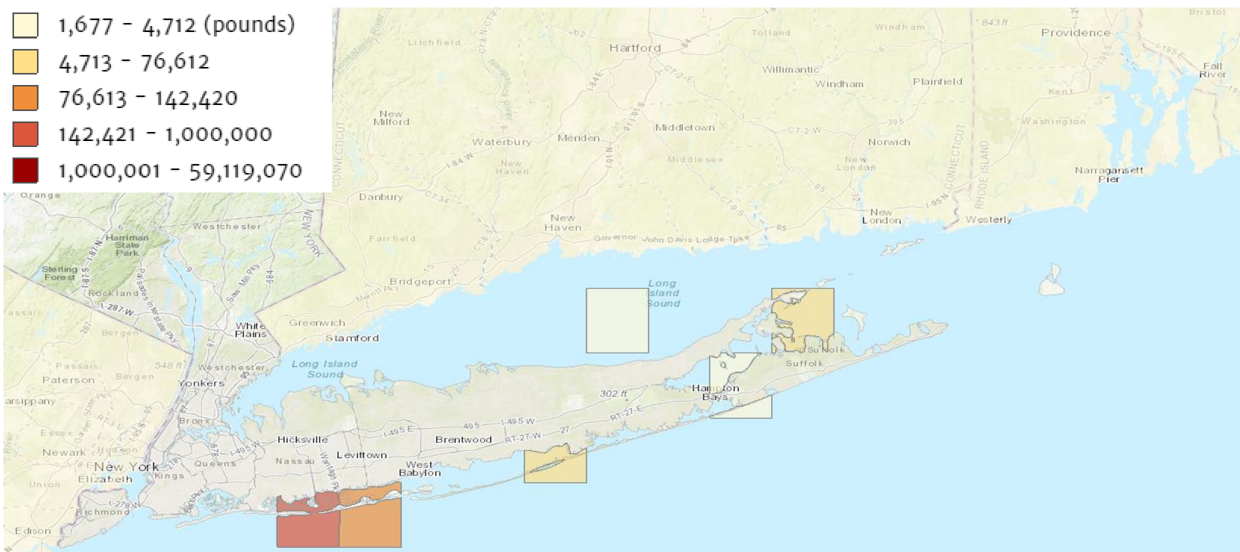


Figure 16-6: [Seine Gear – Regional, Landings [lbs], 2001-2010](). Total commercial fishing landings between 2001 and 2010 using seine fishing gear. Data based on annual VTR summaries provided by the NMFS. Access available via the New York Geographic Information Gateway (NY Geographic Information Gateway, 2017).

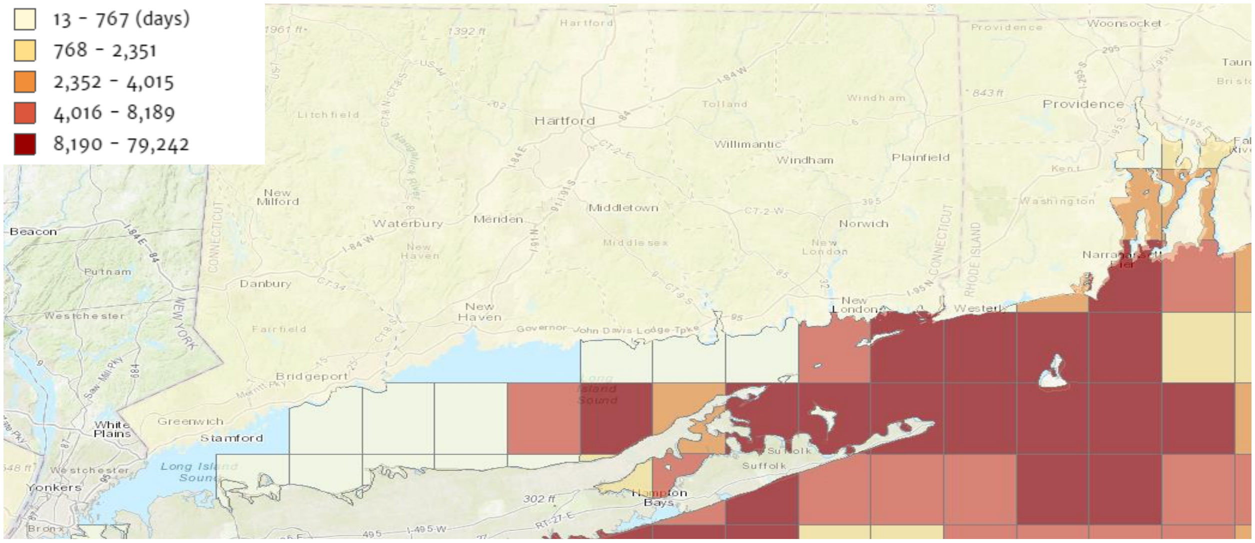


Figure 16-7: [Trawl Gear – Regional, Effort [days], 2001-2010](). This map depicts fishing effort (measured in days) by federally permitted commercial fishing vessels using otter trawl fishing gear between 2001 and 2010. Data based on annual VTR summaries provided by the NMFS. Access available via the New York Geographic Information Gateway (NY Geographic Information Gateway, 2017).

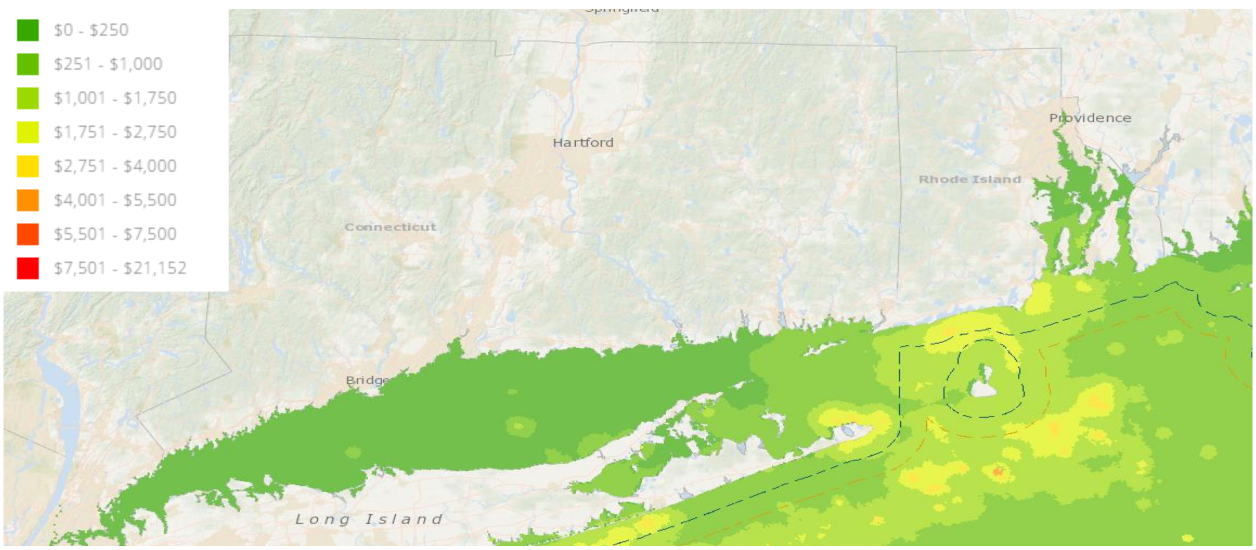


Figure 16-8: [Atlantic Fishing Revenue Intensity, 2007-2012](). This map depicts fishing revenue intensity between 2007 and 2012 in Long Island Sound, though the spatial extent of this dataset encompasses the U.S. Atlantic coast through South Carolina. Values are calculated by BOEM using VTR data. Access available via the Marine Cadastre National Viewer (NOAA, 2017).

<u>Regulatory Zones</u>

The [Northeast Ocean Data Portal]() also includes map products that document NMFS Greater Atlantic Fisheries Regional Office commercial fishing management areas at the Northeast scale

(Northeast Regional Planning Body, 2017). This includes management areas for the American lobster Atlantic Herring fisheries, areas where chain-mat and the turtle deflector dredge gear are required for the fishing and harvesting of Atlantic sea scallops, and regulated mesh areas in Southern New England for the northeast multispecies fishery. All these map products include all of LIS within the management area and are therefore not useful to display here.

Additional map products from the Connecticut Department of Energy and Environmental Protection (CT DEEP) document discrete restricted areas for state managed fisheries, such as Connecticut Atlantic sturgeon gear restriction areas (Figure 16-9), and CT horseshoe crab closed areas (Figure 16-10).

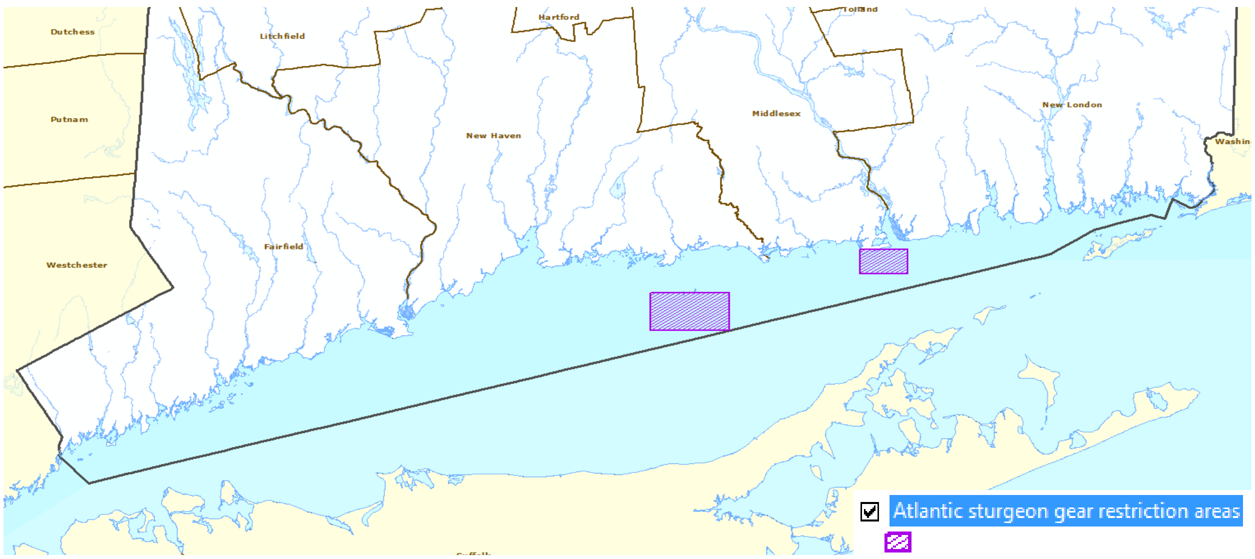


Figure 16-9: Atlantic Sturgeon Gear Restriction Areas. These areas are described in Connecticut State Regulation. Access available via ArcGIS Online (CT DEEP Marine Fisheries Division, 2017b).

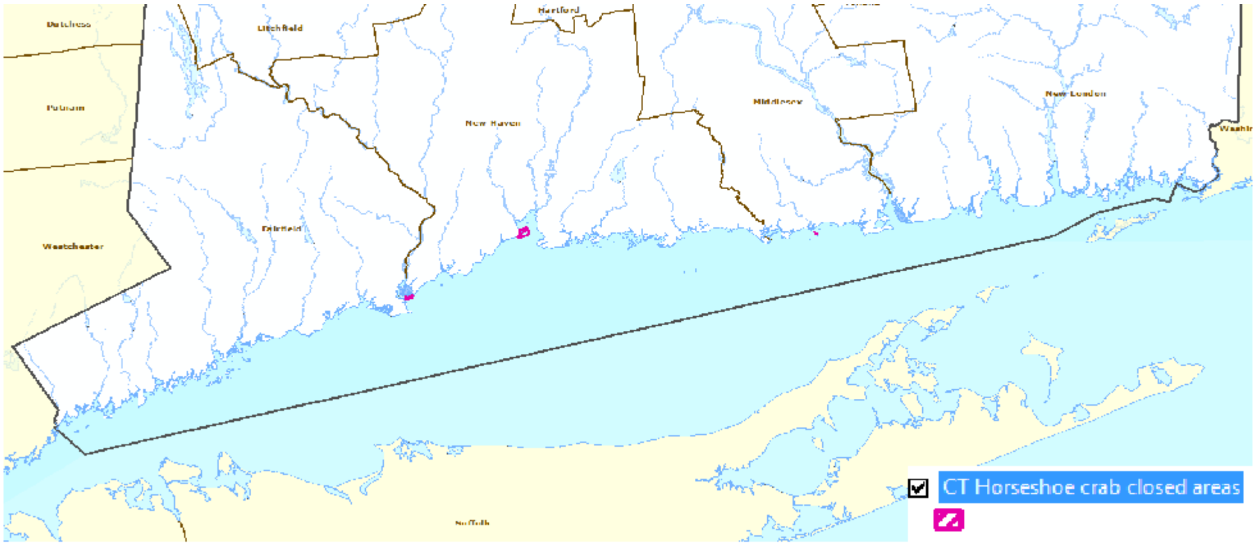


Figure 16-10: [Connecticut Horseshoe Crab Closed Areas](). These areas are described in Connecticut Regulation. Access available via ArcGIS Online (CT DEEP Marine Fisheries Division, 2017a).

<u>Data Abundance</u>

The Mid-Atlantic Regional Council on the Ocean (MARCO) synthesized spatial products characterizing human use in the Mid-Atlantic region using existing data products. This includes a data layer and map products summarizing the abundance of fishing data as well as the fishing use intensity (Figure 16-11). While the resolution is relatively coarse, and it is unclear if data from Connecticut are included, the map product shows fishing use data intensity relatively low compared to the south shore of Long Island, and generally higher in the eastern end of Long Island Sound compared to the western portion.

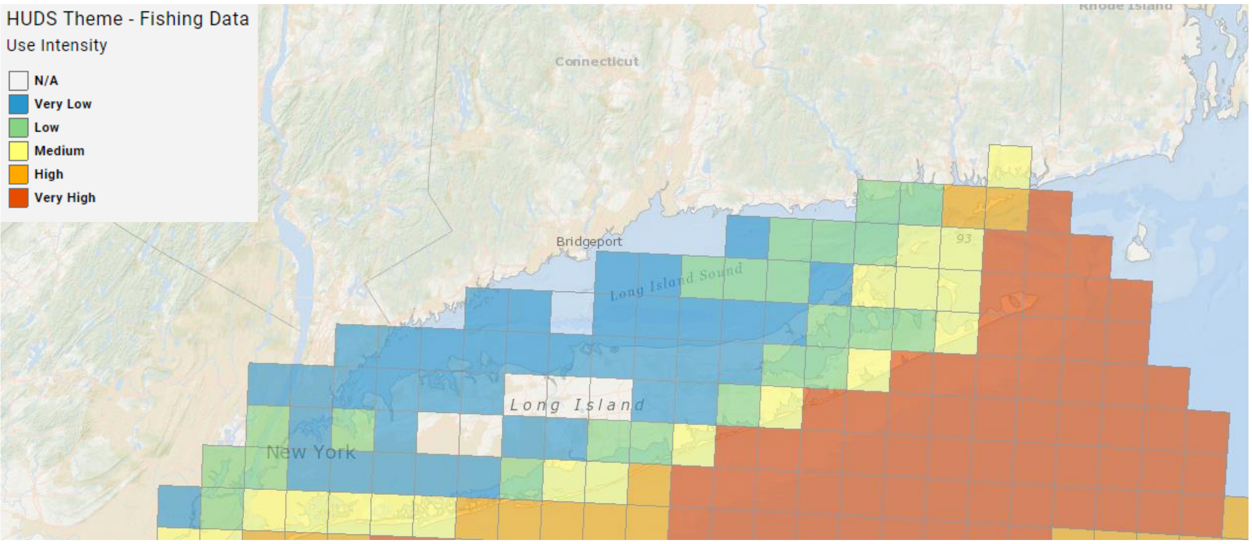


Figure 16-11: [Use Intensity – Fishing Data](). Map of commercial fishing data use intensity in the Mid-Atlantic planning region. Access available via Mid-Atlantic Ocean Data Portal (MARCO, 2017).

16.2 Assessment of Data Quality

16.2.1 Sources of Data and Metadata

The map products included in *Section 16.2 Key Findings* are available online via a variety of data portals, including the Northeast Ocean Data Portal, Mid-Atlantic Ocean Data Portal, New York Geographic Information Gateway, and Marine Cadastre National Viewer. Additional map products created by CT DEEP are also hosted on ArcGIS Online. Metadata for portal-based map products are also hosted on the portal. Metadata for CT DEEP-based map products are available from CT DEEP Marine Fisheries Division. Specific information about source data for individual map products is noted below.

In general, vessels holding permits in certain fisheries are required to use VMS. Additional information can be found at NOAA Fisheries, Greater Atlantic Vessel Monitoring System (VMS) Program site, including a link to federal regulations describing requirements for the use of VMS (NOAA Fisheries, 2017a). Fisheries with vessels required to use VMS include: full-time or part-time limited access scallop; limited access monkfish/occasional scallop or combination permit electing to provide VMS notifications; limited access multispecies (groundfish; e.g., cod, flounder species, haddock, pollock, plaice, halibut, redfish, ocean pout, hake) permit when fishing on a category A or B "day at sea" (DAS); surfclam or ocean quahog open access permit; Maine mahogany quahog limited access permit; limited access monkfish vessel electing to fish in the Offshore Fishery Program; limited access herring permit; limited access squid permit; limited access mackerel permit. These maps display data for vessels using VMS with a limited access multispecies permit fishing under a Category A or B DAS or catch regulated species or ocean pout while on a sector trip, or those with a limited access Northeast multispecies small vessel category or Handgear A permit that fish in multiple Northeast Multispecies Broad Stock Areas (50 Code of Federal Regulations (CFR) 648.10).

It is important to note that these data include all trips using a Northeast Multispecies VMS code by vessels with these permits, and as such, may include trips that target other fisheries but use a Northeast Multispecies VMS declaration for another fishery as a management and reporting mechanism. There are many New England fisheries not described through any VMS-derived maps.

VMS data is subject to strict confidentiality restrictions. Therefore, the map shows the density of vessel locations following the removal of individually identifiable vessel positions. The process of removing sensitive vessel locations followed the “rule of three” mandated by NMFS Office of Law Enforcement by using a screening grid to identify which grid cells contained three or more VMS records. VMS records within cells that contain fewer than three VMS records were not included in the analysis. A statistical method to normalize data was used on the subsequent density grids and data values represent standard deviations. While legends are consistent across products, values represent high or low areas of vessel activity specific to each dataset. Detailed information on processing techniques is outlined in the metadata, which can be accessed through the Northeast Ocean Data Portal.

Operators of NOAA Fisheries Greater Atlantic Region permitted vessels are required to submit a VTR for every fishing trip regardless of where the fishing occurs or what species are targeted, with the exception of those vessels that possess only a lobster permit. Communities-at-Sea maps link fishing communities to specific resource areas in the ocean. They are developed by linking VTR data to vessel permit data. VTRs include trip date, number of crew on board, species and quantities caught, and trip locations, while the permit data includes a vessel's “principal port” as well as other variables describing the vessel itself (e.g. length, horsepower, and age). By linking the two, fishing communities can be categorized based on port and fishing gear group combinations as a function of port of origin or major gear type used on the vessel. For example, fishermen from Newport News, VA and Montauk, NY who fish using dredge gear can be grouped and mapped as two separate communities. This set of maps was created by using trip location point data as input to create density polygons representing visitation frequency (“fisherdays”). The Communities-at-Sea maps show total labor including crew time and the time spent in transit to and from fishing locations. They do not show other variables such as ex-vessel value or number of pounds landed. The results can be interpreted as maps of “community presence.” All data were aggregated to the “community” level, none of the resultant maps represent a fishing area (i.e. “hot spot”) of any individual fisherman or fishing vessel. Draft maps were reviewed and refined in consultation with diverse fishermen in several ports in each Mid-Atlantic state.

VTR data were also used to quantify the total amount of fish landed (measured in pounds) by federally permitted commercial fishing vessels using different gear type between 2001 and 2010. The amount of landings is based on annual VTR summaries provided by the NMFS. These summaries are aggregated by ten-minute square. VTRs are required for most federally permitted fishing vessels. Please note that the use and analysis of these geographic data are limited by the scale at which the data were collected and mapped; as a regional analysis, these data are not intended for site level decisions.

Atlantic fishing revenue intensity between 2007 and 2012 was estimated by BOEM. This represents a single data set from a larger study entitled "Socio-Economic Impact of Outer Continental Shelf Wind Energy Development on Fishing in the U.S. Atlantic" (BOEM, 2017). Each quarter square km (500 m) cell has been summed for the mean correlated economic value over the six year period analyzed (2007-2012). This information was created for each state, gear type, Fishery Management Plan, top 30 exposed ports and top 30 exposed species. This was calculated using VTR, Cumulative Distribution Function which estimates radial distance within which fishing activity is likely to occur, and a 500 m raster cell output. The value is in U.S. dollars for 2012 representing the sum of the mean values for all six years, and then classified into one of the 8 classes. The top 30 species included in this assessment are: Ocean Quahog, Surf Clam, Little Skate, Squid (Illex & Loligo), Menhaden, Winter Skate, Channeled Whelk, Red Grouper, Atlantic Herring, Vermillion Snapper, Atlantic Croaker, Jonah Crab, Red Hake, Atlantic Mackerel, Silver Hake, King Mackerel, Butterfish, Yellowtail Founder, Winter Flounder, Summer Flounder, Black Sea Bass, Monkfish, Bluefish, Lobster, Spiny Dogfish, Scup, Skates, Cod, Sea Scallop. It should be noted that local and regionally important fisheries such as shrimp are not included in this analysis so users should remember that the actual mean revenue if all species were included may be much greater in some areas.

NMFS regulations and management areas vary by species. The American Lobster fishery extends from Maine to Cape Hatteras, North Carolina. There are seven Lobster Conservation Management Areas, which are labeled as Areas 1 to 6 (Area 6 covers LIS,) and Outer Cape Cod Area. A permit holder had to demonstrate trap fishing history in a particular area to hold a permit and continue fishing with traps in that area. Lobster does not require VMS, and the management areas are included for lobster bycatch rules. The American lobster resource and fishery are cooperatively managed by the states and the National Marine Fisheries Service under the framework of the Atlantic States Marine Fisheries Commission. Herring is jointly managed in state and federal waters by the Atlantic States Marine Fisheries Commission and NMFS. Fishing and harvesting of Atlantic sea scallops includes area where chain-mat and the turtle deflector dredge gear are required. NMFS requires the use of this type of gear to help reduce mortality of endangered and threatened sea turtles from May 1 through November 30. The final rule issued by NMFS clarifies where on the dredge the chain mat must be hung. The Northeast Multispecies fishery includes Regulated Mesh Areas in Southern New England. Each mesh area has certain requirements for minimum mesh size, gear, and methods, unless otherwise exempted or prohibited. There are four regulated mesh areas for the Gulf of Maine, Georges Bank, Southern New England, and the Mid-Atlantic. These datasets are from NMFS and represent areas and regulations mandated in the U.S. CFR.

Some species are also managed by states. Locations of Atlantic sturgeon gear restriction areas are described in CT DEEP Notice to Commercial Fishermen dated 04/27/2012. In 2012, polygons were created in ArcGIS by digitizing the areas described in the Notice of Declaration of Regulation Change (12-08). Full text of the Declaration, including latitudinal and longitudinal coordinates, can be found at the CT DEEP website (CT DEEP, 2017b). Locations of horseshoe crab closed areas are described in CT State Regulation 26-159a-17(g). In 2007, polygons were created in ArcGIS by visually digitizing areas using NOAA Nautical Charts for reference. Full text of the regulation can be found at the CT DEEP website (under "Fishing" Title, select link to Commercial and Sport Fishing in the Marine District) (CT DEEP, 2017a).

MARCO contracted with RPS Applied Science Associates (RPS ASA) in partnership with SeaPlan to develop synthesized spatial products characterizing human use in the Mid-Atlantic region using existing data products. This project was referred to as the Human Use Data Synthesis in order to promote ocean planning priorities and goals as laid out in the draft Regional Ocean Action Plan Framework for the Mid-Atlantic region, defined as New York to Virginia from the coast out to the Exclusive Economic Zone. RPS ASA and SeaPlan developed a human use mapping approach that borrows from existing efforts while honoring the goals of MARCO and constraints inherent to the available data. The MARCO web portal was the primary source of data throughout the project, however additional data was incorporated from other sources such as the Marine Cadastre, the U.S. Navy, and from the Northeast Regional Ocean Council's parallel ocean planning efforts. All available data were mapped to a 10 km grid within the region. One of the data products summarizes information specific to data use intensity for fisheries. Each field accounts for variation in the distribution of data across cells by scaling data presence from 0 to 1. This metric is based on selecting a pertinent attribute from each individual layer (e.g. count of infrastructure points, length of lines), summing this attribute within each grid cell, and scaling these summed values from 0-1 to allow for direct comparisons across layers. The result is a more nuanced view of data presence. An additional set of fields tallies the total use intensity per cell and the use intensity for various themes to better identify regional human use trends. There are two sets of 'total' fields, one which sums the use intensity values, and one which classifies use intensity into quantile breaks into categories (i.e. Very High, High, Medium, Low, very Low) using the 20th, 40th, 60th, and 80th percentile.

16.2.2 Accuracy, Representativeness, and Relevance of Map Products

NMFS is an authoritative source of data related to fisheries management, and there is little reason to doubt the technical quality of the data. Further, NMFS recognizes the limitations of the data and their interpretation, namely that the most accurate interpretation of these maps based on VMS is that they indicate relative levels of vessel presence rather than strict fishing activity and that there are many New England fisheries not described through any VMS-derived maps.

Fishermen engaged with VMS-derived maps depicting little to no commercial fishing in Long Island Sound were quick to point that these maps are neither accurate not representative of their knowledge of commercial fishing activity in the Sound and should therefore not be used for Long Island Sound planning purposes as there are not relevant to the sector. Fishermen further pointed out that the few instances of commercial fishing representation in Long Island Sound derived from VMS were more representative of routes to fishing grounds than fishing activities, even when considering data filtered to include only activity at less than 4 kn (often showing areas when they have to slow down because of sea conditions). Fishermen also pointed out that several of the active fisheries in Long Island Sound are not monitored by VMS. VMS-derived maps will in turn inevitably fail to accurately display such fishing activities.

Similarly, most of the Communities-at-Sea VTR-based map products displayed little to no commercial fishing activity in Long Island Sound. It should be noted that these maps do not discriminate between no data and no fishing. These maps, generated for regional scale planning relevance in the Mid-Atlantic, are neither accurate not representative of fishermen's knowledge of commercial fishing activity in the Sound, and should therefore not be used for Long Island Sound planning purposes as they are not relevant to the sector.

VTR-derived landing data for different gear types are likely accurate and may be more representative of the existing commercial fisheries activities in Long Island Sound. However, these maps rely on relatively old datasets (2001-2010) and fisheries change over time, including focus on new species such as conch, which may not be captured by such maps. It should be noted that the scale of these datasets is very coarse and may not be adequate for planning purposes, making them less than fully relevant to the Blue Plan.

Regulatory and management maps are defined by law and therefore inherently accurate, representative of practices that should be observed, and relevant to the fishing sector. However, the map products representing Federal regulations and management are not relevant to the Blue Plan process as they are inclusive of all Long Island Sound. The state regulatory and management map products, however, should be considered in the Blue Plan, although their impact will likely be small given their relatively small footprint.

It is not clear if or how the map of commercial fishing data use intensity in the Mid-Atlantic planning region provides additional information relevant to planning in Long Island Sound.

16.2.3 Data Gaps and Availability of Data to Address Gaps

The most significant data gap is the absence of systematic and comprehensive spatially explicit data accurately documenting commercial fishing activities in Long Island Sound waters. There are numerous maps that document commercial fishing effort at the Northeast regional scale, for example through the Northeast Ocean Data Portal. However, these maps are based on VMS data and fail to accurately represent Long Island Sound fishing activities because they either fail to take into account fishing efforts for species not requiring VMS, or falsely documenting routes to fishing grounds outside of Long Island Sound as fishing activities for species requiring VMS. VTR-derived data documenting landings may be the most representative of fishing efforts, but the scale is coarse and may not be relevant to planning in Long Island Sound. However, it should be pointed out that the landing maps rely on relatively old datasets (2001-2010), and the inventory would benefit from maps from updated datasets that would include representation of more recent commercial fishing activities such as those focused on conch.

Fishermen obviously know where they fish, but such information is often considered proprietary, with reluctance to share considering potential competition and impacts of new regulations.

16.3 Relevance

16.3.1 Relative Historical Importance

Fishing has a long history in Long Island Sound, from the pre-colonial harvest of oysters to the early European colonists netting of alewives and shad and the commercial harvest of fish for local markets in the 18th century (Weigold & Pillsbury, 2014). By the 19th century, commercial fishing thrived in the region, with fish and shellfish sold across the country (Weigold & Pillsbury, 2014). From the abundant harvest of menhaden for oil in the second half of the 1800s to the later fishing for black seabass, cod, bluefish, flounders and lobsters using different types of gear, the history of commercial fishing in Long Island Sound is truly storied (Weigold & Pillsbury, 2014).

16.3.2 Socio-Economic Context

Fishing is a hallmark of the social and cultural fabric of New England, including its tourism industry. A recent assessment of the economic impact of agricultural sectors in Connecticut suggest that while the commercial value (measured as sales) of commercial fishing declined by approximately 50% in Connecticut between 2007 and 2015, mainly due to a decline in wild-caught fish, the sector’s contribution to the statewide sales impacts was $22-24 million in 2015, supporting 250-550 jobs and wages totaling $7-11 million (Lopez, Boehm, Pineda, Gunther, & Carstensen, 2015). Commercial fishing is the second most labor intensive agricultural sector in CT, with 16-35 jobs per million dollars in sales generated (Lopez, Boehm, Pineda, Gunther, & Carstensen, 2015).

16.3.3 Other Notes

Regulations and management are important factors that influence commercial fishing. Fishermen change their fishing habits in time (between seasons and among years) depending on changes in regulations, success rates (e.g., in fulfilling a quota), changes in stock abundance and changes in fish distribution. For example, decline in lobster stocks in the late 1990s has resulted in changes in management practices (e.g., quotas, size limits, license buy-back programs), along with shifts in fisheries to include other species, such as conch, which was not traditionally heavily targeted for commercial purposes. This is important to consider for planning purposes.

16.4 References

BOEM. (2017). *Socio-Economic Impact of Outer Continental Shelf Wind Energy Development on Fisheries in the U.S. Atlantic.* Woods Hole, MA: BOEM.

CT DEEP. (2017a). *DEEP Regulations*. Retrieved from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2704&q=323516
CT DEEP. (2017b). *Notice to Commercial Fishermen: April 27, 2012*. Retrieved from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?A=2588&Q=503242
CT DEEP Marine Fisheries Division. (2017a). *horseshoe_crab_closed_areas*. Retrieved from ArcGIS Online: https://www.arcgis.com/home/item.html?id=d6ea436966a54733b8a036b0e5dc3745
CT DEEP Marine Fisheries Division. (2017b). *sturgeon_gear_restriction_areas*. Retrieved from ArcGIS Online: https://www.arcgis.com/home/item.html?id=3de10accda7a4c78be4be59e0fc5d776
Lopez, R. A., Boehm, R., Pineda, M., Gunther, P., & Carstensen, F. (2015). *Economic impact of Connecticut's agricultural industry, update 2015.* Storrs: Research report NO. 6, Zwick Center for Food and Resource Policy, Department of Agriculturala nd Resource Economocs, University of Connecticut.
MARCO. (2017). *Mid-Atlantic Ocean Data Portal*. Retrieved from Mid-Atlantic Regional Council on the Ocean (MARCO): http://portal.midatlanticocean.org/visualize/
NOAA. (2017). *Marine Cadastre National Viewer*. Retrieved from https://marinecadastre.gov/nationalviewer/
NOAA Fisheries. (2017a). *Greater Atlantic Vessel Monitoring System (VMS) Program*. Retrieved from Greater Atlantic Fisheries: https://www.greateratlantic.fisheries.noaa.gov/vms/regs/index.html
NOAA Fisheries. (2017b). *Vessel Monitoring System Program*. Retrieved from http://www.nmfs.noaa.gov/ole/about/our_programs/vessel_monitoring.html
Northeast Regional Planning Body. (2017). *Commercial Fishing*. Retrieved from Northeast Ocean Data Portal: http://www.northeastoceandata.org/data-explorer/?commercial-fishing
NY Geographic Information Gateway. (2017). *New York Geographic Information Gateway*. Retrieved from http://opdgig.dos.ny.gov/
Weigold, M. E., & Pillsbury, E. (2014). Long Island Sound: A Socioeconomic Perspective. In J. T. Latimer, *Long Island Sound: Prospects for the Urban Sea* (pp. 1-46). New York, NY: Springer.

16.5 Appendices

16.5.1 List of Maps Used to Inform the Chapter

Below is a list of all maps used to inform this chapter, including maps presented above in the narrative and additional maps used to support chapter findings. Maps listed below are organized by the online data portal on which they are hosted (URL links to data portals are noted in *Section 16.4 References* above). Map products not accessible by online data portal are also noted below.

Northeast Ocean Data Portal

- Commercial Fishing: Vessel Activity

New York Geographic Information Gateway

- Communities-at-Sea: Longline Commercial Fishing Activity 2011-2013
- Communities-at-Sea: Lobster Commercial Fishing Activity 2011-2013
- Communities-at-Sea: Groundfish More than 65 ft Commercial Fishing Activity 2011-2013
- Communities-at-Sea: Groundfish Less than 65 ft Commercial Fishing Activity 2011-2013
- Communities-at-Sea: Gillnet Commercial Fishing Activity 2011-2013
- Communities-at-Sea: Dredge Commercial Fishing Activity 2011-2013
- Pot Gear – Regional, Landings [lbs], 2001-2010
- Trawl Gear – Regional, Landings [lbs], 2001-2010
- Gillnet Gear – Regional, Landings [lbs], 2001-2010
- Seine Gear – Regional, Landings [lbs], 2001-2010
- Trawl Gear – Regional, Effort [days], 2001-2010

Mid-Atlantic Ocean Data Portal
- Use Intensity – Fishing Data

Marine Cadastre National Viewer
- Atlantic Fishing Revenue Intensity, 2007-2012

Non-Portal Map Products
- Atlantic Sturgeon Gear Restriction Areas
- Connecticut Horseshoe Crab Closed Areas

More information on some of the map products presented in this chapter, including URL links to data and metadata, can be found in the Commercial Fishing Map Book (CT DEEP, 2017). Not all products showcased in the map book may be addressed in this chapter or will be utilized to inform the final Blue Plan.

16.5.2 Notes on Stakeholder Engagement

The stakeholder engagement process has followed a multi-step approach, with a representative of the fishing community appointed to the Blue Plan Advisory Committee (Mike Theiler) review of the initial map products identified from different sources. Theiler and Sylvain De Guise met with available fishermen in New London to discuss the Blue Plan and data on which it should be based. Theiler further followed up with the Southern New England Fishermen's and Lobstermen's Association for additional input on the map products. Outreach that informed this chapter occurred in the fall of 2017.

Fishermen did not feel comfortable sharing information on where they fish, considering potential competition and impacts of new regulations. They consider such information as personal and proprietary. They would rather engage in specific conversations, individually or as a group, when issues arise or are foreseen.

Chapter 17

Recreational Fishing

Chapter Table of Contents

Chapter List of Figures and Tables

Figures

Tables

17.1 Key Data and Map Products

Recreational fishing is a prominent and popular activity in Long Island Sound (Starbuck & Lipsky, 2013). While the sport includes shellfishing (collection of several species of mollusk and crustacean, including lobster), the vast majority of participants target finfish. Different methodologies and fishing gear are used to catch various species, and participants may fish from the shore, kayak, or power boat. Take of nearly all species is regulated by catch restrictions based on size, number of fish per angler per day, and fishing season (CT DEEP, 2018). These restrictions can differ between Connecticut and New York, and are frequently revised (usually on an annual basis), based on changing fish stocks due to natural variations, fishing pressure, and climate change.

Two data products exist that anglers feel partially represent the areas they utilize for recreational fishing in Long Island Sound (LIS). These are the *Popular Places to Fish* in the Connecticut Department of Energy and Environmental Protection (CT DEEP) Saltwater Fishing Resource Map interactive online viewer (CT DEEP, n.d.), and the *2012 Northeast Recreational Boater Survey* data broken down by target fish species and hosted on the Northeast Ocean Data Portal (Northeast Regional Planning Body, 2018). It must be reiterated that anglers feel these data are insufficient to completely represent their activities in LIS, and while they represent a good start to characterize their sport, more detailed maps are required (see *Section 17.2.3 Data Gaps and Availability of Data to Address Gaps*).

Recreational fishing activity in LIS is described as "fluid," by prominent local anglers, in that the most heavily-used areas of the Sound are always changing. This is driven by many factors, both natural and regulatory, such that anglers vary their locations, target species, their gear, and their technique on a day-to-day and seasonal basis. Anglers describe LIS as "one big nursery," with bait such as menhaden, shad, and squid traveling throughout the Sound, utilizing bottom structure, the open water column, and tidal inlets. The larger sportfish follow these baitfish, and the fishermen, of course, attempt to follow the sportfish. Anglers have noted that there are not so many "popular places to fish, but rather popular places *for* fish."

Layered on top of this are State regulatory components. Black sea bass are a relatively new target species, becoming popular in the last 10 years, and dominate the fishery during May and June. Connecticut anglers seek these fish mid-Sound, where hundreds of boats cluster near the Connecticut-New York state border. Yet "Possession" or "Creel" limits, the number of fish of a given species per angler, varies between the two states: an angler that legally caught their maximum in New York can be over the allowable catch in Connecticut and finable when crossing into CT waters, and visa-versa. As summer fades to fall and the tautog catch limit doubles in October (CT DEEP, 2018), many anglers move close to the rocky shore, frequently fishing from kayaks in water less than 20 feet deep.

These are but a few anecdotes relayed by the recreational fishing community during the outreach process, with the point of illustrating that to fully represent the majority of fishing activity a map must include temporal as well as spatial elements, and should break out target fish by species or guild as well.

The Connecticut Department of Energy and Environmental Protection (DEEP) maintains a Saltwater Fishing Resource Map interactive online map viewer to assist Connecticut anglers in locating bait and tackle shops, charter boat organizations (see *Chapter 18 Charter/Party Boat Fishing*), boat launches, and Popular Places to Fish in the Sound (Figure 17-1) (CT DEEP, n.d.). The effort dedicated to developing this tool has focused on locations important to Connecticut fishers; thus areas in other states' waters are included if they support Connecticut-based angling. The Popular Places to Fish data set is compiled from direct areal observation of personal boats in

1986 and 1987 and DEEP Marine Fisheries Program staff knowledge, updated most recently in 2016. This layer is intended to include historical data as well, and is biased towards areas in the eastern Sound as that is where most contributors recreate. Based on 1:25K to 1:100K scale maps, these maps are generalizations and do not necessarily line up with charted features given the dynamic nature of the Connecticut shoreline. These mapped areas were produced by CT DEEP in response to "numerous requests for GIS map layers of areas in Long Island Sound that are important for recreational fishing" (Resource Map metadata) and are recognized by the Marine Fisheries Program to be an incomplete representation of recreational fishing activity in LIS. The polygons may be filtered by target species using a widget within the map viewer ("Search Fishing Area by Species"). The Saltwater Fishing Resource Map undergoes constant improvement; an additional widget to filter areas by season is under development, as is a layer depicting recreational lobster fishing. CT DEEP Marine Fisheries also uses the Popular Places to Fish data as an internal screening tool for potential impacts from proposed new activities, such as aquaculture and dredging projects (personal communication, DEEP Marine Fisheries).

In addition to the popular fishing polygons, the Saltwater Fishing Resource map also includes known locations that offer crabbing access (for blue crab), shipwrecks/obstructions (complex bottom often attracts numerous species of fish), and Enhanced Opportunity Fishing Sites where regulations for shore-based anglers allow for keeping of smaller scup (porgy) and summer flounder.

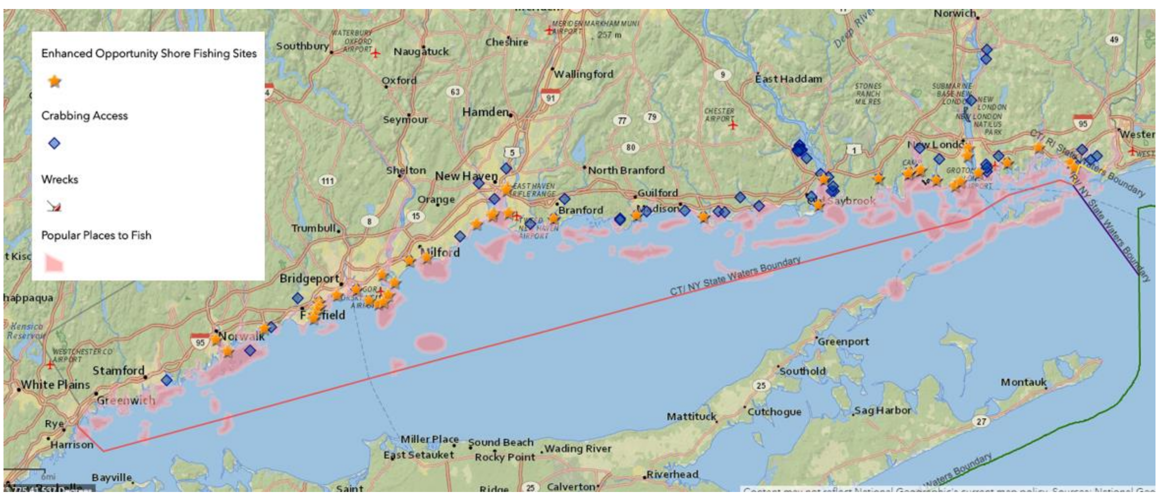


Figure 17-1: [Popular Place to Fish](). Note that shipwrecks are not visible at this scale, but are included as possible fishing locations in the online map viewer. Accessible on the CT DEEP Saltwater Fishing Resource Map (CT DEEP, n.d.).

The *2012 Northeast Recreational Boater Survey* gathered information on recreational fishing from personal pleasure craft. 1,940 eligible respondents from Connecticut and 1,766 from New York participated in the survey, which asked about boat-based recreational activities. Participants from both states, separately, declared 42% of points they placed in the study area as fishing locations (Figure 17-2). The survey also addressed Target Fish Species, as a subcategory of general fishing activity. Participants from Connecticut placed a total of 586 activity points, while participants from New York placed 991 points, though not necessarily in LIS. Figure 17-3 shows a breakdown of targeted fish species based on location.

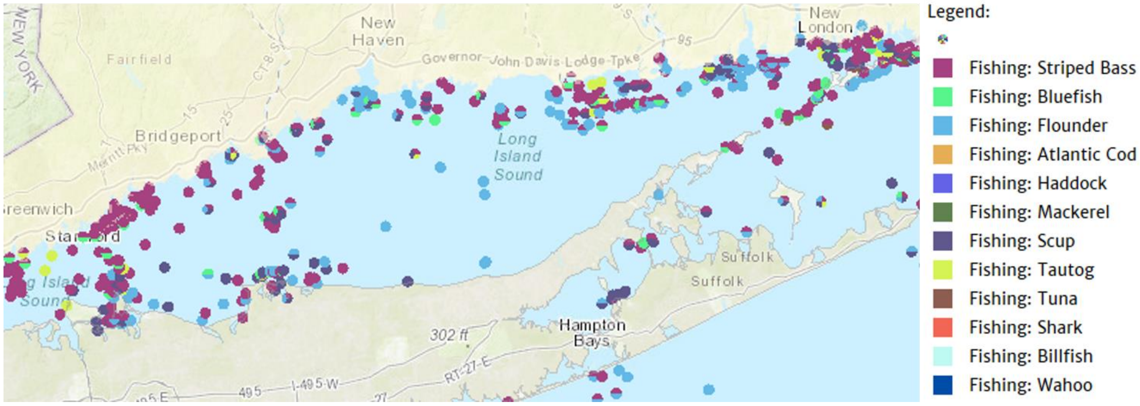


Figure 17-2: [Target Fish Species](). From 2012 Northeast Recreational Boater Survey. Note that black sea bass were not available on the list of possible target species. Additionally, "Flounder" is only summer founder, and "Tuna" is only bluefin tuna. Accessible on the New York Geographic Information Gateway (NYS DOS OPD, 2017; Starbuck & Lipsky, 2013).

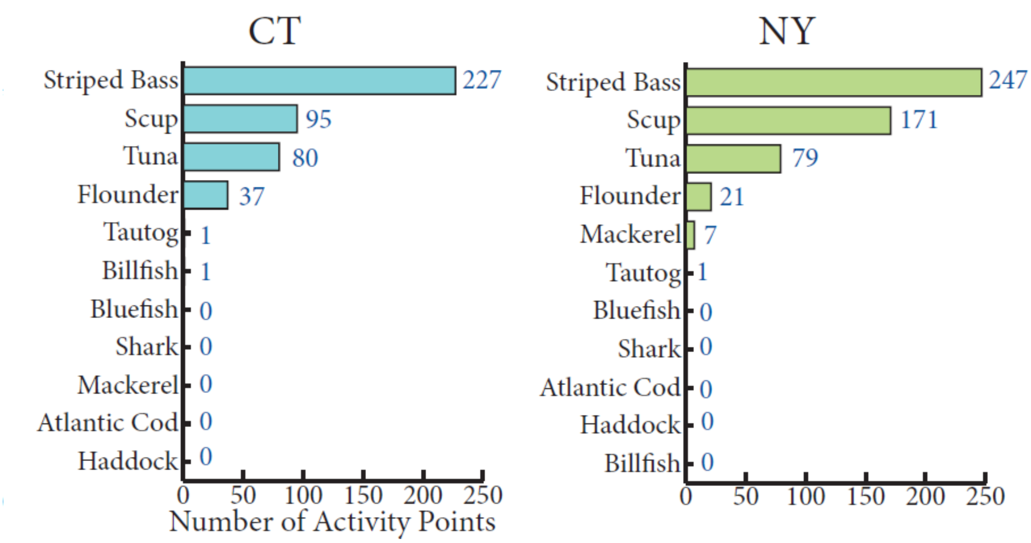


Figure 17-3: Target Fish Species Activity Points. Data comes from the 2012 Northeast Recreational Boater Survey. Angling in Long Island Sound, as with the rest of the Northeast, focuses predominantly on striped bass. Note that black sea bass are absent from the list of target species (Starbuck & Lipsky, 2013).

Recreational shellfishing in Connecticut targets primarily clam, along with a few other bivalve species, and is managed by town governments through the shellfish commissions. Not all towns maintain recreational shellfish beds (Getchis, 2004); those that do exist are represented in the Connecticut Aquaculture Mapping Atlas (Figure 17-4), which is considered the best information consolidated in one place on the location of these beds. Shellfish commissions support themselves through the issuance of permits and through partnerships with commercial growers in neighboring town- or state-managed lease beds (see *Chapter 15 Aquaculture*). Historically, recreational shellfishing and the shellfish commissions emerged in the late 1970s and early 1980s as beds closed in the 1960s were reopened based on a better scientific understanding of health standards and testing developed. Recreational shellfish beds require both unfettered public access to the intertidal, as well as water clean enough that the collected mollusks meet public health standards. The necessity of both of these attributes means that many recreational beds are part of the "relay" system of shellfish aquaculture in Connecticut, with bivalves transported from conditionally-approved commercial areas to recreational beds where they are considered clean to harvest after two weeks of filtering. Many towns that have shellfish commissions do not have recreational beds: in these cases the commission is focused on managing aspects of commercial shellfish aquaculture, such as seed beds (see *Chapter 15 Aquaculture*); in all cases, the shellfish commission gives the town an additional voice and permitting power in the management of its waterways.

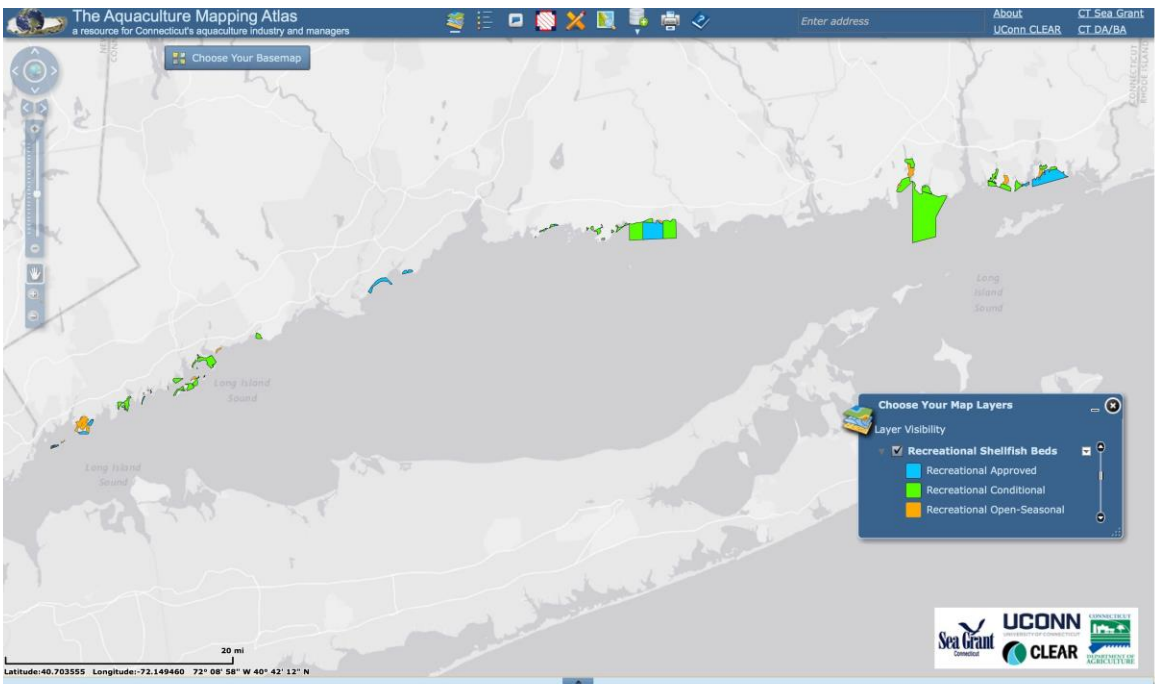


Figure 17-4: [Recreational Shellfish Areas in Connecticut](). Note that the available town beds exist nearshore and may be Approved, Conditional, or Seasonal. Accessible on the Connecticut Aquaculture Mapping Atlas (University of Connecticut, 2014).

New York State Department of Environmental Conservation (NYS DEC) manages recreational shellfishing by gear type, restrictions on minimum size and maximum daily take, and by area closures based on health concerns (NYS DEC, 2017). While New York State does not require a permit to collect shellfish, certain towns do (Rekemeyer, 2016). NYS DEC maintains an online map viewer displaying state closed locations (NYS DEC, 2017).

Other recreational species, such as squid, lobster, whelk, and blue and Jonah crab, are managed in Connecticut by the CT DEEP Marine Fisheries Program. These species are fished with bait, jigs, nets, or traps from shore or boat. Of these, only lobster, and whelk taken in more than half a bushel per day, require a license to collect (Connecticut Department of Energy and Environmental Protection, 2017). Likewise, New York only requires a permit for lobster, while crab species and whelk are regulated by take limits (NYS DEC, 2016). Lobster fishing typically occurs in waters less than 30 ft deep, with popular locations coinciding with complex bottom structure: breakwaters, jetties, and nearshore rocky reefs.

17.2 Assessment of Data Quality

17.2.1 Sources of Data and Metadata

Maps from the Saltwater Fishing Resource Map are available online on the CT DEEP website; see link in References below. Metadata is available on the CT DEEP Marine Fisheries Program ArcGIS Online page, also in References below.

The *2012 Northeast Recreational Boater Survey* targeted the activities of recreational boaters in coastal Northeast counties. These surveys were administered online in monthly increments for the boating season of 2012 and collected information on spatial use, economic information, and additional relevant data (such as number of trips and primary activity). Map data from the survey can be found on both the Northeast Ocean Data Portal and the New York Geographic Information Gateway (Northeast Regional Planning Body, 2018; NYS DOS OPD, 2017). All other data from the survey used in this Inventory come from the final report itself.

Input to the narrative of recreational angling in LIS comes from feedback provided on the Recreational Fishing and Hunting webinar held in November 2017 (see *Section 17.5.2 Notes on Stakeholder Engagement* for more information). Much of this information was provided by a prominent local angler and bait and tackle shop owner, who also contributes a weekly newspaper and web column and radio broadcast to the fishing community, as well as the Advisors Chair of Atlantic State's Marine Fisheries Commission (ASMFC)/Atlantic Coastal Cooperative Statistics Program (ACCSP) Atlantic States partners and CT DEEP's Recreational Fishing Advisor.

17.2.2 Accuracy, Representativeness, and Relevance of Map Products

The map products from both the CT DEEP Marine Fisheries Program and the *2012 Northeast Recreational Boater Survey* are considered by stakeholders a good start but nowhere near sufficient to accurately represent recreational fishing. While the content of both resources – the discrete locations of the many fisheries of the Sound – is highly relevant to planning activity, the data fall short of being completely representative the angling constituency. Other map products, such as the location of bait and tackle shops, state and local boat ramps, and coastal access sites, were not commented on during the webinar.

The main shortcomings of these map products, as discussed above, are that they do not show all target species or seasonality of fishing effort throughout the Sound. Most notably, black sea bass is not represented in the 2012 survey and underrepresented in the CT DEEP data. As the 2012 survey was conducted in monthly increments over a season, it may be possible to distill the information further to see what fish species Connecticut and New York anglers were targeting each month, but this is likely to be not worth the effort, considering the data is already considered insufficient.

17.2.3 Data Gaps and Availability of Data to Address Gaps

Anglers immediately identified data gaps in the existing map products, but also concluded that correcting these gaps will not be a difficult endeavor. In summary, these gaps are:

1. Not all known important fishing areas, including shellfishing, are known or represented.

2. Seasonal changes of primary target fish not represented in data at all. These changes can be driven by regulations (the opening and closing of fishing seasons) or simply by the presence of a fish in LIS based on annual migration patterns.

3. Not all target fish species are represented in the existing data. While most species are featured on the CT DEEP Marine Fisheries Program, they are not symbolized separately but be selected by attribute using the built-in "Search Fishing Area by Species" widget. The 2012 survey data omits at least one of the most important target fish in LIS (black sea bass). Additionally, it was noted that not all bait and tackle shops are represented in the viewer.

4. No mention of decadal changes in fisheries, whether driven by climate change, fishing regulations, or changes in technique or preference. For example, black sea bass have always been in LIS, but until 10 years ago (2007) they were not a primary target or commonly caught. Now they are very common and sought after by many anglers.

In response to these gaps anglers suggested the addition of mapped areas to enhance the accuracy of existing CT DEEP Marine Fisheries Program data to a level that will satisfactorily represent the community. Stakeholder representatives present at the webinar were interested in creating new polygons of heavily-used fishing areas to account for both seasonality and target fish species or guild. At the time of this writing, CT DEEP is currently improving the Saltwater Fishing Resource Map to include seasonality and popular lobster areas. It is also noted that the National Oceanic and Atmospheric Administration (NOAA) information included in this chapter could be expanded by including data from the NOAA Marine Recreational Information Program (NOAA OST NMFS, 2018).

17.3 Relevance

17.3.1 Relative Historical Importance

Recreational fishing has been present in Connecticut for hundreds of years. While the first saltwater fishing permits in the state were required in 2010, inland recreational fishing has been managed since 1866 when the Fisheries Commission was created by state legislature (Connecticut Department of Energy and Environmental Protection, 2016).

Any chronicling of recreational fishing in LIS would be remiss without a specific mention of striped bass. While "stripers" are an Atlantic migratory species, Connecticut sees a few holdover populations that remain in coastal waters year-round; in fact, successful ice fishing for stripers was reported in January 2018. Federal and State regulation of striped bass has varied throughout the decades, as stocks diminish and recover, directly impacting anglers. Despite this, stripers remain overwhelmingly the most important sportfish in LIS, and indeed the entire Northeast (Starbuck & Lipsky, 2013), as they have been since at least the early 1900s. As a prominent local bait and tackle shop owner stated: "This one fish, in addition to menhaden [a common baitfish] is the driving force [of recreational fishing in the Sound]. Bluefish are important, and fun, but stripers bring people onto boats."

Recreational lobster fishing in Connecticut was once a highly popular activity; in the 1980s CT DEEP issued over 3,300 individual-use lobster permits annually. However, in the late 1990s and early 2000s the lobster population collapsed, due to a slight warming of the Sound and deteriorating water quality conditions (LISS, 2018). Today CT DEEP issues under 300 licenses annually.

Lastly, a word must be said about the American shad, Connecticut's state fish. This anadromous fish runs through the Sound to spawn upstream in four rivers with significant LIS estuaries, including the Connecticut itself. While it was once a significant commercial boon to nearby communities, the shad now exists mostly as a seasonal recreational attraction, linking many inland anglers, and tourists, to the ocean through its mid-April run (Woodside, n.d.). A small commercial spring shad market, primarily to coastal restaurants, still persists in the Connecticut River area. Numerous conservation efforts exist to facilitate the recovery of the shad in Connecticut, though the population still fluctuates annually.

17.3.2 Socio-Economic Context

Recreational fishing is a significant industry on both the Connecticut and Long Island shores of the Sound, supporting business as diverse as bait and tackle shops (Figure 17-5), boat yards and dealers, marinas, and even the publication industry. Through sales tax and boat registration fees, anglers support both States' governments, and the Marine Fishing License program in Connecticut funds the state's marine fisheries outreach programs, including enhanced opportunity locations and the Saltwater Fishing Resource Map. NYS DEC does not require a fee, but does require that anglers enroll in the Recreational Marine Fishing Registry before fishing in the State's Marine and Coastal District Waters (NYS DEC, 2016). Recent anecdotal reports indicate that recreational fishing is continuing to grow in popularity, with many millennials joining both the sport and industry.

NOAA's Office of Science and Technology (OST) produces an annual report (NOAA OST ESAD NMFS, 2017) examining the commercial and recreational fisheries economics of each coastal state. The most recent edition, published in May 2017, contains information gathered in

2015, summarized in Table 17-1. The report includes a summary of fish species harvested and released, reprinted here as Table 17-2 (Connecticut) and Table 17-3 (New York). Note that, in all of these statistics, New York numerations represent the State's entire shoreline, not just LIS, and therefore are an unknown degree larger than what the Sound alone supports. Connecticut statistics, however, are exclusively for landings occurring in LIS waters. Please see the report for an explanation of calculation methods.

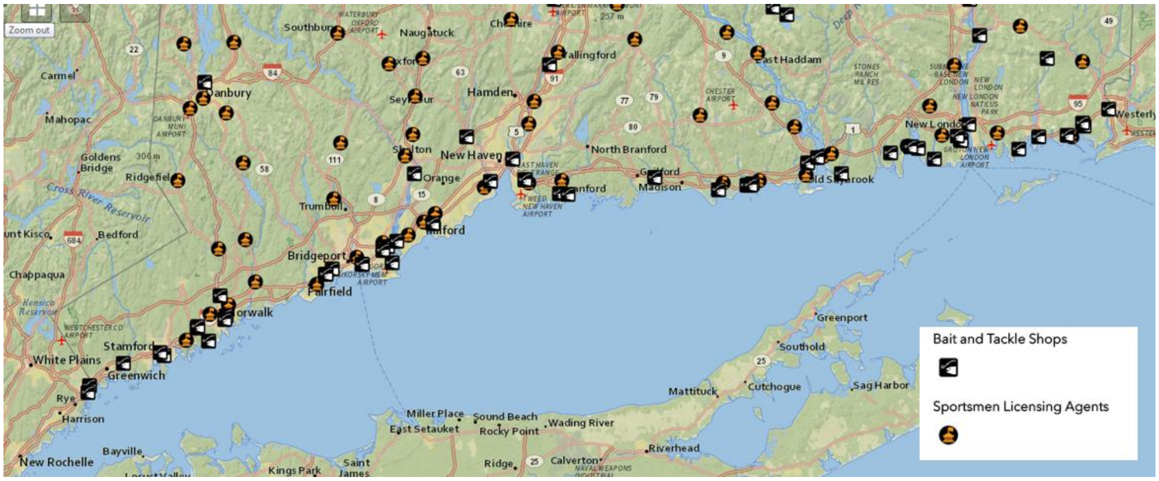


Figure 17-5: Connecticut Bait, Tackle, and Licensing Locations. Data comes from the CT DEEP Saltwater Fishing Resource Map. Note that Long Island locations are not accounted for here (CT DEEP, n.d.).

Table 17-1: Economic contributions of recreational fishing in Connecticut and New York. Summarized from NOAA OST 2015

	Connecticut	New York
Jobs Supported	255	698
Value Added (Not including durable goods sales)	$14.2 M	$42.2 M
Total Value Added	$248 M	$586.8 M
Trip Expenditures	$27.3 M	$96.6 M
Trips Made (Not including charter fishing)	1.3 M	2.7 M
Number of In-State Anglers	252,000	555,000
Number of Out-of-State Anglers	57,000	53,000

Table 17-2: Connecticut Fish Harvest and Release by Species, from NOAA OST 2015

Harvest (H) & Release (R) of Key Species/Species Groups (thousands of fish)[2]

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Atlantic cod	H	< 1	0	0	0	0	0	1	0	0	0
	R	< 1	0	0	0	0	0	0	0	0	0
Bluefish	H	507	451	623	262	591	307	480	893	288	365
	R	1,167	888	1,144	295	715	997	679	727	425	401
Hickory shad	H	63	35	0	0	1	16	39	8	73	0
	R	144	4	5	< 1	0	0	0	1	67	< 1
Little tunny	H	0	0	0	0	1	0	< 1	0	1	0
	R	0	< 1	0	9	8	14	57	0	13	1
Porgies (scup)	H	532	925	549	289	1,088	933	868	937	561	477
	R	740	1,006	974	1,204	1,192	539	1,049	1,218	1,413	764
Striped bass	H	115	119	108	61	93	63	65	140	84	75
	R	987	985	3,105	1,161	671	612	265	775	310	667
Summer flounder	H	138	112	146	45	35	47	63	270	120	93
	R	1,111	297	991	428	373	345	306	866	638	408
White perch	H	0	0	7	60	0	0	10	0	14	< 1
	R	15	18	52	72	0	< 1	48	2	7	< 1
Winter flounder	H	0	0	0	12	14	19	9	0	< 1	12
	R	21	15	0	7	12	< 1	7	4	< 1	31
Wrasses (tautog)	H	201	353	167	86	116	26	194	104	318	126
	R	108	745	250	112	257	36	599	453	1,668	272

[1] NA = data are not available because out-of-state resident information is collected for individual states but does not specify whether an angler resides in a region.
[2] In this table, '<1' = 0-999 fish and '1' = 1,000-1,499 fish.

Table 17-3: New York Fish Harvest and Release by Species, from NOAA OST 2015

Harvest (H) & Release (R) of Key Species Species Groups (thousands of fish)[1]

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Atlantic herring[2]	H	23	214	69	4	79	76	174	222	188	1,462
	R	2	230	50	0	17	< 1	0	59	15	25
Black sea bass	H	269	410	260	566	543	274	322	353	469	877
	R	1,327	1,549	1,655	1,236	1,163	893	2,471	1,372	1,447	2,234
Bluefish	H	1,832	2,151	1,484	1,293	1,026	927	1,150	1,108	1,424	509
	R	2,379	2,650	3,224	1,793	1,471	1,598	1,809	1,030	1,543	1,055
Drum (weakfish)	H	10	4	40	0	3	< 1	5	7	< 1	< 1
	R	17	109	25	3	3	55	11	6	< 1	4
Porgies (scup)	H	1,678	1,596	1,451	1,460	1,990	715	592	1,096	1,182	1,957
	R	2,622	1,964	2,838	2,124	1,864	998	1,235	1,865	1,730	2,136
Shortfin mako shark	H	< 1	< 1	< 1	0	1	0	< 1	0	11	7
	R	< 1	0	0	0	0	3	3	1	11	9
Striped bass	H	368	474	686	356	538	675	425	491	392	154
	R	1,722	1,678	1,346	1,073	1,069	1,506	586	990	703	592
Summer flounder	H	752	866	609	299	334	376	509	518	508	492
	R	4,946	5,272	5,521	5,564	6,571	7,295	5,013	4,667	4,041	3,929
Winter Flounder	H	261	11	41	69	31	65	43	1	24	5
	R	76	15	17	110	63	101	33	3	11	1
Wrasses (tautog)	H	247	224	319	346	146	111	62	77	300	99
	R	823	387	728	665	567	487	365	590	939	1,018

[1] In this table, '<1' = 0-999 ish and '1' = 1,000-1,499 fish.
[2] This species may not be equivalent to species with similar names listed in the commercial tables.

17.3.3 Other Notes

Several stakeholders observed that New York management seasons differ from Connecticut seasons; anglers wondered why there is not consensus on this point since the fish know no political boundaries (Hladky, 2016). Cooperative management does exist through the ASMFC, a group that was established to address the concerns and complications of managing coastal migratory fish on a state-by-state basis. Through this venue there is much coordination between Connecticut, New York, and Rhode Island, though each state is ultimately responsible for the final regulations they adopt, though stocks are evaluated on a coast-wide, and in some cases, a regional scale. Additionally, some species, such as Cod, are superseded by Federal regulations (Atlantic States Marine Fisheries Commission, 2018).

17.4 References

Atlantic States Marine Fisheries Commission. (2018). *Fisheries Managment*. Retrieved from http://www.asmfc.org/

Connecticut Department of Energy and Environmental Protection. (2016). *Bureau of Natural Resources Through the Years*. Retrieved from Connecticut DEEP: http://www.ct.gov/deep/cwp/view.asp?a=2723&q=572732

Connecticut Department of Energy and Environmental Protection. (2017). *Saltwater Anglers Guide.* Retrieved from Fishing: http://www.ct.gov/deep/lib/deep/fishing/anglers_guide/anguide_part3.pdf

CT DEEP. (2017). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635

CT DEEP. (2018). *Marine Recreational Fisheries Regulations*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://www.ct.gov/deep/cwp/view.asp?a=2696&q=322740&deepNav_GID=1647

CT DEEP. (n.d.). *Saltwater Fishing Resource Map*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP) ArcGIS Homepage: http://ctdeep.maps.arcgis.com/apps/webappviewer/index.html?id=4ac9ffcad5e34971a13838bfaa7f5468

Getchis, T. (2004). *Guide to Shellfishing Along the Coast of Connecticut.* Retrieved from Town of Branford Recreational Shellfishing: http://branford-ct.gov/filestorage/285/562/583/shllfsh.pdf

Hladky, G. B. (2016, June 22). Long Island Sound Fishing Entangled in Conflicting Multi-State Regulations. *Hartford Courant*.

Lapinski, T. (2017, November 13). Help Shape the use of Long Island Sound. *The Fisherman*.

LISS. (2018). *Lobster Landings*. Retrieved from Long Island Sound Study (LISS): http://longislandsoundstudy.net/indicator/lobster-landings/

NOAA OST ESAD NMFS. (2017). *Fisheries Economics of the United States 2015.* NOAA Technical Memorandum NMFS-F/SPO-170. Silver Spring: NOAA Office of Science and Technology, Economics and Social Analysis Division, National Marine Fisheries Service (NOAA OST ESAD NMFS). Retrieved from https://www.st.nmfs.noaa.gov/economics/publications/feus/fisheries_economics_2015/index

NOAA OST NMFS. (2018). *Recreational Fisheries Statistics Queries*. Retrieved from National Oceanic and Atmospheric Administration, Office of Science and Technology, National Marine Fisheries Service (NOAA OST NMFS): https://www.st.nmfs.noaa.gov/recreational-fisheries/data-and-documentation/queries/index

Northeast Regional Planning Body. (2018). *Northeast Ocean Data Portal*. Retrieved from www.northeastoceandata.org
NYS DEC. (2016, June 23). *Recreational Crab, Lobster & Whelk Limits.* Retrieved from New York State Department of Environmental Conservation (NYS DEC): http://www.dec.ny.gov/docs/fish_marine_pdf/fishlimitscrabs.pdf
NYS DEC. (2017, 13 December). *NYS DEC Public Shellfish Mapper*. Retrieved from New York State Department of Environmental Conservation (NYS DEC): https://nysdec.maps.arcgis.com/apps/webappviewer/index.html?id=d98abc91849f4ccf8c38db b70f8a0042
NYS DOS OPD. (2017). *New York Geographic Information Gateway*. Retrieved from New York State Department of State, Office of Planning and Development (NYS DOS OPD): http://opdgig.dos.ny.gov/#/map
Rekemeyer, S. (2016, August). *Digging For Burried Treasure - Clamming in New York's Waters.* Retrieved from New York Department of Environmental Conservation: http://www.dec.ny.gov/docs/fish_marine_pdf/clammingcons0816.pdf
Starbuck, K., & Lipsky, A. (2013). *2012 Northeast Recreational Boater Sruvey: a Socioeconomic and Spatial Characterization of Recreational Boating in Coastal and Ocean Waters of the Northeast United States.* Boston, MA: SeaPlan.
University of Connecticut. (2014). *The Aquaculture Mapping Atlas*. Retrieved from UConn Center for Landuse Edcation and Research: https://clear3.uconn.edu/aquaculture/
Woodside, C. (n.d.). *A Tale of Shad, the State Fish*. Retrieved from ConnecticutHistory.org: https://connecticuthistory.org/a-tale-of-shad-the-state-fish/

17.5 Appendices

17.5.1 List of Maps Used to Inform the Chapter

Below is a list of all maps used to inform this chapter, including maps presented above in the narrative and additional maps used to support chapter findings. Maps listed below are organized by the online data portal on which they are hosted (URL links to data portals are noted in *Section 17.4 References* above). Map products not accessible by online data portal are also noted below.

Northeast Ocean Data Portal
- Boat Launches

New York Geographic Information Gateway
- Boat Launches
- Target Fish Species – Northeast Region, 2012

Connecticut DEEP Saltwater Fishing Resource Map
- Popular Fishing Areas
- Bait, Tackle, and Licensing
- Boat Launches
- Party and Charter Boat Locations

CT Aquaculture Mapping Atlas

- Recreational Shellfish Areas

NYS DEC Public Shellfish Mapper

- All Closures

More information on some of the map products presented in this chapter, including URL links to data and metadata, can be found in the Recreational Fishing Map Book (CT DEEP, 2017). Not all products showcased in the map book may be addressed in this chapter or will be utilized to inform the final Blue Plan.

17.5.2 Notes on Stakeholder Engagement

Initial email blasts in September and individual emails and calls in October to identified stakeholder contacts introduced the Blue Plan and Resource and Use Inventory and invited participation in the data-vetting webinar. However, this attempted contact returned very low response. To reach as wide an audience of anglers as possible, a region-wide notice was published in *The Fisherman* in early November. This notice was submitted by a prominent member of the local fishing community who had been involved in the outreach process since September, and is familiar with the community as a whole. *The Fisherman* is distributed monthly, and weekly during the fishing season, and is widely read by anglers. Numerous participants commented that this publication is the best possible way to reach the fishing community, and the initial invite was referenced in another article several days after posting (Lapinski, 2017). Yet, despite this, there were less than 10 participants in the webinar held November 21, 2017.

This webinar included an overview of the Blue Plan and Inventory, presented the associated map products the team had been able to assemble to potentially represent Recreational Fishing in LIS, and provided an avenue for participants to discuss questions with team members. This webinar also included material on Waterfowl Hunting in LIS, as anglers and hunters have similar modes of access to LIS (boat and shore based) and thus, we assumed, similar concern about access and regulation. See *Chapter 22 Waterfowl Hunting* for more information on this topic. Attending participants representing Recreational Fishing included the Commercial and Recreational Advisors Chair of ASMFC/ACCSP, the prominent community figure who published the notification, and active anglers. Discussion with anglers during the webinar was exceedingly helpful in constructing the characterization of Recreational Fishing presented in this Inventory.

Representatives of the constituency note that if notice had been given about the event farther ahead of time, attendance would probably have been much greater. Recent conversations via phone and email with anglers have provided more detail to the context of recreational fishing in the Sound, as well as focused on defining a means and method for improving maps of important fishing areas.

Chapter 18

Charter/Party Boat Fishing

Chapter Table of Contents

Chapter List of Figures and Tables

Figures

Tables

None

18.1 Key Data and Map Products

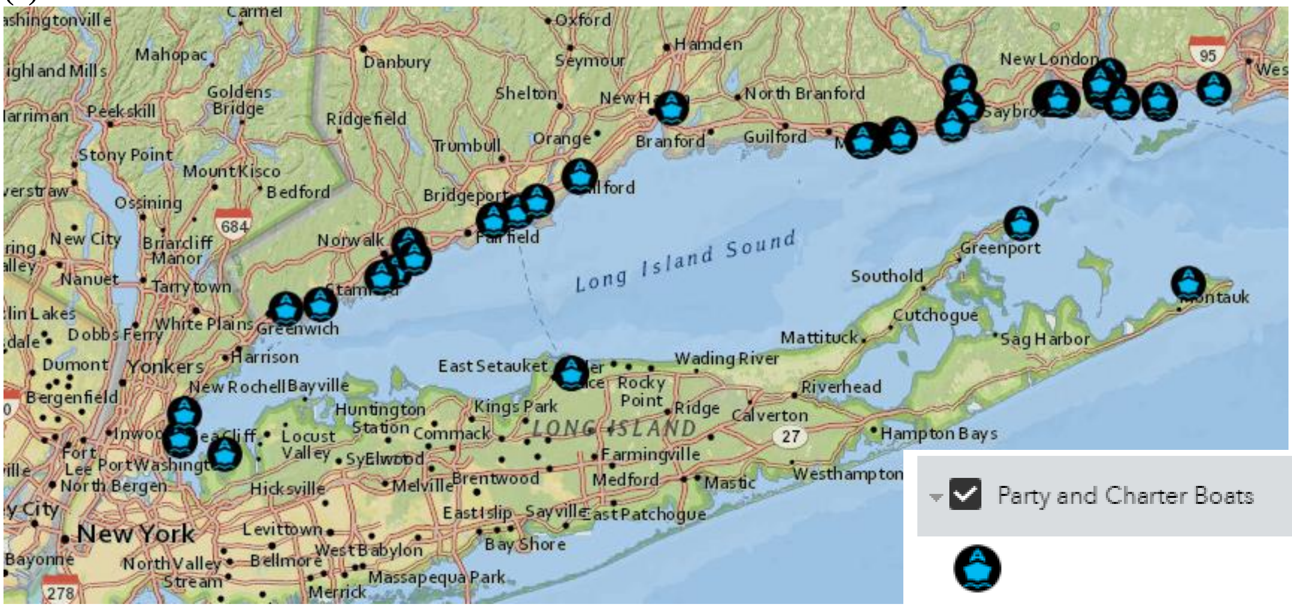
Charter and Party Boats provide opportunities for saltwater fishing trips with experienced captains & crew and represent an important and distinct component of the recreational and commercial fishing sector for Long Island Sound. This for-hire industry in Connecticut contributed 63 jobs, $5.7 million in income, $8.2 in value added, and $10.8 million in output in 2011 (Lovell, Steinback, & Hilger, 2011) There are multiple locations along the coast where these vessels can be hired as indicated in Figure 18-1 below. This sector is a prime example of a traditional human use that is water-dependent and part of the maritime culture of the Sound. It is also a sector that likely depends on being able to access particular areas that are generally known to be more productive on a cost/benefit basis. As such, we anticipate that the sector could be directly affected by how and where spatial areas of the Sound are utilized in the future, particularly in association with proposed new uses.

The maps shown below represent information that is publicly available re charter and party boat fishing. Discussions are underway with the Connecticut Charter and Party Boat Association (CCPBA) about completing “participatory mapping” exercises to more fully and specifically depict areas of importance for charter and party boats for the Sound as-a-whole. These discussions include inquiries about allowing participatory maps that currently exist for Eastern Long Island Sound to be used for the Blue Plan.

In Figure 18-1 below, the names and locations of charter and party boat vendors are available. It shows that there is generally widespread availability along the Connecticut coast to these vendors. This map only includes vendors that have asked to be represented in the data. Because this is voluntary, it is not necessarily complete and the availability or viability of each vendor has not been independently verified that we know of.

Practical limits on average excursion time suggests that fishing activity would likely be conducted within reasonable proximity to the where the vendors are located and therefore, because the vendors are spread out along the coast, likely throughout most of the Sound. This is generally correlated by Figures 18-2 and 18-3 below that show boat trips (2000-2009) and landings in pounds (2001-2010).

(a)



(b)

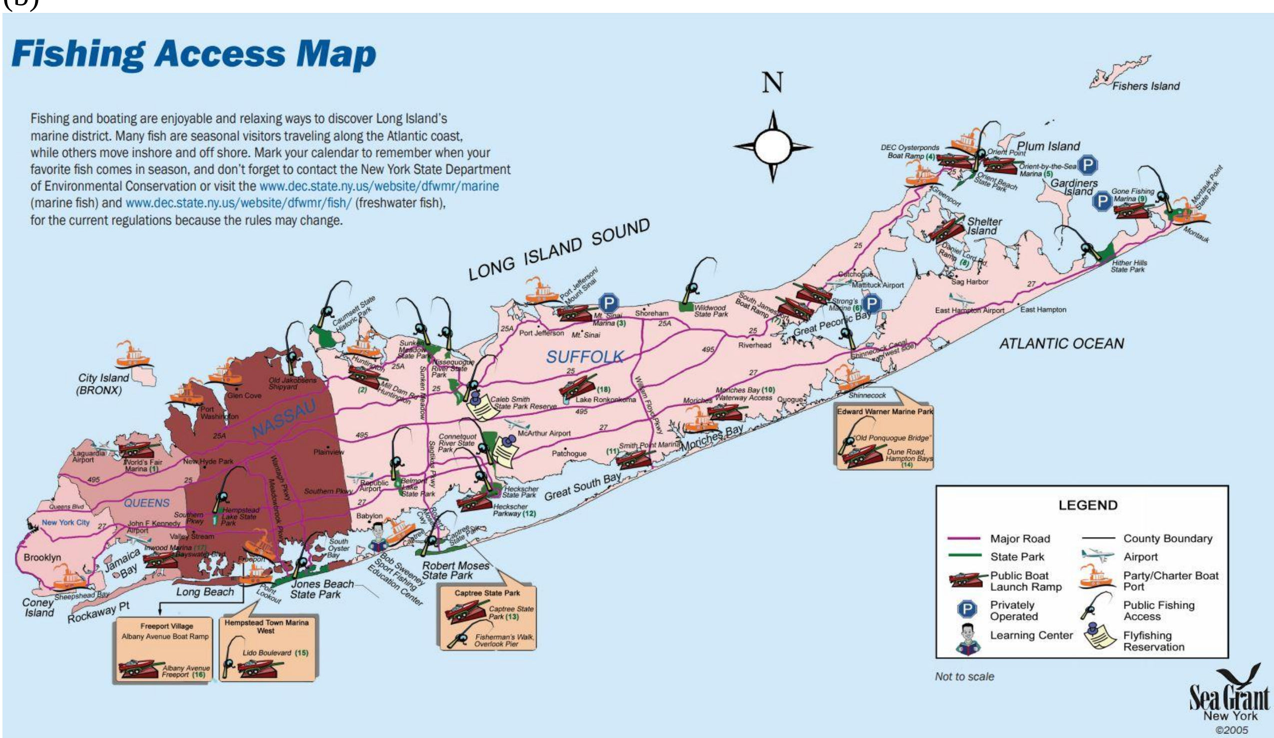


Figure 18-1: [*Party and Charter Boat Operator Locations*](#)*. Locations shown are those known to operate out of (a) Connecticut and (b) Long Island. Access available via the Connecticut Department of Energy and Environmental Protection (CT DEEP) Saltwater Fishing Resource Map* (CT DEEP, 2017) *and New York Sea Grant (New York Sea Grant, 2005).*

Figure 18-3 was created by the Nature Conservancy based on data provided by the National Oceanic and Atmospheric Administration National Marine Fisheries Service (NMFS). The number of trips information is based on vessel trip report (VTR) records that have been aggregated by ten-minute squares and have been screened for confidentiality. The records to produce this dataset are for federally permitted party boats and charter boats only. VTRs are submitted to NMFS by federally permitted fishing vessels for all fishing trips. The screening process protects the identity of each individual permitted commercial fishing vessel. Approximately 70% to 80% of all recorded of trips between 2000 and 2009 are represented in this dataset.

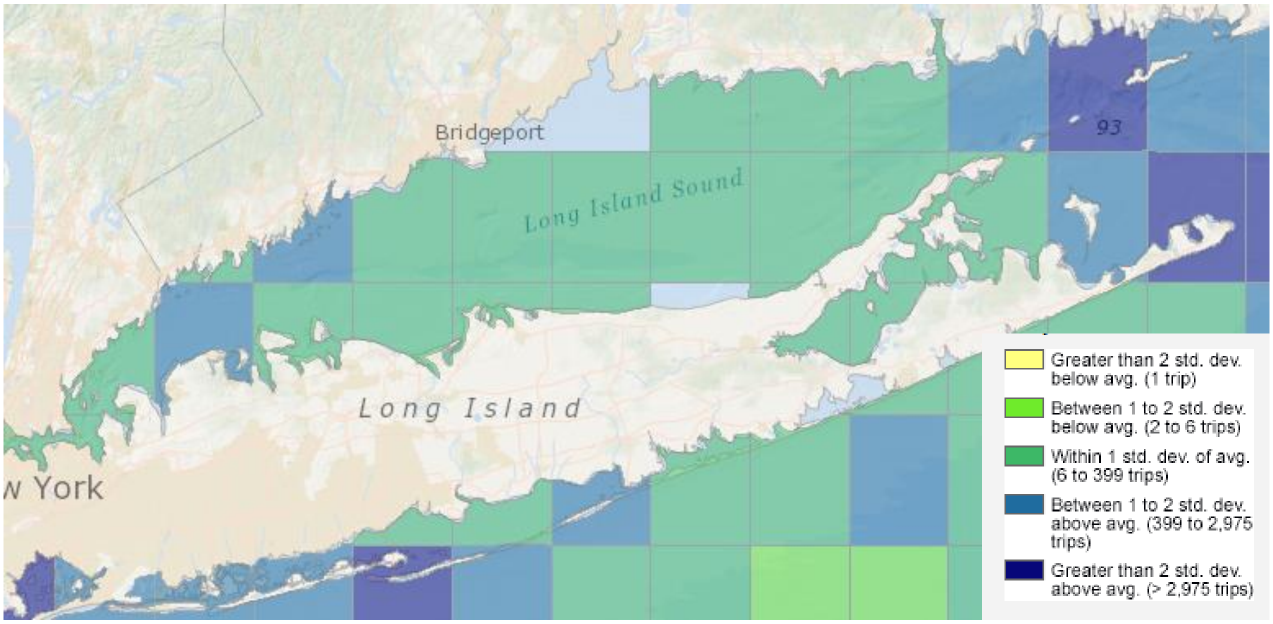


Figure 18-2: Party and Charter Boat Trips (Total 2000 – 2009). Number of trips based on VTRs that have been aggregated by 10 minute squares. Access available via the Mid-Atlantic Data Portal (MARCO, 2017).

The data for the Charter & Party Vessels Regional Landings (lbs) 2001-2010 shown in Figure 18-3 was provided by NMFS. This data product represents the total amount of fish landed (in pounds) by federally permitted for-hire charter and party vessels between 2001 and 2010. The amount of landings is based on annual VTR summaries provided by NMFS. These summaries are aggregated by ten minute square. VTRs are required for most federally permitted fishing vessels. For this Regional Landings and Boat Trips layer (Figure 18-3), data collection is restricted to a certain scale and method of collection, so this is not meant for site level discussions or to represent all landings or trips. Nevertheless, it provides a relative sense of the presence and importance of the charter and party boat sector.

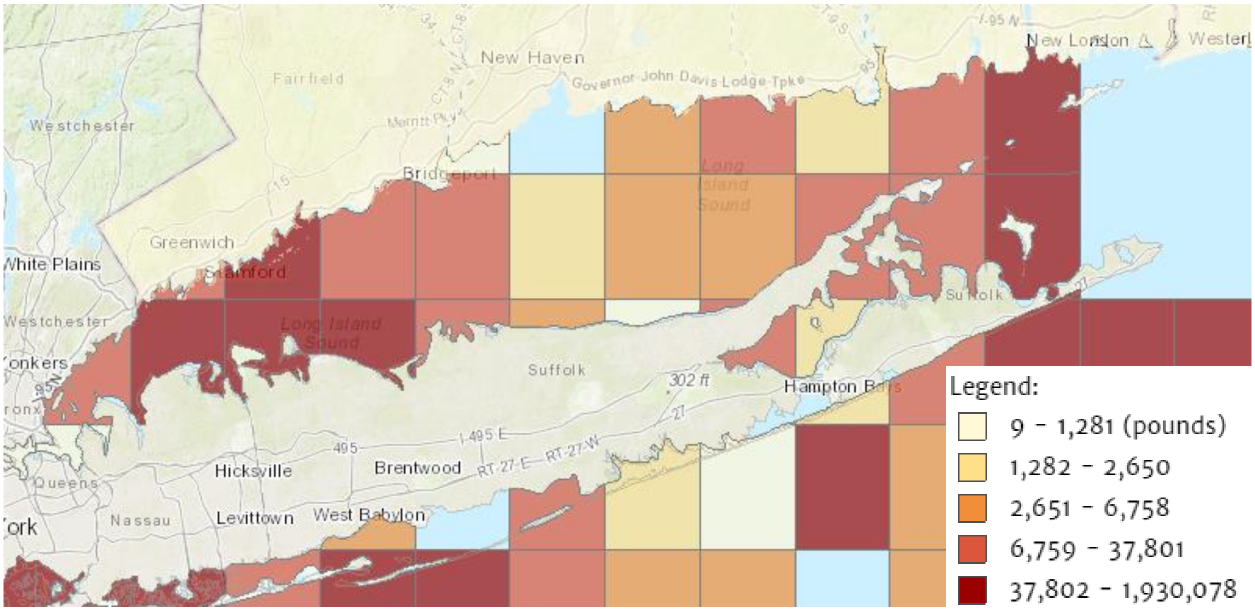


Figure 18-3: [Charter and Party Vessels – Regional, Landings [lbs], 2001 – 2010](). Total amount of fish landed (measured in pounds) by federally permitted for-hire charter and party vessels between 2001 and 2010. Access available via New York Geographic Information Gateway (NY Geographic Information Gateway, 2017).

18.2 Assessment of Data Quality

18.2.1 Sources of Data and Metadata

Data can be found on select online portals such as the Connecticut Department of Energy and Environmental Protection (CT DEEP) Saltwater Fishing Resource Map, Mid-Atlantic Ocean Data Portal, and NY Geographic Information Gateway. Links to Metadata can be found on the NY and Mid Atlantic Gateways. Data collection methods included VTRs, in which a vessel reports what they've caught, where they've caught it and the gear type. More information on this technology can be found in *Chapter 16 Commercial Fishing*.

The Party & Charter Boat location map does not have one source of metadata but more information can be found in the Anglers Guide and CT DEEP website. In the portal you can click on the particular party boat organization and find information on the captain, dock location, and contact information.

18.2.2 Accuracy, Representativeness, and Relevance of Map Products

There has been outreach to CCPBA, which has provided information to other marine spatial planning efforts; however, at this time, the Association (or other representatives of this sector) have not yet been able to provide additional information or vetting of the data presented herein.

In terms of accuracy, although the CT DEEP Party Boat layer (Figure 18-1) only includes vendors that have asked to be represented, it is generally assumed that the information presented is reasonably accurate even if it may be incomplete. Within the Regional Landings and Boat Trips layer (Figure 18-3), recognizing that data collection is restricted to a certain scale and method of collection, the results are generally considered accurate for the scale represented based in part on the credibility of the sources and also general nature of the information. Given consideration of limits in scale (noted above) and methodology, the maps shown are generally considered to be accurate for what they are depicting.

In terms of representativeness, the CT DEEP Party Boat layer (Figure 18-1) is only a partial listing of party boat fishing vendors and may not reflect all vendors in Connecticut or on the North Shore of Long Island. Additionally, the Charter and Party Boat Trips data (Figure 18-2) represents approximately 70-80% of all recorded trips between 2000 and 2009. Although very helpful in seeing the general size and distribution of this sector, it is important to recognize that this information is relatively old and geospatially crude in being confined to 10-minute blocks. This same concern also applies to the regional landings map.

The maps and associated data shown is directly relevant to marine spatial planning and the Blue Plan in showing the relative presence and significance of the charter and party boat sector in Long Island Sound. The maps also provide general spatial information about the sector. These maps, however, do not provide specific geospatial data and mapping that more definitively show the presence of the sector and the places of noted importance to the sector.

18.2.3 Data Gaps and Availability of Data to Address Gaps

The charter and party boat sector is a traditional, water-dependent use that exemplifies the type of use the Blue Plan legislation is seeking to protect. Because this sector generally relies on the suitability and availability of specific geospatial areas, there is a need to identify where these areas are if the Blue Plan is to succeed in helping to protect this traditional use. Although helpful, the data and maps provided in the Inventory at this time do not provide sufficient geospatial specificity to identify these areas and as such this represents a data gap. As noted above, discussions are underway with CCPBA about completing participatory mapping exercises to depict important charter and party boat areas for the Sound as-a-whole. If completed, these maps could help fill a significant data gap. There may also need to be meetings with other representatives of the sector (e.g., New York State) in order to complete a Sound-wide picture. During a meeting held with CCPBA to discuss the Blue plan and review data, their board leaders and members indicated a need for better Charter & Party Boat catch information – information that is more representative & accurate than currently collected by CT DEEP field staff and/or seasonal hires. It also appears that the map and listing of charter and party boat vendors is incomplete with some names potentially being out of date.

18.3 Relevance

18.3.1 Relative Historical Importance

Recreational fishing is considered a historically popular pastime and source of food for many people (National Marine Fisheries Service, 2017). Charter, Party Boat, and For-Hire fishermen is a profitable business industry that provides individuals and groups with the recreational fishing experience. Charter and Party boat fishing in Long Island Sound has been around for decades. Notes from stakeholder engagement efforts identify that charter boats still in operation date back to the 1940s and there was likely a for-hire industry dating back even further. One source speaks of a story of a World War II veteran that started his own party fishing business in 1946, on the Frances Anne (Hel-Cat II, 2017).

For more historical information on the recreational fishing industry as a whole, please refer to the *Chapter 17 Recreational Fishing*.

18.3.2 Socio-Economic Context

Along part of the Atlantic Coast, Maine to North Carolina, there were almost 1.6 million charter or party boat recreational fishing passengers in 2011 (Steinback & Brinson, 2013). In 2012, the average charter boat produced over $5.1 thousand in net income (Steinback & Brinson, 2013). As an industry, in 2010, charter and party boats contributed approximately $334.0 million in sales to businesses, $116.9 million in income, and over 7,000 jobs in the Northeast United States (Steinback & Brinson, 2013). There is also a multiplier effect to the charter and party boat industry, as other service (real estate, marinas, etc.), manufacturing (fishing gear, fuel, etc.), and wholesale and retail industries (sporting goods, bait shops, etc.) can be dependent on for hire fleets (Steinback & Brinson, 2013).

At $6.9 million in trip expenditures in 2011, the Connecticut charter and party boat fleet also has a significant role in the Connecticut economy (Lovell, Steinback, & Hilger, 2011). The for-hire industry in Connecticut also contributed 63 jobs, $5.7 million in income, $8.2 in value added, and $10.8 million in output in 2011 (Lovell, Steinback, & Hilger, 2011). Residents of Connecticut in 2011 had a mean trip expenditure of $164.96 per fishing trip, taking into consideration items like auto fuel, charter fees, food from grocery stores, ice, crew tips, etc. (Lovell, Steinback, & Hilger, 2011). Non-residents trip expenditures average was $144.57. In total, residents of Connecticut spent $5.4 million on for-hire trips, while non-residents spent $1.5 million (Lovell, Steinback, & Hilger, 2011). Total impacts of for-hire, private boat, shore trips, and durable expenses can be found in Figure 18-4.

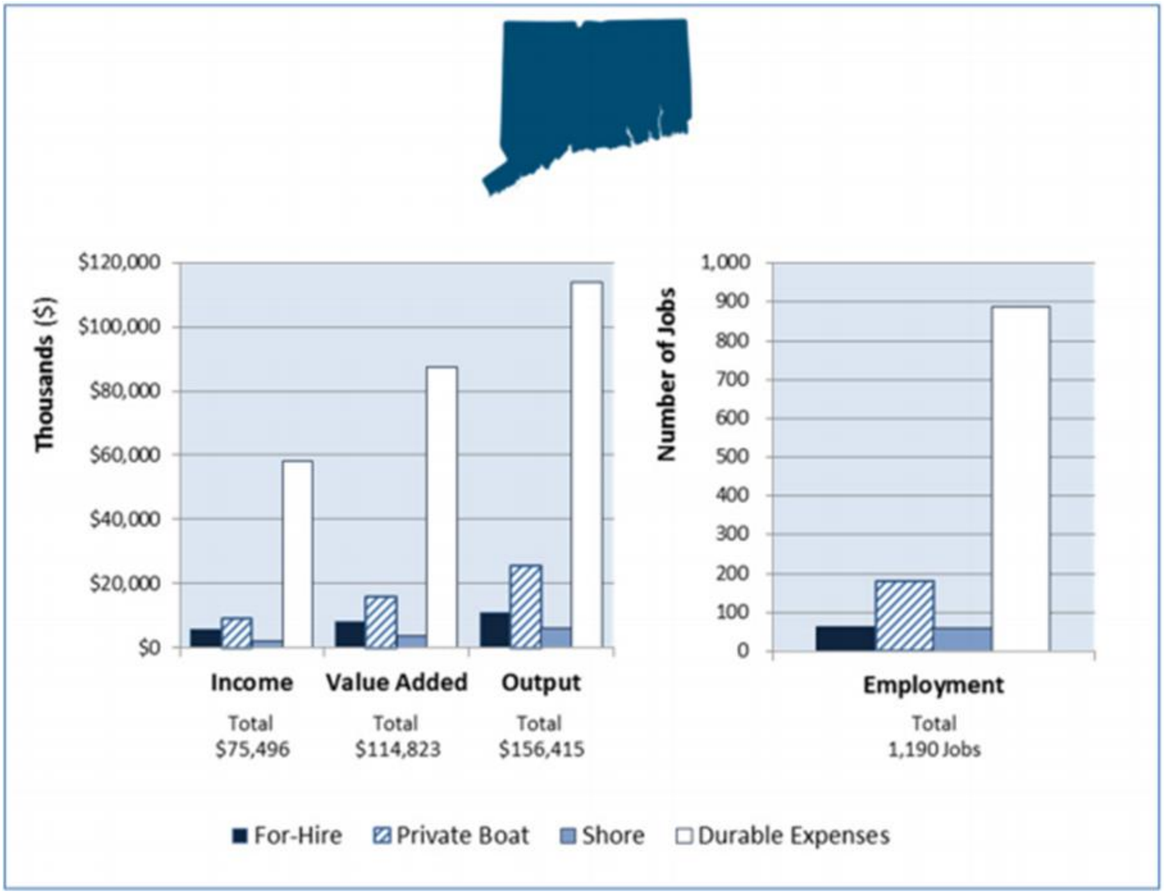


Figure 18-4: Total Economic Impacts of Charter and Party Boats in Connecticut in 2011. Charter and party boats create income, value-added benefits, outputs, and employment across the sector, including through for-hire trips, private boats, shore trips, and durable expenses (Lovell, Steinback, & Hilger, 2011).

The industry has been known to fluctuate over time, aligning with the health of fish stocks and the cost of regulatory fees. In 1981 there were 40 registered boats, 109 boats in 1992, 159 in 1999, 228 in 2002, 147 in 2005, 183 in 2010, and 148 in 2017 (CT DEEP Marine Fisheries, 2017). Stakeholders mentioned that striped bass have been a catalyst for the charter and party boat industry. If stocks of striped bass go down, except for the consideration of blue fish, you will likely see a drop in the for-hire sector. Due to the reliance and restrictions on stocks like striped bass, many for-hire vessels will diversify their target fish species so that the customer will get more from the experience. In terms of for-hire license fees, they have increased substantially over time. The first fee in 1981 was $10, then rose to $25 in 1992, $250 in 2003, and $315 in 2010 (CT DEEP Marine Fisheries, 2017).

18.3.3 Other Notes

Another note from stakeholder engagement efforts, is that varying regulation between states can often be a hurdle for the charter fishing industry and their customers. For instance, different species catch limits in New York, Connecticut, and Rhode Island can result in boats being fined for having a catch that's illegal in one state and not another. For more information, please refer to *Chapter 17 Recreational Fishing*.

18.4 References

CT DEEP. (2017). *Saltwater Fishing Resource Map*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://ctdeep.maps.arcgis.com/apps/webappviewer/index.html?id=4ac9ffcad5e34971a13838bfaa7f5468

CT DEEP. (2018). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635

CT DEEP Marine Fisheries. (2017). Notes from Stakeholders. Connecticut.

Hel-Cat II. (2017). *Pictorial History of Boats Past and Present*. Retrieved from HelCat: http://www.helcat.com/History.html

Lovell, S. J., Steinback, S., & Hilger, J. (2011). *The Economic Contribution of Marine Angler Expenditures in the United States.* U.S. Department of Commerce.

MARCO. (2017). *Mid Atlantic Ocean Data Portal*. Retrieved from http://portal.midatlanticocean.org/ocean-stories/every-map-tells-a-story/

National Marine Fisheries Service. (2017). *Ecology of the Northeast US Continental Shelf* .

New York Sea Grant. (2005). *Fishing Access Map*. Retrieved from New York Sea Grant: https://seagrant.sunysb.edu/nysportfishing/pubs/FishAccessMap.pdf

NY Geographic Information Gateway. (2017). *New York Geographic Information Gateway*. Retrieved from http://opdgig.dos.ny.gov/

Steinback, S., & Brinson, A. (2013). *The Economics of the Recreational For-hire Fishing Industry in the Northeast United States, 2nd Edition.* Northeast Fisheries Science Center.

18.5 Appendices

18.5.1 List of Maps Used to Inform the Chapter

Below is a list of all maps used to inform this chapter, including maps presented above in the narrative and additional maps used to support chapter findings. Maps listed below are organized by the online data portal on which they are hosted (URL links to data portals are noted in *Section 18.4 References* above). Map products not accessible by online data portal are also noted below.

New York Geographic Information Gateway

- Charter & Party Vessels Regional Landings (lbs), 2001 – 2010

Mid-Atlantic Ocean Data Portal

- Party & Charter Boat Trips (Total 2000-2009)

CT DEEP Saltwater Fishing Resource Map

- Party & Charter Boats

More information on some of the map products presented in this chapter, including URL links to data and metadata, can be found in the Charter and Party Fishing Map Book (CT DEEP, 2018). Not all products showcased in the map book may be addressed in this chapter or utilized to inform the final Blue Plan.

18.5.2 Notes on Stakeholder Engagement

CCPBA has been the primary entity engaged to discuss this sector. Staff working on the Blue Plan have had several conversations with officers of the Association and met with members of the Association on December 2017. So far discussions have focused on how the Blue Plan process works, what the policy results are expected to be and addressing concerns expressed by some of the members who are skeptical. As noted above, officers of the Association have interest in completing participatory mapping to reflect the sector for Long Island Sound although that has yet to be scheduled. Captain Morgan from Captain Morgan’s Bait and Tackle shop also contributed his valued insight and experience of the for-hire fishing industry in Connecticut.

Chapter 19

Recreational Boating and Sailing

Chapter Table of Contents

Chapter List of Figures and Tables

Figures

Tables

None

19.1 Key Data and Map Products

The Recreational Sailing and Boating sector is a quintessential traditional water-dependent human use of Long Island Sound (LIS). In addition to recreational boating itself, this broad sector connects to marine trades and associated industries, to harbors and marinas – all of which have geospatial connections – all of which may be affected by how and where new uses are located. Recreational boating is a prime venue for the quality of life Long Island Sound offers to millions of people in addition to being a source of thousands of jobs and economic activity. It is probably the way the most people have access to offshore areas of the Sound, beyond beaches and other shoreline areas.

Some of the geospatial areas of significance to this sector include navigational channels, special areas of use (often unofficial or unmarked, such as locations of sailboat races, key fishing areas), efficient and/or high use navigational courses (areas beyond navigational channels), and areas that afford access to other recreational activities (e.g., scenic, swimming, wildlife viewing), among others. The scenic attributes of Long Island Sound – however, these may be described or mapped - can also be considered important to the quality of the recreational boating sector.

For this Inventory we have covered the various sectors associated with recreational boating in this *and* other chapters. This chapter contains maps associated with recreational boating use and density, boat launches, long distance and other sailboat racing, etc. Our own assessment along with input from stakeholders suggests the need for more localized geospatial information that better depicts the particular places that are important to this sector. There are many aspects of recreational sailing and boating in the Sound that could potentially be mapped to help describe this human use sector.

The first three maps below help illustrate the types of data and maps that currently exist in the Inventory that best relate to Recreational Sailing and Boating. Figure 19-1 provides a Sound-wide picture of recreational boating. This is useful for seeing how widespread and intense recreational boating use is in the Sound and general distinctions between areas of high use and low use. Although it doesn't provide a fine-scale detailed understanding of specific geographies that are important for recreational boating, it does show how important the Sound is for recreational boating and that while not all areas are equal in terms of use, most of the Sound is highly used. General areas of high use are spatially notable as indicated by the reddish colors.

The map was created based on results of the 2012 Northeast Recreational Boater Survey, which was conducted by SeaPlan, the Northeast Regional Ocean Council, states' coastal agencies, marine trade associations composed of many private industry representatives, and the First Coast Guard District. Both a random and supplemental sample of Northeast boaters plotted their boating routes through the 2012 boating season using an online mapping application.

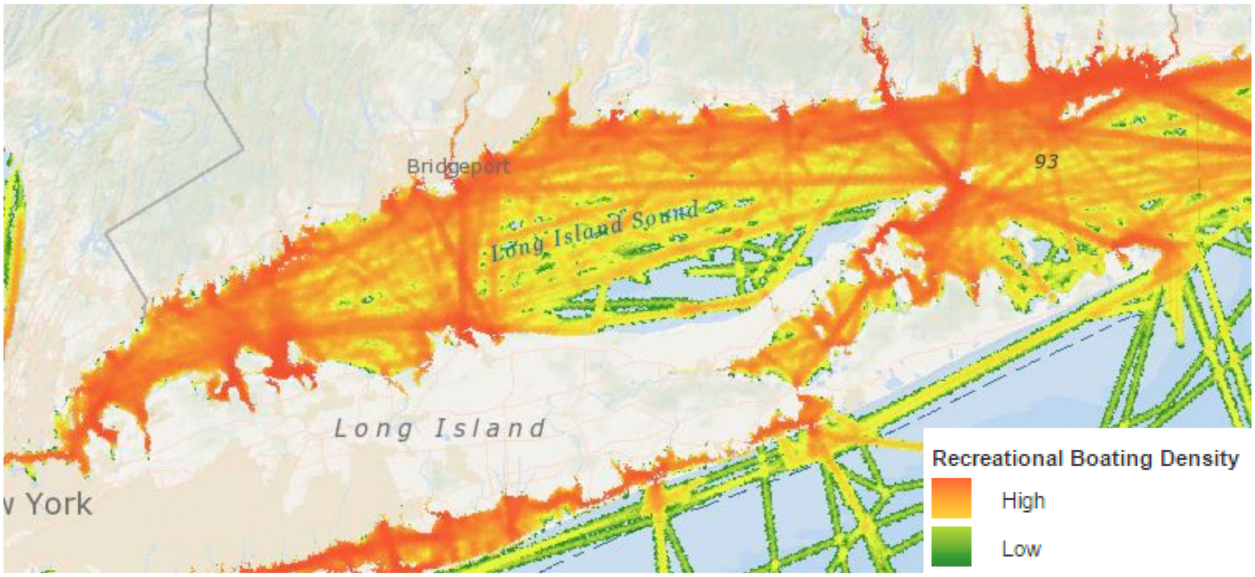


Figure 19-1: [Recreational Boating Density](). Density of recreational boating in Long Island Sound based off of the 2012 Northeast Recreational Boater Survey. Access available via Northeast Ocean Data Portal (Northeast Regional Planning Body, 2017).

Figure 19-2 shows long distance sailboat races that occur over distinct tracks of the Sound. It shows that there are multiple events and that they occur in a relatively common central area of the Sound, branching off in the eastern portion. In addition to this type of sailboat race, there are many races conducted closer to yacht clubs and marinas that this map doesn't capture. The later are often in the same relative area of the Sound. In addition to spatially depicting one type of sailboat racing activity, the map makes the point that in addition to general recreational boating, there are types of recreational boater use that may have specific spatial needs or characteristics.

The study that led to the map was conducted by SeaPlan, the Surfrider Foundation, and Point 97 under the direction of the Northeast Regional Planning Body. Routes were mapped using a combination of outside research, leveraging existing data sources (such as the Rhode Island Ocean Special Area Management Plan), and gathering input from race organizers and other industry experts through participatory mapping. For the purpose of characterizing events for this dataset, a distance race is defined as (1) an offshore race starting at one port and ending in another or (2) an offshore race which begins at a port, has a turning point at a single location, and ends at the same port.

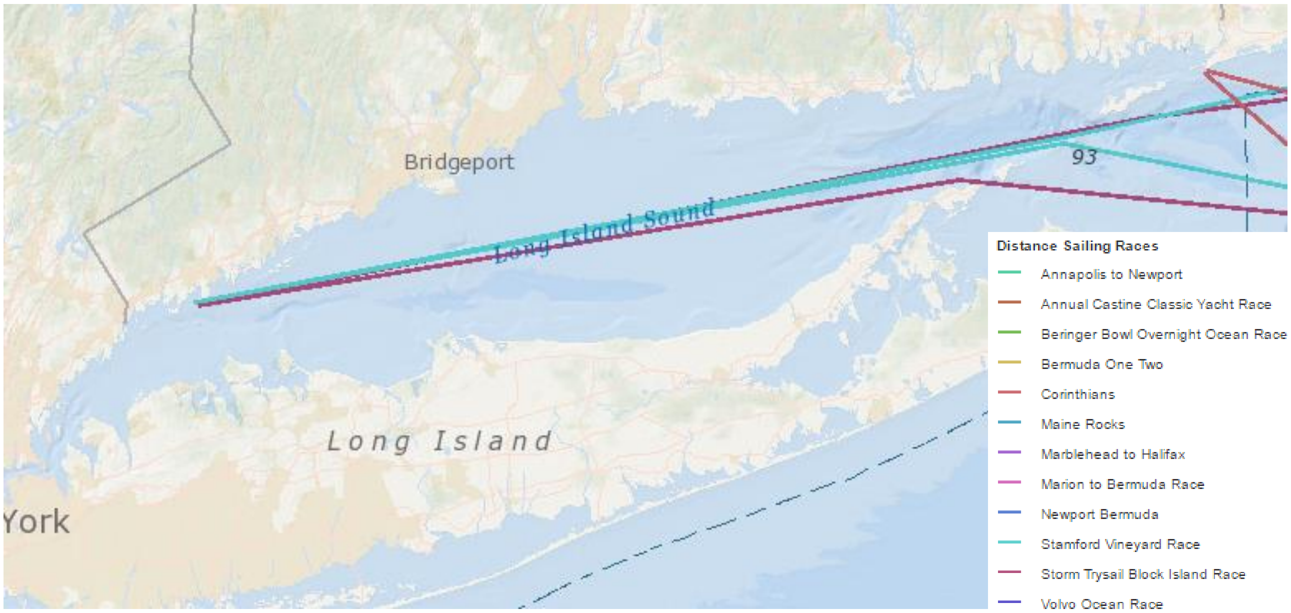


Figure 19-2: [Distance Sailing Races](). Map shows the long distance sailing races that occur through Long Island Sound. Access available via the Northeast Ocean Data Portal (Northeast Regional Planning Body, 2017).

Furthermore, as part of the Blue Plan process, Blue Plan staff met with the Eastern Connecticut Sailing Association and the Yacht Racing Association of Long Island Sound to map "areas important to organized sailing activity" in the Sound. These are discrete areas used consistently by yacht clubs for racing, training, and regattas. Many areas are used every day throughout the summer, while the race course lines are mostly used once a year (Figure 19-3).

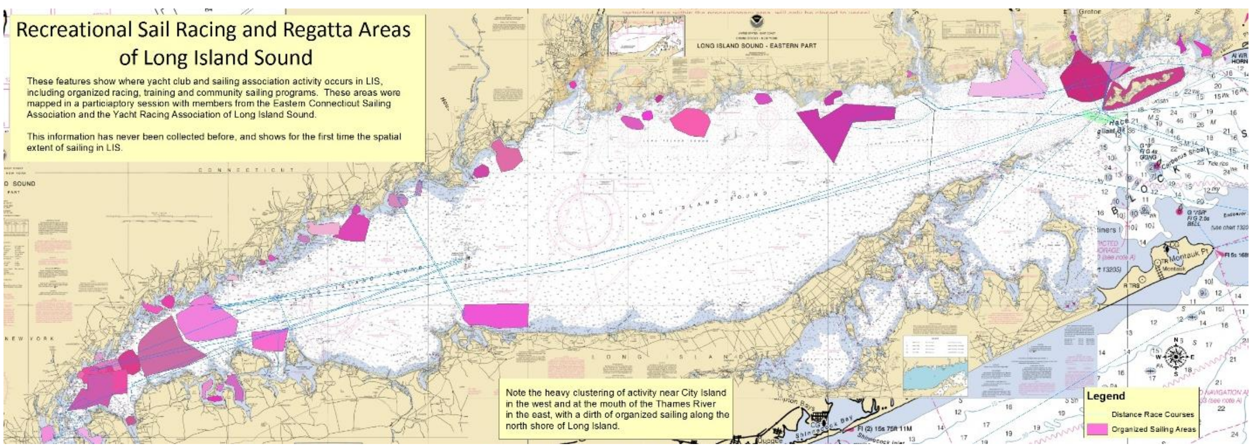


Figure 19-3: Recreational Sail Racing and Regatta Areas of LIS. Each polygon represents a different race area; some clubs may have more than one area, and some areas represent more than one club. Data collected as part of Blue Plan process, and accessible as part of the accompanying web viewer.

Recreational boating emanates from multiple coastal locations including harbor anchorages and marinas to boat launch sites. All these and more are spatially relevant for describing recreational sailing and boating. Figure 19-4 is one of several that depict boat launch sites.

Boat launches shown in this map provide access to Long Island Sound. Town-owned and privately owned boat launches are also included in this map. These listings come from the Connecticut Coastal Access Guide.

Figure 19-4: [Boat Launches](). Boat launches that provide access to Long Island Sound, including town-owned and privately owned launches. Access available via the Saltwater Fishing Resource Map (CT DEEP, 2017b).

The next set of maps further illustrate relevant information for the recreational boating portion of the Inventory. These include: 2013 Pleasure Craft Sailing Vessel Density, All Recreational Boater Activities, and Recreational Boater Routes. A Sailing Race Landside Locations map is shown under the "Data Gaps" section further below.

Figure 19-5 reveals an interesting contrast between sailing vessel use with the 2012 recreational boating survey map (see above) in that the yellow line in central LIS is the most dominant, which was not as clearly the case for recreational boating overall. Other routes of high sailing vessel are connected to Port Jefferson, NY, the mouth of the Lower Connecticut River and access points associated with Fisher's Island Sound while larger ports (Bridgeport and New Haven) do not appear to be heavily used.

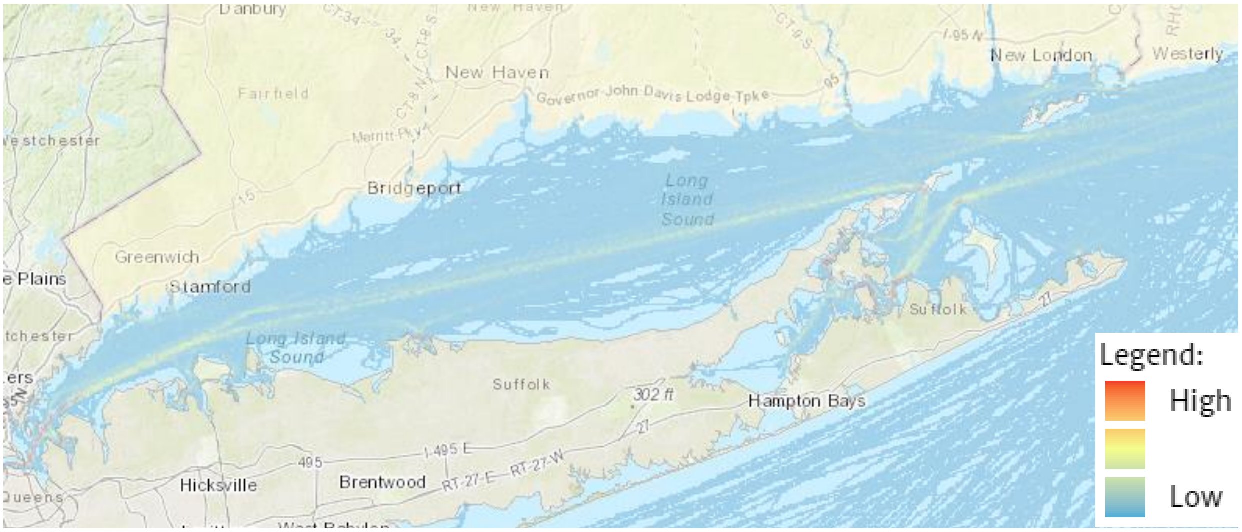


Figure 19-5: [2013 Pleasure Craft Sailing Vessel Density](). Density of all pleasure craft and sailing vessel traffic in 2013 with AIS transponders in 100 m grid cells. Access available via the New York Geographic Information Gateway (NY Geographic Information Gateway, 2017).

Figure 19-6 is helpful in distinguishing the types of use which is not shown in the density of use depicted by the recreational boating map further above. It appears that the activities map here focuses on particular points of interest whereas the density map above includes places of interest, transport and boating movement in general. Fishing is the most prominent use here but may show up this way in part as a function of being more site focused vs. sailing (presumably captured in "Other") is likely more focused on "movement." Also notable is the high concentrations of boater activity in Fisher's Island Sound, just east and west of the Connecticut River and the Western Sound in general.

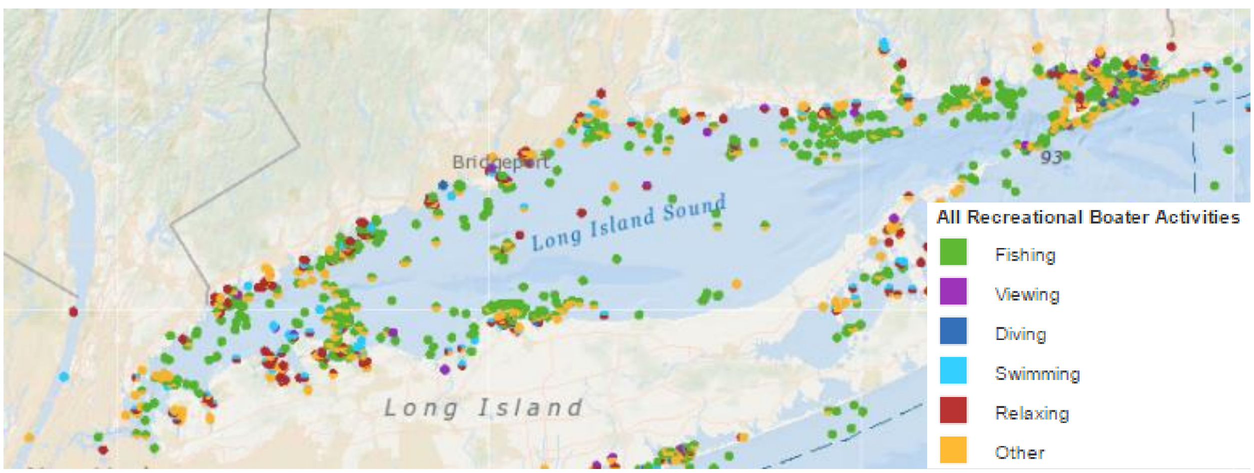


Figure 19-6: [All Recreational Boater Activities](). Locations where participants in the 2012 Northeast Recreational Boater Survey, engaged in various activities during their boating trips. Access available via the Northeast Ocean Data Portal (Northeast Regional Planning Body, 2017).

Figure 19-7 reveals the key role of distinct access points, particularly the passage between Plum Island and the North Fork of Long Island, Port Jefferson, Huntington and Oyster Bays and to and from multiple points on the Connecticut coast. Similar to the recreational boating density map, while there is intense use along virtually all of the Connecticut coast, there is relatively less use along large portions of the north shore of Long Island where there are few to no accessible harbors. It is suggested that looking at these recreational boating survey maps together can provide further insights in examining similarities and differences.

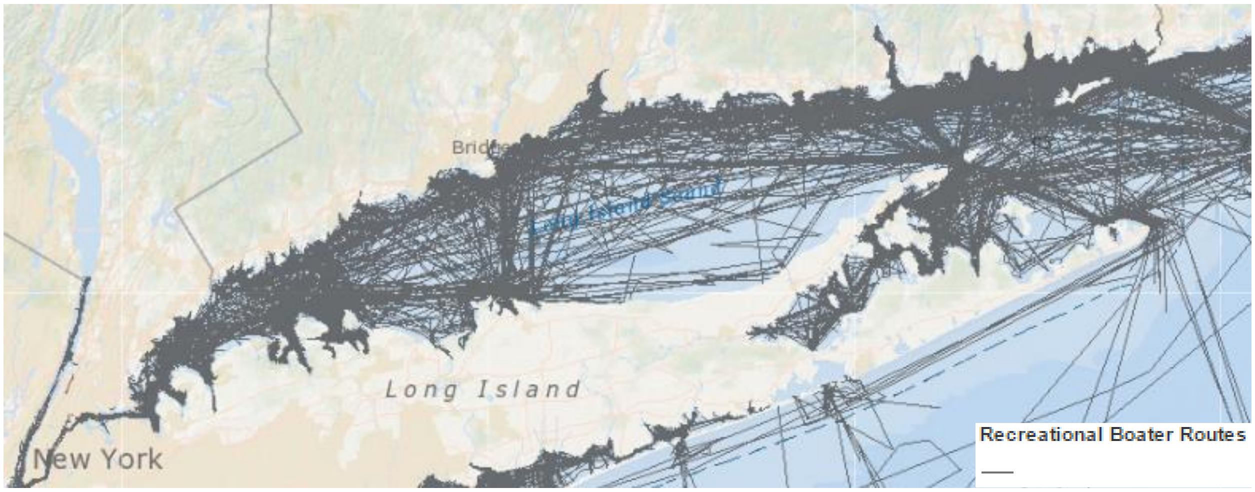


Figure 19-7: [Recreational Boater Routes](). Mapped routes from the 2012 Northeast Recreational Boater Survey. Access available via the Northeast Ocean Data Portal (Northeast Regional Planning Body, 2017).

19.2 Assessment of Data Quality

19.2.1 Sources of Data and Metadata

Most data was available through the Northeast Ocean Data Portal, with a few data layers collected from the Connecticut Department of Energy and Environmental Protection (CT DEEP) Saltwater Fishing Resource Map (Boat Launches) and New York Geographic Information Gateway (Pleasure Craft Sailing).

The full description of the meta-data is available through the online portals. For the Boat Launches layer there isn’t one source of available meta-data but instead a series of information including the Connecticut Boaters Guide, CT DEEP website, and Connecticut Coastal Access Guide. Some sources of metadata are more descriptive, which others are summary.

Data was collected using a variety of methods including the AIS (Automatic Identification Systems) data collection, participatory mapping, social science surveys, and outreach to industry experts.

One particular study, the 2012 Northeast Recreational Boater Survey (conducted by Sea Plan), produced the Recreational Boating Density, All Recreational Boater Activities, and Recreational Boater Route data layers (SeaPlan, 2012). It should be noted that this survey maintained a criteria for those eligible to take the survey including:

1. Registration with a Northeast state and/or registered with the US Coast Guard, with hailing port in Northeast
2. Primary use of recreation
3. At least 10 ft in length
4. Saltwater, if specified (only in Maine and New Hampshire)
5. Located in a coastal county, as in those bordering saltwater, or highlighted to contain larger amount of saltwater boater activity.

Invites were sent out to ensure eligibility, including that the boat was used in saltwater, the boat was used for recreational purposes, and the participant has access to internet with working email address. A final 7,800 were found to meet final criteria, and 4,297 individual boaters completed a least one monthly survey. The survey was also conducted from May to October 2012.

19.2.2 Accuracy, Representativeness, and Relevance of Map Products

In terms of accuracy, maps presented in this sector can be deemed accurate. For instance, Recreational Boating density data was ensured to be accurate by using a mapping tool, reducing error by only allowing the user to plot a start and end point to the route and only at a certain scale. Additionally, AIS data is noted as being a good and accurate source of geographical data, as it monitors the locations of vessels in real time.

In terms of representativeness, some maps may be dated and therefore may be missing new areas of use or changes in use areas. For instance, the recreational boating density map is based on a random sample survey on northeast recreational boaters from May 1 through October 31, 2012 (SeaPlan, 2012). Seasonality of data may also determine representativeness. The 2012 Northeast Recreational Boater Survey occurred through May through October 31, 2012, missing data from large portion of the year when boat traffic is far less frequent. However, because recreational sailing and boating is largely confined to May through October, this survey can be deemed to be representative.

An additional note on representativeness is that the 2012 Northeast Recreational Boater survey had very selective criteria for their survey participants, and this could impact how representative and accurate the data is.

The map products are deemed to be relevant because they depict recreational boating activity spatially. However, the scale of the spatial information is generally broad making it difficult to delineate important human use areas based on these maps alone. As such, while the maps are relevant they may not be sufficient to provide or generate the geospatial products needed to fully represent the sector in the policy of the Blue Plan.

19.2.3 Data Gaps and Availability of Data to Address Gaps

To be more representative of the recreational boating sector, there are a few data gaps that should be pursued to be filled over time. First, more data from the New York side would be helpful, including boat launches on the North Shore of Long Island and possibly New York City.

Additionally, there has been discussion that instead of cruising through Long Island Sound, recreational boaters will tend to move around a certain area for different purposes. During the November 2017 webinar with recreational boaters, we heard that local offshore areas used consistently for regattas (and potentially other boating activities that are consistently held in the same general area) are important to this sector and identifying these areas would be key if the Blue Plan is to adequately represent information vital to the sector. There was also an interest in contributing should such an effort like participatory mapping be undertaken to better identify areas important to recreational boaters.

One source of information that may be able to help fill in this gap is the Characterization of Coastal and Marine Recreational Activity in the U.S. Northeast. This study analyzed some of the smaller scale races in the Northeast and mapped sailing race landside locations (Figure 19-7). In their analysis, they also found that there are clusters of regatta and sailing activity taking place around New London and Mystic (Point 97, SeaPlan, and Surfrider, 2015). Participants in their study also stressed that racing activity during the summer months takes places over the majority of the Sound (Point 97, SeaPlan, and Surfrider, 2015). In this report, Appendix H provides a list of known sailing event organizers and events that cover the Northeast, including Connecticut and New York.

Figure 19-8 is notable as it begins to get at the significance of spatially specific local areas important for boating, particularly sailboat races that are typically held in the same general area year after year but as simple dots on a map, it misses the more specific geographic locations that may be significant for the boating use.

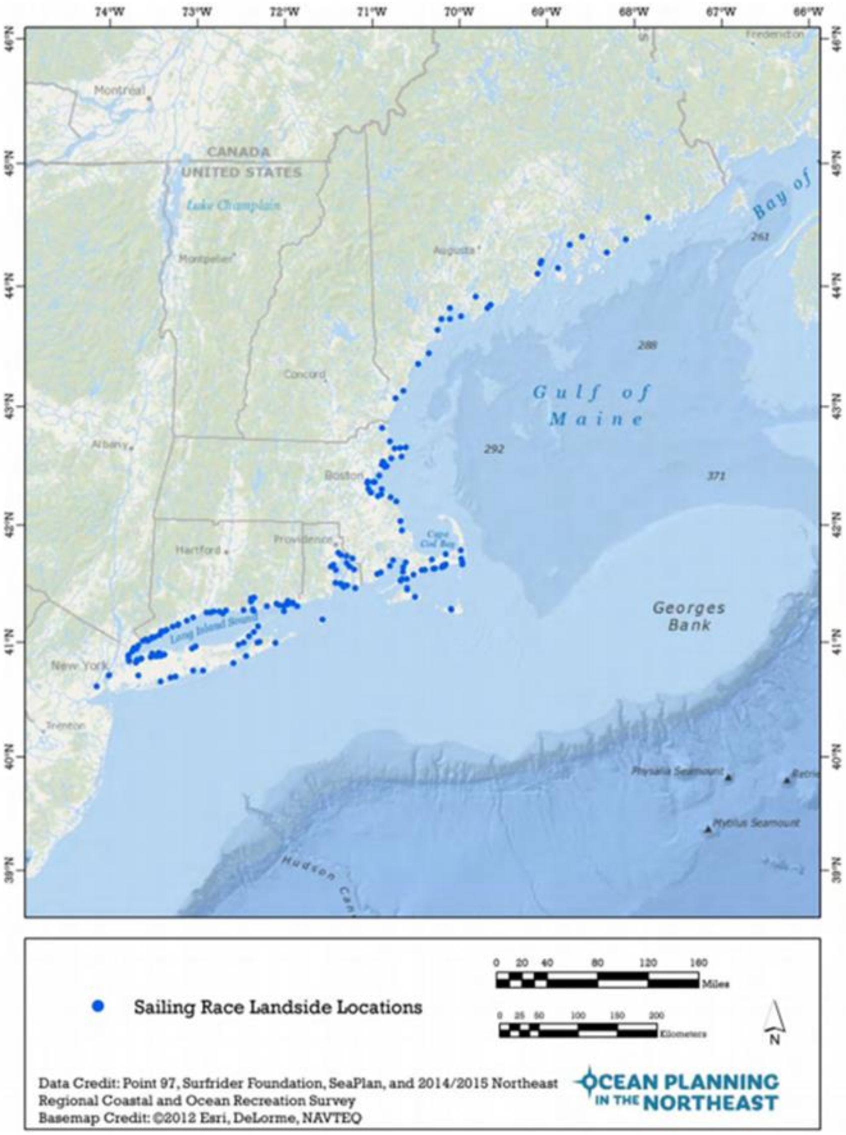


Figure 19-8: [Buoy Race Landside Locations](). Map displaying the landside locations aligned with smaller scale sailing races across the Northeast. Access available via the Characterization of Coastal and Marine Recreational Activity in the U.S. Northeast report (Point 97, SeaPlan, and Surfrider, 2015).

A related but additional gap is a map that depicts where periodic boating related event areas (e.g. SailFest, fireworks, airshows) occur. The data for filling this gap should be available through the U.S. Coast Guard and their Local Notice to Mariners. More information on recurring marine events can also be found in 33 CFR 100 (Navigation and Navigable Waters, 33 CFR, 2017).

Another gap are anchoring areas, as some of these may be formal, recognized areas and others less formal but spatially important (unofficial but established through repeated and extensive use: transient mooring areas, e.g., Duck Island, Westbrook, CT). Examples include mooring areas near the coast where boaters have placed moorings, some of which may be registered with the local town Harbor Management Commission and others may not be. It also includes areas where yacht clubs have permanent moorings that have been recognized by State or other entities but may not be on charts or other geospatial information (e.g., Sachem's Head Yacht Club in Guilford, CT). Outreach activities (e.g., meeting with the Coast Guard) indicated that it is possible that many of these areas could be mapped with relative ease. Finally, small sailboat and dinghy cruising is a popular use of LIS that is not easily identified and was not generally included in the Recreational Survey. Working with this sector would be a starting point to see how the sector could be represented.

19.3 Relevance

19.3.1 Relative Historical Importance

Recreational sailing and boating has strong historical roots in Long Island Sound. Connecticut holds yacht clubs dating back to the 1800s, the oldest being commissioned in 1887. Yacht clubs were known as an area for community engagement and have been used for recreational boating for hundreds of years. A column published in 1891 by The Rudder noted that, "…no yachtsman in the vicinity will dispute the fact that the Sound has superior advantages over any other place in New York City for yachting…" (City Island Nautical Museum, 2017). Another report in 1946 noted that, "waters along the Connecticut shore, including Long Island Sound, Fishers Island Sound, the many indentations in the shoreline, and the many sheltered areas along the coast offer and ideal area for pleasure boating and yachting of all types" (Parsons, Brinckerhoff, Hogan, & MacDonald, 1946).

One particular location that has held great respect for yachting and shipbuilding in Long Island Sound is City Island in New York City, which was most prominent in the 19th and 20th centuries (City Island Nautical Museum, 2017). Images of the islands history and shipbuilding past can be found on the City Island: A Step Back in Time and City Island: Yacht Building webpages (City Island Nautical Museum, 2017).

Sailing races also have a historical role in Connecticut's history. There have been a number of races along the Atlantic coast, some through Long Island Sound (Figure 19-2), that date back to the 20th century and have important historical, cultural, and economic standing (Longley-Wood, 2015). Additionally, many of the America's Cup defenders during the 1890s were serviced and stored by City Island, at the far western edge of Long Island Sound (City Island Nautical Museum, 2017).

19.3.2 Socio-Economic Context

Recreational boating in current times has tremendous economic impacts in the State of Connecticut. The recreational boating industry, considering direct, indirect, and induced spending, has an annual economic impact of more than $1.3 billion (National Marine Manufacturers Association, 2016). Over 500 businesses and 7,000 jobs are supported by this industry in Connecticut (National Marine Manufacturers Association, 2016). As a comparison, the recreational boating industry supported over 10,000 jobs prior to the Great Recession and is tied closely to economic health as a whole. Other industries like marinas and boatyards, boat and yacht brokers, skilled technicians, equipment operators, sail making, finance and insurance, fuel and dock staff, boat building, etc. is supported by the recreational boating industry.

Connecticut has over 90,000 registered boats in the state (National Marine Manufacturers Association, 2016). Registered boats are primarily comprised of motor boats at 87%, followed by personal watercraft at 9%, and sailboats at 4% (National Marine Manufacturers Association, 2016).

According to the 2012 National Boating Survey, 31.9% of households participate in recreational boating in Connecticut while 23.9% of households own a boat (U.S. Coast Guard, 2012). Individual participation in recreational boating is approximately 26.1%, with 26.5% of adults participating and 25.2% of children (under 15) participating (U.S. Coast Guard, 2012). The top three most popular activities while boating are fishing, swimming, and entertaining (National Marine Manufacturers Association, 2016). Further representation on recreational boater activities can be found in Figure 19-5.

Recreational boaters from neighboring states, like New York and Rhode Island, also have a significant economic impact in Long Island Sound. Boaters from New York and Rhode Island add approximately $40 million in output to the State of Connecticut (SeaPlan, 2012). Connecticut boaters also contributed to other states as they spend approximately $33 million in New York, Rhode Island, or outside the region (SeaPlan, 2012).

Additionally, there were approximately 332,000 sailors in the New England region in 2016, 212,000 identified as casual sailors and 123,000 identified as core sailors (Helme, 2016). Sailboat brokerage sales, in the United States dropped slightly from 2015-2016, with the largest drop on boats larger than 56 ft (Helme, 2016). The market for sailboat builders has steadily declined from 2007 to 2015, with a drop from 139 to 92 active North American sailboat builders (Helme, 2016). This decline is also reflected in the number of fulltime employees building sailboats in North America, dropping from 3,000 in 2007 to 1,073 in 2015 (Helme, 2016).

19.3.3 Other Notes

A Sound-wide long-term monitoring project from the University of Connecticut offers real-time data on offshore conditions through an online portal. The Long Island Sound Integrated Coastal Observing System is a series of buoys and high-frequency radar stations; data available in real time online on the project website includes water quality, meteorological conditions, and sea state (UConn Department of Marine Sciences, 2018). Mariners frequently use this data when planning and executing trips offshore in the Sound.

19.4 References

City Island Nautical Museum. (2017). *Boat Building*. Retrieved from City Island Nautical Museum: http://www.cityislandmuseum.org/boat-building.html
City Island Nautical Museum. (2017). *Boat Building*. Retrieved from City Island Nautical Museum: http://www.cityislandmuseum.org/boat-building.html
CT DEEP. (2017a). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635
CT DEEP. (2017b). *Saltwater Fishing Resource Map*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://ctdeep.maps.arcgis.com/apps/webappviewer/index.html?id=4ac9ffcad5e34971a13838bfaa7f5468
Helme, S. (2016). *The Sailing Market 2016: State of the Industry.* Bonnier Corporation .
Longley-Wood, K. (2015). *Distance Sailing Races, Northeast United States.* Boston: Northeast Regional Ocean Council.
National Marine Manufacturers Association. (2016). *Recreational Boating: An American Pastime & Economic Engine.* Connecticut.
Navigation and Navigable Waters, 33 CFR (2017).
Northeast Regional Planning Body. (2017). *Northeast Ocean Data Portal*. Retrieved from http://www.northeastoceandata.org/data-explorer/
NY Geographic Information Gateway. (2017). *New York Geographic Information Gateway*. Retrieved from http://opdgig.dos.ny.gov/
Parsons, Brinckerhoff, Hogan, & MacDonald. (1946). *An Economic and Engineering Survey of all Navigable Waters in the State for the CT Port Survey Comission.*
Point 97, SeaPlan, and Surfrider. (2015). *Characterization of Coastal and Marine Recreational Activity in the U.S. Northeast.*
SeaPlan. (2012). *2012 Northeast Recreational Boater Survey: A Socioeconmic and Spatial Characterization of Recreational Boating in Coastal and Ocean Waters of the Northeast United States.* Retrieved from https://www.openchannels.org/sites/default/files/literature/2012%20Northeast%20Recreational%20Boater%20Survey.pdf
U.S. Coast Guard. (2012). *2012 National Boating Survey.*
UConn Department of Marine Sciences. (2018, February). *Long Island Sound Integrated Coastal Observing System (LISICOS)*. Retrieved from University of Connecticut (UConn), Department of Marine Sciences: http://lisicos.uconn.edu/

19.5 Appendices

19.5.1 List of Maps Used to Inform the Chapter

Below is a list of all maps used to inform this chapter, including maps presented above in the narrative and additional maps used to support chapter findings. Maps listed below are organized by the online data portal on which they are hosted (URL links to data portals are noted in *Section 19.4 References* above). Map products not accessible by online data portal are also noted below.

Northeast Ocean Data Portal

- Recreational Boating Density
- Distance Sailing Races
- All Recreational Boater Activities
- Recreational Boater Routes

New York Geographic Information Gateway

- 2013 Pleasure Craft Sailing Vessel Density

CT DEEP Saltwater Fishing Resource Map

- Boat Launches

Non-Portal Map Products

- Buoy Race Landside Locations

More information on some of the map products presented in this chapter, including URL links to data and metadata, can be found in the Recreational Boating Map Book (CT DEEP, 2017a). Not all products showcased in the map book may be addressed in this chapter or utilized to inform the final Blue Plan.

19.5.2 Notes on Stakeholder Engagement

There are various entities that help represent the multiple facets of the recreational sailing and boating sector. These include marine trades associations (e.g., Connecticut Marine Trades Association) and other maritime industry groups (e.g., Connecticut Maritime Coalition), yacht clubs, power squadrons, sailing and boating associations (e.g., Eastern Connecticut Sailing Association, Singles Under Sail), and others. These groups are a source of information about recreational sailing and boating in the Sound and are considered in other parts of the Inventory (e.g., *Chapter 20 Harbors and Marinas*).

Stakeholder review of data and map products was important in preparing the Recreational Sailing and Boating chapter of the Inventory. Maps were sent to stakeholders in “map books” ahead of events and then presented and discussed at these events. The following describes the events held.

Stakeholder Review and Input Events:

- Connecticut Marine Trades Association: November 8, 2017, meeting of 12 Board members and staff; presentation and discussion

- Recreational Sailing and Boating Webinar: November 30, 2017; 25 attended. In addition to many questions asked by attendees to better understand how the Blue Plan will work, stakeholders at the webinar and meeting were focused on two issues: (1) being able to better define local geospatial areas that capture places that boaters consistently use and (2) there being a better, more complete map of marinas around the Sound.

- Yacht clubs around LIS: The Eastern Connecticut Sailing Association and Yacht Racing Association of LIS were sent invitations/notifications of the November 30, 2017, webinar to their email mailing list ahead of the webinar. These mailing lists are understood to cover most if not all of the yacht clubs around LIS and were significant in accomplishing broad access to the sailing contingent of the rec boating sector. It is assumed that many of the attendees of the webinar resulted from these mailings as the mailings were one of the principal methods of notifying the recreational boating sector. Another method included working with individual yacht club leaders (e.g., Guilford Yacht Club) who helped strategize how to reach the rec boating sector and also provided notice within their immediate circles of potentially interested parties.

- LIS United States Power Squadrons: There was outreach to the leadership of Districts 1, 2 and 3 of the LIS United States Power Squadrons to notify both the leaders and their members about the Blue Plan and the November 30, 2017, webinar in particular. This took the form of working closely with one of the Squadron leaders ahead of the webinar to set up a process of reaching out to her Squadron district members and to the leadership of the other Squadron districts. The method of outreach was in the form of emails providing a brief explanation of the Blue Plan, its relevance to the sector and an invitation to the webinar. There was not a formal sign-up for the webinar so the exact number of Power Squadron attendees at the webinar is uncertain.

- Association of Marina Industries (AMI): Contact was made with an AMI representative to discuss the Blue Plan in general and to invite the representative (and anyone else that he recommended from AMI or other related entities) to the November 30, 2017, Recreation Boating webinar. The representative attended the webinar.

Additional outreach is envisioned to these and other groups to continue the gathering and development of additional data and information, particular regarding the identification of more spatially explicit areas important for recreational boating.

Chapter 20

Harbors and Marinas

Chapter Table of Contents

Chapter List of Figures and Tables

Figures

Tables

20.1 Key Data and Map Products

Harbors and marinas are a defining feature for Long Island Sound (LIS) – not only for coastal areas – but as the points of origin for much of the activity and human use in the offshore areas of the Sound – whether for recreation, commercial activity, research and education, jobs and much more. Because these areas are hubs in the geospatial structure of human use in the Sound they are particularly important to the information, data and mapping of the Blue Plan. These areas also account for much of the economic activity of the maritime industries which have a significant impact on the Sound's economy. For Connecticut, maritime industries have over $5 billion dollars of impact according to a report of the Connecticut Maritime Coalition in 2010 (Connecticut Maritime Coalition, 2010). Because of the close connection between harbors and marinas with the maritime industry sector, we present information on all three. Although there is significant information about these sectors there remains a need for greater geospatial information about them. Several maps and charts are included in this chapter's appendix which provide information and context for harbors, marinas and the maritime industry sector.

Basic geospatial information about harbors can be found on traditional National Oceanic and Atmospheric Administration (NOAA) charts, examples of which are shown immediately below. In addition to showing which and where all the harbors are, these maps contain a wealth of other spatial information relevant to harbors and marinas from depth, channel and navigational information to key landmarks and shore-side features – including marinas.

Maps specifically showing the location of marinas in the Sound have not been completed, at least not that are in the public domain. The maps below provide general information only. Figure 20-1 shows that New Haven County has notably less marinas than the other three Connecticut coastal counties. Each of these three, Fairfield, Middlesex and New London all had the same general number, between 30 and 47. This is generally correlated with the recreational survey maps shown in the *Chapter 19 Recreational Boating and Sailing*. It is important to consider the Connecticut and Thames Rivers which likely contribute to the total number of marinas in those respective counties relative to New Haven County. Figure 20-2 provides greater detail but is incomplete as it is focused on those marinas that have been classified as having "aquaculture purposes."

At the time of this writing, the New York Department of Environmental Conservation is working on a comprehensive dataset of marinas, yacht clubs, boat/beach clubs, boat retailers, shipyards/boat retailers, and marine academies located near or on the waterfront within Nassau and Suffolk counties. This data will eventually be available on the Long Island Sound Study Nutrient Bioextraction webpage (Long Island Sound Study, 2018). Furthermore, Suffolk County Department of Economic Development and Planning has assembled a comprehensive list of all known marinas on Long Island (Table 20-1) (personal communication, Suffolk County Department of Planning and Development).

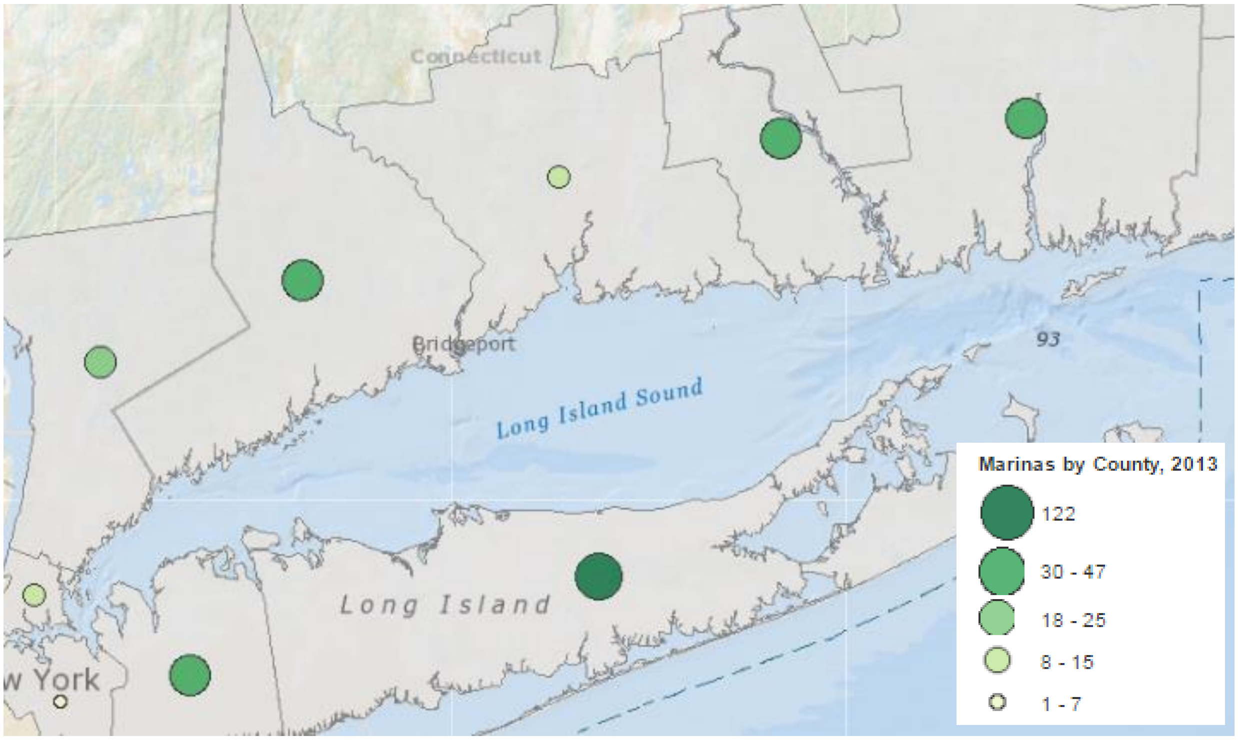


Figure 20-1: [Marinas by County, 2013](). Estimated number of marinas serving the recreational boating community. Access available via the Northeast Ocean Data Portal (Northeast Regional Planning Body, 2017).

Figure 20-2: [Connecticut Marinas](). Locations of marinas in Connecticut used for shellfish growing area classification purposes. Note that Connecticut Department of Energy and Environmental Protection (CT DEEP) Boating maintains a more comprehensive dataset, which is available upon request. Access to the above map available via the Connecticut Aquaculture Mapping Atlas (UConn CLEAR, 2018).

Table 20-1: Known Marinas on Long Island, NY

Name	Address	# Dock Slips
Lighthouse Marina	229 Meeting House Creek Rd, Aquebogue	150
Bayside Marina	28-05 Cross Island Pkwy, Bayside	60
Centerport Boatworks	105 Centershore Rd, Centerport	Not Reported
Centerport Yacht Club	33 Beach Plum Dr, Centerport	Not Reported
Whaler's Cove Yacht Club	150 Harbor Rd, Cold Spring Harbor	32
College Point Yacht Club	304 126th St, College Point	Not Reported
New Suffolk Shipyard & Cutchogue Harbor Marina	3350 W Creek Ave, Cutchogue	70
Setauket Harbor Marina	66 Shore Rd, East Setauket	Not Reported
Williamsburgh Yacht Club	11808 29th Ave, Flushing	Not Reported
World's Fair Marina	1 Marina Rd, Flushing	200
Brewer Yacht Yard at Glen Cove	128 Shore Rd, Glen Cove	550
Glen Cove Marina	76 Shore Rd, Glen Cove	Not Reported
Gladsky Marine	350 Shore Rd, Glenwood Landing	25
Harry Tappen Marina	Shore Rd, Glenwood Landing	267
Steppingstone Park and Marina	Kings Point, Great Neck	Not Reported
Preston's Marine Supply and Docks	102 Main St, Greenport	10
Townsend Manor Inn & Marina	714 Main St, Greenport	50
Halesite Marina	202 E Shore Rd, Halesite	72
Ketewomoke Yacht Club	75 New York Ave, Halesite	Not Reported
Knutson's Yacht Haven Marina	1 Anchorage Ln, Halesite	38
Mill Dam Marina	26 Mill Dam Rd, Halesite	164
Coneys Marine	32 New York Ave, Huntington	0
Huntington Yacht Club	95 E Shore Rd, Huntington	100
West Shore Marina	100 W Shore Rd, Huntington	300
Willis Marine Center	17 Mill Dam Rd, Huntington	120
Wyncote Club	311 W Shore Rd, Huntington	77
Mattituck Fishing Station	2275 Naugles Dr, Mattituck	Not Reported
Strong's Marine	2400 Camp Mineola Rd, Mattituck	100
Village Marine	175 Bay Ave, Mattituck	Not Reported
Mount Sinai Marina	199 Harbor Beach Rd, Mount Sinai	400
Mount Sinai Yacht Club	244 Harbor Beach Rd, Mount Sinai	90
Old Man's Boat Yard	350 Harbor Beach Rd, Mount Sinai	60
Ralph's Fishing Station & Marina	250 Harbor Beach Rd, Mount Sinai	50
New Suffolk Shipyard at Schoolhouse Creek	6775 New Suffolk Rd, New Suffolk	70

Name	Address	# Dock Slips
Britannia Yachting Center	81 Fort Salonga Rd, Northport	310
Northport Village Dock	1 Main St, Northport	Not Reported
Northport Yacht Club	11 Bluff Point Rd, Northport	Not Reported
Seymour’s Boatyard	63 Bayview Ave, Northport	12
Woodbine Marine	Woodbine Avenue, Northport	56
Narrow River Marina	5520 Narrow River Rd, Orient	Not Reported
Orient By The Sea Marina & Restaurant	40200 Main Rd, Orient	95
Oyster Bay Marine Center	5 Bay Ave, Oyster Bay	34
Sagamore Yacht Club	Head of Bay Ave, Oyster Bay	15
Danford’s Hotel and Marina	25 E Broadway, Port Jefferson	100
Port Jefferson Yacht Club	Surf Avenue Pass Way, Port Jefferson	5
Port Jefferson Town Marina	W Broadway, Port Jefferson	174
Silver Bay Marine Services	Surf Avenue, Port Jefferson	Not Reported
Brewer Capri Marina	15 Orchard Beach Blvd, Port Washington	330
Manhasset Bay Marina	10 Matinicock Ave, Port Washington	300
Manhasset Bay Shipyard	451 Main St, Port Washington	Not Reported
Marina at Inspiration Wharf	405 Main St #2, Port Washington	30
North Hempstead Town Dock	347 Main St, Port Washington	Not Reported
North Shore Yacht Club	73 Orchard Beach Blvd, Port Washington	Not Reported
Tom’s Point Marina	1 Sagamore Hill Dr #5C, Port Washington	130
Riverhead Yacht Club	68 River Ave , Riverhead	Not Reported
Riverside Marina	Riverside Dr, Riverhead	Not Reported
Treasure Cove Resort Marina	469 E Main St, Riverhead	120
Coecles Harbor Marina & Boatyard	18 Hudson Ave, Shelter Island	63
The Island Boatyard & Marina	65 Menantic Rd, Shelter Island	75
The Pridwin Hotel & Cottages	81 Shore Rd, Shelter Island	5
East Creek Marina Of Jamesport	185 Town Beach Rd, South Jamesport	90
Great Peconic Bay Marina	13 Washington Ave, South Jamesport	175
Brick Cove Marina	1760 Sage Blvd, Southold	140
Port Of Egypt Marine	62300 Main Rd, Southold	150
Southold Marine Center	49900 Main Rd, Southold	60
Smithtown Bay Yacht Club	552 Long Beach Rd, St. James	108
Smithtown Long Beach Marina	586 E Long Beach Rd, St. James	0
Stony Brook Marine Service	1 Shore Rd, Stony Brook	Not Reported
Stony Brook Yacht Club	21 Shore Rd, Stony Brook	187

20.2 Assessment of Data Quality

20.2.1 Sources of Data and Metadata

Datasets presented above are available via the Northeast Ocean Data Portal and The Aquaculture Mapping Atlas. A full report of the metadata for the Marinas by County, 2013 dataset can be found through the Northeast Ocean Data portal. Results are from research for the Blue Economy and NOAA's 2013 Economics: National Ocean Watch database.

Connecticut Marinas data layer is sourced from the Connecticut Department of Agriculture, Bureau of Aquaculture. A full description of the metadata is available through The Aquaculture Mapping Atlas portal.

20.2.2 Accuracy, Representativeness, and Relevance of Map Products

In terms of accuracy, the information from the Marinas by County, 2013 (Figure 20-1) layer is derived from the Bureau of Labor Statistics and Bureau of Economic Analysis; both of which are considered authoritative sources. The metadata also describes that spots checks on the data were conducted as fields were combined in geographic information systems processing.

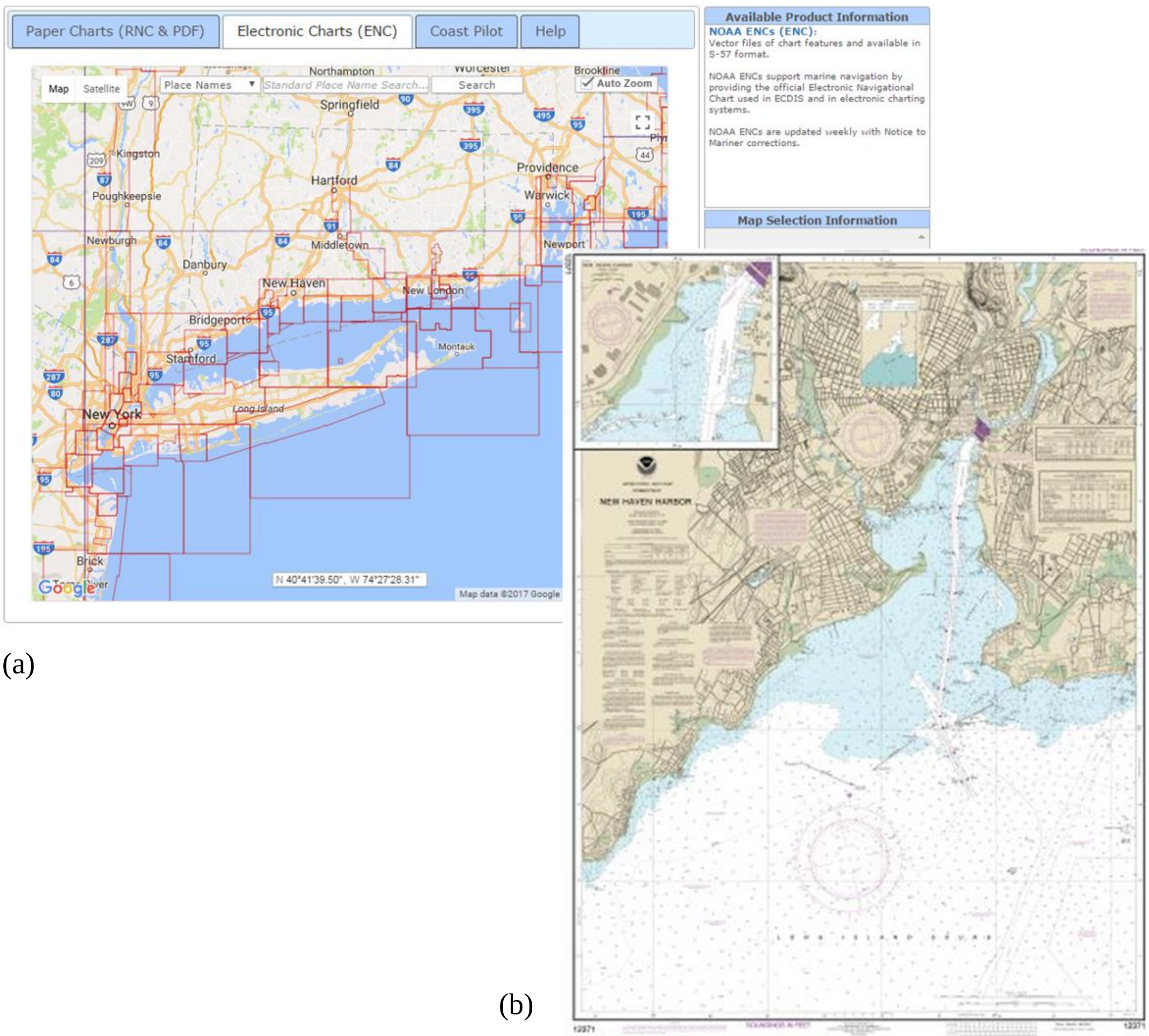
Because of the limited presentation of harbor and marina information, the larger question is how representative the maps are. The NOAA navigational chart (Figure 20-3) information is generally considered to be accurate and an excellent source of geospatial information about harbors. Because of the dynamic nature of these areas it is possible that detailed information may not be completely up to date on all charts at all times, however these maps are generally and frequently updated.

Also in terms of representativeness, the Marinas by County layer may be dated, as the analysis was conducted from 2005-2013. The Connecticut Marinas map may also be under representative as the map only covers marinas classified for aquaculture purposes. A full geospatial depiction of harbors and marinas is missing and the current mapping does not adequately represent this sector of Long Island Sound. Stakeholders from the recreational boating sector and others have expressed a desire to have such a depiction of harbors and marinas.

The existing maps available at this time are relevant to the harbors and marina sector because they assist in depicting the presence and importance of the sector, however they are incomplete for representing it.

20.2.3 Data Gaps and Availability of Data to Address Gaps

As has been noted above, there is not a complete and detailed map or maps that depict the location and identity of harbors and marinas together in Long Island Sound – including both New York and Connecticut. Such a map should also include boatyards (although they are often at the same location as the marinas). NOAA navigational maps (Figure 20-3) provide good geospatial information about harbors for the Sound, however a map which focuses on showing harbors along with marinas could be particularly useful for spatial planning purposes. Additionally, visual & scenic resources related to harbors are not covered in the Inventory. There is a gap in knowing what harbors may be considered scenic and conversely, which harbors serve as access points for viewing scenic resources seaward of the land base (e.g., the historic red cottage viewed in a wild dune and marsh area across the water from the Guilford Harbor is a scenic icon in town). Finally, historic and working waterfronts are missing from the inventory. There is a gap in knowing (and having a map) about which LIS waterfronts are considered historic and/or working waterfronts.



(a)

(b)

Figure 20-3: Example Display of [NOAA Charts](). (a) NOAA charts webpage showing different chart delineations. (a) Example chart for New Haven harbor. Access available via Office of Coast Survey (NOAA Office of Coast Survey, 2017).

20.3 Relevance

20.3.1 Relative Historical Importance

The maritime industry, and related harbor operations, are over three centuries old and are a vital part of Connecticut's culture and economy (Connecticut Maritime Coalition, 2000). Connecticut historically has been seen to be advantageous for the development for harbors and ports as its coastline is sheltered and protected by heavy seas in the Atlantic (Parsons, Brinckerhoff, Hogan, & MacDonald, 1946).

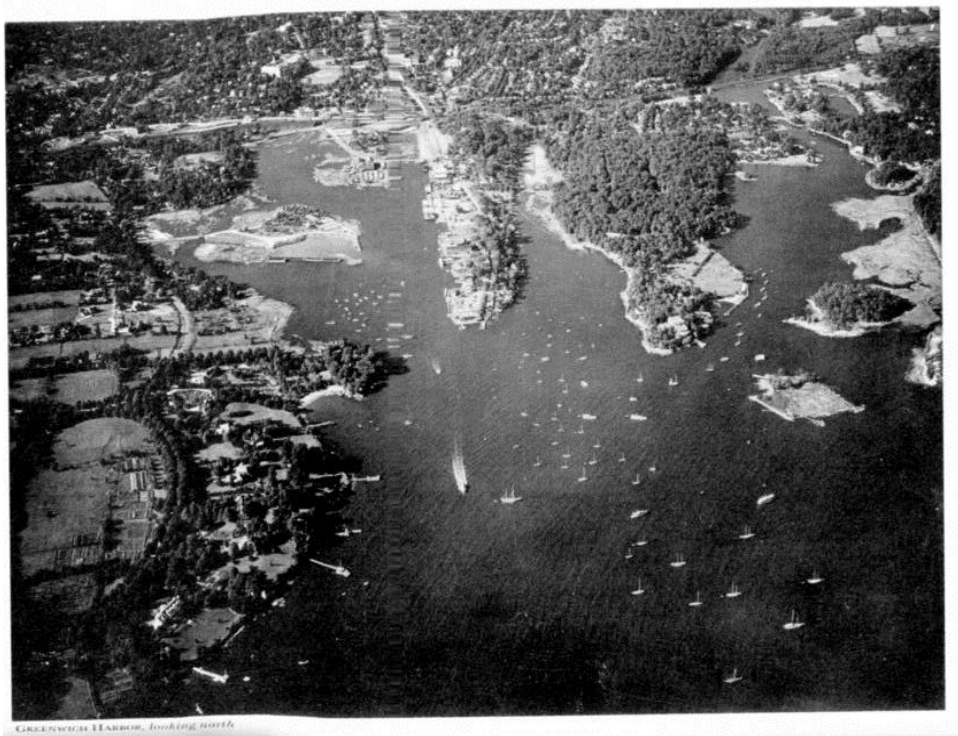
This protected geographical location has allowed harbors to develop and evolve over time. This industry has passed through a series of phases in its evolution, focusing on commercial shipping and industrial facilities, to focusing on recreational use, inclusive of marinas and recreational boating facilities. Through this evolution, Connecticut's coast has demonstrated an ability to restructure and redefine with changing conditions (Connecticut Maritime Coalition, 2000).

To see examples of this evolution, Figures 20-4, 20-5, and 20-6 showcase what harbors looked like in 1946 vs. what they look like today. For example, the modern day Greenwich harbor image illustrates substantial development with office, residential, hotel, and restaurant spaces; which is vastly different from the lumber and coal yards that resided in that spot in the late 1800s and early 1900s.

Another way to understand the historical evolution of Connecticut's harbors and marinas along Long Island Sound is to read through some of the regions Harbor Management Plans. For instance the City of Stamford's Harbor Management Plan describes the origin of the coast in the 1600s as Native American land that was sold to Puritans, transforming it with gristmills, sawmills, and fulling mills (Stamford Harbor Management Commission, 2009). Then the document migrates through the industrial revolution describing railways and industries, and comes into the modern day as the harbor is a hub for corporate offices (Stamford Harbor Management Commission, 2009).

An additional part of the evolution of Connecticut's harbors, has been the recognition by the federal government as to what harbors and ports are important for federal navigation, and therefore open to federal Army Corps of Engineer projects (i.e., dredging) (Figure 20-7) (U.S. Army Corps of Engineers, 2015). These projects have allowed Connecticut ports to be centers of commercial shipping, industry, and recreational use.

(a)



(b)

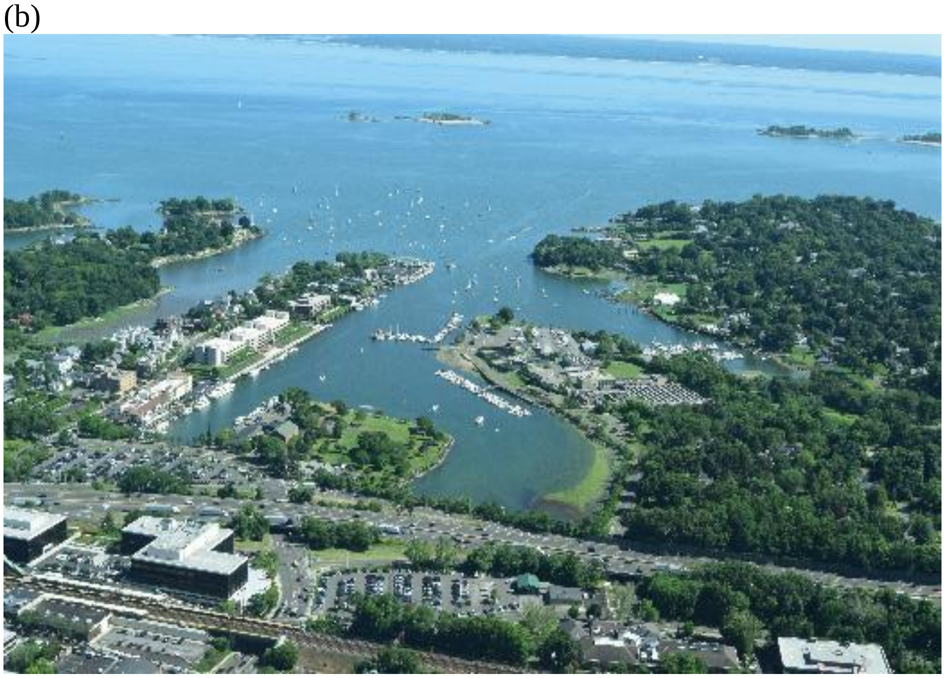


Figure 20-4: Images of Greenwich Harbor. (a) Greenwich Harbor in 1946 looking north (Parsons, Brinckerhoff, Hogan, & MacDonald, 1946). (b) Greenwich harbor in 2016 looking south (Source: Geoffrey Steadman).

(a)

(b)

Figure 20-5: Images of Norwalk Harbor. (a) Norwalk Harbor in 1946, far perspective (Parsons, Brinckerhoff, Hogan, & MacDonald, 1946). (b) Norwalk Harbor in 2015, close perspective (Source: Geoffrey Steadman).

(a)

(b)

Figure 20-6: Images of Stamford Harbor. (a) Stamford Harbor in 1946, far perspective (Parsons, Brinckerhoff, Hogan, & MacDonald, 1946). (b) Stamford Harbor in 2016, close perspective (Source: Geoffrey Steadman).

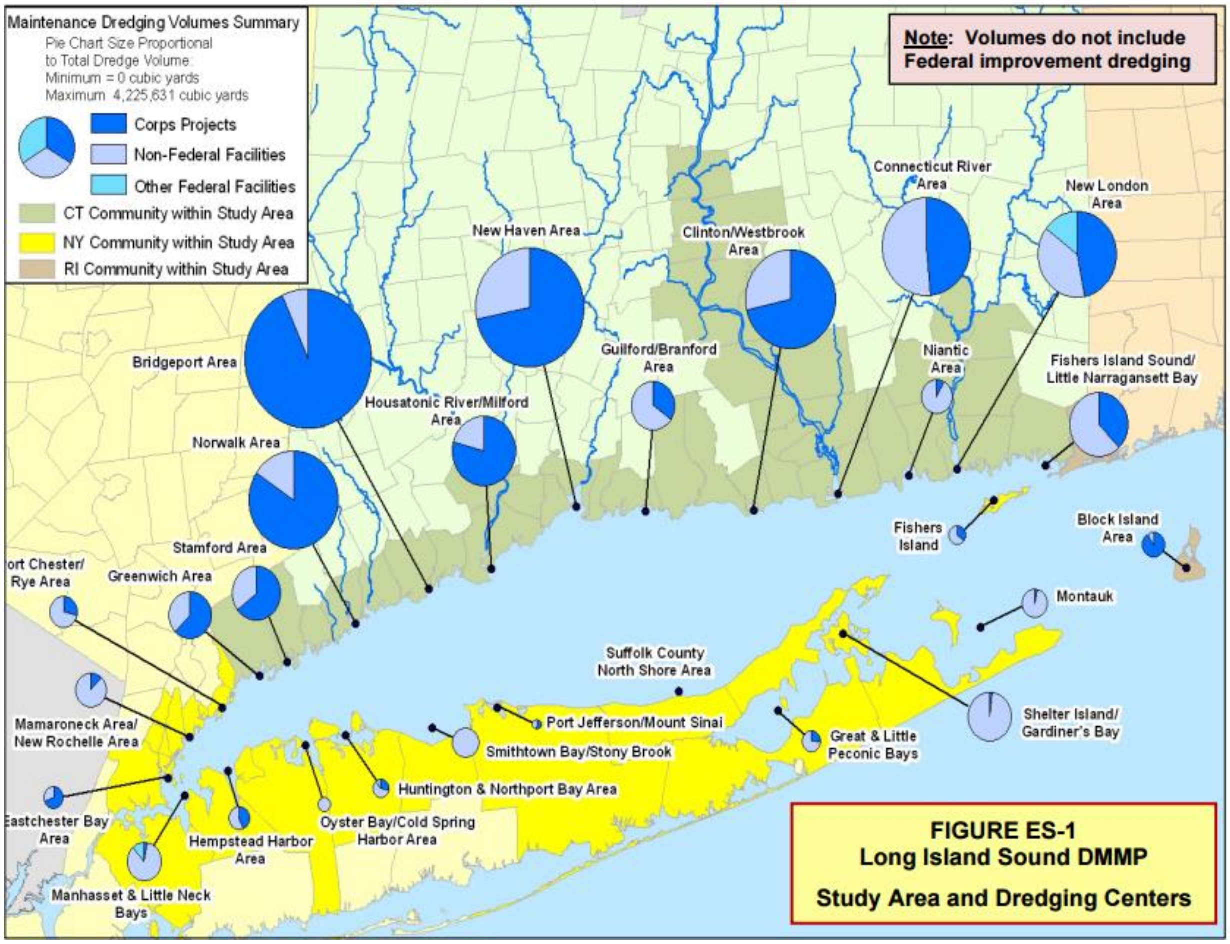


Figure 20-7: Influence of U.S. Army Corps of Engineers Projects in Long Island Sound. Maintenance Dredging summary displayed by port or harbor location along Long Island Sound. (U.S. Army Corps of Engineers, 2015).

20.3.2 Socio-Economic Context

Maritime Industries

Harbors and marinas in Connecticut, and their associated maritime industries have a significant impact on the Connecticut state economy. Within harbors and marinas, there are a variety of businesses that can be housed and operated. These include boat yards, boat/yacht brokers and dealers, contracted skilled technicians (i.e. electrical, mechanical, plumbing, woodworking), equipment operations (i.e., forklift, travelift), sail making and canvas fabrication, finance and insurance, customer services, fuel and dock staff, boat building, and boat and yacht refitting.

In total, maritime industries have over $5 billion dollars in impact on the State of Connecticut (Connecticut Maritime Coalition, 2010). When considering the businesses mentioned above, plus recreational boating, water transportation, shipping, and fishing, there is also the creation of $2.7 billion in gross state product, $56 million in local taxes, and $54 million in state revenues

(Connecticut Maritime Coalition, 2010). Additionally more than 30,000 jobs and $1.7 billion in household income can be attributed to the maritime industry sector. Wages in the maritime-dependent sector averaged $63,000 per job in 2007, which is 15% higher than the average wage for all jobs in Connecticut (Connecticut Maritime Coalition, 2010). A breakdown of marine dependent industries jobs and wages by smaller sectors, like boat dealers and ship building, is noted in Table 20-2.

Table 20-2: Maritime Dependent Industries in Connecticut: Total Jobs and Worker Earnings, 2007 (Connecticut Maritime Coalition, 2010)

NAICS	Sector	Earnings (thousands)	Jobs	Earnings/Job
114	Fishing, hunting, and trapping	$11,798	197	$59,786
3117	Seafood product preparation	$2,636	70	$37,607
336611	Ship building	$19,347	222	$87,235
336612	Boat building	$448,605	8,940	$50,180
441222	Boat dealers (coastal counties only)	$36,810	678	$54,285
483	Water transportation	$217,592	1,216	$178,940
48721	Scenic and sightseeing transportation, water	$2,062	81	$25,504
4883	Support activities for water transportation	$22,412	452	$49,626
61131	Colleges, universities, and professional schools	$63,200	828	$76,329
71393	Marinas (coastal counties only)	$55,355	1,312	$41,176
	Total: Maritime Dependent Industries	**$879,817**	**13,996**	**$62,862**

Source: FXM calculations of data from both BLS's QCEW and BEA's REIS data.

These economic factors are also very different between the coastal counties in Connecticut (Fairfield, New London, New Haven, and Middlesex). New London had the greatest economic output and job creation in 2010, most likely attributed shipbuilding for commercial and military purposes (Figure 20-8) (Pomeroy, Plesha, & Muawanah, 2013).

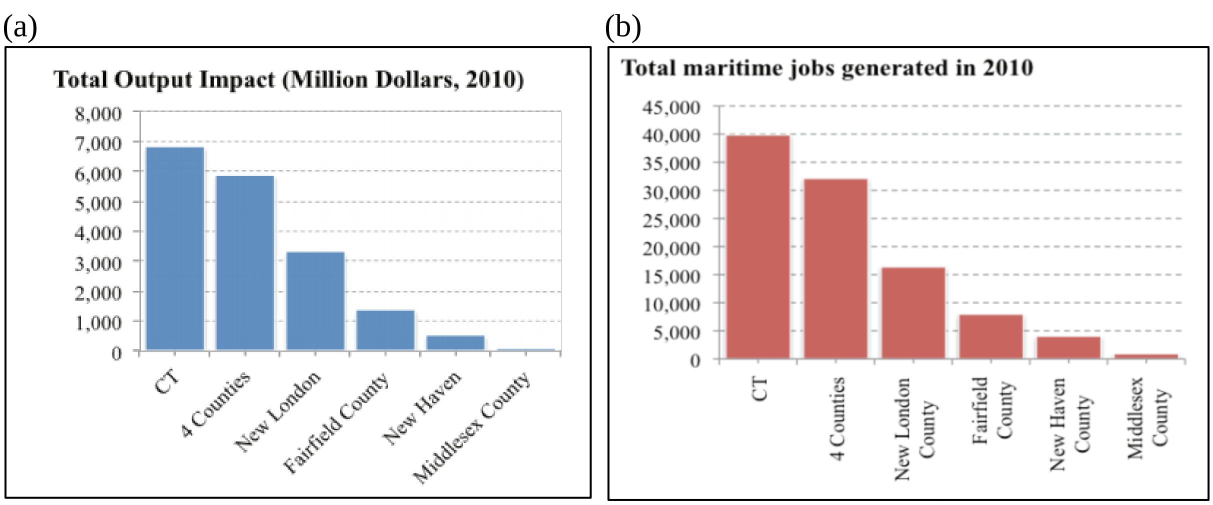


Figure 20-8: Economic Output and Job Creation from Maritime Industries in Connecticut. Output values are expressed in terms of (a) total output impact in 2010 (in million dollars) and (b) total maritime jobs generated in 2010 (Pomeroy, Plesha, & Muawanah, 2013).

Marinas and Harbors

In 2008, marinas in Connecticut's four coastal counties totaled 125, employed over 1,300 individuals, and distributed approximately $60 million in payroll (NOAA NMFS, 2008). Prior to the Great Recession in 2008, there was rapid growth in the marina industry. In the four coastal counties marina employment increased by 42.1% and aggregate payroll increased by 52.5%, from 2001 to 2007 (Connecticut Maritime Coalition, 2010). Fairfield County held the highest increase in both employment and aggregate payroll with 106.8% and 111.0%, respectively (Connecticut Maritime Coalition, 2010).

Visitors to marinas also contribute significantly to the economy, as in 2004 marina visitors spent a total of $554.3 million primarily on marina sales including membership fees, boat rentals, slip and mooring fees, boat repair, sail repair, notary services, and chandlery services (McMillen, 2006). Other significant travel expenditures included shopping at $22.3 million and meals at $17.2 million (McMillen, 2006). For more information on the economics of the recreational boating sector, refer to *Chapter 19 Recreational Boating and Sailing.*

Harbors also require periodic dredging in order to be able to operate. The maintenance of dredging to adequate depths, excluding federal navigation channels, is estimated at $82 million (Connecticut Maritime Coalition, 2010). Without the dredging of these harbors it is predicted that all maritime industries will suffer revenue losses. For instance, over the next 20 years fishing may incur approximately 58.3% in revenue losses, ship/boat building and repair at 44.8%, boat dealers in coastal countries at 9.7%, water transportation at 31.8%, and marinas in coastal countries at 42.7% (Connecticut Maritime Coalition, 2010).

For more information on the economics of marine shipping and infrastructure, refer to *Chapter 25 Marine Transportation, Navigation, and Infrastructure*. Also refer to *Chapter 26 Energy and Telecommunications* for more information on energy facilities and cables that may interact with harbor activities.

20.3.3 Other Notes

Harbor management has a significant role on Connecticut's coast. With the passage of the Harbor Management Act in 1984, Connecticut Department of Energy and Environmental Protection's (CT DEEP) Coastal Management Programs staff have been assisting coastal towns with the development of harbor management plans (CT DEEP, 2017c). The plans allow for the preservation of coastal resources in the harbor, the distribution and location of seasonal moorings, and access to federal navigation channels (CT DEEP, 2017c). The status as of November 2017, of Harbor Management Plans can be found through the Harbor Management Plans in Connecticut Status document on CT DEEP's website (CT DEEP, 2017a). The Harbor Management Act also allows for the appointment of Harbor Masters, who are responsible with the supervision and care of harbors and navigable waters in their jurisdiction (CT DEEP, 2017d).

As an overview of harbor management in Connecticut, there are 36 coastal towns, with 26 harbor management commissions (2 commissions in non-coastal towns, 3 commissions in the Town of

Stonington, and separate commissions for the City and Town of Groton) (Steadman, 2015). There is also 24 harbor management plans (2 of which are in non-coastal towns and 3 in the Town of Stonington) and 40 harbor masters (6 of whom are in non-coastal towns and 5 harbor masters in the Town of Stonington) (Steadman, 2015). There are 24 towns with harbor masters and harbor management commissions and 11 towns with harbor masters but no harbor management commissions (Steadman, 2015).

20.4 References

Connecticut Maritime Coalition. (2000). *Connecticut Maritime Coalition: Strategic Cluster Initiative.*

Connecticut Maritime Coalition. (2010). *Economic Impact Study of Maritime Industries in Connecticut.* South Windor, CT and Mattapoisett, MA: Apex Companies, FXM Associates.

CT DEEP. (2017a). *Harbor Management Plans in Connecticut: Status as of November 2017*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://www.ct.gov/deep/lib/deep/long_island_sound/coastal_management/harbor_masters/hmp_status_november_2017.pdf

CT DEEP. (2017b). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635

CT DEEP. (2017c, July 10). *Overview of the Coastal Management Program*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://www.ct.gov/deep/cwp/view.asp?a=2705&q=323536

CT DEEP. (2017d, November 6). *The Connecticut Harbor Masters Program*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://www.ct.gov/deep/cwp/view.asp?a=2705&Q=594656&deepNav_GID=1635

Long Island Sound Study. (2018). *Practical Applications of Nutrient Bioextraction*. Retrieved from The Long Island Sound Study: http://longislandsoundstudy.net/our-vision-and-plan/clean-waters-and-healthy-watersheds/nutrient-bioextraction-overview/practical-applications-of-nutrient-bioextraction/

McMillen, S. (2006). *The Economic Impact of the Arts, Film, History, and Tourism Industries in Connecticut.* CT Commission on Culture and Tourism by Connecticut Center for Economic Analysis .

NOAA NMFS. (2008). *Marine Economy, Connecticut.* National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS).

NOAA Office of Coast Survey. (2017). *Electronic Charts*. Retrieved from National Oceanic and Atmospheric Administration (NOAA) Office of Coast Survey: http://www.charts.noaa.gov/InteractiveCatalog/nrnc.shtml

Northeast Regional Planning Body. (2017). *Northeast Ocean Data Portal*. Retrieved from http://www.northeastoceandata.org/data-explorer/

Parsons, Brinckerhoff, Hogan, & MacDonald. (1946). *An Economic and Engineering Survey of all Navigable Waters in the State for the CT Port Survey Comission.*

Pomeroy, R. S., Plesha, N., & Muawanah, U. (2013). *Valuing the Coast: Economic Impacts of Connecticuts Maritime Industry.* Connecticut Sea Grant.

Stamford Harbor Management Commission. (2009). *City of Stamford Harbor Management Plan.* Stamford, CT.
Steadman, G. (2015). *Connecticut Towns and Municipal Areas with Coastal and Navigable Waterways: Connecticut Harbor Management Association.*
U.S. Army Corps of Engineers. (2015). *Long Island Sound: Connecticut, New York, and Rhode Island.*
UConn CLEAR. (2018). *Connecticut Aquaculture Mapping Atlas.* Retrieved from University of Connecticut Center for Land Use Education and Research (UConn CLEAR), Connecticut Sea Grant, and Connecticut Department of Agriculture Bureau of Aquaculture: https://clear3.uconn.edu/aquaculture/

20.5 Appendices

20.5.1 List of Maps Used to Inform the Chapter

Below is a list of all maps used to inform this chapter, including maps presented above in the narrative and additional maps used to support chapter findings. Maps listed below are organized by the online data portal on which they are hosted (URL links to data portals are noted in *Section 20.4 References* above). Map products not accessible by online data portal are also noted below.

Northeast Ocean Data Portal
- Marinas by County, 2013

CT Aquaculture Mapping Atlas
- Marinas

Non-Portal Map Products
- NOAA Charts
- Influence of Army Corp Projects in Long Island Sound

More information on some of the map products presented in this chapter, including URL links to data and metadata, can be found in the Recreational Boating Map Book and Marine Transportation, Navigation, and Infrastructure Map Book (CT DEEP, 2017b) . Not all products showcased in the map book may be addressed in this chapter or utilized to inform the final Blue Plan.

20.5.2 Notes on Stakeholder Engagement

Communication with leaders of the Connecticut Harbor Management Association, Connecticut Marine Trades Association (CMTA) and Connecticut Maritime Coalition (CMC) have been instrumental in providing information about the harbors, marinas and maritime industry sectors of Long Island Sound. Blue Plan officials met with CMTA staff and board members in November 2017, and efforts are underway to meet with harbor management commission leaders and the CMC in early 2018.

It is from these discussions that much of the information used to complete this chapter emerged. Other key points included discussion about geographic areas where they may be overlap between harbor management jurisdiction and the spatial areas of the Blue Plan which are from the 10' depth contour seaward. The basic message is that the Blue Plan does not alter or impact the jurisdiction of the harbor management commissions but should aid in providing greater clarity on State of Connecticut policies in general for all areas of the Sound within the State's jurisdiction. In nearly all cases, much of the discussions focused on better understanding how the Blue Plan is intended to work and how it would help protect traditional human uses and ecologically significant resources.

Chapter 21

Non-Consumptive Recreation

Chapter Table of Contents

Chapter List of Figures and Tables

Figures

Tables

21.1 Key Data and Map Products

Non-Consumptive Recreation (NCR) in Long Island Sound (LIS) takes many forms and occurs throughout the Sound, from the beaches along both shores to shipwrecks deep below the surface. For the purposes of this chapter, the non-consumptive recreational activities occurring in LIS include: general recreation and tourism (e.g., beachgoing, lighthouse cruises), recreational Shore-based Activities, and Underwater Activities (SCUBA) diving, kayaking and other paddle sports, and wildlife watching.

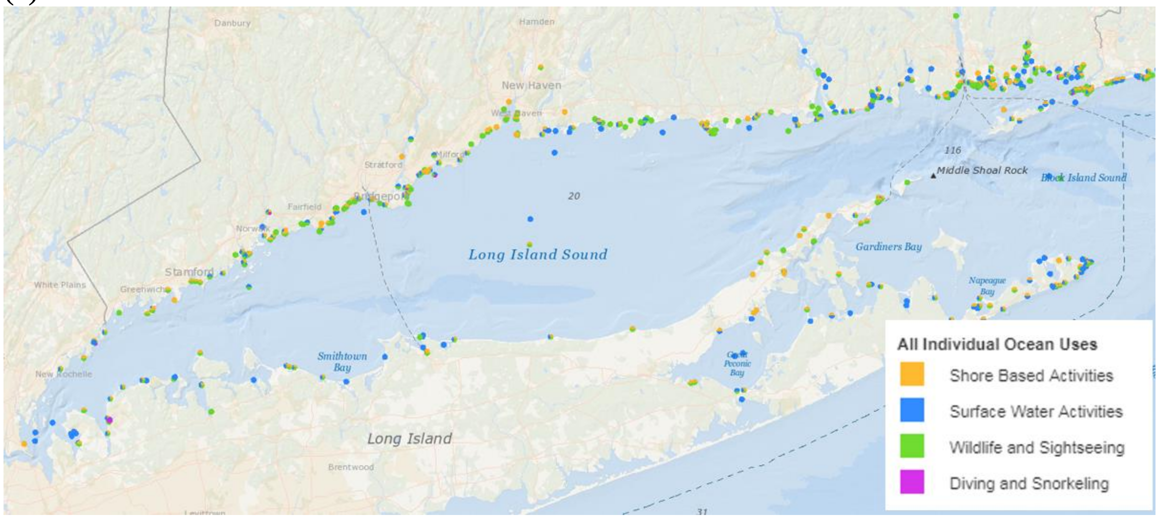
Many non-consumptive recreational activities begin as shore-based activities, even if they occur mostly in water deeper than 10 ft. Because of this, and the bulk of equipment that must be transported by a single participant (kayak and paddle, SCUBA gear, spotting scope, etc.) from a vehicle to the water, these users require unobstructed access points to the Sound. This sentiment was repeated in every SCUBA conversation throughout this process, as well as voiced by paddle sports representatives.

Most geospatial information pertaining to the NCR sector comes from three studies, conducted as part of the regional planning efforts in the Northeast and Mid-Atlantic, between 2012 and 2015. As both regional efforts contain LIS in their study areas, this Inventory benefits by including information from each. Furthermore, the reports symbolize similar data in very different ways, lending a depth to the characterization of NCR that many other sectors do not enjoy.

NCR spatial information from the 2015 Characterization of Coastal and Marine Recreational Activity in the U.S. Northeast report is available on both the New York Geographic Information Gateway (NYGIG) and the Northeast Ocean Data Portal (NODP) (New York Geographic Information Gateway, 2018; Northeast Regional Planning Body, 2017). These data are presented in point form showing many different NCR activities broken out by use (Figure 21-1). These include Shore Based Activities, Surface Water Activities, Wildlife and Sightseeing, and Diving and Snorkeling.

Relevant to this sector, the *2012 Northeast Recreational Boater Survey* gathered information on Wildlife Viewing, Relaxing, Diving, and Swimming as they occur from personal pleasure craft. 1,940 eligible respondents from Connecticut and 1,766 from New York participated in the survey, which asked about boat-based recreational activities. Participants from both states, separately, declared 58% of the locations identified in the survey as used for one form of NCR or another; the other 42% were declared as fishing (Figure 21-1). These map products are also available on the NYGIG and NODP (New York Geographic Information Gateway, 2018; Northeast Regional Planning Body, 2017).

(a)



(b)

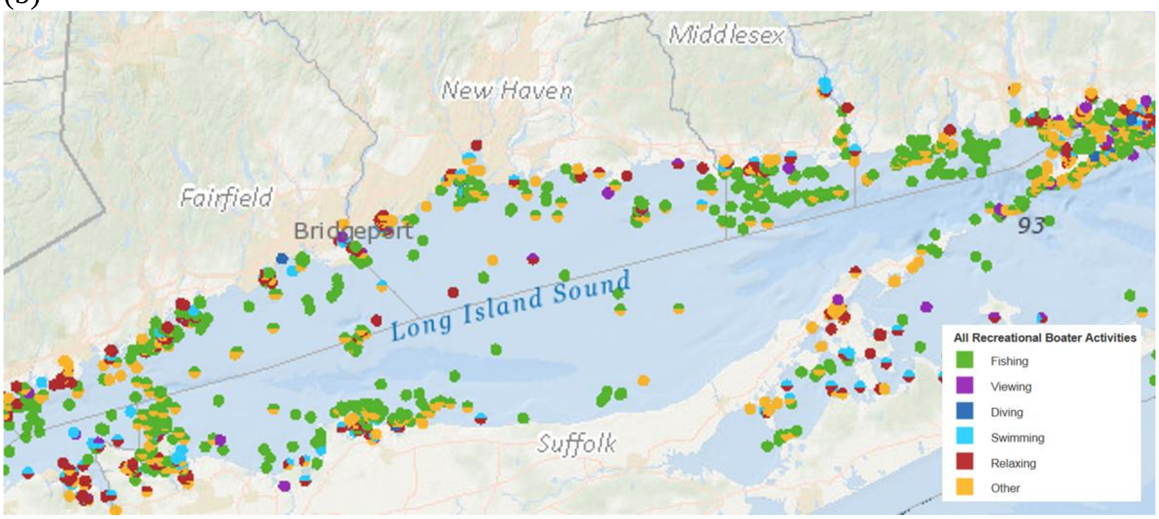


Figure 21-1: Maps of Recreational Activities in Long Island Sound. Information mapped includes (a) All Individual Ocean Uses and (b) All Recreational Boater Activities. Other maps in the later series show further breakdown of activities; for example, wildlife viewing by species. Access available via the Northeast Ocean Data Portal (Northeast Regional Planning Body, 2017).

Data from the U.S. Mid Atlantic Coastal and Ocean Recreation Study, available on the Mid-Atlantic Ocean Data Portal, is not presented based on discrete locations but rather by intensity of use in a grid, 1 km to a side, along the coast (Figure 21-2) (MARCO, 2018). Datasets presented in this report include Wildlife Watching, Surface Water Activities, and SCUBA (Figure 21-3(c)).

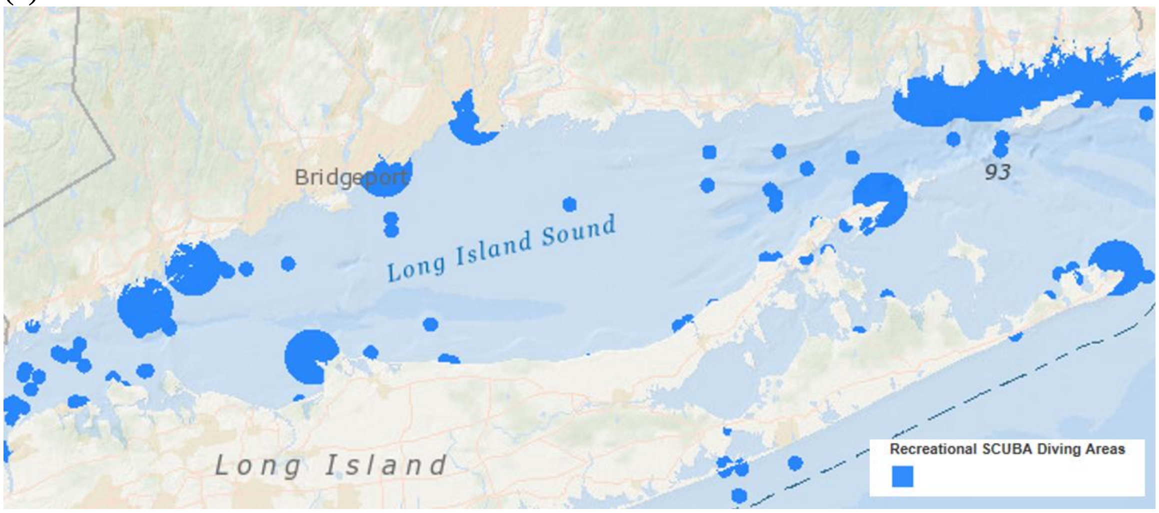
Figure 21-2: Shore-Based Activities. Other maps in this series show Surface Water Activities, Underwater Activities, and Wildlife Watching. Access available via the Mid Atlantic Ocean Portal (MARCO, 2018).

SCUBA diving locations are represented separate from the point datasets in the NYGIG and the NODP, though the data were collected as part of the same effort (New York Geographic Information Gateway, 2018; Northeast Regional Planning Body, 2017). SCUBA locations are shown as points buffered out various distances based on source (Figure 21-3(a)). Several stakeholders also suggested that using the latest National Oceanic and Atmospheric Administration (NOAA) Automatic Wreck and Obstructions Information System (AWOIS) data set (NOAA Office of Coast Survey, 2018) would be helpful to identify some, but not all, features that are important to the dive community (Figure 21-3(b)). However, none of these data were collected with a specific focus on diving in Long Island Sound. To fill this data gap, Blue Plan staff hosted an interactive, online mapping application in early 2018, which asked the SCUBA community to place points on specific locations most important to supporting diving in the Sound. The results of this map are presented in Figure 21-4.

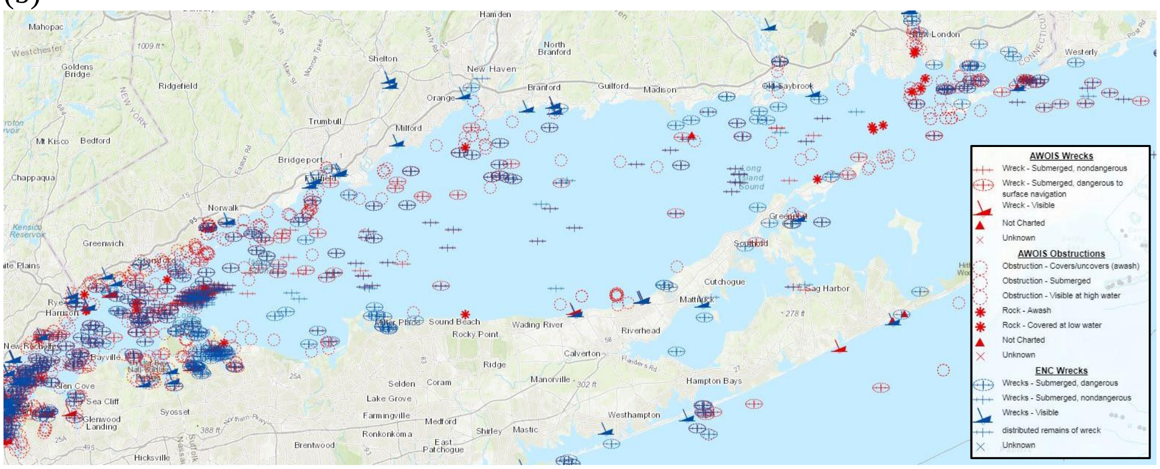
Additional datasets useful in characterizing this sector include Beaches, Water Trails, Boat Launches (CT DEEP, 2017b), and Coastal Access Sites (as presented in the map book used with outreach for this sector). However, the Coastal Access Sites (Figure 21-4) do not necessarily show where a kayak or stand-up paddleboard (SUP) can be launched, or SCUBA may occur. Rather, these points are in many cases where the public may approach and view the shore. There may be barriers – rocks, vertical drops, and fences – separating participants from the Sound. The Connecticut Coastal Access Guide (Figure 21-5) is an interactive online data portal that more completely characterizes and describes these coastal access sites, discovered by staff after the data vetting process, and should be used by anyone interested in coastal access (CT DEEP, n.d.).

In Connecticut SCUBA diving is prohibited from State boat ramps, meaning shore access is limited to a few State and local beaches, which are heavily used by the dive community and crucial to the sport. Divers on Long Island report similar difficulties with coastal access, siting restrictions by private land, limited parking, or required permits.

(a)



(b)



(c)

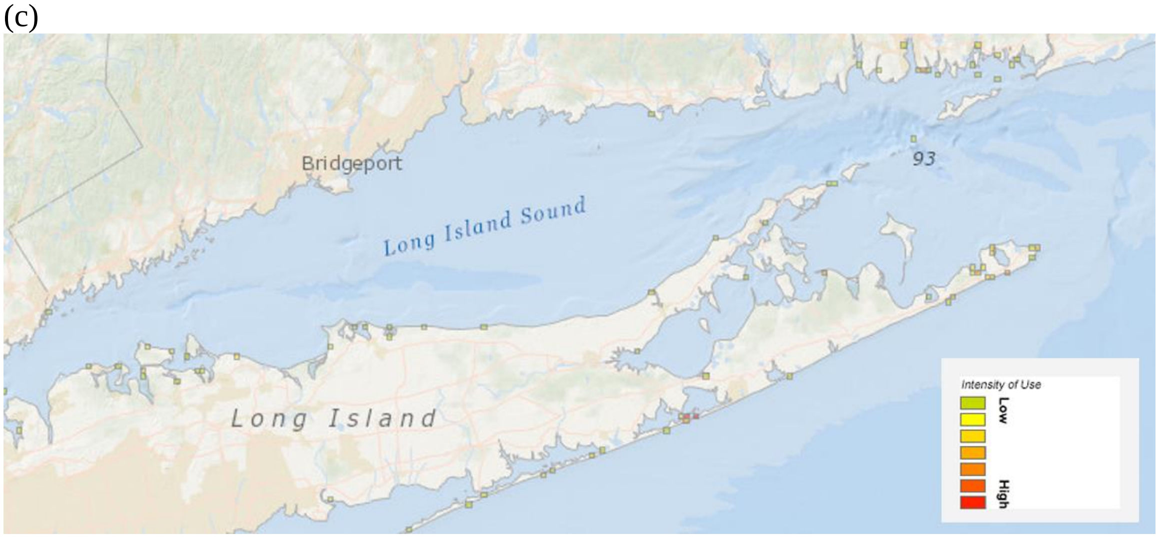


Figure 21-3: Three Possible Ways of Displaying SCUBA Activity in Long Island Sound. (a) Recreational SCUBA Diving Areas, including both shore-accessed and boat-accessed sites; access available via Northeast Ocean Data Portal (Northeast Regional Planning Body, 2017).

(b) [NOAA AWOIS dataset]; many dive sites are reefs, obstructions, and wrecks that appear in the database; access available via the NOAA Wrecks and Obstructions Database (NOAA Office of Coast Survey, 2018). (c) [Underwater Activities], represented as intensity of use areas; access available via the Mid-Atlantic Ocean Data Portal (MARCO, 2018).

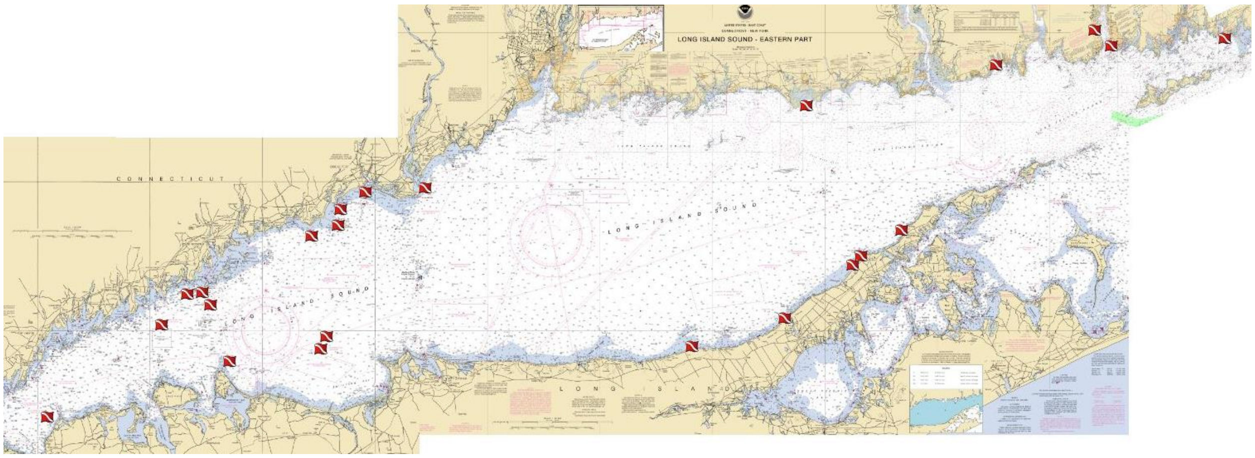


Figure 21-4: Important Recreational Dive Sites in Long Island Sound. These locations were mapped by LIS divers from both states in early 2018 and represent shore dive locations, charter boat sites, and other popular spots that sustain the sport.

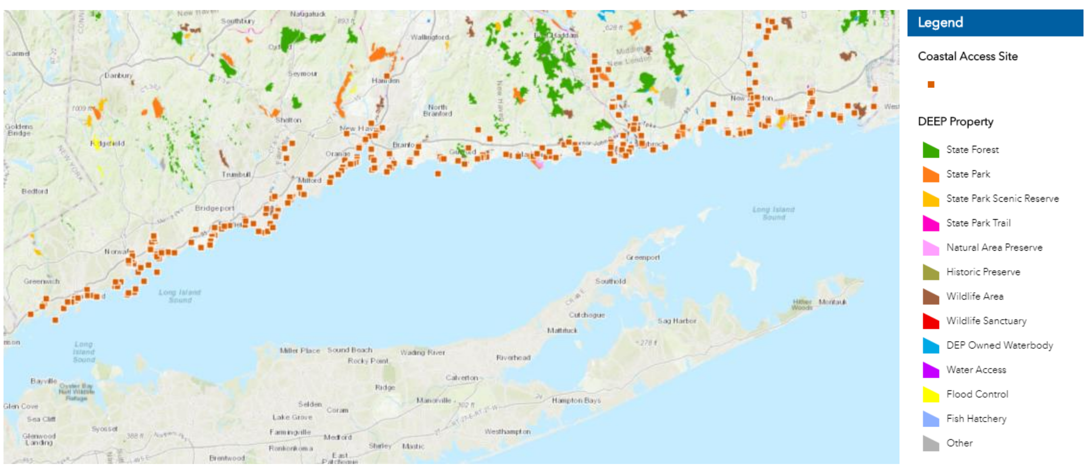


Figure 21-5: [Coastal Access Sites]. Note that not all sites are conducive to all non-consumptive recreational activities, but a more detailed description is available by clicking on each site. Access available via the Connecticut Coastal Access Guide (CT DEEP, n.d.).

One of the most common forms of non-consumptive recreation in LIS is Beachgoing: opt-in surveys indicated that 90% of all recreational users of the Sound went to the coast for the simple intrinsic pleasure of enjoying the beach at least once a year (Point 97, SeaPlan, and Surfrider Foundation, 2015; Surfrider Foundation, Point 97, The Nature Conservancy, & Monmouth University's Urban Coast Institute, 2014). Beaches are a primary draw for coastal tourism in both Connecticut and Long Island, and important to the coastal economy. Figure 21-6 displays beaches throughout LIS that are monitored by the Environmental Protection Agency (EPA) for water quality and other environmental conditions, and may be closed if contaminates exceed minimum health and safety standards. Note that these are not necessarily all of the beaches in Connecticut and Long Island, but the ones that are monitored as part of a national effort. Please see *Chapter 24 Research, Monitoring, and Education*, for a further discussion of water quality monitoring in the Sound.

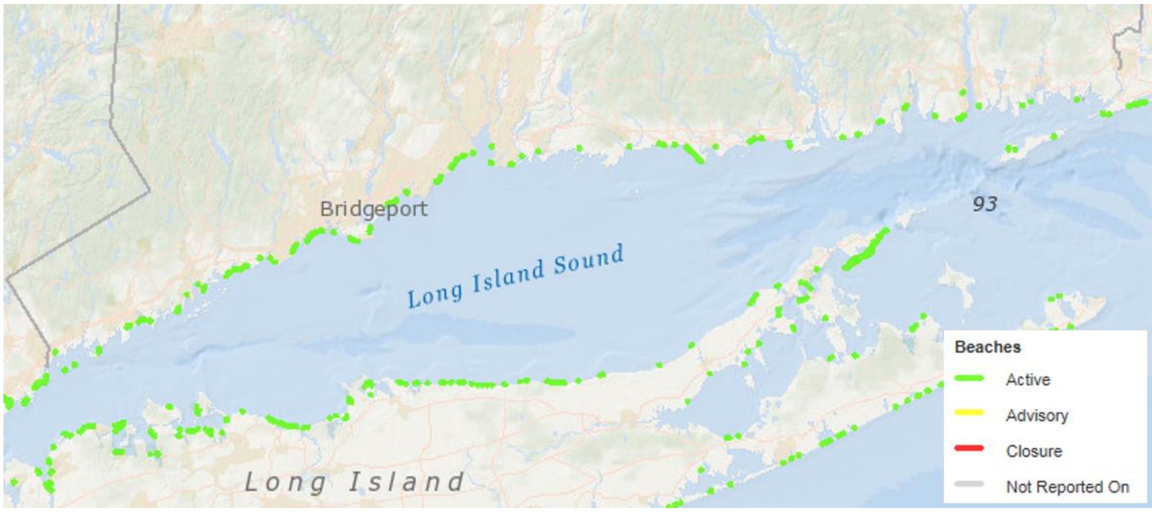


Figure 21-6: Beaches Designated Under the EPA Beach Advisory and Closing Online Notification (BEACON) System. Water quality information in this database is provided by states and other sources. Please see the BEACON website for more information (EPA, n.d.). *Access available via the Northeast Ocean Data Portal* (Northeast Regional Planning Body, 2017).

Wildlife watching may be either an individual or chartered activity. Many bird watchers utilize both shore sites and boat transits to observe sea birds over half a mile out (Figure 21-7). Viewing typically includes use of binoculars, telescopes and telephotography cameras. In addition to being a recreational activity, many bird watchers contribute to citizen science monitoring efforts through programs such as the Christmas Bird Count and eBird database (see *Chapter 24 Research, Monitoring, and Education* for a full explanation of the Christmas Bird Counts and eBird).

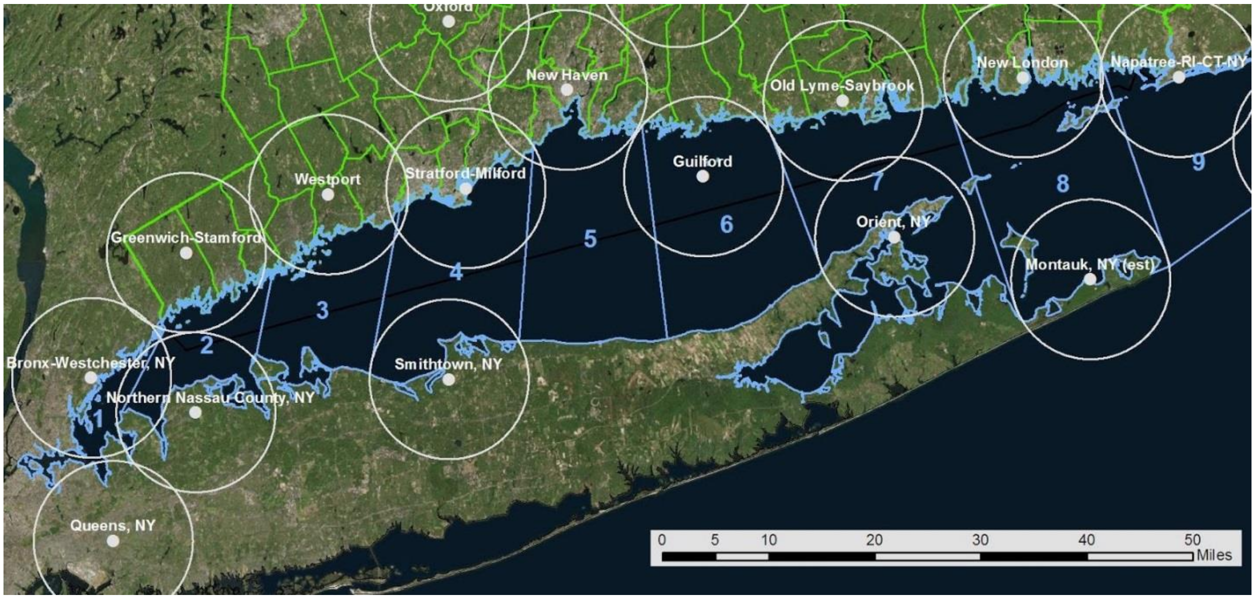


Figure 21-7: Christmas Bird Count Locations. Circles are also use for summer bird counts during the breeding season, but many areas within the circles are frequented by recreational birders throughout the year. Map courtesy of Tom Robben and Lisa Wahle.

The Maritime Aquarium at Norwalk offers dedicated wildlife watching charters on their research vessel (*R/V Spirit of the Sound*) from December through March. These cruises allow customers opportunities to view birds (e.g., buffleheads, mergansers, brant, and long-tailed ducks) and seals at haul-out sites near the Norwalk Islands (The Maritime Aquarium, 2018). See *Chapter 3 Marine Mammals* and *Chapter 5 Birds* for ecological characterization information on these species. Other organizations, such as Project Oceanology, offer seasonal seal watch cruises in the eastern Sound (Project Oceanology, 2016). While whale watching is a significant recreational activity in greater New England and New York (O'Connor, Campbell, Cortez, & Knowles, 2009), most whale sightings in LIS are incidental, not part of a targeted whale watching effort. As is noted in *Chapter 3 Marine Mammals*, sightings of several species of cetaceans in LIS has increased over the last few decades.

Sightseeing on charter vessels occurs throughout LIS. For example, the Maritime Aquarium also offers lighthouse cruises aboard *R/V Spirit of the Sound*; these run spring through fall and visit the lighthouses in Western (Greens Ledge, Sheffield Island, Stamford Harbor [or Harbor Ledge], Great Captain Island, Execution Rocks, Stepping Stones, Sands Point and Eatons Neck) and Central (Peck Ledge, Greens Ledge and Sheffield Island lighthouses in Norwalk, Penfield Reef Lighthouse in Fairfield and Stratford Shoal [Middle Ground] Light) LIS (The Maritime Aquarium, 2018). Please see Table 21-1 below for a list of active sightseeing cruises in LIS.

Table 21-1: Sightseeing Cruises Operating in Long Island Sound

Organization	Cruise Type	Viewing Area
Project Oceanology	Lighthouse, seals	New London, Stonington, and the Race
The Maritime Aquarium	Lighthouses, seals, birds	Western Sound and central Connecticut shoreline
Thimble Island Cruises	Three companies offering island tours	Thimble Islands, CT
Black Hawk Party Boat	Seals, dolphins, birds, sunsets, fireworks	Eastern Connecticut shoreline
Argia Mystic Cruises	Historic, lighthouses	Fishers Island Sound; Eastern Connecticut shoreline
Cross Sound Ferry	Lighthouses	Fishers Island Sound; Eastern Connecticut Shoreline
Skyline Cruise Line	Leisure, lighthouses, sunset, fireworks	Western LIS shoreline
Connecticut Harbor Cruises	Shoreline viewing, Private charter	Bridgeport CT
East Coast Yacht Cruises	Private charter	Western Connecticut shoreline
Lexington Classic Cruises	Private charter	Western Connecticut shoreline
Mystic Whaler Cruises	Lighthouse, sunset	Eastern Sound
Prestige Yacht Charters	Private charter	Western Connecticut shoreline
Connecticut River Cruise and Charter	Sightseeing, overnight charter	Eastern LIS
East End Seaport Maritime Museum	Lighthouse	Greenport, NY; Eastern LIS
Peconic Star Fleet	Lighthouse, seals	Greenport and Southold, NY; Eastern LIS

Long Island Sound sees many special events organized over the course of a year, mostly during the summer months. Such events may feature fireworks displays, swims, kayaking, SUP, SCUBA, and sailing (see *Chapter 19 Recreational Boating and Sailing*). Events are often held annually and can be an important boost to the local economy, given their tourism draw.

Any event occurring in navigable waters and may impose hazards to navigation, such as increased spectator traffic, and exclusion zones around participants. These types of events require the organizing party to obtain a US Coast Guard (USCG) Marine Event Permit (see 33 Code of Federal Regulations (CFR) 100) (Navigation and Navigable Waters, 33 CFR, 2017). In Connecticut, Connecticut Department of Environmental Protection (CT DEEP) regulations mandate that organizers to obtain a State Marine Event Permit (Boating Safety, 2018). The USCG maintains a description of repeated marine events in 33 CFR 100.100 (Navigation and Navigable Waters, 33 CFR, 2017). Locations of these marine events are shown in Figure 21-8.

Other marine events are posted in the USCG Local Notice to Mariners (LNM), a weekly publication by each USCG Sector that lists any irregularities that may impact navigation or safety at sea. While many events are posted in LNMs, information about them are not detailed enough to be included in this Inventory.

Figure 21-8: Repeated Marine Events in Long Island Sound. These events occur annually, and are listed in [33 CFR 100.100] to expedite the permitting process (Navigation and Navigable Waters, 33 CFR, 2017). Note that in addition to these events, there are many others that occur annually that are not listed in the CFR.

21.2 Assessment of Data Quality

21.2.1 Sources of Data and Metadata

Datasets from the 2015 *Characterization of Coastal and Marine Recreational Activity in the U.S. Northeast* (Point 97, SeaPlan, and Surfrider Foundation, 2015) and the 2012 Northeast Recreational Boater Survey (Starbuck & Lipsky, 2013) are available on the NYGIG and NODP (New York Geographic Information Gateway, 2018; Northeast Regional Planning Body, 2017). While a full detailing of the methodology of each is available in the final reports, the details relevant to validating the data quality as the best available are discussed here.

The *Characterization of Coastal and Marine Recreational Activity in the U.S. Northeast* report contains survey-generated location information for the recreational SCUBA Activity, Board and Paddle events, Shore-based Activities, Surface Water Activities, and Wildlife and Sightseeing. These surveys were conducted between September 2014 and May 2015, and "gathered over 19,000 data points from 975 respondents," characterizing twenty non-consumptive activities (Point 97, SeaPlan, and Surfrider Foundation, 2015). These activities are summarized in Table 21-2, and presented in Figure 21-1. All accompanying metadata for the resulting map products, as described above, may be found in this report or associated with each layer in the NODP.

Table 21-2: Breakdown of Recreational Activity Surveyed in the "Characterization of Coastal and Marine Recreational Activity in the U.S. Northeast" Report, 2015

ACTIVITY GROUPINGS	ACTIVITIES	NUMBER OF DATA POINTS
All Activities	Includes all mapped activities (includes 'other' activities)	19,211
Shore-based Activities	Beach going (sitting, walking, running, dog walking, kite flying, etc.)	2,590
	Biking or hiking	1,345
	Camping	140
	Collection of non-living resources/beachcombing (beach glass, shells, fossils, driftwood)	1,136
	Hang gliding/parasailing - not mapped - only one point	1
Surface Water Activities	Boating/sailing	886
	Kayaking or other paddling activity (canoe, stand up paddle board)	1,137
	Kiteboarding	25
	Skimboarding	56
	Surfing (from board or kayak or stand up board)	976
	Swimming or body surfing	1,709
	Windsurfing	90
Wildlife & Sightseeing	Photography	2,226
	Scenic enjoyment/sightseeing	2,945
	Sitting in your car watching the scene	1,121
	Watching birds, whales, seals and/or other marine life (from shore or private boat)	2,179
	Watching birds, whales, seals and/or other marine life (from a charter/party vessel)	187
Diving	Free diving/snorkeling (from shore or boat)	191
	SCUBA diving (from a charter/party vessel)	11
	SCUBA diving (from shore or private boat)	113

The *2012 Northeast Recreational Boater Survey* targeted the activities of recreational boaters in coastal Northeast counties. These surveys were administered online in monthly increments for the boating season of 2012 and collected information on spatial use, economic information, and additional relevant data (such as number of trips and primary activity). All accompanying metadata for the resulting map products as described above may be found in this report, or associated with each layer in the Northeast Ocean Data Portal.

The *U.S. Mid Atlantic Coastal and Ocean Recreation Study* conducted for the Mid-Atlantic Regional Council in 2014 utilizes results from an online use and mapping survey (Surfrider Foundation, Point 97, The Nature Conservancy, & Monmouth University's Urban Coast Institute, 2014). Survey results represented 28 participants from Connecticut and 316 participants from New York, though it should be noted that the majority of mapped areas in New York are on the south shore of Long Island. The maps of use intensity are models based on input from the survey and proven statistical methods (Surfrider Foundation, Point 97, The Nature Conservancy, & Monmouth University's Urban Coast Institute, 2014). All accompanying metadata for the resulting map products as described above may be found in this report, or associated with each layer in the Mid-Atlantic Ocean Data Portal.

The map of Important Recreational Dive Sites in LIS was produced by local divers and was developed as part of the Blue Plan process. Some, but not all, recreational divers that frequently dive in the Sound requested that such information be collected to accurately represent where important dive sites are located.

Coastal Access Sites as reviewed with participants were provided through the Connecticut Aquaculture Mapping Atlas. These appear to have originated in the Connecticut Coastal Access Guide, which provides additional information on each site, such as parking, boat launch capacity, and a brief description of landscape and activities (CT DEEP, n.d.). The superior information from the Guide has supplanted the Access Sites from the Atlas in this Inventory, and should be used by anyone with questions regarding coastal access in Connecticut. Metadata for the Guide is available in the portal (CT DEEP, n.d.).

The Beaches locations also come from the Northeast Ocean Data Portal, but are not identified by the coastal recreation surveys. Rather, this dataset is from the EPA Beach Advisory and Closing Online Notification (BEACON) program, with metadata available here, or associated with the layer on the NODP (EPA, n.d.).

Data on marine events come from the Code of Federal Regulations, available online from the Government Publishing Office, or Cornell Legal Information Institute (Cornell Law School, n.d.).

21.2.2 Accuracy, Representativeness, and Relevance of Map Products

Through an in-person SCUBA club meeting and two webinars, the SCUBA community in Connecticut and Long Island agreed that while diving does occur at all the locations designated in both datasets – and that many of the most important and heavily-used sites are included in the existing maps – there is a need to designate a few of the most important sites: notably, those that are used by SCUBA charter boats and are known throughout the community. The existing map products from the data portals, when displaying the full content of the diving material they contain, are therefore relevant for planning but not accurate or representative enough to fully characterize the diving community.

However, the *Characterization of Coastal and Marine Recreational Activity in the U.S. Northeast* SCUBA diving data may be broken down into several constituent sources, those being: Online geographic information systems (GIS) data portal, Online survey data, Participatory GIS workshop data, Online SCUBA guide, Printed SCUBA guide, and Other. Of these, only the two “guide” sources are consistently represented in a way that is geographically discrete. These sites are represented at 1 km radius circles around a published point. It is worth noting that while some “Other” and “Online GIS data portal” data are also as discrete, many areas are not. Given this, along with the fact that more spatially precise dive sites are more relevant to planning, certain subsets of the data can be said to be both relevant and accurate for planning, if not fully representative of the community.

The Blue Plan staff considers the areas that were identified by LIS divers as “most important to supporting diving in the Sound” to also be the most accurate, relevant, and representative to planning activities.

In a similar webinar held for other non-consumptive recreation experts, all of the non-SCUBA recreational data layers received no response as to validity of map products from expert stakeholders in both Connecticut and New York. Similarly, targeted emails also received no response. A single prominent Connecticut kayak club leader commented by phone that the single greatest limitation to paddle sports is coastal access; that even in busy and industrialized New Haven harbor the difficulty of paddling comes not with conflicting uses, but rather with gaining access to the Sound. These majority of these map products can be considered sufficiently accurate, representative, and relevant to planning, as no dissent was expressed over their content, and locations such as boat launches can be empirically evaluated. The Human Use Data Synthesis data, however, is not accurate, representative, or relevant to this sector, as it is far too small-scale to provide meaningful insight about where in LIS people recreate.

The Connecticut Coastal Access Guide is published by CT DEEP and is an authoritative source for coastal access information in Connecticut. The information it contains should be considered accurate and representative for the Connecticut coast, and is relevant to planning.

The Beach locations map product also received no comment, but can be considered to be accurate and representative, at least of monitored beaches, as a Federal dataset. While beaches are by definition outside of the 10-ft contour policy boundary, they are immensely important to recreation and tourism in both coastal CT and Long Island, and easily impacted by offshore activity that disturbs water or air quality, aesthetic value, or produces sound pollution. Beach locations in this dataset are provided Sound-wide, and are relevant to planning.

The spatial extent of marine events listed in the CFR is relevant and representative to spatial planning. However, it should only be considered partially representative of the full suite of organized events and activities that occur in the Sound.

21.2.3 Data Gaps and Availability of Data to Address Gaps

This study of NCR in LIS revealed several data gaps in each subsector, some of which can be easily filled by simple desktop research and expert consultation, while others will require a detailed and thoughtful study to address.

As expressed by many divers, the existing charted dive locations do not specifically note the most crucial sites in the Sound used by the community. Adding these to the geospatial dataset will accurately reflect sites divers and shops rely on, and will represent the community as a whole. These sites, identified by divers, will be relevant to planning as they are considered the most key to the survival of the sport in the Sound.

Not directly mentioned in this chapter, but still associated, are designated Scenic Areas for both States. These must be researched, mapped, and included in this Inventory. This effort must be conducted in such a way that the resulting dataset is accurate, representative, and relevant to planning, and thus must include shoreline as well as Sound-encompassing viewsheds.

Mapping all beach areas in Connecticut and on Long Island is also a priority. While these are partially covered in the EPA Beaches dataset available on the NODP and NYGIG (New York Geographic Information Gateway, 2018; Northeast Regional Planning Body, 2017), these areas are important to recreation and tourism throughout the Sound and should be further quantified. Included in this is an identification of activities and quantification of beachgoing; especially relevant considering that beachgoing as an activity itself was part of 90% of respondents to the 2014 (Surfrider Foundation, 2014) and 2015 (Surfrider Foundation, 2015) coastal recreation reports.

There is a need to identify where most paddlers go and what areas are most crucial to the sport, as no stakeholders have commented on existing data sets as this time. This can be done through a participatory mapping process with several of the clubs in Connecticut and Long Island, whose input would be believed to be accurate and representative. As conversations with representative experts pointed to a greater concern over shore access, mapping where paddlers go may not be as relevant as mapping where they launch and recover from.

The Wildlife Watching dataset for LIS is currently based on opt-in surveys. While this does include charter and party boat activity (Table 21-2), it does not include input from the charter boat operating community. As several organizations conduct specific wildlife watching cruises, it is possible to generate a complete and user-driven dataset for discrete wildlife watching areas, as well as the relative economic contributions of this sector. This dataset would be more accurate and representative than the opt-in survey, and thus would be more relevant to planning as well. A dataset like this would be particularly useful when combined with the ecological characterization of the species relevant for the cruises (see, in particular, *Chapter 3 Marine Mammals, Chapter 4 Sea Turtles,* and *Chapter 5 Birds*).

Specific to birding, maps should be constructed of where Bird Watching occurs across all of LIS, including shore-side and from boat traffic. This dataset is believed to exist in tabular form already, and several local experts not only desire to see it included, but have offered to help convert it to a map. Doing so will accurately and representatively depict where bird watchers report going most frequently, and will be relevant to planning as this activity is not just recreation, it is also longstanding citizen science.

Furthermore, while there is no listed whale watching operation in the Sound, the closest regional experts in Montauk and New York City should be contacted to confirm this specifically. As whales become more prevalent in the Sound, at least one participant has expressed an interest in citizen science effort tracking whales in the Sound (for more information on citizen science efforts in and around LIS, see *Chapter 24 Research, Monitoring, and Education*).
Similarly, there is a need to determine what lighthouse and sightseeing cruises exist in the Sound, and what areas are important for their businesses. This may relate to both the identification of Scenic Areas and wildlife watching as above.

There is also a need for specific Economic information of subsector-specific non-consumptive recreation and tourism throughout the Sound. While the reports below capture some of this, there is no discrete breakdown by SCUBA, wildlife watching, etc. For many sectors this would not be difficult to approximate, simply by asking all known shop owners and outfitters what their annual budgets are, or a professional firm could be hired to do a comprehensive study. Additionally, there is little tourism-specific data included; such as popular tourist destinations, or how much of coastal economy is from tourism vs. residents. Follow-up on this point should occur with both the Connecticut Office of Tourism and Discover Long Island. All of this information will improve the characterization of the Non-Consumptive Recreation sector and emphasize the importance of considering discrete areas for each group in a planning or permitting process.

Marine events in LIS could be more completely represented by characterizing each event listed in the back-issues of the LNMs. While the LNMs are all freely accessible online, formatting and nomenclature for events is not consistent between issues, and the spatial information about each event is frequently very vague. Nonetheless, including events listed in LNM back-issues would give a much more detailed understanding of the spatial and temporal extent of organized events in LIS.

Lastly, some activities such as parasailing and hang-gliding have not been characterized well, in part because only one participant registered this as an activity in the surveys.

21.3 Relevance

21.3.1 Relative Historical Importance

Recreational SCUBA diving was born in the 1950s when advances in Navy diving techniques became available to the layman. The term SCUBA stands for “Self-Contained Underwater Breathing Apparatus” and has since become the general term for using a tank of compressed air and associated gear to explore the underwater world whether for recreational or commercial purposes. SCUBA diving in Long Island Sound can be directly traced back to the late 1950s and early 1960s with the local SCUBA clubs, Gillmen and South East Connecticut Skin Divers (SECONN) being formed in 1956 and 1963 (respectively). Both clubs have a few members who have witnessed the sport grow from infancy to one of the fastest growing sports in the world. Long Island Sound attracts divers from the Tri-State area as well as the rest of New England.

Diving in Long Island Sound has been active since the beginning of SCUBA as a recreational sport. The desire to explore the unknown drew local divers to the many shipwrecks that litter Long Island Sound. In the early 1960s, many would accompany trawl fishing vessels in a mutualistic relationship – divers would be able to discover potential wreck sites and draggers had experienced personal aboard to retrieve nets and gear that became entangled. Before the invention of sidescan sonar and seafloor mapping, this was the best method of finding new sites to dive.

Paddle sports have gained popularity in LIS over the last 10 years, adding SUP to the existing activities of kayaking and canoeing. While SUP activities remain mostly confined to calmer bays and harbors (Point 97, SeaPlan, and Surfrider Foundation, 2015) where launch and recovery of the boards is easier, kayakers have for decades traveled Sound-wide. The Nassau and Suffolk Counties on Long Island are actively developing “Blueways Trails” for touring kayakers. When complete, these trails will consist of a series of landmarks and recommended routes that paddlers may travel along the coastal North Shore of Long Island (Murphy, 2016). Several Blueways exist in Connecticut as well, around the Norwalk Islands, lower Connecticut River, and Niantic Bay (Northeast Regional Planning Body, 2017).

21.3.2 Socio-Economic Context

There are currently at least five dive clubs in Connecticut and one in Long Island. Each club varies in size, with the largest Connecticut-based club (SECONN) having more than 200 annual members. Many of the divers who frequent Long Island Sound are world-travelers, but prefer “home” waters, and support at least 10 dive shops (more than two per coastal county) in CT, and a further 10 shops in New York and Long Island bordering the Sound (based on a rough Google Maps assessment in 2017). These shops bring in direct cash flow through gear sales and scheduled dive trips (both local and abroad). In addition, there are at least two Connecticut-based SCUBA charter vessels operating in the Sound, at least one charter vessel based in New Rochelle, NY, and several Rhode Island based charters that occasionally use the Eastern Sound as well. Indirectly, divers support local establishments through travel and meal costs associated with most trips.

Similarly, there are at least 21 locally owned and operated paddlesports and beachgoing-related shops along the Connecticut and western Rhode Island coast, and at least 9 establishments on the north shore of Long Island (based on rough Google Maps assessment in 2018). These figures do not include national chains that sell to a larger market of outdoor and boating enthusiasts as these businesses are not necessarily Sound-dependent.

The economic impact of each specific activity or subsector examined in this chapter has not, to date, been published in any known report. However, all three regional reports referenced here have quantified broader aspects of the recreation and tourism economy of Long Island Sound. The NCR reports found that Connecticut stakeholders spend an average of $186.18 per person per coastal visit, with the top most popular activities being beachgoing, sightseeing, and swimming (Point 97, SeaPlan, and Surfrider Foundation, 2015), while New Yorkers spend an average of $55.93 per visit, and engage primarily in beachgoing and sightseeing (Surfrider Foundation, Point 97, The Nature Conservancy, & Monmouth University's Urban Coast Institute, 2014).

The National Ocean Economics Program (NOEP) estimates economic information based on Bureau of Labor Statistics and Bureau of Economic Activities in cooperation with NOAA’s Office of Coastal Management. These data can be sorted by sector industry and county, and are presented in Tables 21-3 and 21-4 below (Middlebury Institute of International Studies at Monterey, 2017).

Table 21-3: Economic Impacts of Recreational Industries in the Four Connecticut Coastal Counties (Fairfield, New Haven, Middlesex, and New London), 2014

Industry	Establishments	Employment	Wages	GDP
Amusement and Recreation Services NEC	149	2,205	$52,317,978	$49,389,332
Eating & Drinking Places	2,233	28,808	$543,845,166	$1,032,465,367
Hotels & Lodging Places	138	4,193	$126,368,788	$459,171,077
Recreational Vehicle Parks & Campsites	D	D	D	D
Scenic Water Tours	10	65	$1,262,855	$1,955,383
Sporting Goods Retailers	D	D	D	D
Zoos, Aquaria	11	613	$22,751,481	$58,495,709

In Table 21-3, “D” represents Disclosure issues prevent that this data from being presented. Information in the table comes from the NOEP (Middlebury Institute of International Studies at Monterey, 2017).

Table 21-4: Ocean Economic Impacts of Tourism and Recreation Industries in the Three New York Coastal Counties (Nassau, Suffolk, and Westchester), 2014

County	Establishments	Employment	Wages	GDP
Nassau	1,242	15,121	$312,866,000	$572,697,000
Suffolk	2,248	29,089	$628,083,000	$1,223,731,000
Westchester	333	3,820	$90,169,000	$168,080,000

In Table 21-4, Establishments are not broken out into sub-sectors, as they are in Table 21-3. Moreover, it should be noted that the Employment, Wages, and GDP values for the two Long Island counties (Nassau and Suffolk) include economic benefits from the Atlantic-facing shore, as well as from LIS-facing shore. Information in Table 21-4 comes from the NOEP (Middlebury Institute of International Studies at Monterey, 2017).

The Connecticut Office of Tourism tracks tourist and travel information within the State. While the published information does not specifically highlight coastal tourism as above, it does divide the information by county, and provides both a tourism industry sales total as well as the percentage represented by recreation. The data for 2015 are the most recent as of this writing, and are presented in Table 21-5. Discussions with “Discover Long Island,” the New York State agency responsible for promoting tourism on Long Island, revealed that in 2016 tourism brought $5.6 billion dollars to the island, resulting in over $700 million in State taxes paid (Tourism Economics, 2017).

Table 21-5: Connecticut Tourism Industry Sales by Coastal County, 2015

County	Recreation (millions)	Tourism Industry Sales Total (millions)	Rec. % of Total
Fairfield	$472.90	$2,369.50	20%
New Haven	$230.70	$1,135.50	20%
Middlesex	$120.50	$660.40	18%
New London	$1,495.20	$2,205.10	68%

For Table 21-5, it should be noted that New London County tourism overwhelmingly relies on recreational opportunities, though this could possibly be due to two casinos near Norwich. Information in Table 21-5 comes from the Connecticut Office of Tourism.

State Parks are often a means to access LIS. In Connecticut there are five State Parks bordering the Sound, while Long Island offers six. In 2010, Connecticut parks saw 6.8 million visitors annually statewide, who spent $425.1 million (Connecticut Center for Economic Analysis, 2011). The parks on Long Island see over 21 million visitors each year, who contribute spend over $1.2 billion to the local economy, over a quarter of the total annual spending associated with all New York State Parks (Political Economy Research Institute, 2016). Note that these figures include all Connecticut and Long Island State Parks, not just those directly adjacent to LIS.

21.3.3 Other Notes

Several members of the dive community expressed interest in the mandated periodic updates to this Inventory, citing the fact that new discoveries or shipwrecks may create popular dive sites. For example, the 1984 sinking the tug and barge *Celtic* and *Cape Race* (Bachand, 2017) created a dive site that remains popular to this day. Furthermore, the contents of the barge *Cape Race* were salvaged in 2008, without the application for a CT DEEP permit (Koch, 2008), removing one of the more interesting facets of the wreck.

Residential beach associations exist along the coast of Long Island Sound, many of which were established in the 19th century and are now populated year-round. Residents of these associations greatly value the daily connection with the shoreline from their homes, which makes the associations a base for all forms of in-water recreational activity. In Connecticut, the extent and type of beach associations vary greatly between communities. Some associations provide simple amenities: garbage collection, lifeguards, and beach maintenance. Others provide more extensive services, such as sewer and water, road maintenance, docks, and police.

As quasi-governmental organizations, coastal associations often have their own charters that govern members, collect taxes, and control their own zoning. In all cases, the draw of these associations is proximity to the Sound and the recreational opportunities that come with it. In fact, 40% of respondents to the 2015 Northeast Recreation Survey stated that access to water-based recreational activities were the primary reason they lived near the coast (Point 97, SeaPlan, and Surfrider Foundation, 2015). Given residents' long-term investment in their communities –

multiple generations of families may live in the same community – members of these associations are often active in the conservation and management of their communities' historic and quality-of-life attributes. These associations have long histories of institutional knowledge about their area as well as an active presence in local projects that would change the use or aesthetics of the region around them (Krause, 1976).

21.4 References

Bachand, R. (2017). *Anatomy of a Shipwreck: the Tug "Celtic" and its Barge "Cape Race"*. Retrieved from Boating World: https://www.liboatingworld.com/single-post/2017/01/12/Anatomy-of-a-Shipwreck-The-Tug-%E2%80%9CCeltic%E2%80%9D-and-Its-Barge-%E2%80%9CCape-Race%E2%80%9D

Boating Safety, Conn. Regs. § 15-121 (2018).

Connecticut Center for Economic Analysis. (2011). *Department of Energy and Environmental Protection.* Retrieved from State of Connecticut : http://www.ct.gov/deep/cwp/view.asp?a=2716&q=561864&deepNav_GID=1650

Cornell Law School. (n.d.). *33CFR Chapter I*. Retrieved from Leagal Information Institute: https://www.law.cornell.edu/cfr/text/33/chapter-I

CT DEEP. (2017a). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635

CT DEEP. (2017b). *Saltwater Fishing Resource Map*. Retrieved from Connecticut Department of Energy and Environmental Protection: http://ctdeep.maps.arcgis.com/apps/webappviewer/index.html?id=4ac9ffcad5e34971a13838bfaa7f5468

CT DEEP. (n.d.). *Connecticut Coastal Access Guide*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://www.depdata.ct.gov/maps/coastalaccess/index.html

EPA. (n.d.). *BEACON 2.0 - Beach Advisory and Closing On-line Notification*. Retrieved from U.S. Environmental Protection Agency (EPA): https://watersgeo.epa.gov/beacon2/

Koch, R. (2008). *Tugboat From 1984 Wreck Salvaged*. Retrieved from The Hour: http://www.thehour.com/norwalk/article/Tugboat-from-1984-wreck-salvaged-8268224.php

Krause, L. B. (1976). *Coastal Districts and Associations; the Connecticut Coastal Area Managment Program.* Hartford: State of Connecticut Department of Environmental Protection.

MARCO. (2018). Retrieved from Mid-Atlantic Ocean Data Portal: http://portal.midatlanticocean.org/visualize/#x=-73.24&y=38.93&z=7&logo=true&controls=true&basemap=Ocean&tab=data&legends=false&layers=true

Middlebury Institute of International Studies at Monterey. (2017). *Ocean Economy Market Data*. Retrieved from National Ocean Economics Program: http://www.oceaneconomics.org/Market/ocean/oceanEcon.asp

Murphy, C. (2016, August 6). *North Shore Sets a Course for Blueway*. Retrieved from Syosset Jericho Tribune: http://syossetjerichotribune.com/2016/08/06/7725/

Navigation and Navigable Waters, 33 CFR (2017).

New York Geographic Information Gateway. (2018). Retrieved from New York State: http://opdgig.dos.ny.gov

NOAA Office of Coast Survey. (2018, June 8). *Wrecks and Obstructions Database*. Retrieved from National Oceanic and Atmospheric Association (NOAA) Office of Coast Survey: https://wrecks.nauticalcharts.noaa.gov/viewer/

Northeast Regional Planning Body. (2017). *Northeast Ocean Data Portal*. Retrieved from http://www.northeastoceandata.org/data-explorer/

O'Connor, S., Campbell, R., Cortez, H., & Knowles, T. (2009). *Whale Watching Worldwide; Tourism Numbers, Expenditures and Expanding Economic Benefits.* Yarmouth, MA: International Fund for Animal Welfare.

Point 97, SeaPlan, and Surfrider Foundation. (2015). *Characterization of Coastal and Marine Recreational Activity in the U.S. Northeast.*

Political Economy Research Institute. (2016). Retrieved from Parks & Trails New York: https://www.ptny.org/application/files/6515/0903/5031/Economic-benefits-of-NYS-parks.pdf

Project Oceanology. (2016). *Public Cruises*. Retrieved from Project Oceanology: http://www.oceanology.org/cruises

Starbuck, K., & Lipsky, A. (2013). *2012 Northeast Recreational Boater Survey: A Socioeconomic and Spatial Characterization of Recreational Boating in Coastal and Ocean Waters of the Northeast United States.* Boston, MA: SeaPlan.

Surfrider Foundation. (2014). *New York: Mid-Atlantic Coastal and Ocean Recreation Study.* Retrieved from Surfrider Foundation: http://surfridercdn.surfrider.org/images/uploads/publications/NY_Report.pdf

Surfrider Foundation. (2015). *Connecticut: Northeast Coastal and Ocean Recreation Study.* Retrieved from Surfrider Foundation: https://gallery.mailchimp.com/a3e6093bfbc11ef17b94c5cdc/files/R3_SRF_NortheastReports_Connecticut.pdf

Surfrider Foundation, Point 97, The Nature Conservancy, & Monmouth University's Urban Coast Institute. (2014). *U.S. Mid Atlantic Coastal and Ocean Recreation Study.*

The Maritime Aquarium. (2018). *R/V Spirit of the Sound*. Retrieved from The Maritime Aquarium at Norwalk: https://www.maritimeaquarium.org/fun-learning/kids-families/cruises

Tourism Economics. (2017). *The Economic Impact of Tourism in New York, 2016 Calendar Year, Long Island Focus.* Philadelphia: Tourism Economics.

21.5 Appendices

21.5.1 List of Maps Used to Inform the Chapter

Below is a list of all maps used to inform this chapter, including maps presented above in the narrative and additional maps used to support chapter findings. Maps listed below are organized by the online data portal on which they are hosted (URL links to data portals are noted in *Section 21.4 References* above). Map products not accessible by online data portal are also noted below.

Northeast Ocean Data Portal

- Recreational Board and Paddle Events
- Boat Launches
- Water Trails
- Beaches

New York Geographic Information Gateway

- Wildlife Viewing – Northeast Region, 2012
- Target wildlife viewing species – Northeast Region, 2012
- Swimming – Northeast Region, 2012
- Relaxing – Northeast Region, 2012

Mid-Atlantic Ocean Data Portal

- Surface Water Activities
- Wildlife and Sightseeing Activities
- Human Use Data Synthesis: Theme – Recreation
- Human Use Data Synthesis: Activity

Connecticut DEEP Saltwater Fishing Resource Map

- Boat launches

More information on some of the map products presented in this chapter, including URL links to data and metadata, can be found in the Non-Consumptive Recreation Map Book and SCUBA Map Book (CT DEEP, 2017a). Not all products showcased in the map book may be addressed in this chapter or utilized to inform the final Blue Plan.

21.5.2 Notes on Stakeholder Engagement

Outreach for this sector began with several email "blasts" sent out to identify contacts in early October 2017. Responses were followed up with individual email and calls. As overall response was very low, other potential stakeholders were identified with internet searches (such as for kayak, paddleboard, or SCUBA shops) and contacted via phone. Overall response on calls was general interest in the Blue Plan process, though if any of these shop owners attended webinars they did not identify themselves.

Formal SCUBA outreach consisted of one in-person presentation to a prominent Connecticut dive club during their monthly meeting, and two webinars in mid-November. A minimum of 26 participants were reached through this process (not including unidentified callers on webinars). These presentations and webinars, like all the webinars conducted as part of the Inventory data-vetting process, covered the basics of the Blue Plan and Inventory, the map books associated with the sector, and requested participant comment on both.

A single webinar was held for other NCR stakeholders, with at least 5 participants (again, not counting unidentified callers), in mid-November but very little comment was offered in this venue. Two follow-up emails were sent to participants whose addresses were known, but only two responses were received, each from the Surf Rider Foundation individuals who helped conduct the Northeast and Mid-Atlantic use surveys.

Outreach to the SCUBA and NCR communities was conducted as part of the 2014 and 2015 Recreational Characterization surveys for the initial data-gathering efforts, and the information contained in the report is considered vetted as is by the original authors, but several members of the local dive community expressed dissatisfaction with this initial effort. Furthermore, several recreational SCUBA community leaders expressed skepticism about all dive-related planning activities at the beginning of the outreach process. This sentiment is based on a history of State impediment to site access. In one example, SECONN divers collaborated with the State Archeologist on the discovery and investigation of historic shipwrecks, volunteering their unique skills and time, only to have access to these wrecks restricted by the State Historical Preservation Office. Anecdotes such as this are pervasive in New England dive culture, and lead to the sentiment that the more information about diving is obscured from resource managers, the more protected divers are in their right to practice their sport in LIS.

Chapter 22

Waterfowl Hunting

Chapter Table of Contents

Chapter List of Figures and Tables

Figures

Tables

None

22.1 Key Data and Map Products

Waterfowl hunting is a longstanding, traditional activity that takes place largely along Connecticut's rivers and the shores of Long Island Sound, particularly in marsh areas where waterfowl tend to congregate. As winter approaches and the southern migration heats up, the Connecticut coastline becomes more heavily populated with a variety of waterfowl species.

Waterfowl hunters follow the migration and harvest species which are generally more abundant. In 2018 and early 2019, larger than usual numbers of Sea Ducks frequented sheltered waters of bays and sounds. Duck hunters reported seeing Sea Ducks in every cove along eastern Connecticut waters. "Sea Ducks" refers to Eider, Scoter, and Long Tailed ducks. Brant can also be considered with this group. There was fairly good success harvesting Brant in the same vicinity as other sea ducks. West of the Connecticut River, there are normally very evident populations of Long Tailed ducks and Common Scoter. The greater abundance of Eider from the Pawcatuck, RI river to the west, presented an opportunity for more hunters to pursue their first Connecticut harvested Eider.

December cold fronts bring the large flights of diving ducks. The most abundant divers are the 3 types of Mergansers generally seen in the Atlantic Flyway and Buffleheads. Lesser Scaup, Redheads, and Goldeneye ducks can be found in the protected coastline and bays. The Canvasback, a once very prevalent duck in this region, is seen on very few occasions.

Puddle ducks such as the Mallard and American Black Duck will migrate to the coastline as ice forms in the inland waters. Both are very hardy birds and will stay in coastal estuaries as long as there is open water and food. As with all of the species mentioned above, their migration south depends on a number of factors, primarily food and open water.

While relatively small in number compared to other user groups, waterfowl hunters seriously pursue their activity, and have contributed directly to habitat conservation and restoration through the purchase of duck stamps and excise taxes on firearms and equipment. As such, waterfowl hunters are statutorily represented on the Blue Plan Advisory Committee as part of the recreational fishing and hunting community.

There are two map products that help represent the spatial distribution of waterfowl hunting around Long Island Sound. These are the Connecticut Hunting Areas map (Figure 22-1) and the Waterfowl Habitat map (Figure 22-2).

The Connecticut Hunting areas data layer displays areas that are open to hunting on Connecticut public land (CT DEEP, 2018b). This layer also distinguishes between what type of hunting is allowed in an area, what method of hunting is allowed in an area, and whether you need a permit to hunt within an area. There are also separate classifications for whether areas are closed to hunting.

Additionally, if an individual scrolls over one of the polygons in the data layer, an informational pop-out appears that may show the name of the public land parcel, the acreage, types of gear and hunting allowed in the area, and a pdf link to a more detailed map of the hunting area (CT DEEP, 2018b).

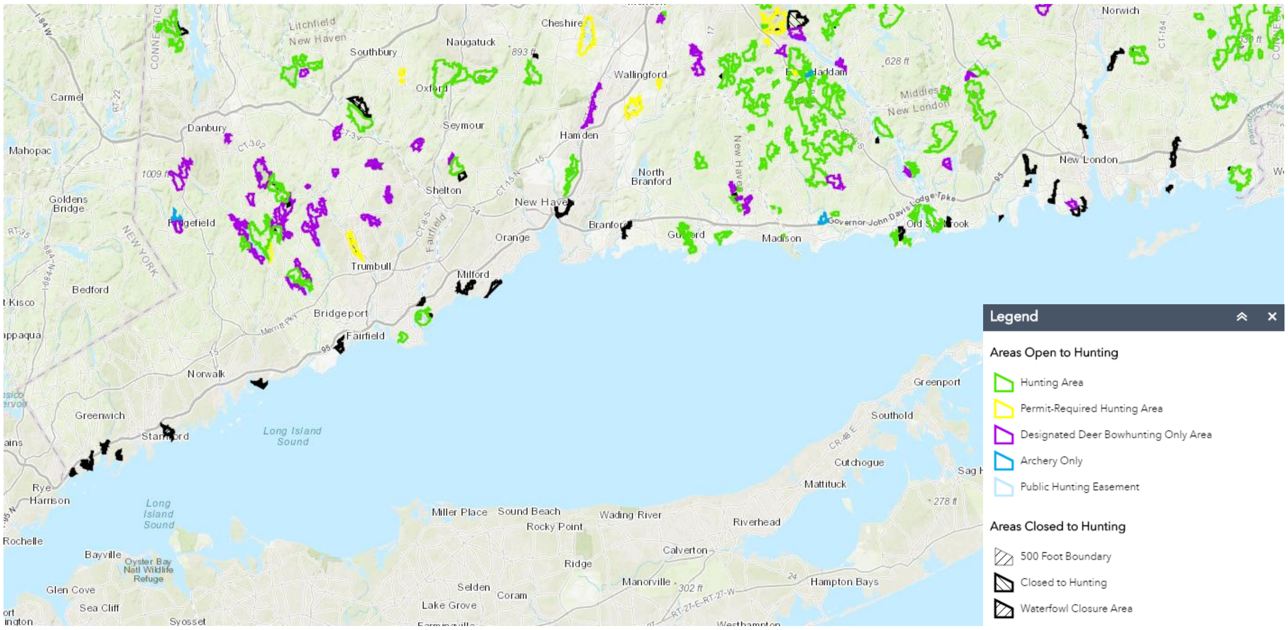


Figure 22-1: [Connecticut Hunting Areas](). Map describes the public hunting areas in Connecticut and their different regulatory designations. Access available via the Connecticut Department of Energy and Environmental Protection (CT DEEP) Hunting Area Viewer (CT DEEP, 2018b).

The Waterfowl Habitat map displays a series of polygons with waterfowl presence. Each of these polygons contains information on what type of waterfowl is present, such as but not exclusive to black duck, Canada goose, brant, goldeye, scaup, mallard, and teal. The polygons also identify if Woodduck is present, if there is migration through the area, and any additional field notes.

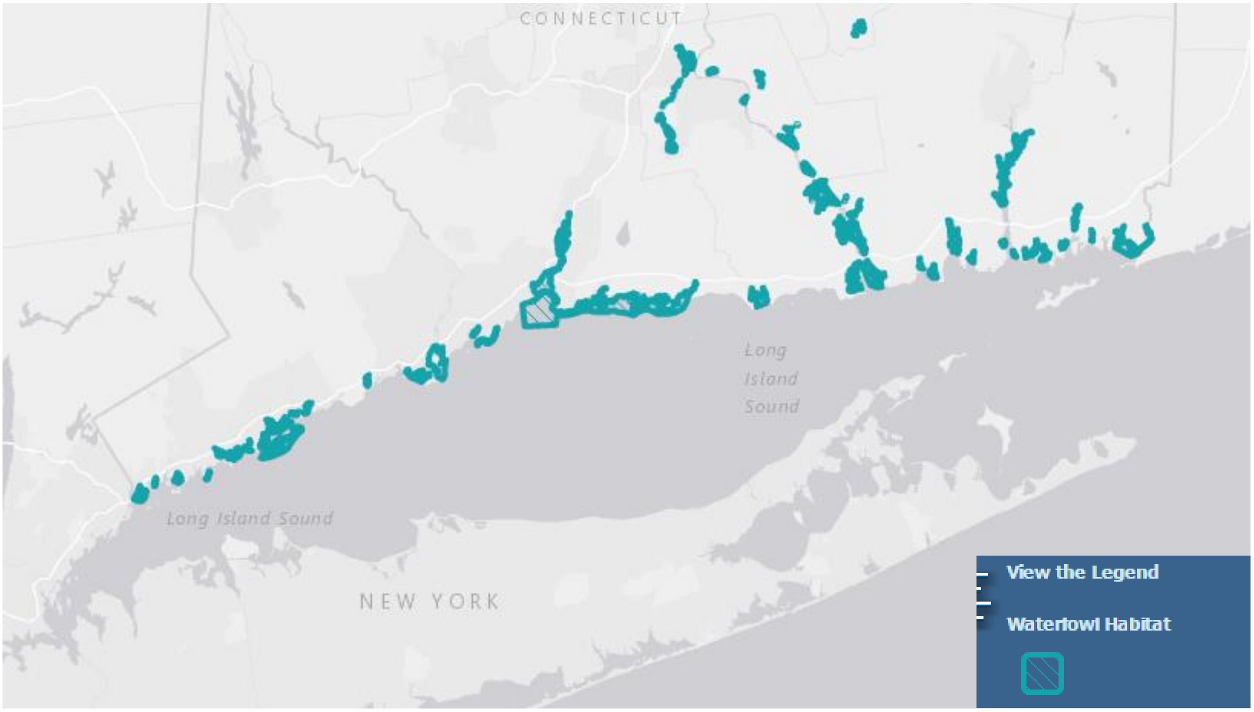


Figure 22-2: Waterfowl Habitat. Map identifies polygons of waterfowl presence with information on what types of waterfowl may be in that region. Access available via the Connecticut Aquaculture Mapping Atlas (UConn CLEAR, 2018).

22.2 Assessment of Data Quality

22.2.1 Sources of Data and Metadata

The data presented above is sourced and/or managed by the Connecticut Department of Energy and Environmental Protection (CT DEEP). The data is available via the CT DEEP Hunting Areas Viewer (Figure 22-1) (CT DEEP, 2018b) and the Aquaculture Mapping Atlas (Figure 22-2) (UConn CLEAR, 2018).

The migratory waterfowl dataset was based on the 1991 Northeast Coastal Areas Study by Joseph Dowhan and supplemented by midwinter surveys, breeding surveys, and personal observations by Paul Merola and Greg Chasko, both CT DEEP biologists (Dowhan, 1991). Each polygon in the map contains information on waterfowl in that location, presence of wood duck, migration routes, and field notes. A full metadata description is available via the Aquaculture Mapping Atlas (Aquaculture Mapping Atlas, 2017).

There is no single collective source of metadata available for the Connecticut Hunting Areas, however more information is available via the CT DEEP Hunting and Trapping webpage (CT DEEP, 2018e). Each polygon also has reference information as to what type of hunting is allowed in that region.

22.2.2 Accuracy, Representativeness, and Relevance of Map Products

All data presented is deemed relevant, as it is vitally important to understand waterfowl species presence and public hunting areas to start estimating coastal waterfowl hunting distribution.

In terms of accuracy, the CT DEEP hunting areas are accurate but they represent only land-based hunting. Therefore, data on waterfowl hunting from the water or on private land is not spatially represented. Additionally, information presented in the waterfowl habitat may be dated and therefore less accurate as it is based on findings from the 1990s.

Also in terms of representativeness, hunting area maps are believed by New York and Connecticut environmental agency staff to understate the extent and range of waterfowl hunting prevalence. Notes from stakeholder engagement efforts have illustrated that hunters will utilize every rock pile off the coast or hunt in boats anchored offshore, and those areas are not represented in these datasets.

22.2.3 Data Gaps and Availability of Data to Address Gaps

There are a few key data gaps in this sector that are in need of being filled in order to accurately represent waterfowl hunting activity along Long Island Sound's coast. These include a lack of waterfowl hunting information on the North Shore of Long Island, on in-water or offshore areas, and on private land.

A source that may be helpful in proceeding forward is the Ducks Unlimited Migration Map (Figure 22-3), which provides additional resources on National Wildlife Refuges, Ducks Unlimited projects completed on areas with public hunting, and real-time observations of migratory birds (Ducks Unlimited, 2017). Additional sources of information may be found in *Chapter 5 Birds*, which addresses the ecological characterization of birds in Long Island Sound.

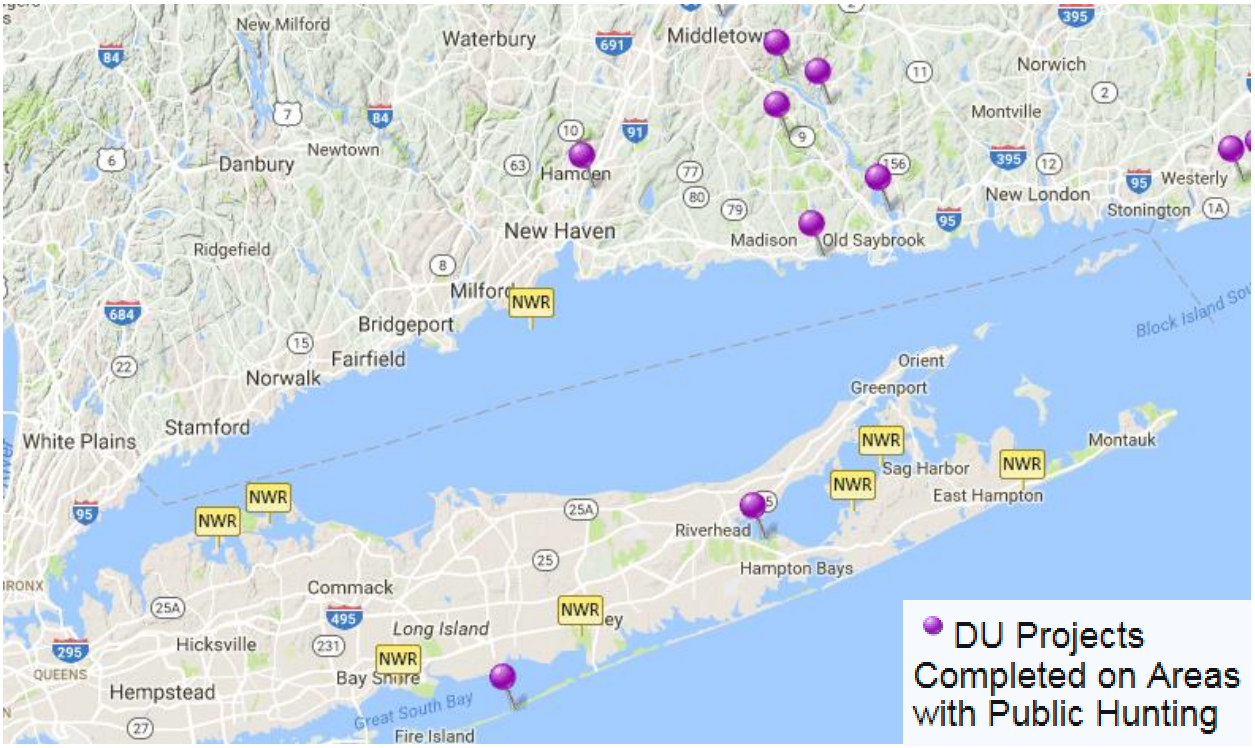


Figure 22-3: Ducks Unlimited Migration Map. Map showcases different Ducks Unlimited Projects on public lands and National Wildlife Refuges (identified as "NWR" on the map). The map is updated daily to show user observations on migration patterns. Access available via the Ducks Unlimited Migration Map (Ducks Unlimited, 2017).

22.3 Relevance

22.3.1 Relative Historical Importance

Historically, the presence of extensive estuarine marshes along migratory flyways in Long Island Sound attracted large numbers of waterfowl, which in turn attracted hunters. In recent years coastal development has encroached on waterfowl habitat and hunting access, but waterfowl hunting remains an important traditional use along Connecticut's shore. Waterfowl hunting in Connecticut is regulated by the CT DEEP Wildlife Division, which works closely with the hunting community (CT DEEP, 2018a). Waterfowl hunters themselves have supported habitat conservation and restoration, through federal excise taxes and the required purchase of both federal and state duck stamps, including a number of tidal wetland restoration projects along Connecticut's coast (CT DEEP, 2018d). Private advocacy groups such as Ducks Unlimited also have a long history of aiding conservation efforts (Ducks Unlimited, 2018b). Ducks Unlimited rates the Mid-Atlantic Coast, which includes Long Island, as a Level II priority area (Ducks Unlimited, 2018c). However, as the data reflects, waterfowl hunting on the shores of Long Island Sound generally takes place in wetlands and nearshore areas, particularly on or from public lands, and thus may have a limited impact on the offshore Blue Plan policy area waterward of the 10 ft depth contour.

22.3.2 Socio-Economic Context

A 2011 national survey by the National Fish and Wildlife Service found that approximately 1.5 million waterfowl hunters nationally spent over $1.3 billion that year in trip and equipment expenditures (Carver, 2011). However, only 7% of the hunters were located in the Northeastern states (Carver, 2011). CT DEEP's Statewide Comprehensive Outdoor Recreation Plan surveys suggest that, among outdoor enthusiasts, a relatively small number participate in waterfowl hunting (CT DEEP, 2018c). Approximately 2,300 waterfowl hunting licenses are issued annually in Connecticut (RealTree, 2017). The limited number of waterfowl hunters is a concern for both the hunting community and Wildlife Division staff, since it may result in less financial and community support for habitat conservation and access, and because a relatively less popular activity may face increasing competition from other user groups seeking to utilize the same areas. In common with the other user groups, waterfowl hunters are concerned to preserve access to open space and coastal waters in the face of continuing residential development of coastal areas and increased use of various types of watercraft.

22.3.3 Other Notes

Waterfowl hunting along the Connecticut coast is a long-running, cherished tradition, and has taken place for many years in close proximity to areas of high human use. For the most part, there have been very few conflicts. However, in recent years, there have been some negative encounters between waterfowl hunters and the non-hunting public. There may be the potential for further use conflicts as non-hunting uses such as paddlecraft navigation and wildlife viewing increase. However, this potential would tend to be mitigated by the seasonal nature of waterfowl hunting, which takes place in the fall while most non-hunting uses are more prevalent in the warmer months, and by adoption of responsible hunting practices as advocated by CT DEEP Wildlife and by waterfowl hunting organizations.

There are a series of additional resources that may be useful when understanding Waterfowl Hunting in Long Island Sound. One resource is the Connecticut Waterfowl Association, which provides waterfowl hunting education in addition to hosting a conservation fund to preserve wetland habitat (CWA, 2018a). Resources from the CT DEEP are also informative including the Migratory Bird Hunting DEEP Resources, which shows information on state managed properties that allow water fowl hunting, and the Migratory Bird Hunting Guide, which provides general information on waterfowl hunting regulation and seasonal events (CT DEEP, 2018a).

22.4 References

Aquaculture Mapping Atlas. (2017). Retrieved from Aquaculture Mapping Atlas : https://clear3.uconn.edu/aquaculture/

Carver, E. (2011). *Economic Impact of Waterfowl Hunting* . Falls Church, VA: U.S. Fish & Wildlife Service.

Coalition of Connecticut Sportsmen. (2017). *Welcome to the Digital Home of the Coalition of Connecticut Sportsmen*. Retrieved from ctsportsmen: http://ctsportsmen.com/

CT DEEP. (2018a). *2018-2019 CT Migratory Bird Hunting Guide.* Retrieved from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2700&q=323426

CT DEEP. (2018b). *Connecticut Hunting Areas.* Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://ctdeep.maps.arcgis.com/apps/webappviewer/index.html?id=58663e71ca114e439f7f3473836db929

CT DEEP. (2018c). *Connecticut Statewide Comprehensive Outdoor Recreation Plan*. Retrieved from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2707&q=323864&deepNav_GID=1642%20

CT DEEP. (2018d). *Federal Funding for Fish and Wildlife.* Retrieved from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2723&q=326164&deepNav_GID=1655

CT DEEP. (2018e). *Hunting and Trapping.* Retrieved from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2700&q=323414&deepNav_GID=1633%20

CT DEEP. (2018f, February 5). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635

CWA. (2018a). *CWA's Conservation Connecticut Fund*. Retrieved from Connecticut Waterfowl Association (CWA): http://www.ctwaterfowlers.org/conservation-fund.html

CWA. (2018b). *Homepage*. Retrieved from Connecticut Waterfowlers Association (CWA): http://www.ctwaterfowlers.org/

Dowhan, J. (1991). *1991 Northeast Coastal Areas Study.* Retrieved from US Fish and Wildlife Service: https://training.fws.gov/resources/knowledge-resources/pubs5/necas/web_link/table%20of%20contents.htm

Ducks Unlimited. (2017). *Ducks Unlimited Migration Map.* Retrieved from Ducks Unlimited: http://www.ducks.org/migrationmap/

Ducks Unlimited. (2018a). *Connecticut*. Retrieved from Ducks Unlimited: http://www.ducks.org/connecticut

Ducks Unlimited. (2018b). *Conservation.* Retrieved from Ducks Unlimited: http://www.ducks.org/conservation

Ducks Unlimited. (2018c). *Mid-Atlantic Coast: Level II Ducks Unlimited conservation priority area, popular wintering area for waterfowl, including the declining American black duck.* Retrieved from Ducks Unlimited: http://www.ducks.org/conservation/where-ducks-unlimited-works/mid-atlantic-coast

RealTree. (2017). *Duck Hunting in Connecticut*. Retrieved from RealTree: https://www.realtree.com/waterfowl-hunting/duck-hunting-nation/2017/connecticut-duck-hunting

UConn CLEAR. (2018, February). *Connecticut Aquaculture Mapping Atlas*. Retrieved from University of Connecticut Center for Land Use Education and Research (UConn CLEAR), Connecticut Sea Grant, and Connecticut Department of Agriculture Bureau of Aquaculture: https://clear3.uconn.edu/aquaculture/

22.5 Appendices

22.5.1 List of Maps Used to Inform the Chapter

Below is a list of all maps used to inform this chapter, including maps presented above in the narrative and additional maps used to support chapter findings. Maps listed below are organized by the online data portal on which they are hosted (URL links to data portals are noted in *Section 22.4 References* above). Map products not accessible by online data portal are also noted below.

CT Aquaculture Mapping Atlas

- Waterfowl Habitat

CT DEEP Hunting Area Viewer

- Connecticut Hunting Areas

Ducks Unlimited Migration Map

- Ducks Unlimited Migration Map

More information on some of the map products presented in this chapter, including URL links to data and metadata, can be found in the Recreational Fishing and Waterfowl Hunting Map Book (CT DEEP, 2018f). Not all products showcased in the map book may be addressed in this chapter or utilized to inform the final Blue Plan.

22.5.2 Notes on Stakeholder Engagement

There are several stakeholder organizations representing waterfowl hunting; in particular, Ducks Unlimited (Ducks Unlimited, 2018a) and the Connecticut Waterfowl Association (CWA, 2018b) have a lot of good waterfowl-related information and background online, while the Connecticut Sportsmen's Alliance advocates for hunters, particularly on gun issues (Coalition of Connecticut Sportsmen, 2017). Identified stakeholder and agency staff contacts have been kept apprised of Inventory development. Eight individuals representing the above and other organizations, including CT DEEP and New York State Department of Environmental Conservation wildlife staff, were sent map books for waterfowl and recreational boating and invited to review the data and participate in the November 21, 2017, webinar, which was held in conjunction with the Recreational Fishing sector. Two state agency wildlife staff members participated on the webinar and/or submitted comments by email. No other stakeholders from this sector chose to partake in the webinar.

Further contact with interested and knowledgeable stakeholders revealed that there is very little known published information on the Sound's Diving Duck population. These species use LIS waters to overwinter, or as part of longer migrations, and waterfowl hunters that harvest these species are concerned that sufficient habitats are maintained to support healthy populations. While published information on sea duck activity in LIS may exist, such information is not largely known to waterfowl hunting and conservation groups, such as Ducks Unlimited, Delta Waterfowl, and Connecticut Waterfowl Association. Participation in this Inventory process alerted members of these groups to this lack of understanding, and as of this writing, there is an effort underway to identify relevant studies.

Chapter 23

Historic and Archaeological Marine and Coastal Cultural Resources

Chapter Table of Contents

Chapter List of Figures and Tables

Figures

Tables

None

23.1 Key Data and Map Products

The waters and lands in and adjacent to Long Island Sound house a rich collection of historic and archaeological resources, both known and yet-to-be discovered. While such resources may not always been visible or recorded, they hold significant cultural value at the local, state, and federal levels. As such, their inclusion in the Resource and Use Inventory for Long Island Sound (LIS) is both appropriate and merited.

Based on stakeholder feedback and available data, spatial information on historic and archaeological resources in, around, and relating to LIS fall into three categories:

1. Submerged archaeological sites and artifacts
2. Submerged areas of archaeological sensitivity
3. Coastal terrestrial historic and archaeological sites, standing historic structures, and artifacts (including those threatened by climate change impacts)

Submerged Archaeological Sites and Artifacts

Submerged archaeological sites and artifacts in LIS consist of two elements: (1) Shipwrecks, and (2) Non-shipwreck sites and artifacts. The former has been mapped out on a Sound-wide scale. For the latter, only Connecticut-based data was made available for Blue Plan purposes.

Figure 23-1 displays recorded shipwrecks in LIS in the public record. Shipwreck density is high around major harbors (e.g., Port Jefferson, NY, and Bridgeport, CT) but is especially concentrated at the westernmost part of the Sound (near New York City and Huntington and Northport Bays of Long Island) and the easternmost part of the Sound (in Fishers Island Sound and at the easternmost opening to Block Island Sound, between Fishers Island and Watch Hill, RI). Spatial data points for additional shipwrecks have been mapped out by the CT State Historic Preservation Office (SHPO) and are currently being integrated into Figure 23-1.

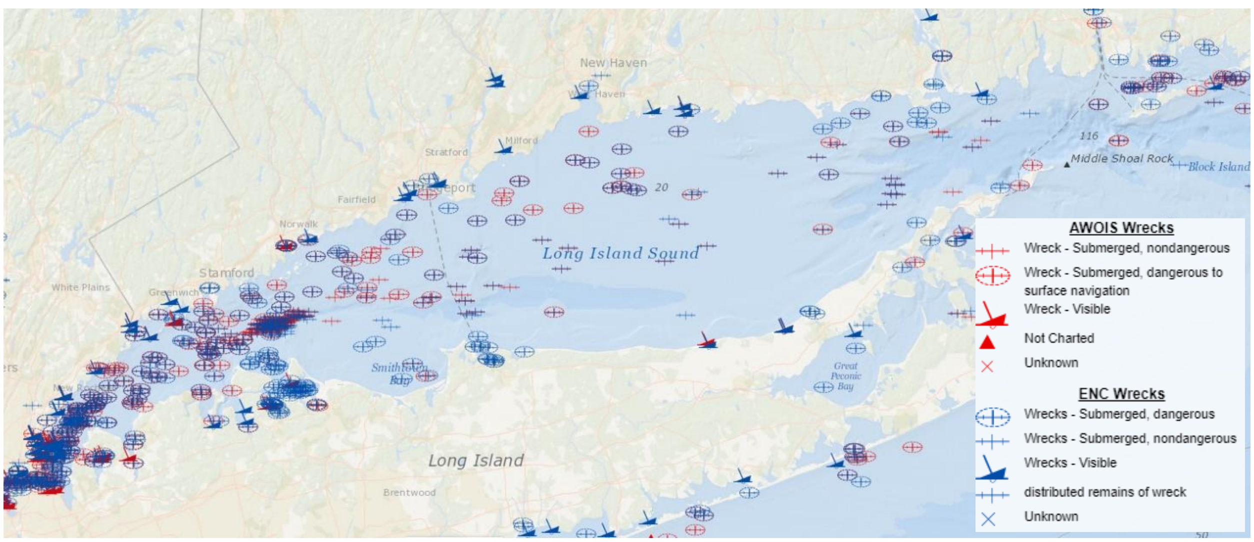


Figure 23-1: Wrecks in Long Island Sound. Recorded shipwrecks in and around Long Island Sound based on data housed in two National Oceanic and Atmospheric Administration (NOAA) databases: the Automated Wreck and Obstruction Information System (AWOIS) and the Electronic Navigational Charts (ENC). Access available via NOAA Office of Coast Survey's Wrecks and Obstructions Viewer (NOAA, 2017a).

Figure 23-2 displays in-Sound and on-shore non-shipwreck archaeological sites within the jurisdiction of Connecticut, as identified by the Connecticut Office of State Archaeology (OSA). Less than 10 sites have been identified in the Sound itself. According to stakeholder feedback, many non-shipwreck sites and artifacts in the Sound remain undiscovered, some likely under 10-30 m of sediment on the Sound floor (Forrest, Raber, Jones, & Thorson, 2006; Jones, 1993).

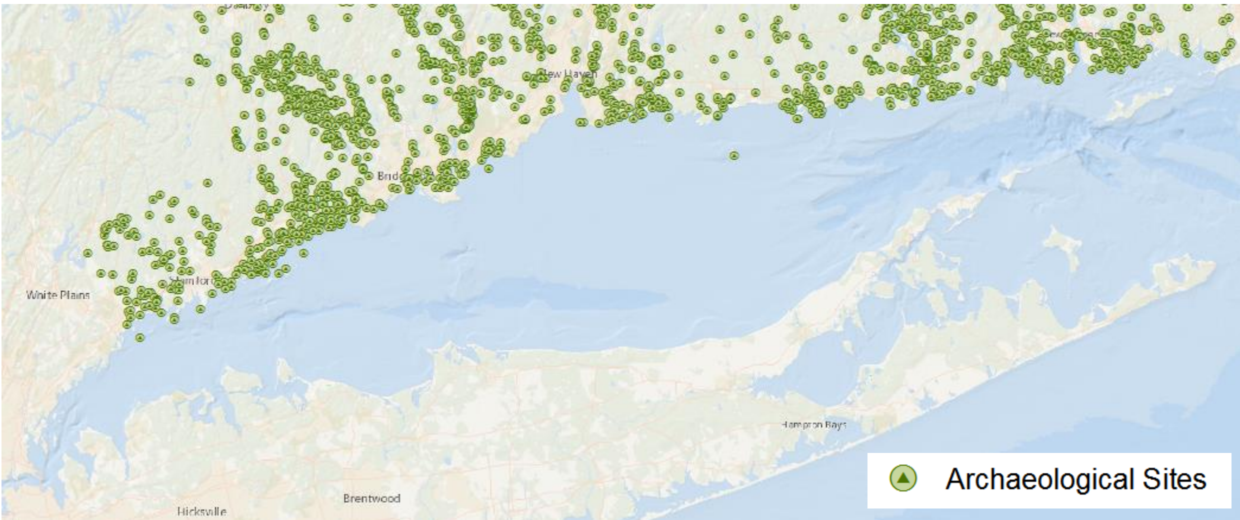


Figure 23-2: Non-Shipwreck Archaeological Sites in Long Island Sound. Recorded non-shipwreck archaeological sites identified in and around Long Island Sound and within the jurisdiction of Connecticut. This map likely represents only a small portion of all archaeological sites in LIS. Data provided in March 2018 by and courtesy of CT SHPO and CT OSA.

Submerged Areas of Archaeological Sensitivity

Submerged areas of archaeological sensitivity can be represented in two ways: (1) Density of known submerged sites and artifacts (e.g., shipwrecks), and (2) Likelihood of presence of submerged archaeological sites and artifacts not yet discovered. The former can be particularly useful in mapping out general locations of submerged archaeological sites and artifacts without compromising exact site and artifact locations, often deemed sensitive for the protection and conservation of these resources. The latter is useful in mapping out areas that may be particularly sensitive, given archaeological knowledge of historical human settlement patterns and the use of ethnographic analogy (Jones, 1993).

Figure 23-3 displays the relative archeological sensitivity of Sound waters, based on the density of known submerged shipwrecks, up to ½ mile offshore. Underwater archaeological resource sensitivity is rated “high” at the study area’s western end, close to New York City, and also at its eastern end around Groton-New London and the north shore of Fishers Island – reflective of the information provided in Figure 23-1.

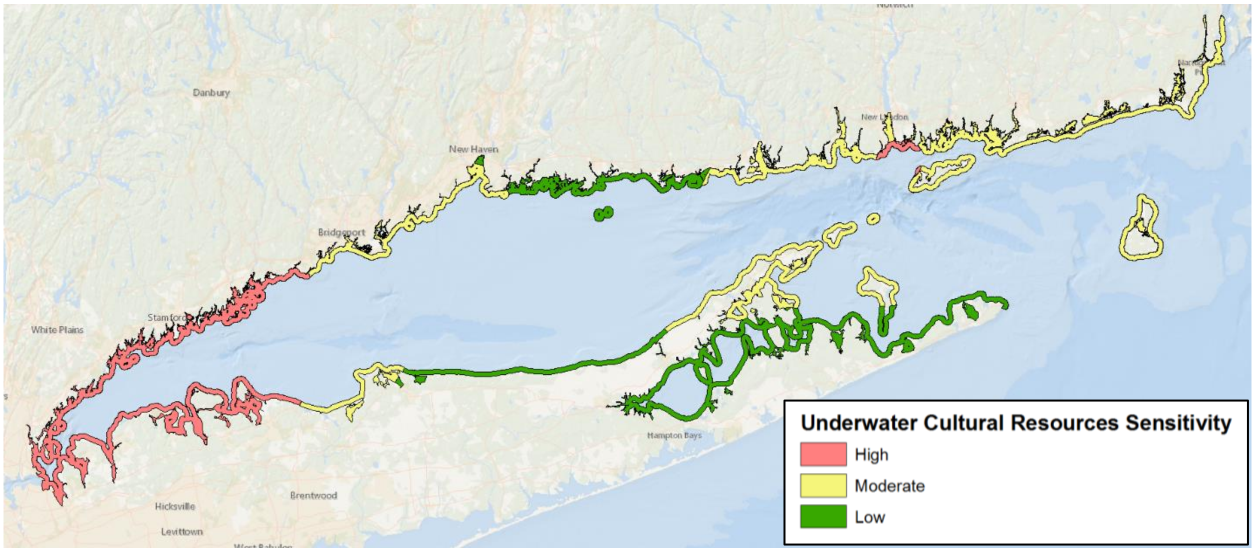


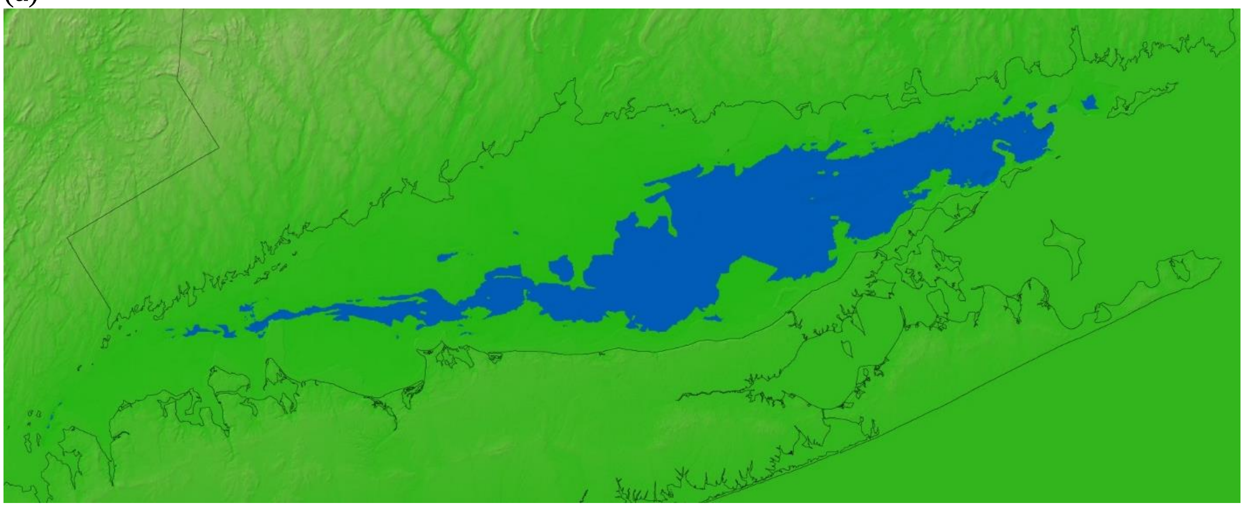
Figure 23-3: Underwater Cultural Resources Sensitivity for Shipwrecks in Nearshore Long Island Sound. Relative archeological sensitivity of large nearshore regions (up to ½ mile from the shoreline) of LIS. High sensitivity indicates that nearshore regions are more likely to contain underwater archaeological deposits, particularly shipwrecks, based on known and plotted sites (Cherau, et al., 2010).

As for mapping out non-shipwreck, submerged archaeological sensitivity data, this can be can be done in two ways. First, sensitivity mapping can be carried out similarly to how it is done for shipwrecks in Figure 23-3 for known non-shipwreck archaeological sites in the Sound. This has not yet been carried out, likely because few sites have been discovered in the Sound.

The second sensitivity mapping method is to demarcate areas where yet-undiscovered submerged archaeological sites or artifacts may be found. This methodology may actually be more relevant for the Sound, as archaeologists believe that the large majority of such sites and artifacts are still to be discovered, particularly those from human settlements between the Paleoindian Period and the Middle Archaic Periods (i.e., those settlements established around the Sound between 11,000 before present (B.P.) and 8,000 B.P. for the Sound). As explained further in *Section 23.3.1 Relative Historical Importance*, it is believed that most human habitation during these two periods would have been concentrated along the shoreline, with access to the water providing a means for sustenance (e.g., seal hunting) (Cherau, et al., 2010; Forrest, Raber, Jones, & Thorson, 2006; Jones, 1993). Figure 23-4 illustrates the estimated extent of the LIS paleoshoreline at periods 11,000 B.P. and 8,000 B.P. As such, a reasonable representation of areas of archaeological sensitivity in the Sound for Paleoindian and Middle Archaic archaeological sites or artifacts are those areas that were land in 11,000 B.P. but were water or coastal land in 8,000 B.P. Of course, such a spatial extent does not eliminate the likelihood of submerged archaeological sites or artifacts falling outside of this area, either from the Paleoindian and Middle Archaic Periods or from more recent periods.

Geological evidence may also provide further insight into what areas may be more sensitive to the presence of archaeological sites or artifacts. While the Sound, in general, provides a good environment for preservation of paleo land surfaces and features – being an embayment relatively protected from strong ocean forces – the eastern end of the Sound is far more likely to have faced heavy erosion and bathymetric reshaping by high energy tidal currents than the western end since the start of the Holocene period (post circa 10,000 B.P.) (Forrest, Raber, Jones, & Thorson, 2006; Jones, 1993). Bathymetric changes in the western end of the Sound were more defined by low-energy deposition processes. According to the best archaeological knowledge available, it is believed that areas west of New Haven, particularly those within close proximity of the Housatonic drainage system – where submerged beach deposits are thought to have been at least intermittently preserved (e.g., south of Bridgeport) – are likelier areas for detecting archaeological materials than areas chosen at random within the Sound (Jones, 1993).

(a)



(b)

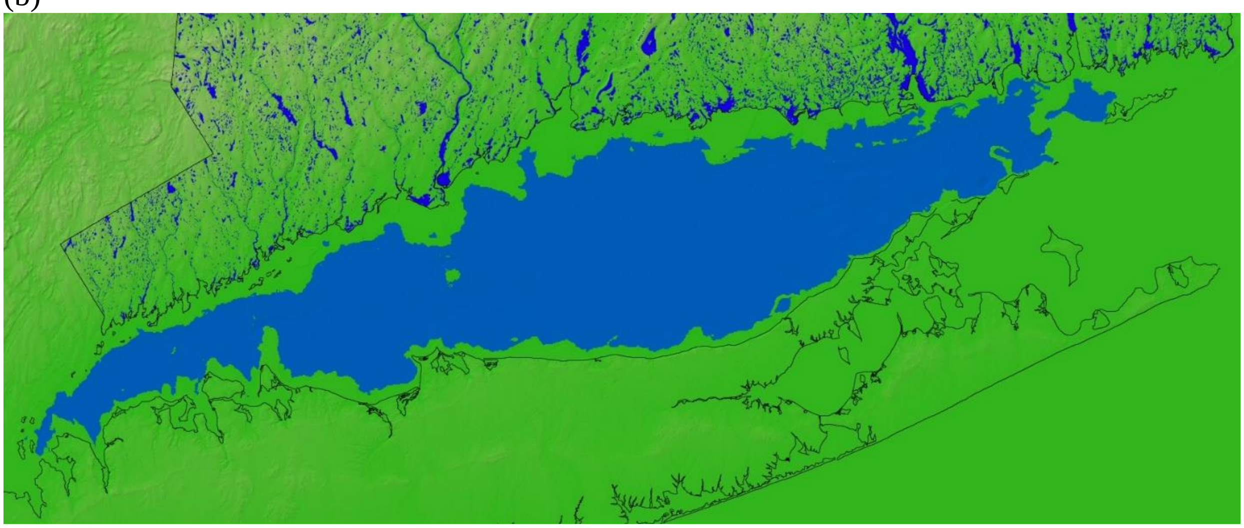


Figure 23-4: Estimated Paleoshorelines for Long Island Sound. Paleoshorelines are modeled at Time Steps (a) 11,000 B.P. and (b) 8,000 B.P. and are projected on a basemap of the current LIS shoreline. Blue areas within the current LIS basin represent water; green areas within the current LIS basin represent land. Areas that are land in (a) but water or coastal land in (b) are believed to be likely areas where archaeological sites or artifacts from the Paleoindian and

Middle Archaic Periods could be located, particularly in areas west of New Haven and within close proximity of the Housatonic drainage system (Forrest, Raber, Jones, & Thorson, 2006).

Areas where Paleoindian and Early Archaic archaeological materials may be more easily unearthed have also been mapped out. As noted in a 2006 report prepared for the Connecticut Office of Policy and Management (OPM), by overlaying a spatial data layer of Holocene sediment deposition on top of a map of the estimated LIS paleoshoreline at 9,000 B.P., one can identify areas where there are "holes" in the Holocene deposition layer that also overlay the paleoshoreline layer. These "holes" represent locations where little-to-no recent Holocene sediment deposition likely occurred and where Paleoindian and Early Archaic people groups may have settled. As such, these locations are areas that may be relatively accessible to divers for unearthing archaeological sites or artifacts from these two periods (Forrest, Raber, Jones, & Thorson, 2006). The report authors note, however, that these dozen or so areas are not definitive, as they may fall in zones where tidal erosion may have already disrupted archaeological remains (Forrest, Raber, Jones, & Thorson, 2006).

It follows logically, then, that sites more modern than 8,000 B.P. will lie between the shoreline at that time and the coast as we know it today. While older sites have a special research priority to the CT OSA, the more recent sites in shallower waters and sediments are likely to be more commonly unearthed, as well as at higher risk of disturbance from dredging and similar activities. In fact, dredging off of Madison, CT, in the 1960s exposed offshore sites, when harvested sands were dumped to replenish the shoreline. Artifact collectors found the redeposited sands to contain artifacts from 8,000 B.P. to present (personal communication, CT OSA).

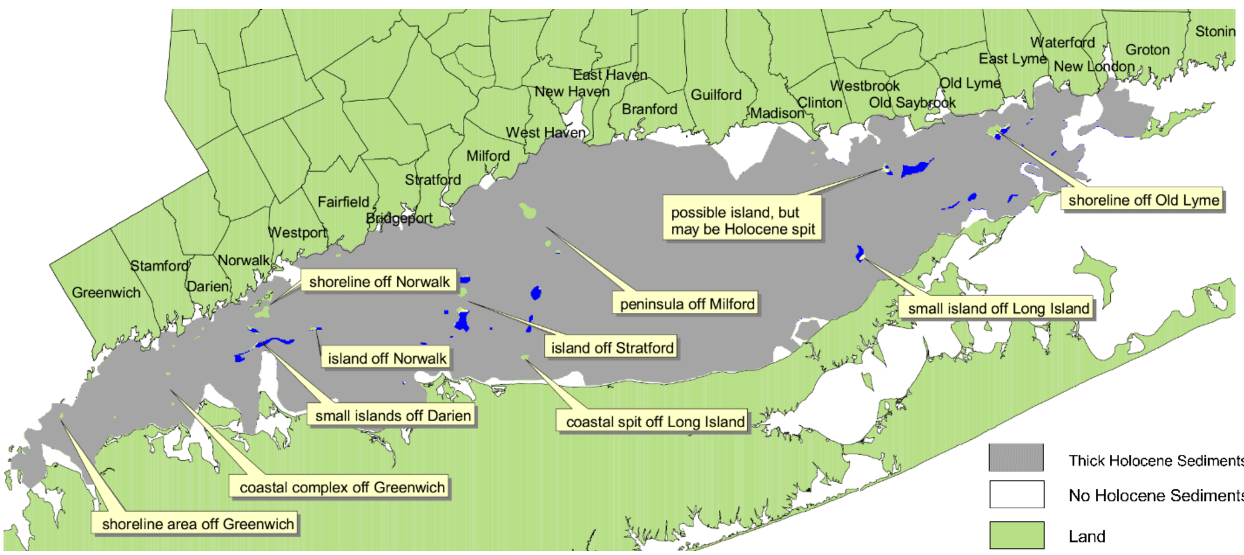


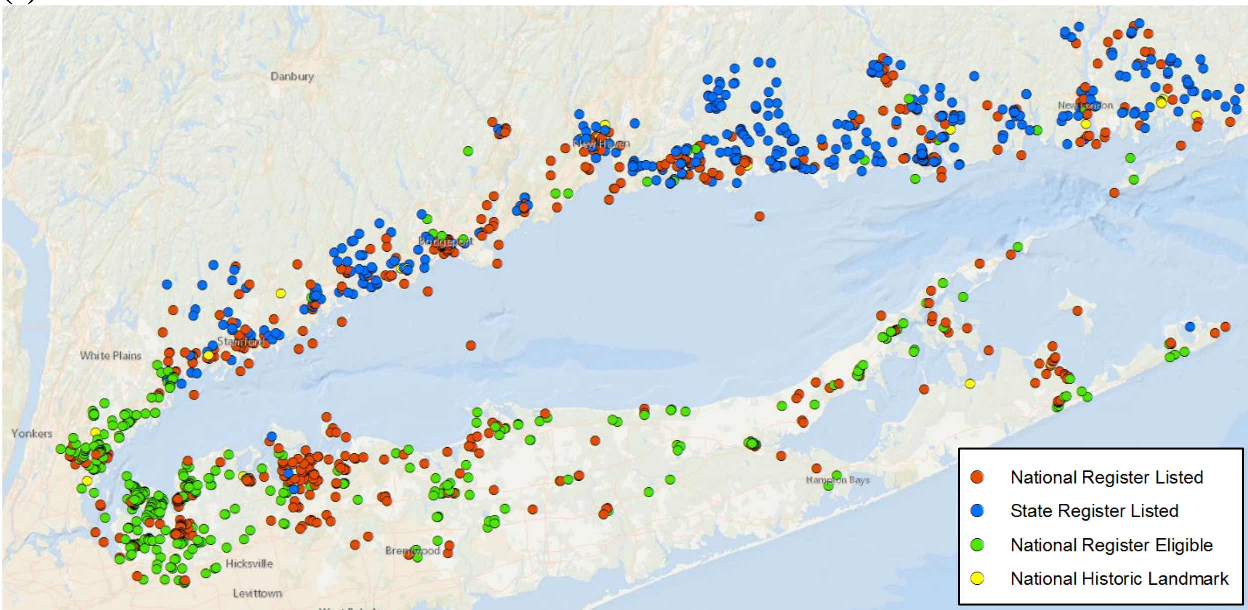
Figure 23-5: Long Island Sound Locations where Paleoindian and Early Archaic Archaeological Material may be More Easily Unearthed. The map overlays a spatial data layer of Holocene sediment deposition on top of a map of an estimated LIS paleoshoreline from 9,000 B.P. Areas where there are "holes" in the Holocene deposition depth layer, but still overlaying the paleoshoreline layer, represent locations where little-to-no recent Holocene sediment deposition likely occurred and thus areas may be more accessible to divers for unearthing archaeological sites or artifacts (Forrest, Raber, Jones, & Thorson, 2006).

Coastal Terrestrial Historic and Archaeological Sites, Standing Historic Structures, and Artifacts

A number of terrestrial historic and archaeological sites, properties, and artifacts in and around LIS are represented in the records of the National Register of Historic Places, State Registers of Historic Places for Connecticut and New York, and local historic registers. However, it should be noted that these Registers primarily account for historic properties, sites, and districts; that is, the vast majority of known archaeological sites are not captured in these registers. Archaeological sites, standing historic structures, and artifacts are also inventoried in largely confidential records curated by CT SHPO, NY SHPO, and other archaeology-related state offices (e.g., CT OSA, New York State Museum). On-shore archaeological sites for Connecticut are included in Figure 23-2.

Figure 23-6 displays known historic buildings, sites, structures, objects, and districts along the Connecticut coastline, along Long Island's north and east shore coastlines, and in the Sound. Nearly all depicted sites located in the Sound are lighthouses. As sea levels are predicted to rise over the next century, coastal and in-water historic and archaeological sites and properties may be in danger of chronic inundation, persistent flooding, or other damage by storms and natural coastal processes. Data on what sites and properties may be at risk from climate change impacts were not made available for Blue Plan purposes at this time. Spatial data points for additional historic buildings, sites, structures, objects, and districts along the Connecticut coastline have been mapped out by CT SHPO and are currently being integrated into Figure 23-6.

(a)



(b)

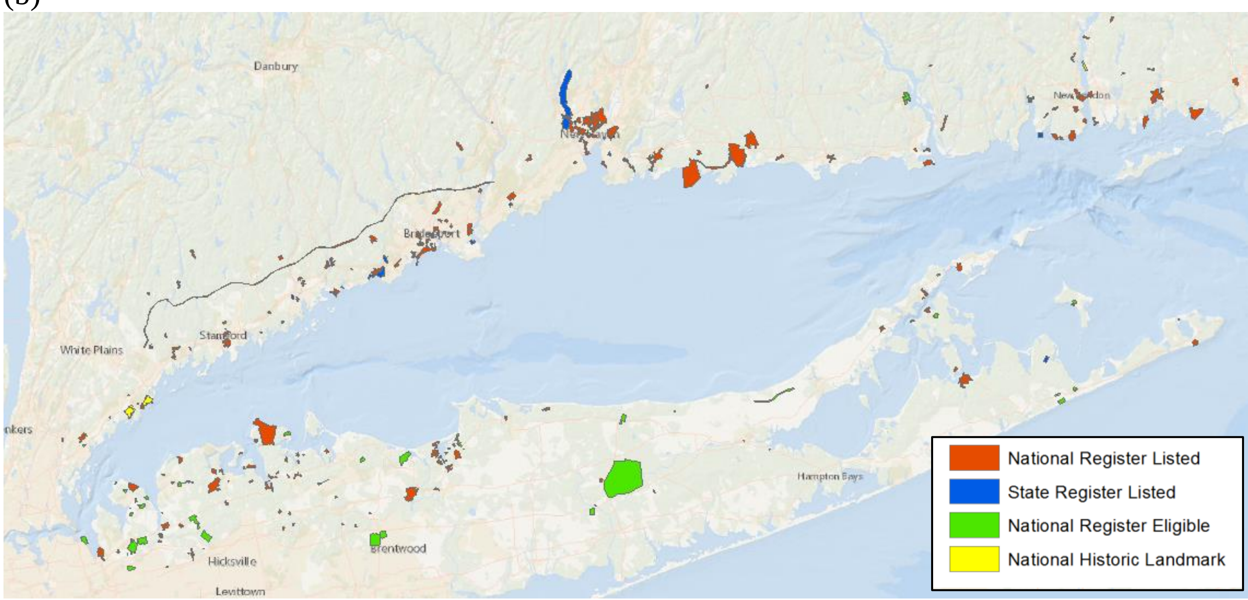


Figure 23-6: Historic Resources Inventory for Coastal Land Surrounding Long Island Sound. (a) Coastal buildings, sites, structures, and objects and in Connecticut and north and east Long Island (NY) that are listed in, or eligible for listing in, the National Register of Historic Places (including National Historic Landmarks) or listed in a State Register of Historic Places; (b) Coastal sites and districts in Connecticut and north and east Long Island (NY) that are listed in, or eligible for listing in, the National Register of Historic Places (including National Historic Landmarks) or listed in a State Register of Historic Places (Cherau, et al., 2010). Coastal sites and districts data provided by Cherau, et al. (2010) were supplemented by National Register data provided in November 2017 by and courtesy of NY SHPO.

23.2 Assessment of Data Quality

23.2.1 Sources of Data and Metadata

Figure 23-1 was created using information from the National Oceanic and Atmospheric Administration (NOAA) Automated Wreck and Obstruction Information System (AWOIS) and NOAA Electronic Navigational Charts (ENC) databases. AWOIS was consolidated primarily for the purpose of planning hydrographic surveys (NOAA, 2017e). ENC is consolidated primarily to provide real-time ship positioning, as well as collision and grounding avoidance (NOAA, 2017c). Spatial data is accessible via the NOAA Office of Coast Survey's Wrecks and Obstructions Viewer (NOAA, 2017a). There is no single collective source of metadata available for this map product; however, information on the data structure, attribute data, and symbology of the AWOIS and ENC data can be found on the NOAA Office of Coast Survey website, under the Wrecks and Obstructions Database, NOAA ENC, and NOAA ENC Direct to GIS, and U.S. Chart No. 1 (Chart Symbols) webpages (NOAA, 2017b; NOAA, 2017c; NOAA, 2017d; NOAA, 2017e). Map product data was collected in January 2018.

Figure 23-2 was created from archaeological site records curated by CT SHPO and CT OSA. These records represent official archaeological data used by the state for decision-making. Metadata is available from CT SHPO and CT OSA.

Figures 23-3 and 23-6 were created using information from the 2010 U.S. Army Corps of Engineers' (USACE) LIS Dredged Material Management Plan (DMMP) Cultural Resources Inventory (Cherau, et al., 2010). The Cultural Resource Inventory catalogued historic properties and archeological sites in 57 coastal communities along Long Island Sound. The USACE DMMP looked at both submerged archaeological sites and terrestrial historic and archaeological sites. Metadata is available from either USACE New England District or from the original sources of information informing the Cultural Resources Inventory (Cherau, et al., 2010, pp. 6-7).

The DMMP submerged archaeological sensitivity data were generated using known locations of underwater wrecks and obstructions (Figure 23-3). Using this information, along with input from archaeological experts, the DMMP study authors determined areas of high, medium, and low archaeological sensitivity for all nearshore waters of LIS (up to ½ mile from the shoreline). High, medium, and low sensitivity designations were set via a "Jenks 'natural breaks' method" and were further fine-tuned using qualitative knowledge of the "study area's cultural and environmental contexts and existing knowledge regarding the area's archaeological sensitivity based on previous investigations" (Cherau, et al., 2010, p. 13). The study authors note that the sensitivity evaluation was "based on the observed relative frequencies and geospatial distributions of the shipwrecks and obstructions […] located within the LIS DMMP study area" (Cherau, et al., 2010).

The DMMP coastal terrestrial archaeological sites, standing historic structures, and artifacts data come from a "Historic Resources Inventory" that the DMMP study authors created, based on Connecticut and New York SHPO records (Figure 23-6). This "Historic Resources Inventory" accounts for "all recorded aboveground and belowground terrestrial historic properties within the project study area" at the time of report preparation (Cherau, et al., 2010, p. 13). "Historic properties", for DMMP purposes, was defined as all "buildings, sites, structures, objects, and districts [within the DMMP study area] that are listed, determined eligible, or potentially eligible for the National Register and or State Register within the respective states in which they are located" (Cherau, et al., 2010, p. 134). It should be noted that "historic properties", as defined by the DMMP study authors, only represents a small subset of all known archaeological sites and districts. Figure 23-6 also encompasses coastal terrestrial historic and archaeological site and district data provided by NY SHPO in November 2017; this information was used to supplement the DMMP data, which was collected in 2010.

Figures 23-4 and 23-5 were taken from a 2006 report prepared for CT OPM by Archaeological and Historical Services, Inc. These records represent the best and most recent spatial estimates of Holocene sediment deposition in the Sound and of estimated LIS paleoshorelines at millennial increments from 11,000 B.P. to 8,000 B.P. and at 3,000 B.P. Metadata is available from Archaeological and Historical Services, Inc.

23.2.2 Accuracy, Representativeness, and Relevance of Map Products

In terms of representing archaeological shipwrecks in LIS, the quality of the AWOIS and ENC datasets (Figure 23-1) is sub-optimal. Neither AWOIS nor ENC were created for marine spatial planning purposes. As mentioned previously, AWOIS was designed for planning hydrographic surveys while ENC is primarily intended to provide real-time ship positioning and collision and grounding avoidance. NOAA itself has cited limitations to AWOIS, including the fact that AWOIS records are not comprehensive, exclude reported wrecks that have been salvaged or disproved by further investigation, and stopped being updated altogether in 2016 (NOAA, 2017e). As such, the data is not particularly representative and only moderately relevant. Despite this, the map product in Figure 23-1 is assumed to be the most accurate spatial data representing submerged archaeological sites and artifacts that was made available for Blue Plan purposes at this time (and will be more accurate after incorporating additional shipwreck data from CT SHPO records, a task currently being pursued by the Blue Plan team).

The CT SHPO- and CT OSA-provided dataset (Figure 23-2) is both accurate and relevant in representing submerged and coastal archaeological sites and artifacts, as the dataset comes from the most up-to-date, official state records. However, given the high likelihood of yet-undiscovered archaeological sites in the Sound, this dataset is not completely representative without an accompanying, comprehensive non-shipwreck archaeological sensitivity map. Moreover, no archaeological site and artifact data for New York state, either in-Sound or on-shore, were made available for Blue Plan purposes at this time.

In terms of representing submerged shipwreck-based archaeological sensitivity, the quality of the DMMP data (Figure 23-3) is helpful but sub-optimal. This is primarily because the spatial extent of the data covers only a small portion of the Sound's waters. Thus, while the DMMP archaeological sensitivity data is indeed relevant – after all, the DMMP report was created for development and planning purposes and contains specific, verified historic and archaeological data, much of it derived from SHPO datasets – it is not particularly representative of Sound-wide submerged archaeological sensitivity. Despite this, the map product in Figure 23-3 is assumed to be the most accurate spatial data representing submerged archaeological sensitivity that was made available for Blue Plan purposes at this time.

In terms of representing non-shipwreck submerged archaeological sensitivity, the Archaeological and Historical Services, Inc.-provided map products (Figures 23-4 and 23-5) are accurate to the extent that they utilize the best available archaeological and geological data to generate map estimates of Holocene sediment deposition and estimated LIS paleoshorelines. To the knowledge of the Blue Plan team, no more-recent, Sound-wide maps have been generated since the publishing of these map products, making them sufficiently representative. With the report having been submitted to CT OPM, these map products were intended to be used for planning purposes, making them relevant for Blue Plan purposes. At the same time, these map products are not geographically-specific and could be improved in terms of increased granularity or in the mapping of sensitivity on a gradient.

With regards to coastal terrestrial archaeological sites, standing historic structures, and artifacts, the quality of the DMMP and NY SHPO data (Figure 23-6) is helpful but not fully realized. For one, the data is not complete. As the DMMP report authors note, “The number of potentially eligible resources that have not been previously identified in the historic property inventories maintained by the Connecticut and New York SHPOs is probably much higher as only a few of the towns within those study areas have anything that approaches a comprehensive survey and most of those were conducted years ago” (Cherau, et al., 2010). Moreover, while NY SHPO provided updated information, effective November 2017, the information made available was limited. Stakeholder feedback indicated the importance of updated information, as any map product of terrestrial historic and archaeological sites, properties, and artifacts should be considered a static representation of a dynamic dataset. Stakeholders also emphasized that the narrow definition of historic properties used in the DMMP report excludes many known archaeological sites and districts. Finally, information on which historic sites may be threatened by climate change impacts was also not made available. As such, while the DMMP and NY SHPO data is indeed relevant, it is likely not fully representative of all the terrestrial historic and archaeological sites, properties and artifacts relevant for LIS marine spatial planning. Despite this, the map product in Figure 23-6 is assumed to be the most accurate spatial data representing coastal terrestrial archaeological sites, standing historic structures, and artifacts that was made available for Blue Plan purposes at this time (and will be more accurate after incorporating additional data from CT SHPO records, a task currently being pursued by the Blue Plan team).

23.2.3 Data Gaps and Availability of Data to Address Gaps

The major data gaps are noted explicitly below, accompanied by potential solutions for filling these data gaps.

<u>Major Data Gaps</u>

- <u>Archaeological site data for New York</u> – The shipwrecks data in Figure 23-1 and archaeological site data in Figure 23-2 only represent sites identified by NOAA or sites within the jurisdiction of Connecticut. This data gap could be filled by the incorporation of such data from NY SHPO records (discussed in the Solutions section below).

- Submerged shipwreck archaeological sensitivity data further offshore – Archaeological sensitivity categorizations for submerged shipwreck data were only available for the Sound's nearshore (< ½ mile) coastal region, via the DMMP report. Expansion of this sensitivity data to all LIS waters – along with non-shipwreck archaeological sensitivity data, as mentioned previously – would greatly enhance the value of the Inventory. This data gap could also be filled by sensitivity mapping using more comprehensive shipwreck datasets curated by the CT and NY SHPOs (discussed in the Solutions section below).

- More granular submerged non-shipwreck archaeological sensitivity data – While existing knowledge and modeling has identified general areas where there may be Paleoindian and Early-to-Middle Archaic archaeological sites and artifacts in the Sound, these areas are not geographically-specific beyond specific locations where such sites or artifacts could be more easily excavated by divers. Moreover, there is no sense of how to map archaeologically sensitive areas for sites or artifacts in more recent periods nor any indication of whether sensitivity, as a metric, could be mapped on a gradient for different areas in the Sound. This data gap could be filled through further engagement with archaeological experts of LIS and through further mapping efforts. However, such efforts would be contingent on new information being available to create more robust models – information that may not actually exist at this time.

- Coastal terrestrial historic resource point data for New York – Detailed point data for coastal terrestrial historic buildings, sites, structures, and objects is not included for Long Island beyond what was provided in 2010 via the USACE DMMP Cultural Resources Inventory. This data gap could be filled by the incorporation of more detailed point-level data from NY SHPO (discussed in the Solutions section below).

- Climate change impacts on coastal terrestrial historic and archaeological sites and resources – Information on which coastal terrestrial historic sites would be most threatened by climate change impacts, such as sea level rise and flooding, was not made available for Blue Plan purposes at the time this document was published. This data gap could be filled by the incorporation of the "Goodwin dataset" from CT SHPO (discussed in the Solutions section below).

- Areas of tribal significance – Areas of particular significance or sensitivity (in-Sound and onshore) for both federally- and state-recognized Native American tribes in Connecticut and on Long Island are not necessarily captured in any of the datasets made available to the Blue Plan at this time (nor may they be fully captured in official records curated by CT SHPO or NY SHPO). This data gap, therefore, can only be filled by the tribes themselves through shared knowledge and insight. As such, active engagement with the tribes in Connecticut and Long Island is being pursued so that the Inventory can capture any accurate, relevant, and representative information the tribes may want to share for Blue Plan purposes.

Solutions

The most immediate way to address the above data gaps is to incorporate more accurate, comprehensive, and up-to-date data into the map products. The large majority of this data is housed in the CT and NY SHPO databases. SHPOs, located in 59 states, territories, and districts of the U.S., are mandated by Sections 101b and 106 of the National Historic Preservation Act of 1966, as amended, to, among other things:

- conduct a comprehensive survey of historic properties;
- maintain an inventory of historic properties;
- identify and nominate eligible properties to the National Register of Historic Places;
- advise and assist Federal, State and local governments in matters of historic preservation;
- provide consultation for Federal and State undertakings;
- prepare and implement a statewide historic preservation plan;
- work with local governments in the development of local historic preservation programs;
- coordinate with tribal governments on historic preservation matters;
- hold and enforce historic preservation easements; and
- provide public information, education, training and technical assistance (NCSHPO, 2017).

As such, SHPO data can be considered authoritative and relied-upon for planning and permitting purposes at various spatial scales. Every non-SHPO sector stakeholder who was engaged as part of this Inventory chapter development process encouraged coordination with the SHPO offices. While SHPO data is largely confidential and not available for public distribution, CT SHPO has given permission for their data to be used for Blue Plan purposes. While CT SHPO datasets were provided to the Blue Plan team, not all the datasets were able to be incorporated in this version of the Inventory. These data sets should be fully incorporated in future versions of the Inventory.

The CT SHPO data-to-be-incorporated will certainly enhance the Inventory. CT SHPO recently updated their historic property inventory for the four coastal counties of Connecticut. This information is an output of work carried out by R. Christopher Goodwin & Associates, Inc., Dewberry, and Milone & MacBroom and funded through a federal Disaster Relief Assistance Grant awarded to CT SHPO post-Hurricane Sandy. Work carried out by the Grant team included "preparing National Register nominations, conducting neighborhood-wide historic resources inventories, creating a searchable database of State Register-listed properties, providing resiliency planning as part of the next Statewide Preservation Plan, completing an inventory of historic dams, conducting archeological surveys, and implementing the first comprehensive survey of Connecticut's submerged cultural resources" (Connecticut Trust for Historic Preservation, 2015). This "Goodwin dataset" may be especially helpful, given that the Grant team provided each coastal Connecticut municipality with a report and spatial dataset outlining historic and archaeological sites and properties at risk of coastal and climate change hazards, such as inundation, erosion, wind, and winter storms (R. Christopher Goodwin, et al., 2017). Such data would be useful for the Blue Plan in determining terrestrial historic and archaeological sites and resources susceptible to climate change impacts; however, such data was not made available for Blue Plan purposes at this time.

Finally, as noted previously, continued engagement with state- and federally-recognized tribal nations in Connecticut and on Long Island will be necessary to capture any accurate, relevant, and representative information on areas of tribal significance or sensitivity (in-Sound and on-shore) that the tribes may want to share for Blue Plan purposes.

Other Data Gap Considerations

There are two data gaps intrinsic to the nature of this sector and are not resolvable by the addition of more data. However, they are important to mention, nonetheless, to provide context:

- Exact locations of archaeological sites and artifacts – The exact locations of shipwrecks and other archaeological sites and artifacts usually constitute sensitive data for protection purposes by state SHPOs. These sites and artifacts contain immense cultural and economic value, and public access to precise locations of sites could enable theft and vandalism. For this reason, "buffering" of exact site locations or sensitivity mapping may be preferable to detailed mapping of exact locations for some Blue Plan purposes.

- Incomplete knowledge of locations of archaeological sites and artifacts – Stakeholders expressed confidence that only a small portion of submerged archaeological sites and artifacts in LIS have been identified at this time. Most archaeological resources are buried under large quantities of benthic sediment. This characteristic of the sector means that the Blue Plan will not, in all feasibility, be able to Inventory all archaeological sites in the Sound. Informed sensitivity mapping, however, provides an avenue for addressing this issue in a way that is still beneficial to coastal and marine planners.

23.3 Relevance

23.3.1 Relative Historical Importance

The shorelines of Connecticut and New York have been inhabited by various peoples for at least 12,500 years. The oldest widely-accepted archaeological evidence for Native American settlements in Connecticut date back to the Paleoindian Period (12,500 to 10,000 years B.P.). The oral histories from several New England tribes suggest use of coastal areas in the region may have extended back to at least 15,000 B.P. (Harris & Jones, 2015). From the Paleoindian period through the Archaic (10,000-3,000 B.P.), Woodland (3,000-450 B.P.), and Contact/Post-Contact (450 B.P.-present) periods, humans have left behind extensive remnants of their presence.

Relatively few sites from the Paleoindian period have been found in Connecticut. Sea level rise, following the last glaciation, inundated the former shorelines that may have been visited and settled by the region's earliest peoples. It is believed that from approximately 13,000 B.P. to 6,000 B.P., most human habitation would have been concentrated along the shorelines (Figure 23-6), with access to the water providing a means for sustenance (e.g., seal hunting) (Forrest, Raber, Jones, & Thorson, 2006; Jones, 1993).

Archaeological evidence of human activity dating from the Middle Archaic period (8,000 to 6,000 B.P.) and more recent periods is relatively abundant (Cherau, et al., 2010). Prior to European Contact (before 450 B.P.), artifacts were predominantly made of stone materials, although use of pottery increased after the Late Archaic period. Coastal archaeological sites predating the arrival of Europeans in the New World have yielded a wide variety of artifacts ranging from pottery to projectile points, knives, drills, hoes, and other stone tools, to bone and shell fish hooks and harpoon tips. Projectile points are particularly useful artifacts, because they can be used as temporal indicators of site occupation. Food remains from shell middens, storage pits, and remnants of ancient fishing weirs suggest marine and estuarine plants and animals were important elements in Native American subsistence patterns. Shorelines, coastal landscapes, and seascapes in the Northeast were also (and continue to be) important places of ceremony for many indigenous people. Known sites include small camps, large habitations, shell middens, and fishing stations and weirs. Particularly sensitive locations include cemeteries and individual burial sites.

During the Contact period, underwater and terrestrial archaeological evidence indicates increases in trapping, shipping, and agricultural production in Connecticut (Cherau, et al., 2010). Coastal areas around Long Island Sound were transformed by rapidly growing ports and settlements, intensive trade, and wide-scale land clearing for farming and pastures. Parts of ancient docks, wharves, and other marine infrastructure elements can be found along the waterfronts in ports and fishing villages, often preserved beneath sediments used to expand waterfront lands. Centuries of fishing, shipping, and marine transport within LIS have also left numerous shipwrecks in the waters off Connecticut's shoreline.

All of these sites and artifacts are potentially valuable resources for historians and archaeologists trying to understand pre-colonial and historic-period societies in northeastern North America. The value of some coastal and submerged cultural resources extends well beyond their capacity to yield new information about past cultures. The cultural beliefs and practices of many Native American tribes are closely associated with a variety of places and landscapes within the region. Understanding the different values cultural resources may hold for a range of stakeholders is often critical in identifying, understanding, and preserving elements of cultural heritage.

While many archaeological resources likely remain undiscovered, a region's cultural, geological, and environmental history can be used to predict the locations where undiscovered sites are most likely to be preserved. Site location patterns from extensively studied terrestrial settings are often employed as an analog for the now-submerged areas of the ancient landscape. Numerous recent scientific studies in southern New England and adjacent sections of the eastern seaboard are providing new data on the timing and nature of environmental change in the region. For example, a range of studies for off-shore development planning near Rhode Island have included detailed investigations of the geology, paleo-landscapes, and potential cultural resources in Rhode Island Sound (State of Rhode Island, 2010). These and related studies sponsored by the Bureau of Ocean Energy Management are refining the chronology of deglaciation, sea level rise, and marine incursions, and the nature of formerly terrestrial landscapes now submerged beneath the sea. U.S. Geological Survey (USGS) studies of Long Island Sound from 1998 to 2005 provide important baseline information on the location of ancient waterways and other natural resources within the Sound that would likely have supported Native American peoples when sea levels were much lower (Stone, et al., 2005).

Previous archaeological assessments for nearshore environments in Long Island Sound have focused on shipwrecks (Cherau, et al., 2010). However, terrestrial archaeological resources along the present-day shoreline provide another important source of information on potential archaeological resources in submerged environments. Both terrestrial and submerged artifacts and sites have been discovered near all four of Connecticut's shoreline counties (New London, Middlesex, New Haven and Fairfield). The four counties also contain important archaeological resources, with New London and Fairfield counties having the highest estimated archaeological sensitivities for shipwrecks.

New London and Middlesex counties both lie in the Eastern Coastal Slope geographic region. This region is characterized by low hills and hardwood trees. Inlets, marshes, and rivers provided marine and estuarine resources for both Native American and European groups that settled in the region. In the colonial period, large ports developed at Mystic, New London, and Stonington alongside robust shipbuilding and whaling industries. Most of the coastal waters in New London County are rated "moderate" to "high" in archaeological sensitivity for shipwrecks, while most coastal waters in Middlesex County are rated "low" to "moderate" (Cherau et. al., 2010).

Most of New Haven County is located in the Central Valley geographic region. New Haven Harbor and other former estuaries would have provided relatively abundant and varied resources to people in the pre-contact and early historic periods. Urban development and the filling of former marshes have likely buried much of the archaeological record of early maritime settlements. Dredging from the late 19th century through modern times has also altered the seabed within and near ports. Coastal waters in the eastern portion of the county generally have "low" estimated archaeological sensitivity for shipwrecks, while waters in the western portion of the county are generally rated as "moderate" (Cherau et. al., 2010).

Fairfield County lies within the Western Coastal Slope geographic context, which includes a highly protected shoreline and previously abundant salt marshes and marine resources. It is now one of the most heavily populated regions in Connecticut. Known shipwrecks and archaeological sensitivities increase moving westward through the county, from mostly "moderate" designations to "high" designations (Cherau et. al., 2010).

Because sea levels rose dramatically since the last glacial retreat (22,000 to 18,000 B.P.), ancient archaeological sites may be preserved offshore, located in marine benthos that were once terrestrial soils. At the beginning of the Paleoindian period, sea levels were between 180-90 ft below current sea levels (Figure 23-4). Early archaeological sites may be preserved where ancient shorelines are buried beneath the sands and muds of the modern-day seabed. The preservation of these resources is enhanced along protected, low energy sections of the shoreline, such as bays and estuaries, where the force of waves and tidal currents is dissipated by the nearshore environment.

Submerged sites can also be preserved when they were deeply buried before rising seas inundated Long Island Sound. Ancient rivers and streams drained the Long Island Sound basin following the last glaciation. Native American sites along these rivers may be preserved in floodplain deposits buried by more recent marine sediments. Unique archaeological resources are likely to be found in submerged environments; the colder temperatures, lower oxygen levels, and more consistent conditions can preserve organic materials that would decompose in the acidic terrestrial soils of New England.

For example, all of the Native American canoes discovered in New England have been found underwater (Connecticut Office of State Archaeology, 2018). The preservation of these resources is enhanced along protected, low energy sections of the shoreline, such as bays and estuaries. Additionally, more recent shipwrecks have left remnants of 17^{th} - 20^{th} century life throughout the waters of LIS. Many of these shipwrecks have become popular dive sites, adding economic value to their cultural and historical importance.

23.3.2 Socio-Economic Context

Shipwrecks are popular dive sites in the Sound, bringing income to Connecticut- and Long Island- based recreational diving operations. Historic and archaeological resources may also benefit the larger tourism industries in Connecticut and Long Island, as well. Additionally, underwater artifacts, relics, and other cultural resources are highly valued by museums and archaeological curators. Though all these elements add economic value to this sector, to the best of the Blue Plan team's knowledge, no robust valuation estimates have been calculated in monetary terms.

It should be emphasized that this sector's value is primarily noneconomic in nature. It is hard to place an economic value on historical importance, which could encompass such elements as community-building (e.g., the long-standing presence of local historical society chapters), scholastic enhancement (e.g., development of educational curriculums), and hobby inspiration and facilitation. Additionally, the value of some coastal and marine cultural resources extends well beyond their capacity to yield new information about past cultures. The cultural beliefs and practices of many Native American tribes are associated with a variety of places and landscapes within the region. Understanding the different values cultural resources may hold for a range of stakeholders is critical for identifying, evaluating, and preserving elements of cultural heritage.

23.3.3 Other Notes

<u>Regulatory Considerations</u>

It is understood that the Inventory and subsequent Blue Plan will guide how future development projects are proposed and developed in the Sound. Such development projects often require a cultural resource impact analysis as part of their development plans. Known historic and archaeological sites and artifacts – and archaeologically sensitive areas – are a crucial concern in coastal and marine development projects, as dredging can disrupt or destroy known or unknown sites. While development projects may uncover sites or artifacts, these projects can also simultaneously damage or remove them from their original state or spatial context. As such, by making cultural artifacts and sensitive areas visible on maps, the Blue Plan is using historic and archaeological data to help protect both known sites and potential future discoveries.

Stakeholders interviewed for this chapter emphasized their confidence that many archaeological resources in the LIS still await discovery and documentation. While this uncertainty and promise of future discovery makes this Inventory chapter necessarily incomplete, outlining known resources and sensitivities is an essential first step, at the very least to provide Plan users with a more robust sense of the dynamic history of LIS. Nevertheless, stakeholders expressed that, in the absence of comprehensive sensitivity mapping for the entire LIS basin, required cultural resource impact analysis for substantial construction projects – particularly if they involve consultations with the SHPOs – will remain a very important method for ensuring continued protection of historic and archaeological resources in the Sound.

Additional Resources

Narrative history can provide a helpful context to better understanding the historic and archaeological resources in a planning area. Pace University historian Marilyn E. Weigold is considered an expert on the environmental and social history of Long Island Sound post-1614. Two oft-cited pieces by Dr. Weigold include her book, *The Long Island Sound: A History of Its People, Places, and Environment* and her chapter contribution (with collaborator Elizabeth Pillsbury) to the environmental management anthology, *Long Island Sound: Prospects for the Urban Sea* (Weigold M. E., 2004; Weigold & Pillsbury, 2014). Additionally, an environmental history of LIS, with a particular focus on environmental mismanagement and pollution, has been documented by Tom Andersen in his book, *This Fine Piece of Water: An Environmental History of Long Island Sound* (Andersen, 2002).

Geologic and archaeological history may also be helpful in understanding and mapping out archaeologically sensitive areas. Resources that may shed light on such history include a USGS map on *Quaternary Geologic Map of Connecticut and Long Island Sound Basin* (Stone, et al., 2005) and a journal article on "Sea Levels and Archeology in the Long Island Sound Area" (Salwen, 1962).

23.4 References

Andersen, T. (2002). *This Fine Piece of Water: An Environmental History of Long Island Sound.* New Haven: Yale University Press.

Cherau, S., Olausen, S., Robinson, D., Banister, J., Allegretto, K., & Stuart, Q. (2010). *Cultural Resources Inventory - Long Island Sound - Dredged Material Management Plan, Long Island Sound, Connecticut, New York, and Rhode Island - Volume I.* Prepared for the U.S. Army Corps of Engineers, New England District. PAL Report No. 2394. Pawtucket: PAL Publications. Retrieved from http://www.usace.army.mil/Portals/74/docs/Topics/LISDMMP/STID11-LIS-DMMP-CulturalResourceInventory.pdf

Connecticut Office of State Archaeology. (2018). *Dugout Canoe*. Retrieved from Issues in Underwater Archaeology: http://www.mnh.uconn.edu/underwater/Dugout.html

Connecticut Trust for Historic Preservation. (2015, September/October). After Sandy: Recovery and Preparedness. *Connecticut Preservation News, XXXVIII*(5), p. 2. Retrieved from https://cttrust.org/_IMAGES/2015%205%20sept.pdf

CT DEEP. (2018, February). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635

Forrest, D. T., Raber, M. S., Jones, B. D., & Thorson, R. M. (2006). *Archaeological and Historical Resource Study: Adriaen's' Landing Project, Hartford, Connecticut.* Prepared for the Connecticut Office of Policy and Management. Storrs: Archaeological and Historical Services, Inc.

Harris, D., & Jones, D. (2015). Ceremonial Stone Landscapes of New England and Developing Best Practices to Assess Submerged Paleocultural Landscapes. *Proceedings of the Maritime Cultural Landscape Symposium.* Washington, D.C.: National Park Service, National Center for Preservation Technology and Training. Retrieved from https://www.ncptt.nps.gov/blog/ceremonial-stone-landscapes-of-new-england-and-developing-best-practices-to-assess-submerged-paleocultural-landscapes/

Jones, B. D. (1993). *An Examination of the Potential Paleoindian Use* . Unpublished manuscript in possession of the author available upon request.

NCSHPO. (2017). *What is a State Historic Preservation Officer (SHPO)?* Retrieved from National Conference of State Historic Preservation Officers: http://ncshpo.org/about-us/what-is-shpo/

NOAA. (2017a). *NOAA Coast Survey Wrecks and Obstructions Viewer*. Retrieved from NOAA Office of Coast Survey: https://wrecks.nauticalcharts.noaa.gov/viewer/

NOAA. (2017b). *NOAA ENC Direct to GIS*. Retrieved from NOAA Office of Coast Survey: https://encdirect.noaa.gov/ENC_Direct/encdirect_download.html

NOAA. (2017c, October 2). *NOAA ENC® – Electronic Navigational Charts*. Retrieved from NOAA Office of Coast Survey: https://www.nauticalcharts.noaa.gov/charts/noaa-enc.html

NOAA. (2017d). *U.S. Chart No. 1 (Chart Symbols)*. Retrieved from NOAA Office of Coast Survey: https://nauticalcharts.noaa.gov/publications/us-chart-1.html

NOAA. (2017e, October 2). *Wrecks and Obstructions Database*. Retrieved from NOAA Office of Coast Survey: https://nauticalcharts.noaa.gov/data/wrecks-and-obstructions.html

Salwen, B. (1962). Sea Levels and Archaeology in the Long Island Sound Area. *American Antiquity, 28*(1), 46-55. Retrieved from https://www.jstor.org/stable/278077

State of Rhode Island. (2010). *Rhode Island Ocean Special Area Management Plan.* Wakefield: Rhode Island Coastal Resources Management Council. Retrieved from http://seagrant.gso.uri.edu/oceansamp/

Stone, J. R., Schafer, J. P., London, E. H., DiGiacomo-Cohen, M. L., Lewis, R. S., & Thompson, W. B. (2005). *Quaternary Geologic Map of Connecticut and Long Island Sound Basin.* Scientific Investigations Map 2784. Denver: U.S. Geological Survey. Retrieved from https://pubs.usgs.gov/sim/2005/2784/

Weigold, M. E. (2004). *The Long Island Sound: A History of Its People, Places, and Environment.* New York: New York University Press.

Weigold, M. E., & Pillsbury, E. (2014). Long Island Sound: A Socioeconomic Perspective. In J. S. Latimer, M. A. Tedesco, R. L. Swanson, C. Yarish, P. E. Stacey, & C. Garza (Eds.), *Long Island Sound: Prospects for the Urban Sea* (pp. 1-46). New York: Springer.

23.5 Appendices

23.5.1 List of Maps Used to Inform the Chapter

Below is a list of all maps used to inform this chapter, including maps presented above in the narrative and additional maps used to support chapter findings. Maps listed below are organized by the online data portal on which they are hosted (URL links to data portals are noted in *Section 23.4 References* above). Map products not accessible by online data portal are also noted below.

NOAA Coast Survey Wrecks and Obstructions Viewer
- NOAA AWOIS Wrecks
- NOAA ENC Wrecks

Non-Portal Map Products
- CT SHPO/CT OSA Non-Shipwreck Archaeological Sites Inventory – Points
- NY SHPO Historic Inventory – Polygons
- USACE LIS DMMP Historic Resources Inventory – Points
- USACE LIS DMMP Historic Resources Inventory – Polygons
- USACE LIS DMMP Underwater Cultural Resources Sensitivity
- Estimated Paleoshorelines for LIS, Modeled at Time Steps 11,000 B.P. and 8,000 B.P.
- LIS Locations Where Paleoindian and Early Archaic Archaeological Material May Be More Easily Unearthed

More information on some of the map products presented in this chapter, including URL links to data and metadata, can be found in the Historic and Archaeological Map Book (CT DEEP, 2018). Not all products showcased in the map book may be addressed in this chapter or utilized to inform the final Blue Plan.

23.5.2 Notes on Stakeholder Engagement

Stakeholder engagement was crucial to informing, vetting, and reviewing the data presented in this Inventory chapter. Engagement included phone, webinar, email, and in-person correspondence with a number of stakeholders.

Within the public sector, the Blue Plan team engaged CT SHPO and the Connecticut State Archaeologist via an in-person meeting in early December 2017, along with email and phone follow-up. The Blue Plan team also engaged New York SHPO staff and the U.S. Army Corps of Engineers, New England District, both via email. Public sector engagement primarily consisted of providing an overview of the overall Blue Plan process and gathering government-based data on historic and archaeological resources.

Efforts were also made to consult with representatives from state- and federally-recognized tribal nations in Connecticut and on Long Island, including the Mashantucket Pequot Tribal Nation (CT), Eastern Pequot Tribal Nation (CT), Schaghticoke Indian Tribe (CT), Golden Hill

Paugussett Tribe (CT), Shinnecock Indian Nation (NY), and Unkechaug Indian Nation (NY). The Blue Plan team held a webinar with the Mohegan Tribe of Connecticut's Tribal Historic Preservation Officer in November 2017 to provide a general overview of the Blue Plan process. The Blue Plan team also presented at the March 2018 Connecticut Native American Heritage Advisory Council meeting, through which the team summarized the Blue Plan Inventory and planning process and invited feedback from the Connecticut-based tribes (and others representatives present) on how to best represent coastal lands, waters, and cultural resources important to the tribes. Representatives from the Mashantuck Pequot Tribal Nation and Mohegan Tribe of Connecticut were present at the meeting and expressed interest in continuing to stay engaged with the Blue Plan process.

Feedback in the form of data input and interpretation, along with Inventory chapter review, was largely provided by non-government sector experts, representing organizations such as Archaeological Consulting Services; Archaeological and Historical Services, Inc.; Long Island Traditions; Pace University; and Public Archaeology Laboratory. Engagement with these stakeholders took place, and continue to take place, over phone and email.

Sector stakeholders provided a critical amount of data and information, both spatial and contextual, that went to inform this Inventory chapter. Entities that contributed data and information to the Inventory include CT and NY SHPOs; the Connecticut State Archaeologist; the U.S. Army Corps of Engineers; New England District; Archaeological and Historical Services, Inc.; and Public Archaeology Laboratory.

Overall, stakeholders strongly recommended that CT and NY SHPOs be continually involved with the preparation, editing, and updating of the Inventory and Blue Plan. One stakeholder reiterated the importance of including clear and robust archaeological sensitivity mapping in the Inventory and Blue Plan. This is because, according to the stakeholder, many cultural resource impact analyses carried out today for proposed construction projects are done by the project managers, who are not often cultural resource experts. As such, the stakeholder expressed concern that project managers may not be incorporating archaeological sensitivity information into their analyses in the same way a trained archaeologist would. The stakeholder also re-emphasized the importance of the SHPOs as a data and information resource, given their access to comprehensive cultural resource inventories and individual sensitivity maps (e.g., municipal sensitivity maps), which allows them to also be an informed resource for cultural resource impact analysis consultations.

Chapter 24

Research, Monitoring, and Education

Chapter Table of Contents

Chapter List of Figures and Tables

Figures

Tables

24.1 Key Data and Map Products

Research, Monitoring, and Education (RME) is a persistent use of Long Island Sound (LIS). Numerous universities, schools, private organizations, and national security interests conduct

RME activities entirely dependent the Sound. Research, monitoring, and education are often closely linked, and occur throughout LIS. The societal benefits provided by continued RME activities are very difficult to quantify, but can be qualified by saying that an informed, educated, and engaged population promote management decisions that increase quality of life for all by promoting a strong economy and an intact environment that provides numerous ecosystem services (Earth Economics, 2015).

The research opportunities provided by LIS are diverse and unique as the Sound itself. Numerous research laboratories are located on the Sound or use it as a testbed, conducting studies that span years or decades in time. The sound is a “natural laboratory,” offering a unique suite of ecological and sociological conditions for research benefiting innumerous sectors and subjects.

Long-term environmental monitoring is inherently place-based, seeking to understand the conditions and changes that exist at a precise location over extended periods of time. The value of long-term sites like these to natural resources management cannot be understated: without the baselines and trends they provide, policies enabling sustainability would be impossible to create or adjust to changing conditions.

The educational opportunities offered by organizations throughout the Sound are multifarious, and range from introductory sailing to nutrient cycling, from students in kindergarten to those in their post-doctoral studies. Traditional education is provided by magnet schools, colleges, academies, and universities, while other opportunities are available from aquaria, museums, and experiential outfits that teach sailing (see *Chapter 19 Recreational Boating and Sailing*), SCUBA diving (see *Chapter 21 Non-Consumptive Recreation*), estuarine ecology, and many other subjects.

Few map products exist that are representative of RME activities in the Sound. Perhaps the most endorsed are those curated by the Connecticut Department of Energy and Environmental Protection (CT DEEP), such as sampling locations for fish trawls (i.e., the Long Island Sound Trawl Survey (LISTS)) and water quality (WQ). CT DEEP is responsible for monitoring the entire Sound on behalf of both Connecticut and New York, with funding provided in part by the U.S. Environmental Protection Agency (EPA) through the Long Island Sound Study (LISS). The results of these studies are used by both states to define their environmental management strategies independently.

CT DEEP LISTS activities are conducted spring and fall from the State research vessel *John Dempsey* at 40 sites annually. These locations (Figure 24-1) are selected in a statistically random method based on bottom type and depth, but include at least one instance of each type/depth combination per year. Sampling activities occur throughout the water column along the towpath. Results from this survey are combined with fisheries reports and analyzed statistically to determine next year’s acceptable fish catch. Full methodology and results are available online on the CT DEEP LISTS webpage (CT DEEP, 2017a).

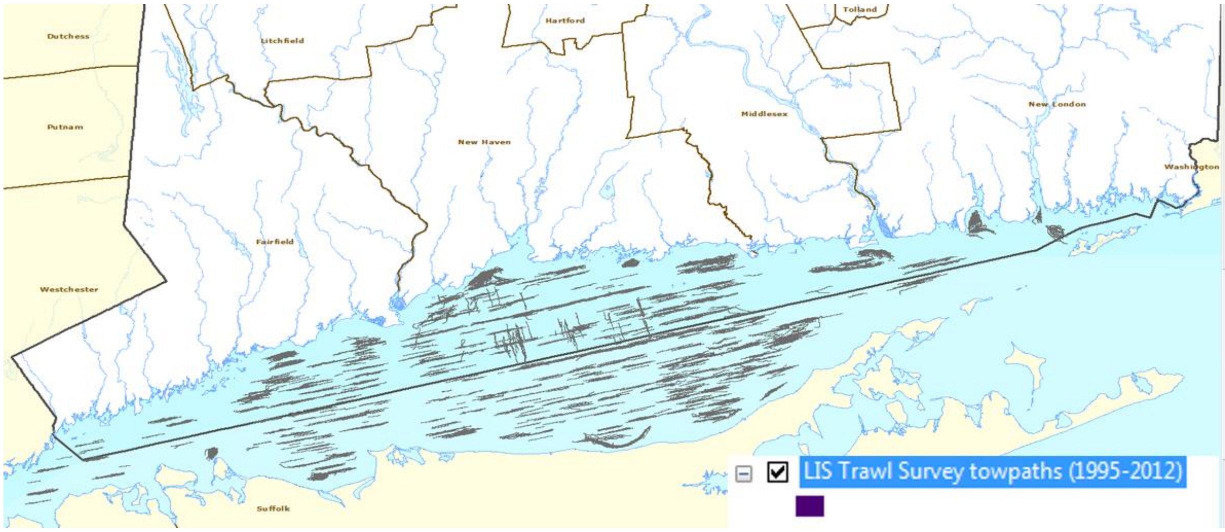


Figure 24-1: Long Island Sound Trawl Survey Towpaths, 1995-2012. Note that some areas are much more frequently sampled during this time series (dense patches of lines); these are representative of particular bottom type/depth combinations uncommon in the Sound and thus appear more regularly in the random sampling algorithm. Data from CT DEEP (CT DEEP, 2017a).

CT DEEP Water Quality monitoring sites (Figure 24-2) were established in 1994 as part of the effort to study and resolve hypoxic conditions that manifest annually in the bottom waters of the western Sound (CT DEEP, 2017b). The majority of the 47 active stations are sampled during the summer months, while 17 stations are sampled year-round. Parameters recorded at each site include dissolved oxygen (DO), temperature, salinity, dissolved and particulate silica and nitrogen, chlorophyll a, and total suspended solids. These data are used to set the LISS Water Quality Indicators (LISS, 2018d), which are used by regional WQ managers to set assess and set project goals. Much of the data and information generated by both the LISTS and WQ studies area are available online.

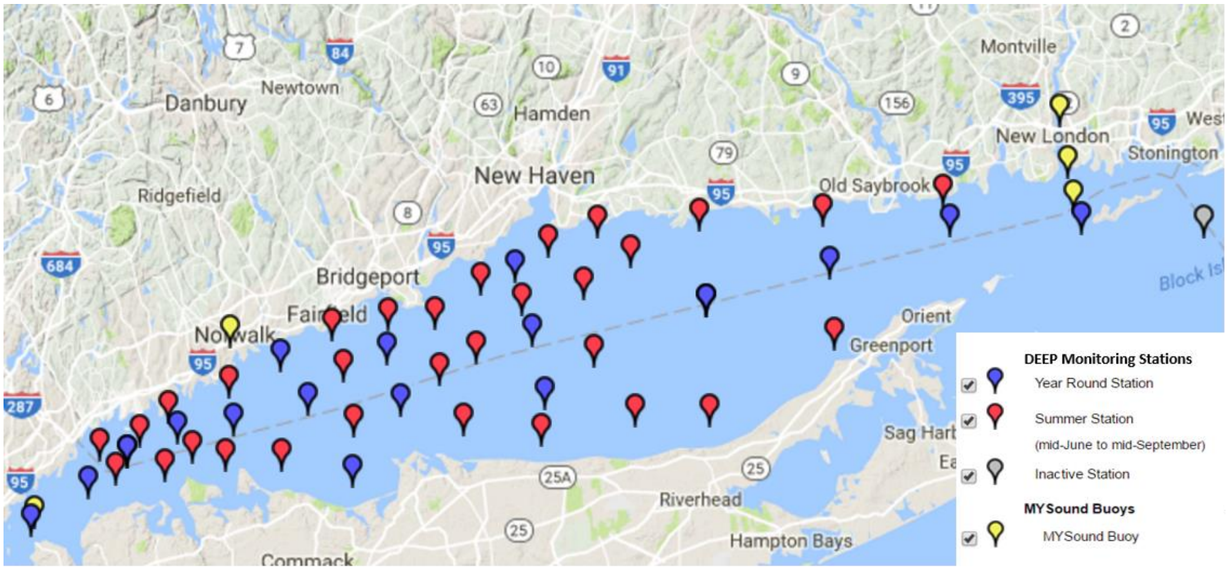


Figure 24-2: [CT DEEP Water Quality Monitoring Program Sample Sites](). Blue stations are Axial (monitored annually) while red stations are monitored in the summer months only. Yellow stations are UConn MYSound buoys, with water quality parameters available in real time on the Long Island Sound Integrated Coastal Observing System website. Access available via the CT DEEP Water Quality Monitoring Program Sample Sites map, using the hyperlink above (CT DEEP, 2017c; UConn Department of Marine Sciences, 2018c).

Another Sound-wide long-term monitoring project is the University of Connecticut Long Island Sound Integrated Coastal Observing System (LISICOS). A series of buoys and high-frequency radar stations, the LISICOS data is available in real time online on the project website and includes water quality, meteorological conditions, and sea state (UConn Department of Marine Sciences, 2018b). These data are used by scientists conducting long-term studies, natural resources managers, and mariners venturing onto the Sound.

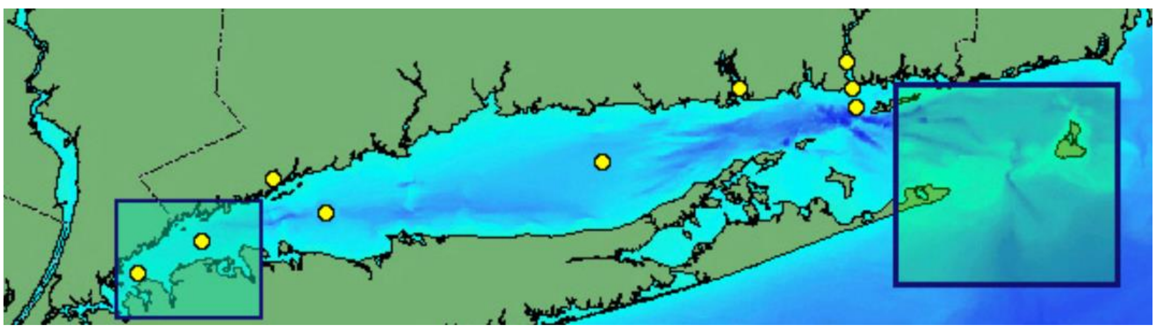


Figure 24-3: Long Island Sound Integrated Coastal Observing System Station Locations. Equipment is owned and maintained by the University of Connecticut, and readings are available in real time on the project website. Boxed areas also include real-time current data. Note that not all stations are at all times operational (UConn Department of Marine Sciences, 2018c).

[LISS](#) is a partnership of Federal, State, and local entities working to preserve and restore the environmental quality of the Sound (LISS, 2018a). LISS developed and implements a Comprehensive Conservation and Management Plan (CCMP) for Long Island Sound, which presents restoration goals for the waterbody as a whole. LISS also provides the Long Island Sound Futures Fund (LISFF) through the Federal National Fish and Wildlife Foundation to support research, monitoring, education, and restoration/conservation projects consistent with the CCMP. Some of the Sound-wide projects highlighted in this chapter have been funded by LISFF grants, while many more are too localized to be featured here. An example of such a project is the installation of reef balls to restore sediment and salt marsh vegetation at Stratford Point. While the long-term success and impacts of the project are currently being studied, it is possible that this technique may be used more extensively along Connecticut's shoreline to stabilize areas losing sediment that was once protected by oyster reefs. (Lambeck, 2016)

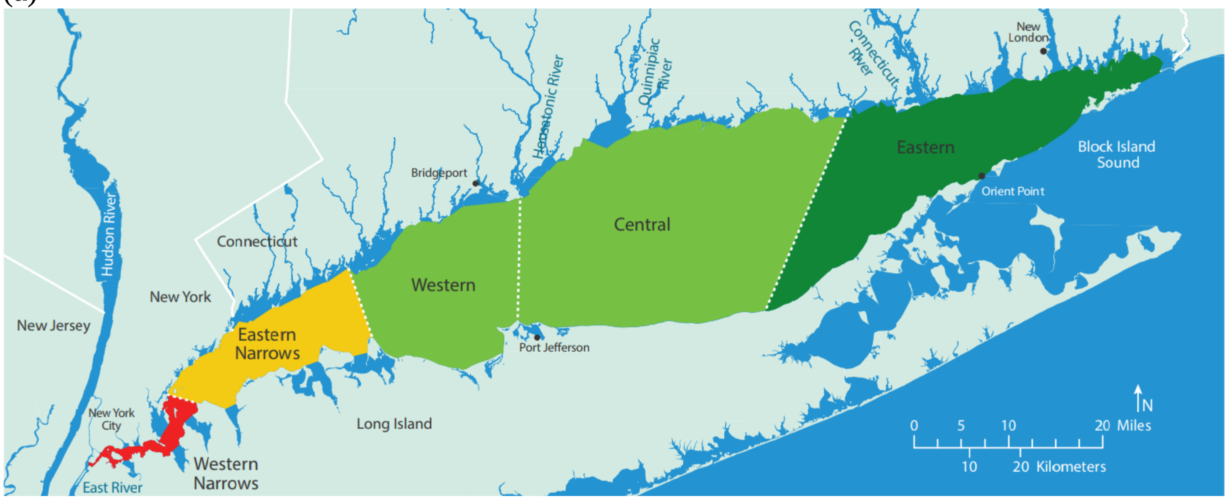
The above "living shoreline" is not the only example of artificial reefs in LIS; New York State Department of Environmental Conservation (NYS DEC) manages two listed artificial reefs in the Sound. Smithtown Reef, in Smithtown Bay, covers 3 acres in 40 feet of water, and consists of 22,000 tires, 5 barges, and 6 concrete-filled steel cylinders. Matinecock Reef, off of Lattingtown, is listed as covering 41 acres, though the construction materials are not yet published (Figure 24-4). These reefs were developed to support enhanced recreational angling and diving interests (also see *Chapter 17 Recreational Fishing* and *Chapter 21 Non-Consumptive Recreation*) (NYS DEC, 2018).

Figure 24-4: Artificial Reef Locations in Long Island Sound. Note that reefs exist to satisfy different goals: Long Island reefs are under about 40 feet of water and serve to enhance angling and diving experiences. The Stratford Point reef is an experimental restoration project in the intertidal. Modified from data received from NYS DEC.

Connecticut Fund for the Environment (CFE) is a non-profit group that works to improve LIS water quality through monitoring, restoration, and advocacy (Connecticut Fund for the Environment, 2018a). Through their flagship Save the Sound project, which operates on both shores of the Sound, the group conducts numerous activities on the water and around the coast, several of which are monitoring programs. Save the Sound coordinates the Unified Water Study

(Connecticut Fund for the Environment, 2018b) for monitoring water quality in 11 LIS embayments, as well as the [Sound Health Explorer](#) (Save the Sound, 2018b) for tracking bacterial contamination at swimming beaches based on EPA databases (Figure 24-5).

(a)



(b)

Figure 24-5: Save the Sound Water Quality Displays. (a) LIS Report Card displaying an averaged rating of 4 water quality indicators (DO, Water clarity, Chlorophyll a, and Nutrients), with dark green rating an "A" and red rating an "F". (b) Sound Health Explorer, with similar rating system for bacterial counts at beaches (Save the Sound, 2016; Save the Sound, 2018b).

[*Project Limulus*](#), run by the Sacred Heart University Department of Biology, collects data about the horseshoe crab population in LIS and the habitat these animals need to survive (Project Limulus, 2018). Horseshoe crab monitoring occurs on beaches throughout LIS (Figure 24-6) within 5 days of new and full moon high tides when the chelicerates lay eggs in the surf. Monitoring includes counting the number of individuals of each sex, the presence and health of tagged animals, and the environmental conditions. This research has been ongoing since 1998, and is an excellent example of citizen science monitoring. Data from *Project Limulus* has been used by both CT DEEP and the Atlantic States Marine Fisheries Commission to set no-harvest zones and other management parameters for the species.

Figure 24-6: [Project Limulus Monitoring Locations](). Note that each location is staffed predominantly by volunteer citizen scientists, and not all mapped sites are monitored each year. Map courtesy of Professor Jennifer H. Mattei, Sacred Heart University, Department of Biology (Project Limulus, 2018).

Bird monitoring occurs throughout LIS, primarily conducted by citizen-scientists participating in two longstanding surveys (Christmas and Summer Bird Counts, below), as well as collecting incidental observation data from shore and boat. The eBird system (Figure 24-7) houses the central database which is now collecting bird observation data from a rapidly increasing percentage of bird watchers, who use eBird to host most of their bird watching field reports (Audubon and Cornell Lab of Ornithology, 2018). Scientists are able to specify downloads of selected subsets of this database to conduct their research. Bird watchers enter their bird observations from their mobile phones or computers, including the number of each species, seen where and when, with the option of including comments and photographs, etc. Other LIS bird surveys tabulated in eBird include: breeding bird surveys, the Connecticut Bird Atlas (Connecticut Bird Atlas, 2018), Big January Counts (Connecticut Ornithological Association, 2018), bird banding, the LIS Super Seawatch (Super Sea Watch, 2018), and numerous waterfowl surveys performed by the U.S. Fish and Wildlife Service (USFWS, 2017).

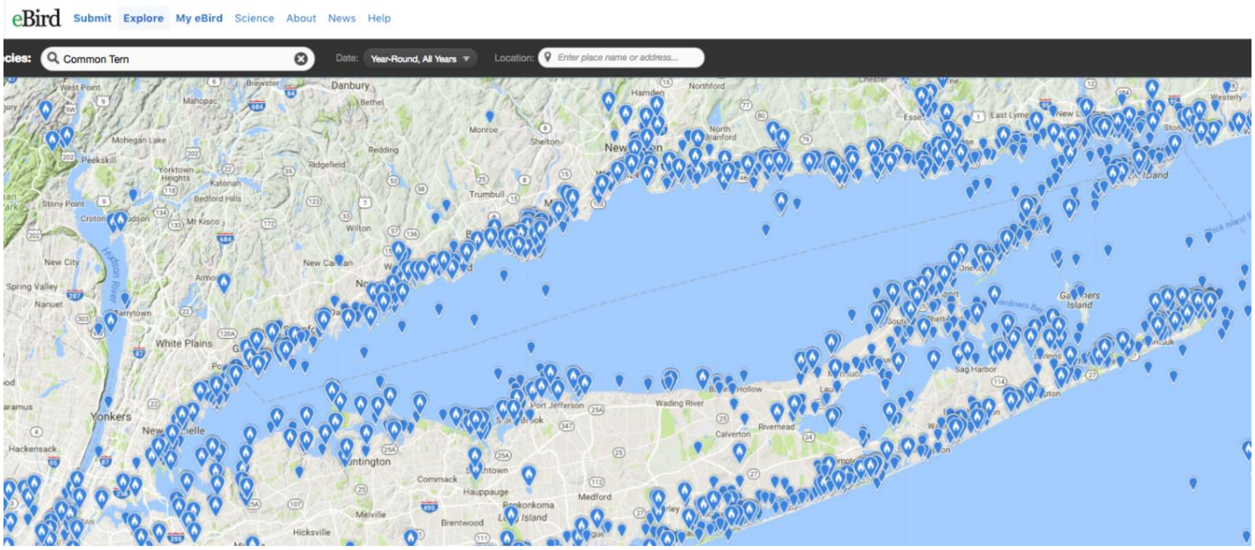


Figure 24-7: [Example eBird Map](). Maps shows the thousands of trips in LIS that were reported to eBird and included a sighting of one or more common terns. Access available via eBird (Audubon and Cornell Lab of Ornithology, 2018).

Christmas Bird Counts (CBC) (see Figure 21-6: Christmas Bird Count Locations in *Chapter 21 Non-Consumptive Recreation*) occur annually from mid-December through early January. Counts are concentrated efforts that follow prescribed methods and occur in defined areas 15 miles in diameter annually (Audubon, 2017; Audubon Connecticut, 2018). There are 14 CBC locations around the perimeter of LIS: Napatree Point, New London, Old Lyme, Old Saybrook, Guilford, New Haven, Stratford/Milford, Westport, Greenwich/Stamford, Bronx/Westchester, Queens, Northern Nassau County, Smithtown, Orient, and Montauk. The CBC circles serve as the anchor points for 9 zones that define survey areas over the width of LIS. Most of these counts have been done every year for many decades, at the same time of year, each with dozens of observers, and provide good time series for decadal analysis. Most birds are counted by experienced bird watchers "seawatching" from shore, often looking out hundreds of yards into LIS using tripod-mounted telescopes and long telephoto cameras. The majority of birds in LIS are within that range of shore, with a minority further out, beyond scope range. All CBC data are maintained in their own central database by the National Audubon Society, and are available to scientists to do their research. Most of these CBCs have many decades of historical data which reveal trends in bird numbers over time. Over the last decade much of these data have also been reported in eBird.

Summer Bird Counts are simply Christmas Bird Counts conducted in June, by similar CBC procedures, in the same circles as the CBCs use in winter (Connecticut Ornithological Association, 2016). Eight counts are done in CT, including two overlapping the LIS area: Greenwich-Stamford and New Haven.

The Motus Wildlife Tracking System uses "nano-tag" radio transmitters affixed to flying organisms and a network of receiving stations to track the movements of birds, bats, and large flying insects (Bird Studies Canada, 2018). The data gained through this international collaborative research effort are used by scientists in many projects, including tracking migratory birds. There are several Motus tracking antennas along the coast of LIS, established and maintained through various research efforts (Figure 24-8).

Figure 24-8: [Motus Receiving Antenna Locations](). Note that a single animal passing through may be picked up by any and all antennas in range. This allows for spatial and temporal tracking of organisms near stations. Access available via Motus (Bird Studies Canada, 2018).

There are several long-standing datasets that are used as baselines with regard to monitoring data, either for comparing results or for designing studies. One of these is the [Sediment Texture]() (grain size) data maintained by the U.S. Geological Survey, used by CT DEEP when preparing the annual LISTS program (USGS, 2018). Another is Pellegrino and Hubbard's 1983 benthic community sampling work, which covers the entire northern half of LIS (Figure 24-9).

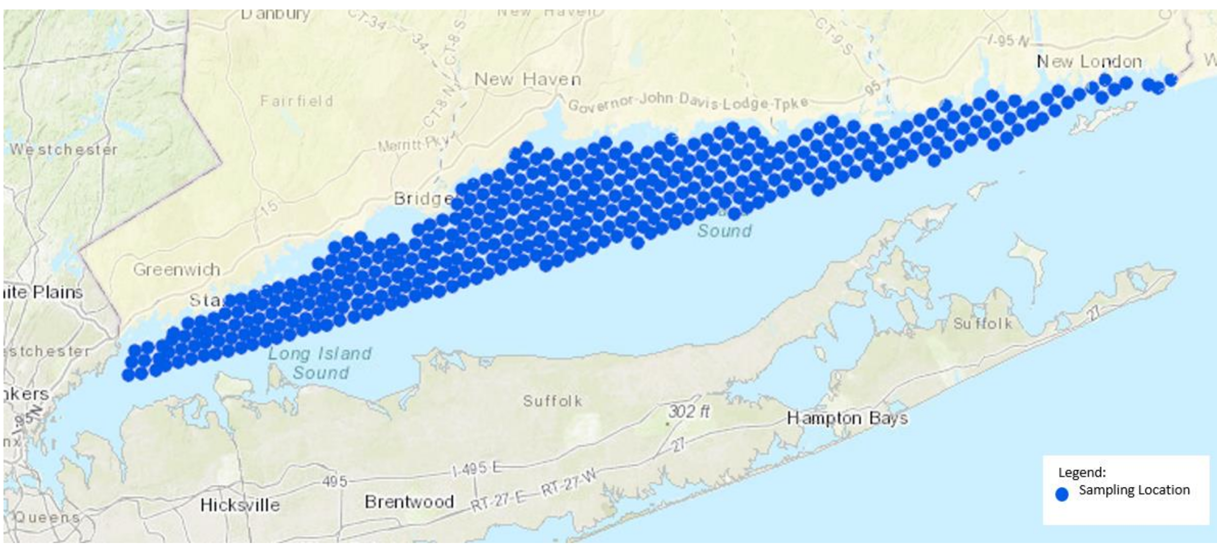


Figure 24-9: Benthic Community Sampling Locations, from Pellegrino and Hubbard, 1983. Data from this study is still used today in characterizing the LIS benthic ecosystem. Data layer by Larry Poppe, USGS. Accessible via the [NY Geographic Gateway]() (NYS DOS OPD, 2017).

Not all research in the Sound is focused on the waterbody itself. The Navy, through the Naval Undersea Warfare Center (NUWC), has designated a Testing Range for the waters south of New England that includes the central and eastern portions of LIS (see Figure 28-4: Naval Undersea

Warfare Center Testing Range in *Chapter 27 National Security*). There is a NUWC facility on Fishers Island, and additional influence from the larger Newport, RI-based NUWC Division Newport. While NUWC use of the Sound is infrequent, it is possible that naval testing will become more common in the protected waters offered by the LIS portion of the Test Range. Much of this research is underwater, including unmanned vehicles, but some work includes use of equipment on the surface or in the airspace just above the water. While naval research activities typically does not impact other user of the Sound, information may be published in the U.S. Coast Guard Local Notices to Mariners from time to time. When planning where to conduct research activities NUWC refers to the Northeast Ocean Data Portal for identifying conflicts to avoid and has expressed interest in knowing where other existing and emerging uses of LIS are. For more information on NUWC, see *Chapter 27 National Security*.

Representing every RME effort occurring in LIS is not the intent of this Inventory; the studies highlighted above are the most obvious and crucial to management of the Sound. Many other research, monitoring, and educational endeavors exist. Figure 24-10 and Tables 24-1 through 24-3 below demonstrate this, and should be considered as a representative cross-section of the breadth of this sector, though by no means comprehensive.

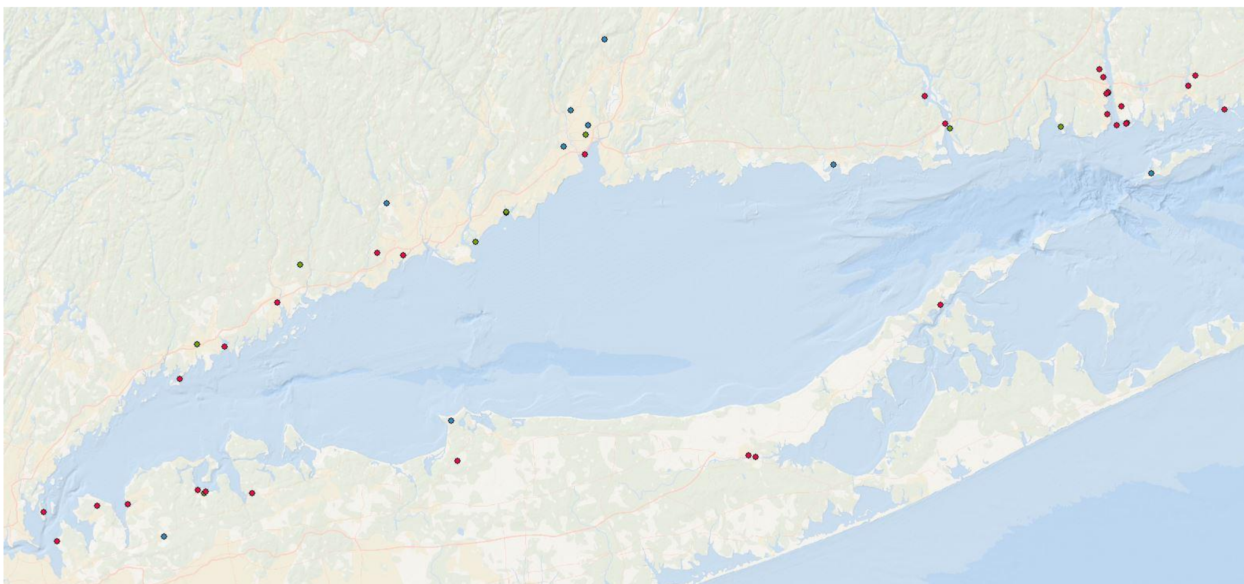


Figure 24-10: RME Institutions Dependent on Long Island Sound. Locations were mapped by Blue Plan staff and are representative of the listed organizations in Tables 24-1 through 24-3.

Table 24-1: Known Institutions that Use Long Island Sound for Research.

Research Institution	**Location**
UConn (UConn, n.d.)	Groton and Storrs, CT
State University of New York – Stony Brook University (including the Flax Pond Marine Laboratory), Maritime College, and College of Environmental Science and Forestry campuses (ESF, 2018; Stony Brook University, 2017; Stony Brook University, 2018; SUNY Maritime College, 2018)	Stony Brook, Old Field, Bronx, and Syracuse, NY
Sea Grant (Sea Grant, 2018)	Groton, CT; Stony Brook, NY
Quinnipiac University (Quinnipiac University, 2018)	Hamden, CT
Wesleyan University (Wesleyan University, 2018)	Middletown, CT
Yale University (Yale University, 2018)	New Haven, CT
Sacred Heart University (Sacred Heart University, 2018)	Fairfield, CT
University of New Haven (University of New Haven, n.d.)	New Haven, CT
University of Hartford (University of Hartford, 2017)	West Hartford, CT
Central Connecticut State University (Central Connecticut State University, 2017)	New Britain, CT
Southern Connecticut State University (Southern Connecticut State University, 2018)	New Haven, CT
Long Island University (Long Island University, n.d.)	Brookville, NY
City University of New York (The City University of New York, 2018)	Staten Island, NY
National Oceanic and Atmospheric Administration Northeast Fisheries Science Center (NOAA NEFSC, n.d.)	Milford, CT
Naval Undersea Warfare Center (Naval Sea Systems Command, n.d.)	Newport, RI
Mystic Aquarium (Mystic Aquarium, 2016)	Mystic, CT
The Maritime Aquarium (The Maritime Aquarium at Norwalk, 2018a)	Norwalk, CT
Cedar Island Marina Research Lab (Cedar Island Marina, 2018)	Clinton, CT

The list in Table 24-1 may be incomplete and should be updated in future revisions of this Inventory.

Table 24-2: Monitoring Organizations and Activities in Long Island Sound

Organization	Monitoring Activity	Location
Project Oceanology (Project Oceanology, 2016)	Seafloor and plankton tows	Groton, CT; Mouth of the Thames
Project Limulus (Project Limulus, 2018)	Horseshoe crab breeding and movement studies	Throughout LIS
New York Horseshoe Crab Monitoring Network (Cornell Cooperative Extension of Suffolk County, 2018a)	Horseshoe crabs	New York State's Marine and Coastal District Waters (NYS DEC, n.d.)
Clean Up Sound and Harbor (Clean Up Sound and Harbor, 2017)	Water quality, bacteria	Mystic and Stonington, CT
Millstone Power Station (Dominion Energy, 2018)	Effluent, regional ecosystem	Waterford, CT
National Audubon Society (Audubon, 2017)	Christmas Bird Counts, others	Throughout LIS
Connecticut Ornithological Association (Connecticut Ornithological Association, 2018)	eBird; capture of almost all bird observations in LIS (Audubon and Cornell Lab of Ornithology, 2018)	Throughout LIS
The Maritime Aquarium (The Maritime Aquarium at Norwalk, 2018a)	Water quality, plankton, seafloor tows, Project Limulus	Norwalk, CT
Coastal Research and Education Society of Long Island (Coastal Research and Education Society of Long Island, Inc, n.d.)	Marine mammals	West Sayville, NY
Ferry-based Observations for Science Targeting Estuarine Research (University of Rhode Island Graduate School of Oceanography, 2013) and SoundScience (Stony Brook University, n.d.)	Water column currents; marine and atmospheric observations	Cross Sound Ferry and Bridgeport-Port Jefferson Steamboat Co. routes.
Friends of the Bay (Friends of The Bay, n.d.)	Water quality	Oyster Bay, NY
Long Island Sound Study (LISS, 2018e)	Diverse monitoring projects including those not mentioned above, including climate change and sea level rise, seafloor mapping, and riparian restoration	Throughout LIS
U.S. Fish and Wildlife Service (USFWS, 2017)	Eelgrass and shorebirds	Throughout LIS

Organization	Monitoring Activity	Location
Harbor Watch (Earthplace, 2018)	Water quality	Western Coastal LIS
Gotham Whale (Gotham Whale, 2018)	Whales and other marine mammals	Potential to expand into LIS soon
The Nature Conservancy (The Nature Conservancy, 2018)	Eel Grass	CT and Fisher's Island Coast
Greenwich Shellfish Commission (Greenwich Shellfish Commission, 2018)	Local water quality	Greenwich, CT

Many of the entities noted Table 24-2 maintain or contribute to long time series datasets about environmental conditions in and around the Sound. The list in the table is incomplete but represents many of the most prominent groups.

Table 24-3: Educational Institutions Dependent on Long Island Sound

Institution Type	Organization	Location
Higher Education	UConn (UConn, n.d.)	Storrs, CT; Groton, CT; Stamford, CT
	Stony Brook University (Stony Brook University, n.d.)	Stony Brook, NY
	Fairfield University (Fairfield University, n.d.)	Fairfield, CT
	U.S. Coast Guard Academy (United States Coast Guard, n.d.)	Groton, CT
	Maritime Merchant Academy (U.S. Department of Transportation, n.d.)	Kings Point, NT
	Mitchell College (Mitchell College, n.d.)	New London, CT
	Connecticut College (Connecticut College, n.d.)	New London, CT
Secondary Education	Marine Science Magnet High School of Southeastern CT (Marine Science Magnet High School, n.d.)	Groton, CT
	The Sound School (The Sound School, n.d.)	New Haven, CT
	Bridgeport Regional Aquaculture Science & Technology Education Center (Bridgeport Regional Aquaculture, n.d.)	Milford, CT

Institution Type	Organization	Location
Aquariums and Museums	Mystic Aquarium (Mystic Aquarium, 2016)	Mystic, CT
	The Maritime Aquarium at Norwalk (The Maritime Aquarium at Norwalk, 2018a)	Norwalk, CT
	Cold Spring Harbor Whaling Museum (The Whaling Museum and Education Center, n.d.)	Cold Spring Harbor, NY
	Mystic Seaport (Mystic Seaport, 2018)	Mystic, CT
	Long Island Aquarium (Long Island Aquarium, 2017)	Riverhead, NY
	New London Maritime Society (New London Maritime Society, n.d.)	New London, CT
	The Ledge Light Foundation (The Ledge Light Foundation, n.d.)	Groton, CT
	Garvies Point Museum (Garvies Point Museum & Preserve, 2018)	Glen Cove, NY
	Sands Point Preserve (Sands Point Preserve Conservancy, n.d.)	Sands Point, NY
	The Bruce Museum Seaside Center (Bruce Museum, 2018)	Greenwich, CT
	East End Seaport Maritime Museum (East End Seaport, n.d.)	Greenport, NY
	Connecticut River Museum (Connecticut River Museum, 2017)	Essex, CT
	City Island Nautical Museum (City Island Nautical Museum, n.d.)	City Island, NY
Other Experiential Education	Mystic Whaler Tall Ship (Mystic Whaler Cruises, n.d.)	New London, CT
	Mystic Seaport (Mystic Seaport, 2018)	Mystic, CT
	SoundWaters (SoundWaters, 2017)	Stamford, CT
	Maritime Education Network, Inc. (Maritime Education Network, Inc. , n.d.)	Old Saybrook, CT

Institution Type	Organization	Location
Other Experiential Education (cont.)	Thames River Heritage Park (Thames River Heritage Park, 2018)	New London, CT
	New England Science and Sailing (New England Science and Sailing, n.d.)	Stonington, CT
	Project Oceanology (Project Oceanology, 2016)	Groton, CT
	The Waterfront Center (The Waterfront Center, 2018)	Oyster Bay, NY
	Oakcliff Sailing (OakCliff Sailing, 2018)	Oyster Bay, NY
	Cornell Cooperative Extension (Cornell Cooperative Extension of Suffolk County, 2018b)	Riverhead, NY

For Table 24-3, it should be noted that there is some overlap between research, monitoring, and education activities, as well as between educational programs.

24.2 Assessment of Data Quality

24.2.1 Sources of Data and Metadata

CT DEEP monitoring data come from the CT DEEP website and from personal communication with the Marine Fisheries staff. All data informing the map products come from DEEP monitoring activities. Metadata for the DEEP fisheries data is available from DEEP Marine Fisheries, while WQ metadata is available here (CT DEEP, 2014). Information on LISICOS comes from the project website; metadata for the map and project are available here (UConn Department of Marine Sciences, 2018a), or by contacting LISICOS staff. The CFE LIS Report Card is composed from water quality monitoring data from CT DEEP, New York City Department of Environmental Protection, and the Interstate Environmental Commission/New England Interstate Water Pollution Control Commission, with more information available here (University of Maryland Center for Environmental Science, n.d.). The Sound Health Explorer is based on the EPA Storage and Retrieval (EPA, 2018) and EPA Beach Advisory and Closing Online Notification 2.0 system (EPA, n.d.) databases, with more information available here (Save the Sound, 2018a).

Major funding for DEEP monitoring, LISICOS, and many CFE projects come from LISS, a partnership of the EPA, state agencies from both Connecticut and New York, user groups, and interested organizations and individuals (LISS, 2018a). LISS supports many projects in the Research, Monitoring, and Education sector through the Long Island Sound Futures Fund, a grant program primarily funded by the EPA and managed by the National Fish and Wildlife Foundation (National Fish and Wildlife Foundation, 2018). Other efforts funded through LISS include seafloor mapping (LISS, 2018c), eelgrass monitoring, Project Limulus, and endangered and migratory bird surveys. Information about and resulting from these long-term monitoring efforts is available on each project's website, and in their annual published results.

The eBird database is maintained by the Cornell Lab of Ornithology and populated by recreational bird watchers and professional scientists globally; more information about the project available here (Audubon and Cornell Lab of Ornithology, 2018). Christmas and Summer Bird Counts are organized and facilitated by the National Audubon Society and Connecticut Ornithological Association (COA) (Connecticut Ornithological Association, 2018). More information on CBC's in Connecticut is available here (Audubon Connecticut, 2018); Long Island here (Eastern Long Island Audubon Society, Inc., 2018). Map used in this Inventory available from through COA, from Tom Robben, and others. Information on the Motus system is available here (Bird Studies Canada, 2018) or by contacting Bird Studies Canada.

Sampling locations from Pellegrino and Hubbard are available on the New York Geographic Information Gateway; metadata is available here (NYS DOS OPD, 2016).

Information about NUWC comes from contact with Navy representatives (see below); map used here if from the Northeast Ocean Data Portal; metadata here (Ecology and Environment, Inc., 2016).

24.2.2 Accuracy, Representativeness, and Relevance of Map Products

Experts consulted about data products associated with this sector confirm that the most accurate, relevant, and representative are those that are most frequently referenced and are already actively used in natural resources management considerations. These include the CT DEEP LISTS and WQ monitoring annual reports and LISICOS day-to-day reporting.

The Save the Sound Health Explorer and Report card were not mentioned by RME sector experts, though anecdotal information indicates the public at large uses both when thinking about water quality in the Sound. This is most likely because the infographics and portal are highly accessible to anyone interested in general water quality information, and provide pragmatic insight to users (i.e., helping determine a clean beach to swim at). These products are both accurate and representative, as they cover the entire Sound and are based on Federally-approved data, but have somewhat limited relevance for planning purposes.

Longstanding datasets such as Pellegrino and Hubbard accurately display where research has occurred, but alone are not representative of the RME sector, and thus should not be considered relevant for planning considerations related to RME. They are, however, valuable to aspects of the Ecological Characterization of the Sound (see *Chapter 1 Ecological Characterization Process*).

Thirteen CBC locations include LIS waters, spanning all of the CT shoreline, and most of the NY shoreline. CBCs are considered research and monitoring, since their count data is collected centrally and used by many scientists. The map of CBCs is accurate and representative (complete). CBC locations are relevant to consider in LIS planning because their multi-decadal time series of data suggest cause and effect relationships.

The eBird system is at least as accurate as the CBCs, since the eBird computers spot unlikely bird reports and contact the observer to discuss those unusual reports and verify/delete them. The database is more representative than the CBCs because it covers every area, including outside the CBC 15-mile diameter circles, and contains observations from a full year, not just the three weeks starting in mid-December as CBCs do. The eBird database is relevant to LIS planning for the same reasons as CBCs, but does not sample from repeated discrete locations around the Sound.

Both eBird data and the cross-Sound zones (Figure 24-6) have been adopted by the National Oceanic and Atmospheric Administration (NOAA) Office of Response and Restoration Ecological Sensitivity Index for oil spill management, and thus can already be seen to be relevant to planning. See *Chapter 5 Birds*, for more information on Bird Counts and eBird. The numerous other bird monitoring studies (Motus, Connecticut Bird Atlas, Big January Counts, the LIS Super Seawatch, Federal waterfowl studies, etc.) are all part of the larger ornithological and ecological understanding of the Sound and its place in migratory routes. Information from each is considered accurate and representative of the natural history of LIS, and thus relevant to planning, both as it relates to RME activities as well as ecologically. Additionally, the discrete locations these studies are conducted at should be considered relevant to planning.

24.2.3 Data Gaps and Availability of Data to Address Gaps

Data gaps persist in the characterization of this sector. The tables of organizations above (Tables 24-1 through 24-3) are known to be incomplete, and should be revised in the future. This can be addressed through a more comprehensive study, including further stakeholder engagement. Other relevant RME organizations, including citizen science programs, need to be identified and if their activities are accurate, relevant, and representative these efforts should be reflected in this Inventory. As part of this, any discrete areas that are important to education, especially experiential education, should be identified and mapped. Additionally, it is unknown if there are particular areas in LIS that are important for research that is not based in monitoring, but rather on undisturbed local conditions. Furthermore, as the LISS seafloor mapping program evolves, this should be evaluated for incorporation as part of the RME use of the Sound.

Lastly, there is a need to quantify the contribution research institutions make to the socioeconomic wellbeing of everyone living near and using the Sound. This can be accomplished through research into existing studies, or by conducting a dedicated study.

24.3 Relevance

24.3.1 Relative Historical Importance

Scientific exploration of the Sound has been occurring since its "discovery" by Adriaen Block in 1614. Early scientific inquiry consisted primarily of charting the coasts for resources, trade, and safe marine navigation.

Since at least the mid-1800s NUWC has conducted weapons and technology research within the confines of the sound, including many aspects of submarine warfare, and continuing today. NUWC use of the Sound for research has intensified since 2012, with the expansion of the Test Range to include LIS.

Bird watchers are very active in and around Long Island Sound, but until the last decade, most of their data, from their many field trips, were kept in paper notebooks and personal computers, eventually being lost. Of course, the state birding journals (such as Connecticut Warbler, since 1981 when COA formed, and the Kingbird, since 1950 for NY State), and national journals (such as Audubon Field Notes and American Birds) did publish some summaries of field reports and the less common species, but generally without full trip details, such as numbers of all species. Bird watchers have transformed increasingly the last decade into citizen scientists as their observations and studies are increasingly quantified, standardized, and entered into central databases for scientists to analyze, especially thanks to the rise of the eBird system in the last 15 years. In 1900 the first avian citizen science event began, the annual CBC, which now reveal long-term population and distribution trends at hundreds of locations across the USA and the world. Summer Bird Counts, the summer version of those CBCs, began in 1971 and has been conducted in numerous Connecticut locations since then. These and most other bird observations are increasingly reported via the eBird system, into its one central database which is used for many academic studies of bird and environmental changes. The eBird system has been lauded as a way to "democratiz[e] science" with many associated benefits, including getting more of the public more comfortable and confident about science and its methods (Cooper, Dickinson, Phillips, & Bonney, 2008, p. r1). Birders, for example, have watched and counted birds over the decades, and have seen the declines in many bird species. Their citizen-science experiences have helped them better understand the changing ecosystems on the planet, and be leaders in conservation and environmental issues.

24.3.2 Socio-Economic Context

Most research conducted in and about LIS is grant funded and aimed at answering a specific question. These projects support research teams, technical personnel, peripheral staff, and suppliers in the community. Knowledge derived from research in LIS may be applied locally or globally, depending on the study.

Monitoring efforts are conducted to determine changes in the LIS system, such that corrective changes can be made before any given natural resource is diminished or denigrated. Given that the overall estimated value of LIS in ecosystem benefits ranges from $9.4 billion (LISS, 2018b) to $37.0 billion (Earth Economics, 2015) management based on quality data is paramount.

Citizen science is the collection of scientific data according to prescribed methods by trained volunteers. Citizen science has become an increasingly crucial part of monitoring throughout the U.S. and abroad, and LIS is no different. Many smaller monitoring efforts, including those funded by the LISS and CFE depend on citizen science for much of their annual data. These data are used directly in the management of the Sound in both Connecticut and Long Island, so the importance of public involvement cannot be overstated. LISS maintains a list of volunteer opportunities available around the Sound, accessible on their website (LISS, 2018f). Additionally, there is an emerging citizen science effort concerned with the increasing presence of whales in LIS. This includes both a possible expansion of the New York Harbor based Gotham Whale reporting database (see Table 24-2), as well as a proposal to improve organized response to strandings, in light of the failed attempt to save, and ultimate euthanasian of, a juvenile humpback in November 2016 (Uda, 2016).

Education based in or focusing on LIS primarily centers on the history and ecology of the estuary. The economic value of the institutions curating exhibits or offering related lessons has not been quantified in any identified report thus far. Despite this, the social value of learning opportunities related to the Sound can be said to enhance quality of life for all, by promoting preservation of the natural resources the Sound offers and an appreciation of the many uses that rely on those uses today.

24.3.3 Other Notes

At the time of this writing, New York State is investing $10.4 million in shellfish restoration efforts in both LIS and the southern Long Island bays. The goal of this program is to improve water quality by increasing the population of bivalves. The State has selected five sanctuary sites in Uncertified areas (see *Chapter 15 Aquaculture*), one of which is located in Long Island Sound, in Huntington Harbor (Bolger, 2017). This effort will include water quality and bivalve monitoring at the sites. More information on this initiative is available on NYS DEC's Restore New York Shellfish webpage (NYS DEC, 2018).

Additional Resources

In addition to ongoing monitoring activities, many specific studies have been conducted to characterize the Sound as a system. One of the most authoritative resources on environmental research conducted in LIS is the 2014 volume *Long Island Sound, Prospects for the Urban Sea* compiled by James S. Latimer and others (Latimer, et al., 2014). Assembled with the management needs of LIS in mind, the text draws together empirical studies from numerous disciplines to present a holistic understanding of the natural history and state of the Sound. Chapter topics consist of the socioeconomic condition, the geology, physical oceanography, geochemistry, contaminants and nutrients, and biology and ecology of the Sound, as well as a final synthesis for management. Each chapter is not a discrete study, but rather the product of decades of work by dozens of scientists summarizing their findings. When considering the benefits of research and monitoring in LIS, this compendium should be a first stop for both researchers and natural resource managers.

24.4 References

Audubon. (2017). *Audubon Christmas Bird Count Results*. Retrieved from Audubon Christmas Bird Count: http://netapp.audubon.org/CBCObservation/

Audubon and Cornell Lab of Ornithology. (2018). *About eBird*. Retrieved from eBird: https://ebird.org/about

Audubon Connecticut. (2018). *Christmas Bird Count*. Retrieved from Audubon Connecticut: http://ct.audubon.org/christmas-bird-count

Bird Studies Canada. (2018). *About*. Retrieved from Motus Wildlife Tracking System: https://motus.org/about/

Bolger, T. (2017, September 7). *NY Spends $10M on Shellfish to Improve Long Island Water Quality*. Retrieved from Long Island Press: https://www.longislandpress.com/2017/09/07/ny-spends-10m-on-shellfish-to-improve-long-island-water-quality/

Bridgeport Regional Aquaculture. (n.d.). *Welcome to Aqua*. Retrieved from Bridgeport Public Schools: https://www.bridgeportedu.net/Domain/1530

Bruce Museum. (2018). *Seaside Center*. Retrieved from Bruce Museum: https://brucemuseum.org/site/about_us_detail/seaside-center

Cedar Island Marina. (2018). *Research Lab*. Retrieved from Cedar Island Marina: http://www.cedarislandmarina.com/marine-biology/marine-life/marine-research-laboratory/

Central Connecticut State University. (2017). Retrieved from Central Connnecticut State University: http://www2.ccsu.edu/

City Island Nautical Museum. (n.d.). *Visit*. Retrieved from City Island Nautical Museum: http://www.cityislandmuseum.org/index.html

Clean Up Sound and Harbor. (2017). Retrieved from Clean Up Sound and Harbor: http://cushinc.org

Coastal Research and Education Society of Long Island, Inc. (n.d.). Retrieved from CRESLI News: http://cresli.org/

Connecticut Bird Atlas. (2018). *Project Goals*. Retrieved from Connecticut Bird Atlas: http://www.ctbirdatlas.org/About-Project-goals.htm

Connecticut College. (n.d.). Retrieved from Connecticut College: https://www.conncoll.edu/

Connecticut Fund for the Environment. (2018a). *About Us*. Retrieved from Connecticut Fund for the Environment/Save the Sound: http://www.ctenvironment.org/about-us/

Connecticut Fund for the Environment. (2018b). *Unified Water Study*. Retrieved from Connecticut Fund for the Environment/Save the Sound: http://www.ctenvironment.org/uws

Connecticut Ornithological Association. (2016, Summer). 2016 Summer Bird Count. *COA Bulletin*, pp. 1-2. Retrieved from http://www.ctbirding.org/wp-content/uploads/2017/01/COABulletinSummer2016.pdf

Connecticut Ornithological Association. (2018). *About*. Retrieved from Connecticut Ornithological Association: http://www.ctbirding.org/about/

Connecticut River Museum. (2017). Retrieved from Connecticut River Museum: https://www.ctrivermuseum.org/

Cooper, C. B., Dickinson, J. L., Phillips, T., & Bonney, R. (2008). Science Explicitly for Nonscientists. *Ecology and Society, 13*(2), r1. Retrieved from http://www.ecologyandsociety.org/vol13/iss2/resp1/

Cornell Cooperative Extension of Suffolk County. (2018a). *New York Horseshoe Crab Monitoring Network*. Retrieved from Cornell University Cooperative Extension of Suffolk County: http://nyhorseshoecrab.org/NY_Horseshoe_Crab/Home.html

Cornell Cooperative Extension of Suffolk County. (2018b). *Suffolk County*. Retrieved from Cornell Cooperative Extension: http://ccesuffolk.org/

CT DEEP. (2014, August 21). *Long Island Sound Water Quality Monitoring*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://www.ct.gov/deep/cwp/view.asp?a=2719&q=325534&deepNav_GID=1654

CT DEEP. (2017a). *Long Island Sound Trawl Survey*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://www.ct.gov/deep/cwp/view.asp?a=2696&q=322660&deepNav_GID=1647

CT DEEP. (2017b, May 2). *Long Island Sound Water Quality Monitoring Program and Information*. Retrieved Feb 5, 2018, from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://www.ct.gov/deep/cwp/view.asp?a=2719&q=325570&deepNav_GID=1635

CT DEEP. (2017c). *Long Island Sound Water Quality Monitoring Stations*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://www.depdata.ct.gov/maps/lis/liswqmap.htm

CT DEEP. (2018b). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635

Dominion Energy. (2018). *Millstone Power Plan*. Retrieved from Dominion Energy: https://www.dominionenergy.com/about-us/making-energy/nuclear/millstone-power-station

Earth Economics. (2015). *The Trillion Dollar Asset.* Retrieved from Long Island Sound Study: https://drive.google.com/file/d/0ByzlUWI76gWVVW1qdXRCbGhMMTg/view?pref=2&pli=1

Earthplace. (2018). *Harbor Watch*. Retrieved from Earthplace: http://earthplace.org/page/harbor-watch-projects

East End Seaport. (n.d.). Retrieved from East End Seaport Museum: https://www.eastendseaport.org/aboutthemuseum/

Eastern Long Island Audubon Society, Inc. (2018). *Christmas Bird Count & Winter Waterfowl Census*. Retrieved from Eastern Long Island Audubon Society, Inc.: http://www.easternlongislandaudubonsociety.org/christmasbirdcount.html

Ecology and Environment, Inc. (2016, April 16). *NUWCDIVNPT Testing Range Boundary.* Retrieved from Northeast Ocean Data Portal: https://www.northeastoceandata.org/files/metadata/Themes/Security/NENUWCDIVNPTTestingRangeBoundary.pdf

EPA. (2018, January 16). *Water Quality Data (WQX)*. Retrieved from U.S. Environmental Protection Agency (EPA): https://www.epa.gov/waterdata/water-quality-data-wqx

EPA. (n.d.). *BEACON 2.0 - Beach Advisory and Closing On-line Notification*. Retrieved from U.S. Environmental Protection Agency (EPA): https://watersgeo.epa.gov/beacon2/

ESF. (2018). Retrieved from College of Environmental Science and Forestry (ESF): http://www.esf.edu/

Fairfield University. (n.d.). Retrieved from Fairfield University: https://www.fairfield.edu/

Friends of The Bay. (n.d.). Retrieved from Friends of the Bay: http://friendsofthebay.org/

Garvies Point Museum & Preserve. (2018). Retrieved from Garvies Point Museum & Preserve: http://www.garviespointmuseum.com/

Gotham Whale. (2018). *Gotham Whale*. Retrieved from https://gothamwhale.org/

Greenwich Shellfish Commission. (2018). *Shellfish Commission*. Retrieved from Greenwich Connecticut: http://www.greenwichct.org/government/commissions/shellfish_commission/

Lambeck, L. C. (2016, December 12). *Creating a 'Living Shoreline' with Reef Balls.* Retrieved from CTPost: https://www.ctpost.com/local/article/Creating-a-living-shoreline-with-Reef-Balls-10778523.php#photo-12000867

Latimer, J. S., Tedesco, M. A., Swanson, R. L., Yarish, C., Stacey, P. E., & Garza, C. (Eds.). (2014). *Long Island Sound: Prospects for the Urban Sea.* New York: Springer. doi:10.1007/978-1-4614-6126-5

LISS. (2018a). *About the Long Island Sound Study*. Retrieved from Long Island Sound Study: http://longislandsoundstudy.net/about/about-the-study/

LISS. (2018b). *Long Island Sound - By The Numbers*. Retrieved from Long Island Sound Study (LISS): http://longislandsoundstudy.net/about-the-sound/by-the-numbers/

LISS. (2018c). *Seafloor Mapping*. Retrieved from Long Island Sound Study (LISS): http://longislandsoundstudy.net/research-monitoring/seafloor-mapping/

LISS. (2018d). *Status and Trends: LISS Ecosystem Targets and Supporting Indicators*. Retrieved from Long Island Sound Study (LISS): http://longislandsoundstudy.net/research-monitoring/long-island-sound-environmental-indicators/

LISS. (2018e). *Status and Trends: LISS Environmental Indicators - Marine and Coastal Animals*. Retrieved from Long Island Sound Study: http://longislandsoundstudy.net/?indicator_categories=marine-and-coastal-animals

LISS. (2018f). *Volunteer Opportunities.* Retrieved from Long Island Sound Study (LISS): http://longislandsoundstudy.net/get-involved/lis-volunteer-opportunities/

Long Island Aquarium. (2017). Retrieved from Long Island Aquarium: http://www.longislandaquarium.com/

Long Island University. (n.d.). *LIU*. Retrieved from http://www.liu.edu/

Marine Science Magnet High School. (n.d.). Retrieved from Marine Science Magnet High School: Marine Science Magnet High School

Maritime Education Network, Inc. . (n.d.). Retrieved from Maritime Education Network, Inc. : http://maritimeeducation.org/programs.htm

Mitchell College. (n.d.). Retrieved from Mitchell College: http://mitchell.edu/

Mystic Aquarium. (2016). Retrieved from Mystic Aquarium: http://www.mysticaquarium.org/

Mystic Seaport. (2018). Retrieved from Mystic Seaport: https://www.mysticseaport.org/

Mystic Whaler Cruises. (n.d.). *Eductaion Cruises*. Retrieved from Mystic Whaler Cruises: https://mysticwhalercruises.com/sailing-and-environmental-education-cruises/

National Fish and Wildlife Foundation. (2018). *Who We Are*. Retrieved from NFWF: http://www.nfwf.org/whoweare/Pages/home.aspx#.WnIo8bynG01

Naval Sea Systems Command. (n.d.). *NUWC Newport Devision*. Retrieved from Warfare Centers: http://www.navsea.navy.mil/Home/Warfare-Centers/NUWC-Newport/
New England Science and Sailing. (n.d.). Retrieved from New England Science and Sailing: http://nessf.org/
New London Maritime Society. (n.d.). Retrieved from Custom House Maritime Museum: http://www.nlmaritimesociety.org/
NOAA NEFSC. (n.d.). *Milford Laboratory*. Retrieved from National Oceanic and Atmospheric Administration (NOAA) Northeast Fisheries Science Center (NEFSC): https://www.nefsc.noaa.gov/nefsc/Milford/
NYS DEC. (2018). *Artifical Reefs*. Retrieved from New York State Department of Environmental Conservation (NYS DEC): https://www.dec.ny.gov/outdoor/7896.html
NYS DEC. (2018). *Restore New York Shellfish*. Retrieved from New York State Department of Environmental Conservation (NYS DEC): https://www.dec.ny.gov/outdoor/110939.html
NYS DEC. (n.d.). *New York's Marine & Coastal District Waters*. Retrieved from New York State Department of Environmental Conservation: https://www.dec.ny.gov/permits/95483.html
NYS DOS OPD. (2016, December 19). *Long Island Sound Benthic Communities Sample Locations - 1983 (LISRC_Samples_Pellegrino)*. Retrieved from New York Geographic Information Gateway: http://opdgig.dos.ny.gov/geoportal/catalog/search/resource/detailsnoheader.page?uuid=%7b41B6C28F-F552-4A9F-8725-A0EC8E8FD495%7d
NYS DOS OPD. (2017). *New York Geographic Information Gateway*. Retrieved from New York State Department of State, Office of Planning and Development: http://opdgig.dos.ny.gov/#/map
OakCliff Sailing. (2018). Retrieved from OakCliff Sailing: https://www.oakcliffsailing.org/
Project Limulus. (2018). *SHU Biology Department*. Retrieved from Sacred Heart University: http://www.sacredheart.edu/academics/collegeofartssciences/academicdepartments/biology/projectlimulus/
Project Oceanology. (2016). *Public Cruises*. Retrieved from Project Oceanology: http://www.oceanology.org/cruises
Quinnipiac University. (2018). Retrieved from Quinnipiac University: https://www.qu.edu/
Sacred Heart University. (2018). *Sacred Heart University*. Retrieved from http://www.sacredheart.edu/
Sands Point Preserve Conservancy. (n.d.). Retrieved from Sands Point Preserve Conservancy: http://sandspointpreserveconservancy.org/about/
Save the Sound. (2016, October). *Long Island Sound Report Card 2016.* Retrieved from Eco Report Card: https://ecoreportcard.org/site/assets/files/1853/2016-long-island-sound-report-card.pdf
Save the Sound. (2018a). *About the Sound Health Explorer*. Retrieved from Connecticut Fund for the Environment/Save the Sound: http://www.soundhealthexplorer.org/pages/about/
Save the Sound. (2018b). *Sound Health Explorer*. Retrieved from Connecticut Fund for the Environment/Save the Sound: http://www.soundhealthexplorer.org/
Sea Grant. (2018). *Sea Grant*. Retrieved from NOAA: http://seagrant.noaa.gov/
SoundWaters. (2017). Retrieved from SoundWaters: https://soundwaters.org/
Southern Connecticut State University. (2018). Retrieved from Southern Connecticut State University: http://www.southernct.edu/

Stony Brook University. (2017). *Flax Pond Marine Laboratory*. Retrieved from Stony Brook University, School of Marine and Atmospheric Sciences: https://www.somas.stonybrook.edu/about/facilities/flax-pond-marine-laboratory/

Stony Brook University. (2018). Retrieved from Stony Brook University: http://www.stonybrook.edu/

Stony Brook University. (n.d.). *Sound Science*. Retrieved from Marine Sciences Research Center: http://www.stonybrook.edu/soundscience/main.html

SUNY Maritime College. (2018). Retrieved from The State University of New York (SUNY) Maritime College: https://www.suny.edu/campuses/maritime/

Super Sea Watch. (2018). *Homepage*. Retrieved from Super Sea Watch: https://superseawatch.blogspot.com/

Thames River Heritage Park. (2018). Retrieved from Thames River Heritage Park: http://www.thamesriverheritagepark.org/

The City University of New York. (2018). Retrieved from The City University of New York: http://www2.cuny.edu/

The Ledge Light Foundation. (n.d.). Retrieved from The Ledge Light Foundation: http://www.ledgelighthouse.org/

The Maritime Aquarium at Norwalk. (2018a). *Homepage*. Retrieved from The Maritime Aquarium: https://www.maritimeaquarium.org/

The Nature Conservancy. (2018). *Taking to the Skies to Help the Sea*. Retrieved from Connecticut: https://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/connecticut/explore/taking-to-the-skies-to-help-the-seas.xml

The Sound School. (n.d.). Retrieved from The Sound School: http://sound.school/

The Waterfront Center. (2018). Retrieved from The Waterfront Center: https://www.thewaterfrontcenter.org/

The Whaling Museum and Education Center. (n.d.). Retrieved from The Whaling Museum and Education Center: http://www.cshwhalingmuseum.org/

U.S. Department of Transportation. (n.d.). Retrieved from U.S. Merchant Marine Academy: https://www.usmma.edu/

UConn. (n.d.). Retrieved from University of Connecticut: https://uconn.edu/

UConn Department of Marine Sciences. (2018a). *LISICOS -- The Long Island Sound Integrated Coastal Observing System (LISICOS)*. Retrieved from University of Connecticut, Department of Marine Sciences: http://lisicos.uconn.edu/lisi_about.php

UConn Department of Marine Sciences. (2018b, February). *Long Island Sound Integrated Coastal Observing System (LISICOS)*. Retrieved from University of Connecticut (UConn), Department of Marine Sciences: http://lisicos.uconn.edu/

UConn Department of Marine Sciences. (2018c). *Monitoring Your Sound*. Retrieved from University of Connecticut (UConn), Department of Marine Sciences: http://www.mysound.uconn.edu/index.html

Uda, R. (2016, November 22). *Humpback whale grounded on Moriches Bay sandbar draws crowds.* Retrieved from Newsday: https://www.newsday.com/long-island/suffolk/humpback-whale-grounded-on-sandbar-in-moriches-bay-draws-crowds-1.12654407

United States Coast Guard. (n.d.). Retrieved from The United States Coast Guard Acadamy: http://www.cga.edu/

University of Hartford. (2017). Retrieved from University of Hartford: http://www.hartford.edu/
University of Maryland Center for Environmental Science. (n.d.). *How are the scores calculated?* Retrieved from Eco Health Report Cards: https://ecoreportcard.org/report-cards/long-island-sound/indicators/
University of New Haven. (n.d.). *Marine Biology*. Retrieved from Univeristy of New Haven: https://www.newhaven.edu/arts-sciences/undergraduate-programs/marine-biology/
University of Rhode Island Graduate School of Oceanography. (2013). *FOSTER*. Retrieved from Physical Oceanography and Remote Sensing: http://www.po.gso.uri.edu/~codiga/foster/main.htm
USFWS. (2017). *Population Surveys*. Retrieved from U.S. Fish and Wildlife Service (USFWS): https://www.fws.gov/birds/surveys-and-data/population-surveys.php
USGS. (2018). *USGS Studies in Long Island Sound*. Retrieved from Woods Hole Coastal And Marine Science Center, U.S. Geological Survey (USGS): https://woodshole.er.usgs.gov/project-pages/longislandsound_archive/Data/Texture.htm
Wesleyan University. (2018). Retrieved from Wesleyan University: http://www.wesleyan.edu/
Yale University. (2018). *Yale University*. Retrieved from https://www.yale.edu/

24.5.1 List of Maps Used to Inform the Chapter

Below is a list of all maps used to inform this chapter, including maps presented above in the narrative and additional maps used to support chapter findings. Maps listed below are organized by the online data portal on which they are hosted (URL links to data portals are noted in *Section 24.4 References* above). Map products not accessible by online data portal are also noted below.

Please note that many of the maps used in this chapter are simply meant to serve as examples that represent the larger extent of available maps on a certain map portal. Maps that specifically serve as example maps are demarcated with the caret symbol (^) below.

Northeast Ocean Data Portal

- Naval Undersea Warfare Center Testing Range

New York Geographic Information Gateway

- Long Island Sound Benthic Communities

CT DEEP Long Island Sound Water Quality Monitoring Stations Viewer

- Water Quality Monitoring Program Sample Sites

eBird

- Common Tern – Sterna hirundo, Year-Round, All Years^

UConn Department of Marine Sciences

- LISICOS Station Locations

Motus Wildlife Tracking System

- Receiver Locations^

Save the Sound's Sound Health Explorer

- Bacterial Levels and Safe Swimming – Sampling Locations^

Non-Portal Map Products

- Artificial Reef Locations in Long Island Sound
- Christmas Bird Count Locations
- CT DEEP Long Island Sound Trawl Survey Towpaths, 1995-2012
- Project Limulus Monitoring Locations
- Save the Sound LIS Report Card 2016^

More information on some of the map products presented in this chapter, including URL links to data and metadata, can be found in the Research, Monitoring, and Education Map Book (CT DEEP, 2018b). Not all products showcased in the map book may be addressed in this chapter or utilized to inform the final Blue Plan.

24.5.2 Notes on Stakeholder Engagement

Outreach for data review in this sector included conversations with Marine Fisheries staff, emails with two university professors familiar with many of the potential data sets, and a call with the NUWC Senior Environmental Planner. This contact all occurred in January and February 2018, and was efficient for confirming relevant map products, rejecting irrelevant information, and identifying more appropriate sources. The meeting with CT DEEP staff evaluated the LISTS, CT DEEP WQ sampling sites, and Pellegrino and Hubbard maps, as well as several that were deemed irrelevant. University of Connecticut professors were each involved with research work mentioned here: one leads the LISICOS program and discussed that, and pointed to Latimer, et al. (2014) as a good resource. The other has lead several studies characterizing LIS benthic ecology and seafloor surveys, and confirmed that CT DEEP monitoring data is accurate, representative, and relevant, as well as suggesting several other, localized research efforts that could be considered there. However, these studies are not considered representative research in the Sound as a whole in the way Latimer, et al. (2014) is. The conversation with NUWC staff characterized Navy research activities in and around LIS.

Chapter 25

Marine Transportation, Navigation, and Infrastructure

Chapter Table of Contents

Chapter List of Figures and Tables

Figures

Tables

25.1 Key Data and Map Products

The Marine Transportation, Navigation and Infrastructure Sector encompasses a variety of traditional water-dependent uses including transportation by cargo vessels, tug and tow vessels, and ferries and the associated activities and facilities that support such uses. In addition, because it represents such an intensive use of Long Island Sound (LIS), recreational boating is mentioned in this sector but is more deeply explored in *Chapter 19 Recreational Boating and Sailing*.

The All Vessel Density map, which is an aggregation of the passenger, cargo, tug-tow and tanker vessel density maps, is an important and useful map product for this sector. This map shows commercial vessel density traffic routes as "heat maps" based on actual vessel tracking over the course of the year and is the best available source of data for identifying potential conflict with the commercial transportation sector.

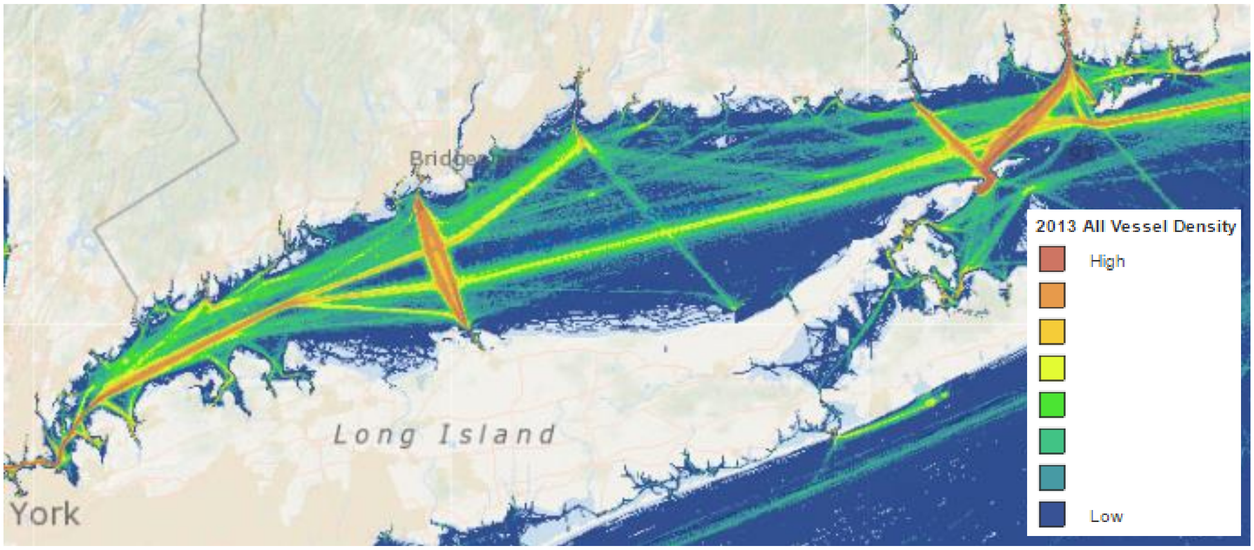
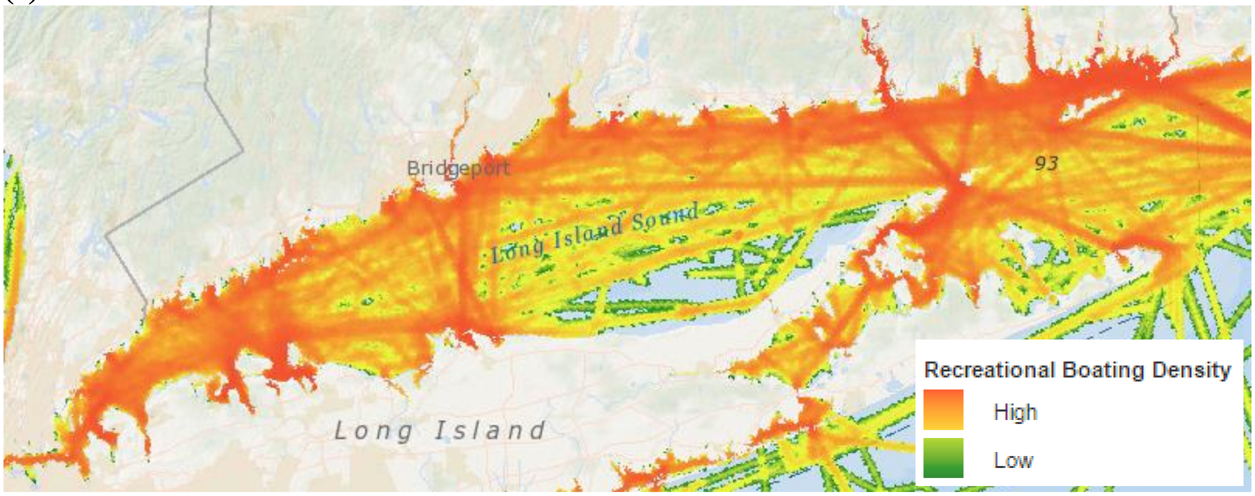


Figure 25-1: [Commercial Traffic, 2013 All Vessel Density](). Commercial vessel traffic derived from Automatic Identification System (AIS) tracking data. The relative amount of vessel activity is indicated qualitatively from high (red) to low (blue). Access available via the Northeast Ocean Data Portal (Northeast Regional Planning Body, 2018).

Similar to the commercial vessel density maps, the Recreational Boating Density Map is a valuable source of information for identifying potential conflicts with boating traffic. This map is also a heat map showing intensity of use. A map showing the individual track lines used to generate the heat map is also available on the Northeast Ocean Data Portal (NODP) and provides useful context when zoomed in for more granular analysis of where recreational boating occurs.

(a)



(b)

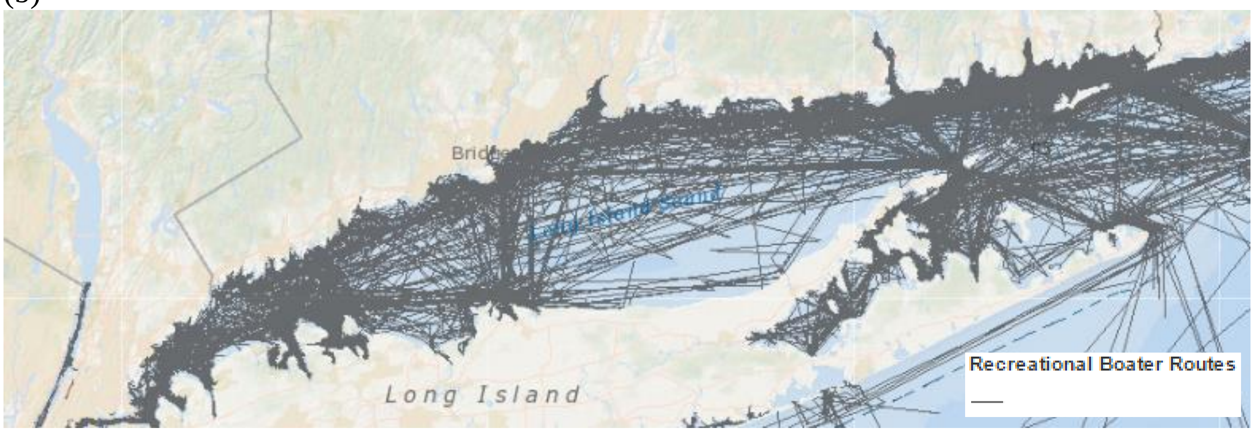


Figure 25-2: [Recreational Boating Routes](). Recreational boating route as reported in 2012 recreational boating survey. Information is displayed as (a) a boating density "heat map" showing the relative amount of vessel activity indicated qualitatively from high (red) to low (green) and (b) track lines or routes reported by boaters. Access available via the Northeast Ocean Data Portal (Northeast Regional Planning Body, 2018).

The map book includes a map of maintained federal navigation channels. Navigation channels are extremely important human use areas where potential for conflict is high and uses other than navigational will be severely restricted. The channels are difficult to see at a sound-wide scale and the information is most useful by accessing directly through the NODP and zooming in.

The Marine Transportation view on the NODP also includes designated anchorage areas and dredged material disposal locations, areas in which certain uses may be restricted or prohibited. For example, activities that disturb the seafloor should not be allowed in dredged material disposal areas and placement of permanent structures in anchorage areas should be restricted.

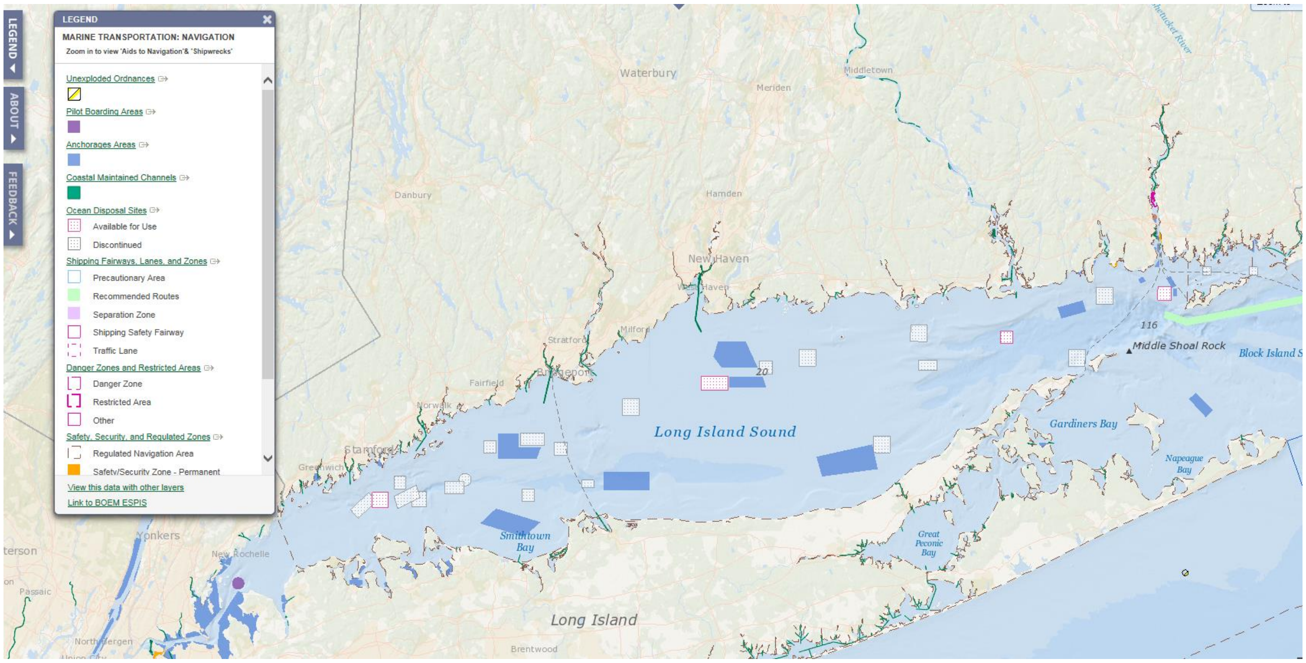


Figure 25-3: [Navigation Summary Map](). Information includes maintained navigation channels, anchorage areas and dredged material disposal areas. Access available via the Northeast Ocean Data Portal (Northeast Regional Planning Body, 2018).

LIS has also played host to a number of sand harvesting sites over the last few decades. Exact locations of these sites are recorded in permit files at the Connecticut Department of Energy and Environmental Protection (CT DEEP) and the U.S. Army Corps of Engineers (USACE). However, conversations with CT DEEP officials in January 2018 indicated that past sand harvesting sites do not merit being designated as future harvesting sites for marine spatial planning purposes.

Even when sand (and other resources such as gravel and stone) are not harvested from LIS, they are transported commercially throughout the Sound, usually by barge. A map product of past and present sand, gravel, and stone producers along the LIS shoreline can be found in the Marine Transportation, Navigation, and Infrastructure Map Book (CT DEEP, 2018a). Moreover, Table 25-1 lists known onshore sand, gravel, and stone terminals with nearshore mooring sites.

Table 25-1: Summary Information of Known Onshore Sand, Gravel, and Stone Terminals with Nearshore Berthing Sites

Name	Location	Technical Specifications	Ownership	Citations
Harborview Terminal	Bridgeport, CT	Asphalt terminal	Harborview Terminals, Inc.	1 2 3
O&G Industries, Main Wharf	Bridgeport, CT	Sand and stone terminal	O&G Industries	1 2
O&G Industries, Seaview Avenue Wharf	Bridgeport, CT	Sand and stone terminal	O&G Industries	1 2
Sprague Terminal, Bridgeport	Bridgeport, CT	Asphalt terminal; max length 650’, max beam 105’, max draft 32’, vessels with draft over 27’5” must transit channel on high water due to shoal in channel	Sprague Energy / Global Partners LP (formerly owned by Motiva Enterprises)	1 2 3 4 5 6 7 8 9
Gateway Terminal	New Haven, CT	Asphalt and road salt terminal; seven berths (four for ships [dry and liquid commodities] and three for barges [dry commodities only]): (1) Main Pier, North Berth (ships) – Max length 650’, max beam 100’, max draft 28’ (2) Main Pier, South Berth (ships) – Max length 735’, max beam 110’, max draft 36’ (3) Wharf #1 (ships) – Max length 650’, max beam 105’, max draft 36’, channel draft 35’ (4) Finger pier (ships) – 650’ long (5) Dock #1 (barges) – 300’ long (6) Dock #2 (barges) – 300’ long (7) Wharf #2 (barges) – 225’ long	Gateway Terminal	1 2 3 4

Name	Location	Technical Specifications	Ownership	Citations
Magellan Terminal, East Street	New Haven, CT	Asphalt terminal; max length 700’, max width 106-110’, max beam 106’, max draft 34-36’	Magellan Midstream Partners LP / Global Partners LP	1 2 3 4 5 6 7 8
LafargeHolcim Terminal	New Haven, CT	Cement terminal	LafargeHolcim Ltd	1
Buchanan Marine, Barge Yard	New Haven, CT	Aggregates terminal	Buchanan Marine LP (subsidiary of U.S. Waterways Transportation LLC)	1 2 3
Tilcon Connecticut, Pine Orchard Dock	Branford, CT	Stone and asphalt terminal; connected by Tilcon Connecticut’s Branford Steam Railroad to Tilcon’s quarry in North Branford, CT	Tilcon Connecticut, Inc. (subsidiary of CRH plc)	1 2 3
Tilcon, Port Washington Aggregates Terminal	Port Washington, NY	Stone terminal	Tilcon New York Inc. (subsidiary of CRH plc)	1 2
Tilcon, Port Jefferson Aggregates Terminal	Port Washington, NY	Stone terminal	Tilcon New York Inc. (subsidiary of CRH plc)	1 2

Numerous other transportation terminals exist along the LIS shoreline. A list of such known terminals in Bridgeport, New Haven, and New London, along with parcel maps indicating their locations, is noted in the Connecticut Deep Water Port Strategy Study, a 2012 report developed for the Connecticut Office of Policy and Management (Moffatt & Nichol and BETA Group Inc., 2012). These maps are being actively updated for Blue Plan purposes to encompass new information and known terminal sites outside these three cities and will be included in future versions of the Inventory.

Finally, it is important to note coastal infrastructure in this sector that could influence surrounding water quality, commercial activity, and recreational use. Figure 25-4 is a map showcasing the Sewage Treatment Plants on the Connecticut side of Long Island Sound. For more information on coastal infrastructure and activity, please refer to *Chapter 20 Harbors and Marinas* and *Chapter 26 Energy and Telecommunications*.

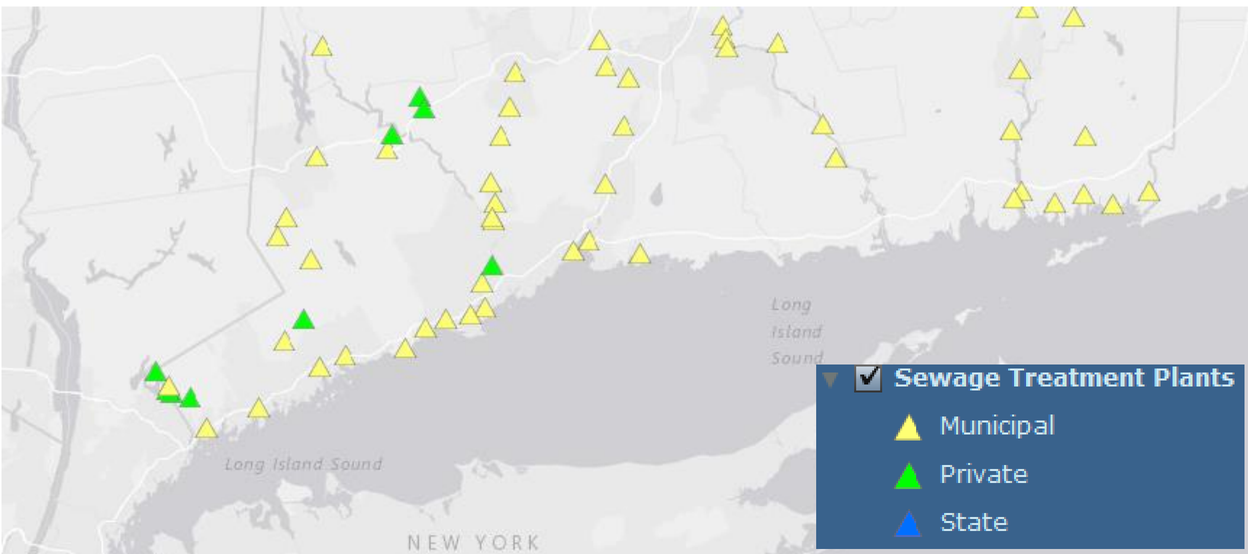


Figure 25-4: Sewage Treatment Plants. Municipal, Private, and State-Owned Sewage Treatment Plants. Access available via the Aquaculture Mapping Atlas (UConn CLEAR, 2018).

25.2 Assessment of Data Quality

25.2.1 Sources of Data and Metadata

All the data used to inform this chapter, with the exception of the Sewage Treatment Plants data layer, are available via the Northeast Ocean Data Portal. Some sets of data can also be viewed on other portals. Shipping Lanes and Zones can also be viewed on the New York Geographic Information Gateway and Maintained Channels can also be viewed via the Mid-Atlantic Ocean Data Portal. Full metadata descriptions can be found on the Northeast Ocean Data Portal, New York Geographic Information Gateway, and Mid-Atlantic Ocean Data Portal.

The Sewage Treatment Plan data layer is the one exception and can found on The Aquaculture Mapping Atlas. The data source and maintainer is UConn Center for Land Use Education and Research in partnership with Connecticut Sea Grant and the Connecticut Department of Agriculture, Bureau of Aquaculture. More metadata information on sewage treatment plants and municipal wastewater can be found on CT DEEP's Municipal Wastewater webpage (CT DEEP, 2017). Additional source and metadata information may be found in Connecticut's Open Data Sewage Treatment Plant data layer, which uses information from CT DEEP (CT DEEP, 2018b).

To inform the Commercial Vessel Density data layer, Automatic Identification System (AIS) data was collected from vessels in 2013. Further information on the requirement of vessels to have AIS can be found Marine Cadastre's AIS Frequently Asked Question webpage (Marine Cadastre, 2016).

Marinas by County, 2013 and Ports Cargo Volumes were developed in part through economic research and reports. Marinas by County, 2013 was based on research from the Center for the Blue Economy and the National Oceanic and Atmospheric Administration's (NOAA) 2013 Economics National Ocean Watch database. The Ports Cargo Volumes layer was sourced through the National Geospatial-Intelligence Agency World Port Index.

Recreational Boating Density was created based on resulted from the 2012 Northeast Recreational Boater Survey, which was conducted in part by SeaPlan. More information on this report, and how it was used to develop this data layer, can be found in *Chapter 19 Recreational Boating and Sailing*.

Other layers are federally sourced and maintained including the Pilot Boarding Areas developed by the United States Coast Pilot, Shipping Lanes and Zones developed by the NOAA Coastal Services Center, and Maintained Channels developed by the U.S. Army Core of Engineers.

25.2.2 Accuracy, Representativeness, and Relevance of Map Products

Commercial vessel density map products are highly relevant in Long Island Sound. Commercial traffic data are considered accurate and representative of vessel tracks but do not identify if or where vessels may stop between end points. Vessel AIS data may not represent all types of commercial vessel traffic in Long Island Sound. Some subsectors of marine commercial vessel use such as sightseeing and small commercial fishing and charter vessels may be excluded. These uses could be important in some areas. Stakeholders generally responded positively to commercial vessel traffic maps. Some expressed concerns about representativeness because the maps are not based on more current AIS datasets and the maps do not reflect the temporal aspect of vessel traffic (for example the track lines representing the Bridgeport-Port Jefferson Ferry appear as solid lines but the ferry may run only once per hour).

Recreational boating maps are highly relevant but accuracy and representativeness are uncertain because they are based on boater survey responses over a narrow time scale. Some stakeholders raised concerns about the representativeness of the recreational boating traffic data.

Stakeholders commented that data on marinas may be highly relevant and expressed concern that detailed location information on individual marinas is not available and that aggregating the number of marinas by county as shown in these maps is of limited value.
The maintained channels maps are highly relevant and because they are based on USACE and NOAA surveys are also highly accurate and representative of the location of Federal Navigation Projects. However, the maps are not fully representative of all maintained channels, which may also include locally or privately maintained channels

Maps showing anchorage areas and dredged material disposal site, which are on the Northeast Ocean Data Portal but are not in the map book, are relevant and very accurate and representative. It was noted by one stakeholder that the Bridgeport Dredged Material Management Plan and the locations of Confined Aquatic Disposal (CAD) cells for dredged material may be relevant.

25.2.3 Data Gaps and Availability of Data to Address Gaps

As noted above, more current vessel traffic map products are needed and NOAA has indicated that the commercial vessel density maps products are expected to be updated in the early 2018. The updated map products are expected to represent vessel traffic on a monthly rather than annual time scale.

As noted earlier AIS is not required on some smaller commercial and passenger vessels and recreational vessels are not represented. Vessel AIS data may not represent all types of commercial vessel traffic in Long Island Sound. Thus, some subsector of marine vessel use such as sightseeing and small commercial fishing and charter vessels may be excluded. These uses could be important in some areas. A stakeholder noted that dinner and tour boats are an important use (e.g., Thimble Island tours, New London lighthouse tours).

More current, comprehensive and detailed recreational vessel boating density information is desirable, however there is no readily available source of data and the survey approach used for the existing dataset would be costly and time consuming to repeat and there are currently no plans for doing so.

While non-federal channels are not included in the navigation channels dataset, identifying and creating new map products for other maintained channels could be a significant effort relative to the value of the information.

While maps of existing open water dredged material disposal sites are available, the location of CAD cells and other future dredged material management locations could be beneficial and would not require significant investment to create.

Mapping of specific locations of marinas would be useful and may be available. The Connecticut Aquaculture Mapping Atlas contains locations of some but not all marinas (UConn CLEAR, 2018).

Updated and more detailed information on ports cargo volume will become available from a study that is being conducted for the Connecticut Port Authority by the Connecticut Economic Resource Center.

A stakeholder commented that Massachusetts has identified historic shipping lanes, which could be helpful when considering potential future shipping opportunities.

A stakeholder suggested that other past uses, such as lobstering areas, should be identified in the event that such uses return.

25.3 Relevance

25.3.1 Relative Historical Importance

The State of Connecticut has long support traditional water-dependent uses through the Connecticut Coastal Management Act (CCMA), giving "high priority and preference to water-dependent use," where such uses are defined to include, among others, marinas, recreational and commercial fishing and boating facilities, port facilities, navigation aids, basins and channels and uses dependent upon waterborne transportation (C.G.S. Sec. 22a-93(16)) (Coastal Management, 2015). The CCMA establishes various policies pertaining to marine transportation as follows:

- "To promote, through existing state and local planning, development, promotional and regulatory authorities, the development, reuse or redevelopment of existing urban and commercial fishing ports giving highest priority and preference to water-dependent uses, including but not limited to commercial and recreational fishing and boating uses" (*C.G.S. Sec. 22a-92(b)(1)(C)*)
- "To disallow uses with unreasonable congest navigation channels, or unreasonably preclude boating support facilities elsewhere in a port or harbor" (*C.G.S. Sec. 22a-92(b)(1)(C)*)
- "To encourage, through the state permitting program for dredging activities, the maintenance and enhancement of existing federally maintained navigation channels, basins and anchorages" (*C.G.S. Sec. 22a-92(c)(1)(C)*)
- "To encourage increased recreational boating use of coastal waters" (*C.G.S. Sec. 22a-92(b)(1)(G)*)

(Coastal Management, 2015)

In 2016, the Connecticut Port Authority (CPA) was established as a state-wide authority to coordinate the development of Connecticut's ports and harbors (CPA, 2018). The CPA is a primary stakeholder in the Blue Plan and is represented on the Blue Plan Advisory Committee by Executive Director Evan Matthews. Among various other significant stakeholders include the Connecticut Maritime Coalition, Connecticut Harbor Management Association, towing service companies, ferry operators and cargo terminal operators (Connecticut Harbor Management Association, 2018; Conneticut Maritime Coalition, 2017).

Marine transportation has been an important use of Long Island Sound historically and, though having suffered a decline, remains so today. Marine transportation can provide economic, cultural, environmental and quality of life benefits through increased economic activity (statewide and in urban waterfront areas), reductions in highway congestion and air emissions, availability of recreational boating opportunities. Connecticut has three deep water ports in Bridgeport, New Haven and New London, and numerous smaller harbors that support various commercial water-borne transportation activities (e.g., Stamford, Norwalk, Stonington) and numerous recreational boating marinas. As previously mentioned, in 2012, the State of Connecticut released Connecticut Deep Water Port Strategy Study to assist the state in developing and implementing a long-term strategy for the economic development of Connecticut's three deep water ports (Moffatt & Nichol and BETA Group Inc., 2012). This study reports that "despite its rich maritime history, the Connecticut ports and related maritime industries have not fared well in recent decades" noting that "export volumes have grown modestly, while import volumes have declined by nearly 80% since 2006. Much of this decline is due to the phasing out of coal and elimination of fresh fruit imports into Bridgeport, as well as the loss of imports due to the real estate market collapse and the corresponding loss of demand for lumber, steel and other building materials that would have passed through Connecticut ports."

In New York, the vast majority of cargo enters through the Port of New York/New Jersey which is not located on Long Island Sound. The north shore of Long Island, which fronts Long Island Sound includes facilities in Port Jefferson, Riverhead, and Orient Point that support water-borne transportation of cargo and fuel and/or ferry services. Ferries also service Fishers Island and Plum Island. Various harbors on Long Island, Fishers Island and in Westchester County support recreational boating.

25.3.2 Socio-Economic Context

According to a report by Pomeroy, et al. (2013), the total output impact of the maritime industry in Connecticut in 2010 was nearly $7 billion and contributed nearly 40,000 jobs. The report also cites a study commissioned by the Connecticut Maritime Coalition that found that in 2007, Connecticut's maritime-dependent industries, including their suppliers and related economic activities, were estimated to account for over $5 billion in business output, generating 30,000 jobs; approximately $1.7 billion in household income; and $2.7 billion in Connecticut's gross domestic product (GDP) (Pomeroy, Plesha, & Muawanah, 2013).

25.3.3 Other Notes

No other notes at this time.

25.4 References

ANL. (2017, December). *Energy Zones Mapping Tool*. Retrieved from Argonne National Laboratory (ANL): https://ezmt.anl.gov/mapping/viewer

Coastal Management, Conn. Gen. Stat. § 22a-90 to 22a-113j (2015).

Connecticut Harbor Management Association. (2018). *An Assocation of Local Harbor Management Commissions, Harbormasters, Interested Companies and Individuals* . Retrieved from Connecticut Harbor Management Association: http://www.ctharbormanagement.org/

Conneticut Maritime Coalition. (2017). *Advocating for Connecticut's Maritime Industry* . Retrieved from Connecticut Maritime Coalition: http://www.ctmaritime.com/

CPA. (2018). *Home Page*. Retrieved from Connecticut Port Authority: http://ctportauthority.com/

CT DEEP. (2017). *Municipal Wastewater*. Retrieved from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2719&q=325580&deepNav_GID=1654%20

CT DEEP. (2018a). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635

CT DEEP. (2018b). *Sewage Treatment Plants*. Retrieved from Connecticut Open Data: https://data.ct.gov/Environment-and-Natural-Resources/Sewage-Treatment-Plants/c4sk-h5dj

Marine Cadastre. (2016). *AIS FAQ*. Retrieved from Marine Cadastre: https://marinecadastre.gov/ais/faq/

Moffatt & Nichol and BETA Group Inc. (2012). *Connecticut Deep Water Port Strategy Study*. Presented to the State of Connecticut, Office of Policy and Management. New York: Moffatt & Nichol.

Northeast Regional Planning Body. (2018). Retrieved from Northeast Ocean Data Portal: http://www.northeastoceandata.org/data-explorer/

Pomeroy, R. S., Plesha, N., & Muawanah, U. (2013). *Valuing the Coast: Economic Impacts of Connecticuts Maritime Industry.* Connecticut Sea Grant.

UConn CLEAR. (2018, February). *Connecticut Aquaculture Mapping Atlas*. Retrieved from University of Connecticut Center for Land Use Education and Research (UConn CLEAR), Connecticut Sea Grant, and Connecticut Department of Agriculture Bureau of Aquaculture: https://clear3.uconn.edu/aquaculture/

25.5 Appendices

25.5.1 List of Maps Used to Inform the Chapter

Below is a list of all maps used to inform this chapter, including maps presented above in the narrative and additional maps used to support chapter findings. Maps listed below are organized by the online data portal on which they are hosted (URL links to data portals are noted in *Section 25.4 References* above). Map products not accessible by online data portal are also noted below.

Northeast Ocean Data Portal

- 2013 All Vessel Density
- 2013 Cargo Vessel Density
- 2013 Tug-Tow Vessel Density
- 2013 Tanker Vessel Density
- Pilot Boarding Areas
- Ports Cargo Volumes
- Marinas by County, 2013
- Recreational Boating Density

New York Geographic Information Gateway

- Shipping Lands and Zones

Mid-Atlantic Ocean Data Portal

- Maintained Channels

Aquaculture Mapping Atlas

- Sewage Treatment Plants

Energy Zones Mapping Tool (must sign up for an account)

- Mineral Resources

More information on some of the map products presented in this chapter, including URL links to data and metadata, can be found in the Marine Transportation, Navigation, and Infrastructure Map Book (CT DEEP, 2018a). Not all products showcased in the map book may be addressed in this chapter or utilized to inform the final Blue Plan.

25.5.2 Notes on Stakeholder Engagement

Emails were sent on December 4, 2017, to various sector representatives including port authorities, the Connecticut Harbor Management Association, port terminal operators, ferry operators, shipping companies, marine towing companies, regional planning organizations, the U.S. Department of Transportation, and the USACE. The email communications briefly introduced the Blue Plan and Inventory and the important role of stakeholder engagement, distributed the marine transportation map book for review and notified stakeholders of an upcoming webinar and the opportunity for additional stakeholder engagement as needed. A follow-up reminder email was sent on December 15, 2017.

A Marine Transportation Sector webinar was held on December 18, 2017. The webinar provided participants with an overview of the Blue Plan and reviewed map products contained in the marine transportation and navigation sector map book. During the webinar comments and questions were received from representatives of the Connecticut Maritime Coalition, New Haven Port Authority and Bridgeport Port Authority.

The Blue Plan was briefly discussed at a meeting of the Connecticut Port Authority Board of Directors in Stamford on November 1, 2017. On January 9, 2018, a brief overview of the Blue Plan was presented at the Connecticut Maritime Coalition Board of Directors meeting and was followed by several questions and comments by board members.

A meeting with the Connecticut Harbor Management Association Board of Directors was scheduled for late-December 2017 but was postponed due to schedule conflicts. The meeting will be rescheduled.

Chapter 26

Energy and Telecommunications

Chapter Table of Contents

Chapter List of Figures and Tables

Figures

Tables

26.1 Key Data and Map Products

The lands surrounding Long Island Sound (LIS) are some of the most densely populated areas in the United States; in fact, it is believed that about 7.5% of the entire U.S. population (approximately 23.3 million people) live within a 50-mile radius of the Sound (LISS, 2018). Given that energy and telecommunications demand grows with population size, it is expected that such demand is significant in the LIS region, not in the least because of the area's notable history of human development and resource use.

For Blue Plan purposes, the energy and telecommunication sector is best described by the existing energy and telecommunications infrastructure and activity in place in and around the Sound. Such infrastructure and activity falls into four general data categories:

1. In-Sound Infrastructure and Designated Areas
2. Coastal Fuel Terminals and Storage Facilities with Nearshore Infrastructure
3. Coastal Energy Facilities (including hydroelectric, fossil fuel, and nuclear)
4. Renewable Energy (including wind, wave, and tidal)

Each of these categories is explained in more detail below.

<u>In-Sound Infrastructure and Designated Areas</u>

Spatial data on existing in-Sound infrastructure and designated areas, such as cables, pipelines, and lightering/ship-to-ship transfer zones, are available through the National Oceanic and Atmospheric Administration (NOAA) Electronic Navigational Charts (ENCs) and various reputable online data sources. Figure 26-1 illustrates the known offshore oil terminal platforms, submarine (electric and telecommunications) cables, submarine (gas) pipelines, and cable and pipeline areas in LIS. The difference in nomenclature between "submarine cable' and "cable area" (and, for that matter, "submarine pipeline" and "pipeline area") is simply one of classification distinction by NOAA for its navigational charts, in which navigators are to expect that cables and pipelines can be found anywhere in their respective named areas.

Major infrastructure in Long Island Sound includes the following.

Two offshore terminal platforms, from west to east:

- National Grid Northport Terminal Platform
- United Riverhead Terminal Platform

Two gas pipelines, from west to east:

- Eastchester Extension
- Long Island Sound crossing of the Iroquois Gas Pipeline

Two submarine cables, one west-east-oriented and the other north-south-oriented:

- Fiber-optic Link Around the Globe (FLAG) Atlantic-1 (telecommunications cable)
- Cross-Sound Cable (electric and telecommunications cable)

Four cable areas, each of which contain a cable or group of cables, from west to east:

- Y49 Cable (also known as the Sprain Brook-East Garden City Cable)
- 1385 Cable (also known as the Northport-Norwalk Harbor Cable)
- AT&T Cable
- MCI/Verizon Cable

A NOAA-designated pipeline area just west of the Y49 Cable is the Y50 Cable (also known as the Dunwoodie-Shore Road Cable); the Y50 Cable is an electric cable line; however, because it is encased in a steel pipe, NOAA considers the cable to be within a pipeline area.

Finally, there are various, minor cable areas around the eastern entrance of the Sound (i.e., around Fishers Island, Great Gull Island, and Plum Island) and as well as those protruding into the Sound, primarily from mainland Connecticut.

It should be noted that some of the infrastructure named above is solely in New York waters. Such infrastructure includes both offshore terminals, the FLAG Atlantic-1 telecommunications cable, the Eastchester Extension pipeline, the Y49 Cable, the Y50 Cable, and some of the minor cables on the eastern end of the Sound. State water boundaries are included in Figure 26-1 to illustrate this spatially.

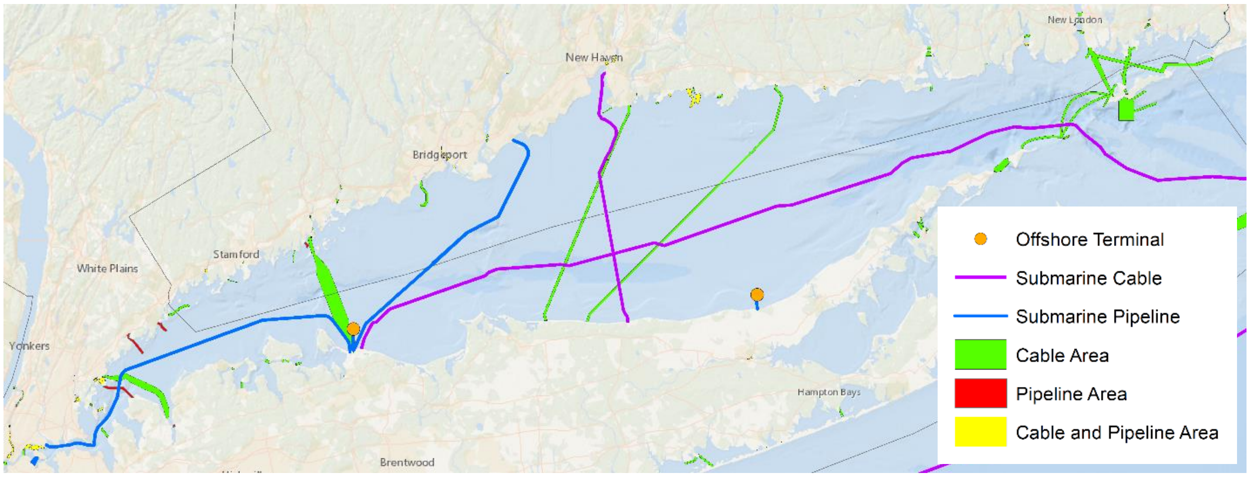


Figure 26-1: Major Energy and Telecommunications Infrastructure in Long Island Sound. This map is a combination of spatial information from a variety of different sources, including NOAA Electronic Navigation Charts and the Northeast Ocean Data Portal (NOAA, 2018; Northeast Regional Planning Body, 2018).

Information about all the major infrastructure named above – as well as information about some of the minor cable areas – are described in more detail in Tables 26-1 through 26-4 below. It is necessary to mention that the minor cable areas mentioned in Table 26-4 should not be considered a comprehensive list of all the minor cable areas depicted in Figure 26-1. In fact, information about many of these minor cable areas is either outdated or non-existent. However, for Blue Plan purposes, specific data about these cable areas is not as important as the location of the cable areas, which is fully captured in Figure 26-1.

It is likely that some of these minor cable areas house cables that either currently serve (or formerly served) as electric sources for inhabited islands. For instance, the Cable and Pipeline Area surrounding the Thimble Islands in Branford represents a collection of cable and pipeline infrastructure that services the inhabitants on these Islands. The Town of Branford has on public file a comprehensive map outlining the electric and telecommunications cables and water and sewer pipelines that travel between the Thimble Islands and mainland Connecticut and amongst the Islands themselves (Figure 26-2).

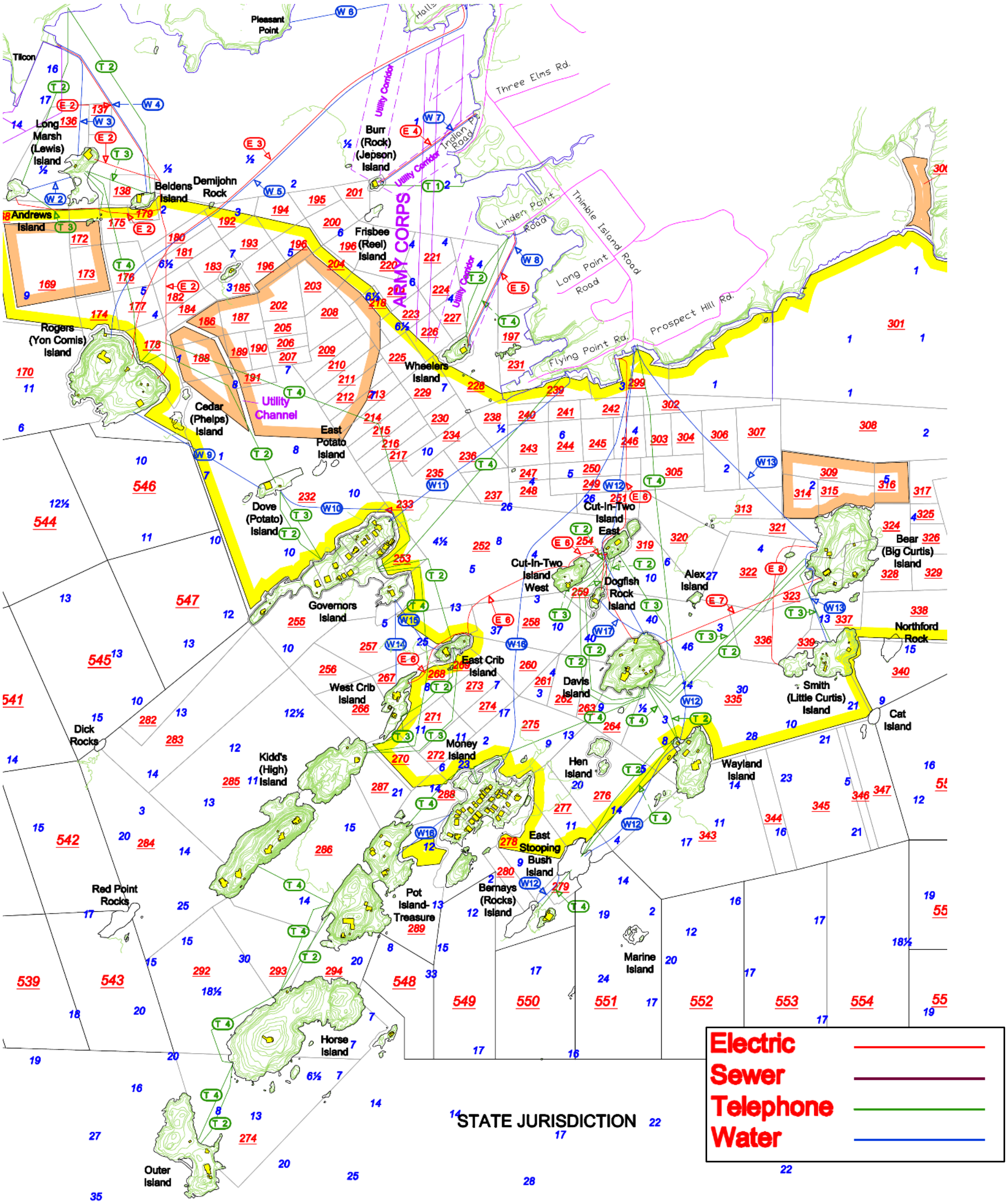


Figure 26-2: Cables and Pipelines Surrounding the Thimble Islands. The Town of Branford has mapped out, among other things, the electric and telephone cables and the water and sewer pipelines running between and to/from the Thimble Islands. Electric cables are owned by the

Thimble Island Electric Cooperative (The State of New York, 1982). Map access available via the Town of Branford (Lust & Kardos, 2008).

It is also possible that some of the minor cable areas house cable that currently serve (or formerly served) as electric sources for lighthouses and beacons in the Sound. To illustrate this possibility, Figure 26-3 depicts the cable areas from Figure 26-1 (along with pipeline areas, to account for the Y50 Cable), overlaid on a spatial data layer of shore-adjacent lighthouses and named, in-Sound lighthouses and beacons that either closely border, overlap with, or cap-end known cable lines or cable areas (Cherau, et al., 2010; NOAA, 2018; Northeast Regional Planning Body, 2018).

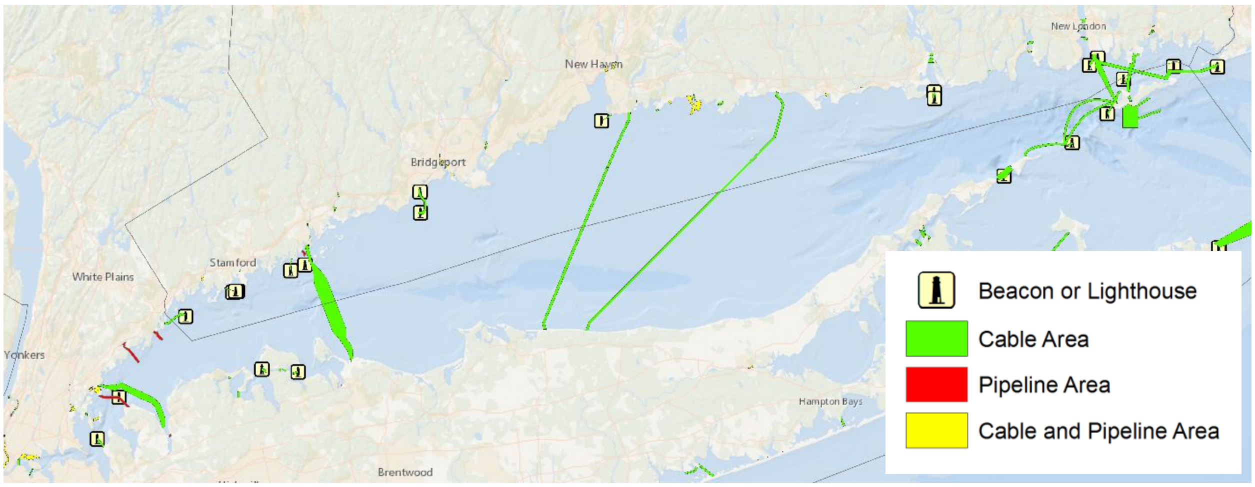


Figure 26-3: Major Cable infrastructure and Lighthouses in Long Island Sound. Pipeline areas were included in this map graphic, due to the Y50 cable being designed as a Pipeline Area in the NOAA ENC. This map is a combination of spatial information from a variety of different sources, including NOAA Electronic Navigation Charts and the Northeast Ocean Data Portal (NOAA, 2018; Northeast Regional Planning Body, 2018).

All cables and pipelines depicted in Figure 26-1, either individually demarcated or lying within a cable and/or pipeline area, connect to an onshore facility (e.g., coastal energy facility, fuel terminal or storage facility, electrical substation) and/or an existing on-land network (e.g., electric grid, pipeline system). Map products of this on-land infrastructure can be found in the Energy & Telecommunications Map Book (CT DEEP, 2017).

In addition to physical infrastructure in the Sound, designated lightering and ship-to-ship transfer zones exist within the Sound. Both petroleum and coal lightering is known to take place in LIS. Official lightering and ship-to-ship transfer zones have been designated in the Sound since at least July 1999, when the U.S. Coast Guard (USCG) issued an official Policy Letter, outlining six zones in the Sound where lightering could take place (each zone named after the location from which it was found offshore: Bridgeport [CT], New Haven [CT], Niantic [CT], Northport [NY], Port Jefferson [NY], and Riverhead [NY]) (USCG, 1999). While not nationally regulated, lightering and ship-to-ship zones are designated through the general authority granted to the Captain of the Port Long Island Sound (National Research Council, 1998). As of February 2017, the designated lightering and ship-to-ship transfer zones in LIS are the seven established anchorage areas outlined in the Code of Federal Regulations (CFR) [33 CFR Part 110.146] and depicted in Figure 26-1: Anchorage Areas in *Chapter 27 National Security* (USCG, 2017). These seven zones, for the most part, closely resemble the six former lightering/ship-to-ship transfer zones, with the exception of the former New Haven lightering zone: The New Haven area is now served by two anchorage areas (a "North" and a "South" area) instead of a single lightering/ship-to-ship transfer zone (FERC, 2008, Appendix C).

Lightering is primarily carried out for economic reasons, given that it is usually most economical for a large tanker to transport petroleum and coal products long distances and then, upon approaching the destination site, move the product to smaller vessels for final delivery to one or more ports. Lightering is also used as a way to transport commodities into harbors where there is a restricted depth (or too shallow of a draft to accommodate large vessels) or when lightering is specified in the terms of contract between cargo traders (Colman & Kleiman, 2010; National Research Council, 1998).

Lightering that takes place in LIS is known as "inshore lightering", which consists of a deepwater anchorage in a sheltered location (such as the Sound). The ship to be lightered (STBL) is anchored and a service vessel (usually a tug-barge unit) maneuvers alongside the STBL. The lightering process consists of three phases (National Research Council, 1998):

1. *Approach* – Begins when the STBL and service vessel are about three miles apart.
2. *Transfer* – After being moored together, the transfer begins. Each discharge from the STBL to the service vessel is known as a "lift".
3. *Post-Transfer* – The service vessel continues on to the delivery sites

Petroleum-based lightering in LIS consists primarily of refined products (i.e., gasoline, jet fuel, and diesel fuel) and sometimes small amounts of crude oil. The STBLs carrying such products are typically 30,000-50,000 deadweight tonnage tankers (with approximately capacity of 400,000 barrels) whose journeys start at refineries in the Caribbean, Gulf of Mexico, Canada, or Europe (Colman & Kleiman, 2010; National Research Council, 1998). As of 2010, it was believed that approximately 1.4 million barrels of finished petroleum products are lightered in LIS annually (Colman & Kleiman, 2010).

Coal-based lightering in LIS originates from 700-800 ft, 87,000 deadweight tonnage tankers, the largest of all vessels entering the USCG's Captain of the Port Long Island Sound zone. STBLs arrive in the Bridgeport lightering zone about every 10 days (FERC, 2008, Appendix C).

According to a September 2006 USCG report, the following was true of the then six lightering and ship-to-ship transfer zones (FERC, 2008, Appendix C); this information may or may not be accurate for the corresponding seven lightering/ship-to-ship transfer zones of today, but the following is provided as the latest publicly-available information on such zones:

- *Bridgeport (CT)* – Lightering of coal occurs "almost continuously" in this zone, with the lightered product being delivered by barge to a power generation facility in Bridgeport

(FERC, 2008, Appendix C, pg. 97); lightering of petroleum products also occurs in this zone (Colman & Kleiman, 2010).

- *New Haven (CT)* – This area is the most heavily used for petroleum products, particularly the transfer of gasoline from tankers to barges, which go on to further deliver the products to onshore New Haven terminals (see Table 26-5 for more information); gasoline lightering in this zone began on a more regular basis in 2005 and is expected to continue for the foreseeable future.

- *Niantic (CT)* – Lightering is infrequently conducted in this zone; when conducted, lightering consists of petroleum products.

- *Northport (NY)* – Frequency of lightering in this zone is unknown; however, when conducted, lightering likely consists primarily of petroleum products, as this zone is frequently used as an anchorage area for vessels wanting to conduct transfer operations at the National Grid Northport Terminal Platform (see Table 26-1 for more information).

- *Port Jefferson (NY)* – Frequency of lightering in this zone is unknown; however, when conducted, lightering likely consists primarily of petroleum products, as Port Jefferson has marine oil transfer facilities in addition to an energy generation facility.

- *Riverhead (NY)* – Lightering is infrequently conducted in this zone; when conducted, lightering consists of petroleum products; this zone is more frequently used as an anchorage area for vessels wanting to conduct transfer operations at the United Riverhead Terminal Platform (see Table 26-1 for more information).

Coastal Fuel Terminals and Storage Facilities with Nearshore Infrastructure

There are numerous onshore energy terminals and storage facilities that have nearshore docks, wharfs, or other berthing areas for ships to load or unload raw or processed fuel products. Table 26-5 provides a list of known terminals and storage facilities with shipping berths in LIS, along with known anchorage areas, both designated and informal, that ships carrying fuel products can utilize. Efforts by the Blue Plan team are currently being undertaken to capture all the onshore terminals and storage facilities on Tables 26-1 and 26-5 into a single map product.

Table 26-1: Summary Information of Offshore Terminal Infrastructure in Long Island Sound, from West to East

Name	Location	Technical Specifications	Additional Notes	Ownership	Citations
National Grid Northport Terminal Platform	Offshore (two miles north of Fort Salonga, NY)	Offshore petroleum terminal; consists of an unloading platform, two mooring platforms (each approx. 50’ x 50’), and mooring buoys; stands 17’ above water surface; max draft 45’	Completed in and operating since 1967; connected to onshore terminal in Fort Salonga, NY (just north of Northport) via submarine pipelines; the Iroquois gas pipeline and its associated Eastchester extension crosses onto Long Island at Northport	National Grid USA (formerly owned by Long Island Lighting Company (LILCO) and KeySpan)	1 2 3 4 5
United Riverhead Terminal Platform	Offshore (one mile north of Riverhead, NY)	Offshore petroleum terminal; stands 24.5’ above mean low water; consists of a center platform (approx. 100’ x 45’) with berths on either side (2 berths total); overall platform footprint of approx. 250’ x 100’; (1) North Berth: Max length 1150’ (designed for “very large crude carriers” and Suezmax tankers), min length 220’, max draft 62’ (2) South Berth: Max length 640’, min length 220’, max draft 42’	Originally constructed in 1956 with further construction in 1974; connected to onshore terminal in Riverhead, NY, via two 24” submarine pipelines	United Riverhead Terminal, Inc. (affiliate of United Refining Company Inc.; formerly owned by ConocoPhillips and Northville Industries, Tosco, Phillips Petroleum, ConocoPhillips, and Phillips 66)	1 2 3 4 5 6 7

Table 26-2: Summary Information of Major Pipeline Infrastructure in Long Island Sound, from West to East

Name	Location	Technical Specifications	Additional Notes	Ownership	Citations
Eastchester Extension Pipeline	National Grid's Northport Station, Northport, NY, to ConEdison's Hunts Point Station, The Bronx, NY	Liquefied natural gas (LNG) pipeline; 30.3 miles of 24" pipeline (26.4 miles of which are buried); pipeline trenches were dug using a combination of horizontal directional drilling (shallow nearshore waters only) and plowing; mechanical backfilling of excavated material was attempted without much success within 1 year, total seafloor impacts was between 7,800-14,600 acres (depending on extent of use of mid-line buoys)	Completed in 2004; construction inadvertently damaged Y49 cable but cable was later repaired; Iroquois Gas Transmission System states that the project allowed the delivery of an additional 230 MMcf/day of LNG to the New York City metropolitan area (with the ability to expand upwards of 750 MMcf/day).	Iroquois Gas Transmission System LP (partnership of TC PipeLines Intermediate LP, TransCanada Iroquois Ltd, Dominion Iroquois Inc., and Iroquois GP Holding Company LLC)	1 2 3 4 5 6 7
Iroquois Pipeline, Long Island Sound crossing	GenConn's Devon B Station, Milford, CT, to National Grid's Northport Station, Northport, NY	LNG pipeline; approx. 26 miles of 24" pipeline; pipeline trenches were dug using a combination of methods (based on water depth): dredging (shallow nearshore waters only), plowing, and excavation; pipeline was partially buried: (a) Non-buried portions were largely placed on silt and sand-silt areas with expected partial burial due to natural sediment movement, (b) Pipeline areas near oyster beds and oyster harvesting areas were buried with	Completed in 1991; pipeline crossing is part of a larger 416-mile interstate pipeline system connecting to various other pipeline systems including the TransCanada Pipeline at the northern terminus in Waddington, NY; the southernmost termini are National Grid's South Commack Station in Commack, NY, and ConEdison's Hunts Point Station in The Bronx, NY via the Eastchester Extension Pipeline (see below); the entire system transports more than 1 Bcf/day of LNG from Canada into	Iroquois Gas Transmission System LP (partnership of TC PipeLines Intermediate LP, TransCanada Iroquois Ltd, Dominion Iroquois Inc., and Iroquois GP Holding	1 2 3 4 5 6 7

Name	Location	Technical Specifications	Additional Notes	Ownership	Citations
		a min. of 3' cover, (c) Landfall areas were buried with 5-15' of cover (some with concrete coating), depending on historical erosion patterns and topography; assuming a 75-ft construction right-of-way, total seafloor impact was approx. 243 acres	the U.S. and started operating commercially in 1992	Company LLC)	

Table 26-3: Summary Information of Major Electric and Telecommunications Cable Infrastructure in Long Island Sound, from West to East

Name	Location	Technical Specifications	Additional Notes	Ownership	Citations
Y49 Cable (Sprain Brook-East Garden City Cable)	ConEdison's Sprain Brook Substation, Yonkers, NY, to Long Island Power Authority's (LIPA) East Garden City Substation, East Garden City, NY	Submarine electric cables; 26.6 miles long in total, 7.9 miles of which cross LIS; four self-contained, high-pressure fluid-filled cables buried in the seabed (three energized phase cables and a de-energized spare) along with two fiber optic cables; 345 kV; 637 MW; cable placement utilized underwater jet plow; cables laid approx. 10' into sea bottom and backfilled 4', pipe-type cable used for land portions of the cable route	Construction began in 1989 and was completed in 1991; when constructed, the Y49 was considered the final link in New York Power Authority's (NYPA) high voltage transmission network installed to provide lower-cost electricity from Canada/upstate NY to New York City and Long Island, NYPA leases a section of the Sprain Brook Substation; National Grid (formerly KeySpan Electric Services) maintains the East Garden City Substation as an agent of LIPA; cable system experienced anchor strikes in 2004 and 2014 but were repaired	NYPA (cable used by LIPA under contract with NYPA)	1 2 3 4 5 6 7 8 9 10 11 12 13
Y50 Cable (Dunwoodie-Shore Road Cable)	ConEdison's Dunwoodie North Substation, to LIPA's Glenwood Landing Station, Glenwood Landing, NY, via both LIS and Hempstead Harbor	Submarine electric cables; approx. 18 miles long; 12.75" pipe-type cable circuit (i.e., housed in steel and concrete piping) coated in concrete; dielectric fluid circulated to cool conductors and insulate electricity; 345 kV; 653 MW; cable placement utilized dredges (clam shell, drag line, or suction)	Construction began between 1976-1977, operations began in 1978; in-Sound cable failure in May 2002 possibly due to thermo-mechanical bending; cable was subsequently repaired and temporarily de-rated from 600 MW to 400 MW temporarily to minimize thermal bending	Jointly by ConEdison and LIPA	1 2 3 4 5 6 7 8 9 10 11

Name	Location	Technical Specifications	Additional Notes	Ownership	Citations
		to dig 5' trenches in LIS and 10' trenches in Hempstead Harbor; indeterminate backfill was used to fill trenches after pipe-laying			
1385 Cable (Northport-Norwalk Harbor Cable)	Eversource's Norwalk Harbor 6J Substation, Norwalk, CT, to Long Island Power Authority's Northport 6F Substation, Northport, NY	Submarine electric cables; approx. 11 miles long; originally consisted of seven 3" dielectric fluid-filled cables; cable placement of original cables two methods: (1) In nearshore waters, dredged (conventional and hydraulic) trench with concrete, rock, and other backfill, (2) In deeper water, laid directly on seafloor and later filled (though not completely); from 2007-2008, all seven cables were replaced with three, 9", 138 kV alternating current (AC) cables, which carry up to 300 MW of electricity; the new cables were completely buried under the seabed (avg. 6') using an underwater jet plow system	Original cables placed in 1969; original cables were damaged on at least 55 occasions by various causes, including fishing vessels, barges, and anchors, resulting in leaks of dielectric fluid; construction of new cables from 2007-2008 was seen as more environmentally conscious, less vulnerable to ship traffic, and less burdensome for repairs (which usually required the use of underwater divers and barge cranes)	Jointly owned by Eversource (formerly Connecticut Light & Power) and LIPA	1 2 3 4 5 6 7 8 9

Name	Location	Technical Specifications	Additional Notes	Ownership	Citations
FLAG Atlantic-1, North Cable	Dual fiber, trans-Atlantic submarine cable between London, Paris, and New York with onward connectivity to Washington DC and Frankfurt; only the North Cable enters LIS via The Race and connects at Northport, NY; sits entirely in NY waters; South Cable does not enter LIS	Submarine telecommunications cable; 100 Gbps dual fiber loop; collective length of both North and South Cables approx. 7500 miles; the North Cable's run in LIS is approx. 93 miles	Completed in 2001; joint venture between FLAG Atlantic Holdings Ltd and GTS TransAtlantic Holdings Ltd; constructed by Alcatel Submarine Networks	Global Cloud Xchange (subsidiary of Reliance Communications Ltd, formerly owned by FLAG Atlantic Holdings Ltd and GTS TransAtlantic Holdings Ltd)	1 2 3 4 5
Cross-Sound Cable	Halvarsson Converter Station (connected to the United Illuminating electric grid), New Haven, CT, to Tomson Converter Station (connected to	Electric and telecommunications (fiber-optic) cables; approx. 24 miles long; cable placement utilized horizontal directional drilling (shallow nearshore waters only) and remotely operated jet sled; two high-voltage direct current (HVDC) power cables and one 192-fiber fiber optic	Completed in 2002 with operations beginning in 2003; connects New England and Long Island power grids with transmission capacity contracted to LIPA through 2032; also designed to promote competition in New England and New York by enabling electricity trading; some sections of the cable were not installed to the required burial depth; six months after installation, some bottom	Cross-Sound Cable Company LLC (subsidiary of Argo Infrastructure Partners, formerly owned by Brookfield Asset Management Inc., Babcock & Brown	1 2 3 4 5 6 7 8 9 10 11

Name	Location	Technical Specifications	Additional Notes	Ownership	Citations
	the Long Island Power Authority electric grid), Shoreham, NY	cable bundled together; 4.1” diameter; contains no insulating or cooling fluid; 330 MW ± 150 kV HVDC with max current of 1175 A; AC voltage conversion on both ends of the cable (345 kV in New Haven, 138 kV in Shoreham); cable buried approx. 3-6’ under the seabed	topographic scars remained (2-8’ wide, 0.5-2’ deep)	Infrastructure, and the joint ownership of TransEnergie HQ Inc. and UIL Holdings Corp)	
AT&T Cable	East Haven, CT to Miller Place, NY	Submarine telecommunications cable; approx. 22 miles long; cable placement utilized horizontal directional drilling (up to 3500’ waterward of high tide line) to approx. 8-50’ below the sediment surface and jet plowing to approx. 10’ below the sediment surface (20’ for an anchorage area)	Completed in 1993	AT&T Corp	1 2 3
MCI/Verizon Cable	Madison, CT, to Rocky Point, NY	Submarine telecommunications cable; approx. 27 miles long; cable placement utilized horizontal directional drilling (up to 1600’ waterward of high tide line) to approx. depth of	Completed in 1996 by Caldwell Diving Company	Verizon Communications (formerly owned by MCI Communications Corp.)	1 2 3 4 5

Name	Location	Technical Specifications	Additional Notes	Ownership	Citations
		50-75’ National Geodetic Vertical Datum and jet plowing to approx. 3-6’ below the ocean bottom			

Table 26-4: Summary Information of Minor Electric and Telecommunications Infrastructure in Long Island Sound

Name	Location	Technical Specifications	Additional Notes	Ownership	Citations
Cable and pipeline area around the Thimble Islands, Branford, CT	Thimble Islands	Submarine electric and telecommunications cables to many of the Thimble Islands; water and sewer pipelines also run between the Islands	The Town of Branford has mapped out the specific cables and pipelines that travel around, between, and to/from the Thimble Islands (Figure 26-2)	Thimble Islands Electric Cooperative	See Figure 26-2
Cable areas between mainland Connecticut and Fishers Island	Two cable areas: (1) Groton Long Point, Groton, CT, to Hawks Nest Point, Fishers Island, NY (2) Avery Point, Groton, CT, to Silver Eel Cove, Fishers Island, NY	Submarine electric and/or communications cable(s); (1) Today, there are two cables in use: (a) Installed in 1989, single three conductor steel armored cable, 15 kV, max. continuous full load current of 3200 kW, approx. 15,500’ (300’ on land in Groton, 150’ on land in Fishers Island), in use at all times (b) Installed in 1967, single three conductor shielded galvanized steel armored cable, 15 kV, max. continuous full load current of 2200 kW, approx. 14,500’, emergency cable (2) Not known, possibly inactive	(1) First cable laid in 1892; new and replacement cables laid in 1912, 1922, 1928, 1962, 1968, and 1989; since 2000, all Island power comes through the cables except for the emergency backup generator (2) Not known; the U.S. War Department asked the U.S. Coast and Geodetic Survey (now the U.S. National Geodetic Survey) in 1935 to place a “military communications cable” in the vicinity of the already-existing cable area, causing the cable area to widen	(1) Fishers Island Electric Corporation (formerly owned by Fishers Island Farms Inc. and Southern New England Telephone Company) (2) Not known	1 2 3 4

Cable area south of Fishers Island	Cable area south of Fishers Island	Cable area used to contain hydrophones, cables, and related infrastructure; these were all later removed	Cable area was used for hydrophone testing during World War II	Presumably, the former infrastructure belonged to the U.S. War Department / Department of Defense	1
Cable area between Fishers Island and Race Rock	Cable area between Silver Eel Cove, Fishers Island, NY, to Race Rock (off southwestern tip of Fishers Island)	Potential submarine electric and/or communications cables (unconfirmed)	In 1957, the U.S. Army Corps of Engineers requested that the U.S. Coast and Geodetic Survey (now the U.S. National Geodetic Survey) to add this cable area; may contain utility cable that power the lighthouse	Not known	1
Cable areas between Fishers Island and Great Gull Island	Two cable areas connecting Fishers Island to Great Gull Island	Submarine electric and/or communications cable(s): (1) Northern cable area: Contains inactive cable (2) Southern cable area: Not known, cables may have been removed or are no longer active	(1) Cable area added by NOAA after request by War Department to the Secretary of Commerce in 1940; contained a cable between Fort Wright on Fishers Island and Fort Michie on Great Gull Island; neither fort is active nor is seemingly the cable (2) Not known According to a 1915 issue in the now-defunct trade journal Electric World, the Atlantic Insulated Wire & Cable Company had previously constructed a 35,000’ cable across The Race, which was said at the time to be the	(1) Not known (2) Not known	1 2

			large cable the U.S. government owned on the Atlantic coast		
Cable area between Great Gull Island and Little Gull Island	Cable area connecting Great Gull Island to Little Gull Island	Potential submarine electric and/or communications cables (unconfirmed); no active power cable or utility lines to Little Gull Island	U.S. Coast Guard maintains an active lighthouse on Little Gull Island powered by solar panels; cable area may contain utility cables that previously powered the lighthouse	Not known	1
Cable area between Orient Point, NY, and Plum Island	Cable area between Orient Point, NY, and Plum Island	Submarine electric cables; single 13.2 kV aerial line serves two underwater electric cables from a transfer station on Orient Point; historical peak demand on the electrical service is 2.3 MW (each cable is capable of supplying 2.3 MW load at a voltage drop of the 2.5 mile conductor length); only one line is used at any given time (current distribution isolation switches are arrayed to operate Plum Island facilities on one cable)	Cables supply electrical power particularly for the Plum Island Animal Disease Center, the only major facility on Plum Island	LIPA	1

Table 26-5: Summary Information of Known Anchorage Areas for Fuel Ships and Onshore Fuel Terminals and Storage Facilities with Nearshore Berthing Sites

Name	Location	Technical Specifications	Ownership	Citations
Anchorage areas outlined in the CFR	Throughout and around LIS	Various "Special Anchorage Areas" are outlined in 33 CFR Part 110, Subpart A, a number of which fall in and adjacent to LIS (Navigation and Navigable Waters, 33 CFR, 2017)	Established by the Secretary of Homeland Security	1 2
Other anchorage area in Bridgeport Harbor	Bridgeport, CT	Anchorage/waiting area for fuel ships in the Main Harbor	State of Connecticut	1
Other anchorage areas in New Haven Harbor	New Haven, CT	Three anchorage/waiting areas for fuel ships: (1) Deep draft vessels can anchor about one mile south of the sea buoy (2) Vessels with a draft of ≤ 20 ft can anchor inside the West Breakwater and the southwest half of the Middle Breakwater (depths in the anchorage area were reported to be less than the charted depths) (3) Vessels can anchor north of the Southwest Ledge Light in depths of 18-20 ft, where there is a soft bottom in places	State of Connecticut	1
Sprague Terminal, Stamford	Stamford, CT	Petroleum terminal; max length 300', max draft 15.5'	Sprague Energy	1 2
Global Partners Terminal, Bridgeport	Bridgeport, CT	Petroleum terminal	Global Partners LP (formerly owned by Consumers Connecticut Petroleum Wholesalers)	1 2 3 4
Harborview Terminal	Bridgeport, CT	Petroleum terminal	Harborview Terminals, Inc.	1 2 3
Hi-Ho Petroleum Bulk Terminal	Bridgeport, CT	Petroleum terminal	Hi-Ho Petroleum (subsidiary of D'Addario Industries)	1 2

Name	Location	Technical Specifications	Ownership	Citations
Inland Fuel Terminals, Bridgeport Terminal	Bridgeport, CT	Petroleum terminal	Inland Fuel Terminals, Inc. (subsidiary of Santa Energy)	1 2 3 4
Sprague Terminal, Bridgeport	Bridgeport, CT	Petroleum terminal; max length 650', max beam 105', max draft 32', vessels with draft over 27'5" must transit channel on high water due to shoal in channel	Sprague Energy / Global Partners LP (formerly owned by Motiva Enterprises)	1 2 3 4 5 6 7 8 9
Public Service Enterprise Group (PSEG) Bridgeport Harbor Station	Bridgeport, CT	Petroleum and coal terminal; max length 848', max beam 137.3', max draft 34', vessels with draft over 27'5" must transit channel on high water due to shoal in channel	PSEG Power Connecticut LLC	1 2 3 4
American Green Fuels	New Haven, CT	Biofuel terminal; integrated into the New Haven Terminal	American GreenFuels LLC (subsidiary of Kolmar Americas Inc.); tenant of New Haven Terminal	1
Gateway Terminal	New Haven, CT	Petroleum and biofuel terminal; seven berths (four for ships [dry and liquid commodities] and three for barges [dry commodities only]): (1) Main Pier, North Berth (ships) – Max length 650', max beam 100', max draft 28' (2) Main Pier, South Berth (ships) – Max length 735', max beam 110', max draft 36' (3) Wharf #1 (ships) – Max length 650', max beam 105', max draft 36', channel draft 35' (4) Finger pier (ships) – 650' long (5) Dock #1 (barges) – 300' long	Gateway Terminal	1 2 3 4

Name	Location	Technical Specifications	Ownership	Citations
		(6) Dock #2 (barges) – 300' long (7) Wharf #2 (barges) – 225' long		
Gateway Petroleum Terminal (possibly under a different name)	New Haven, CT	Petroleum terminal (possibly inactive); max length 260', max draft 16-20'	Unknown; possibly Power Test Realty Company (formerly owned by Getty Realty Corp.)	1 2 3 4 5
Gulf Oil Terminal Wharf	New Haven, CT	Petroleum and biofuel terminal; max length 650', max beam 110', max draft 38'	Gulf Oil LP	1 2 3 4
Magellan Terminal, East Street	New Haven, CT	Petroleum and biofuel; max length 700', max width 106-110', max beam 106', max draft 34-36'	Magellan Midstream Partners LP / Global Partners LP	1 2 3 4 5 6 7 8
Magellan Terminal, Forbes Avenue	New Haven, CT	Petroleum and biofuel terminal; max length 320', max width 60', max draft 16'	Magellan Midstream Partners LP / Global Partners LP	1 2 3 4 5
Magellan Terminal, Waterfront Street	New Haven, CT	Petroleum and biofuel terminal; max length 750', max width 106', max beam 105', max draft 35-36'	Magellan Midstream Partners LP / Global Partners LP	1 2 3 4 5 6 7 8
Magnico Energy Terminal	New Haven, CT	Petroleum terminal; max length 300', max draft 15'; only one vessel can moor at a time	Magnico Energy, LLC (formerly owned by R&H Terminal LLC)	1 2 3

Name	Location	Technical Specifications	Ownership	Citations
New Haven Terminal	New Haven, CT	Petroleum terminal; finger pier and marginal wharf; finger pier can accommodate 2 ships, 2 barges, or 1 ship + 1 barge concurrently: (1) Finger Pier, South Side (primary berth) – Max length 600’, max beam 105’, max draft 36’ (2) Finger Pier, North Side – Max length 500’, max beam 100’, max draft 28-35’ (3) Marginal Wharf – Approx. 650’ long (dry commodities only)	New Haven Terminal, Inc.	1 2 3 4 5 6
PSEG New Haven Harbor Station	New Haven, CT	Petroleum terminal; max length 400’, max draft 25’	PSEG Power Connecticut LLC	1 2 3
Shell Terminal	New Haven, CT	Petroleum terminal; two berths: (1) Outer Berth – Max length 738’, min length 300’; max beam 106’, max draft 37’ (2) Inner Berth – Max length 400’, min length 250’; max beam 85’, max draft 20’	Equilon Enterprises LLC (doing business as Shell Oil Products US) / Global Partners LP (formerly operated by Motiva Enterprises LLC [subsidiary of Saudi Aramco])	1 2 3 4 5 6 7 8
DDLC Energy Terminal	New London, CT	Petroleum terminal	DDLC Energy (subsidiary of HOP Energy)	1 2 3
Buckeye Terminal	Groton, CT	Petroleum terminal; max length 900’, max draft 34’	Buckeye Partners LP (terminal formerly owned by Hess Corp.)	1 2 3
Westmore Fuel Co. Terminal	Port Chester, NY	Petroleum terminal	Westmore Fuel Co., Inc.	1 2

Name	Location	Technical Specifications	Ownership	Citations
Global Partners Terminal, Glenwood Landing	Glenwood Landing, NY	Petroleum terminal	Global Partners LP	1 2
Global Commander Terminal	Oyster Bay, NY	Petroleum terminal	Global Partners LP	1 2
Northville Port Jefferson Facility	Port Jefferson, NY	Petroleum terminal; two berths: (1) Tanker Berth – Max length 700', max beam 106', max draft 35', vessels enter through channel of only 26' (2) North Berth – Max length 350', max beam 75', max draft 20'	Northville Industries (subsidiary of NIC Holding Corp.)	1 2
Port Jefferson Power Station	Port Jefferson, NY	Petroleum terminal	National Grid USA (formerly owned by LILCO)	1 2
Plum Island Animal Disease Center Fuel Storage and Distribution System	Plum Island, NY	Petroleum terminal	U.S. Department of Homeland Security	1

Coastal Energy Facilities

A number of coastal energy (i.e., power generating) facilities can be found along the LIS shoreline (Figure 26-4). Most power plants in proximity of the Sound are either natural gas- or petroleum-powered, with only one coal-based plant and one nuclear plant. The energy facilities tend to concentrate around the largest population centers around the Sound.

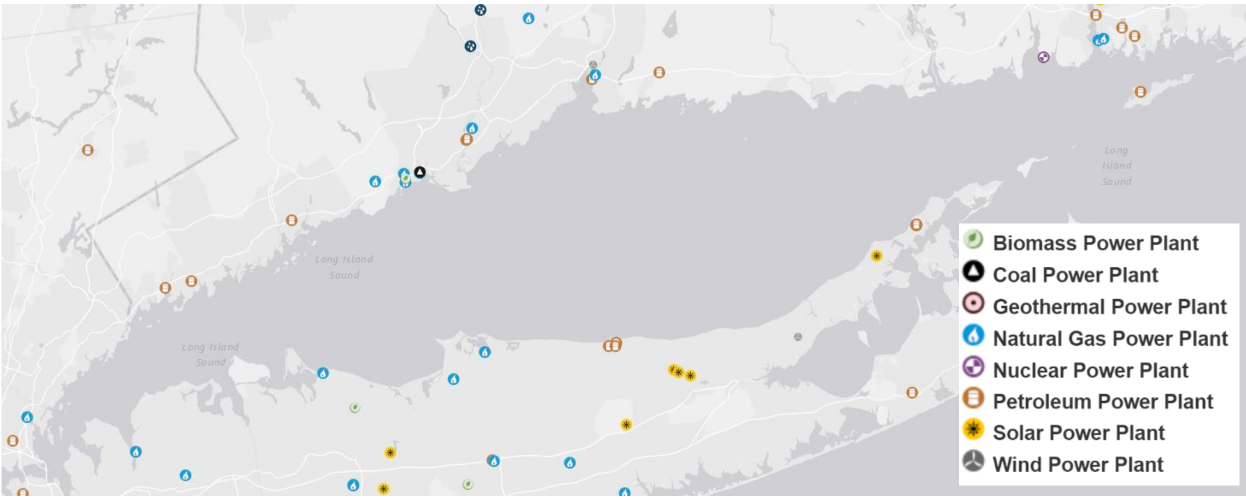


Figure 26-4: Coastal Energy Facilities around Long Island Sound. The power plant "type" indicates the primary fuel with which the facility generates power and does not necessarily mean the plant does not utilize other fuel types. For instance, some of the facilities denoted as Natural Gas Power Plants also use petroleum as fuel. More information about all the fuel types used at each facility, as well as access to the map product, are available via the U.S. Energy Information Administration Connecticut Profile Overview (EIA, 2018).

Hydropower refers to electricity generated using the energy of moving water (i.e., hydroelectricity) and is most commonly associated with the use of dams to generate electricity. A 1995 U.S. Department of Energy study identified and assessed 68 hydropower sites in the Connecticut. The study determined potential capacities ranging from 6.5 kilowatts to 10 megawatts at these sites, resulting in their classification as "small scale hydropower" facilities (McCarthy, 2010). Hydropower facilities are only located on rivers and tributaries of the Sound (not adjacent to the Sound itself) and thus are less relevant to this Inventory chapter. A list of current hydropower facilities in Connecticut can be found in a 2007 report prepared for the Connecticut Clean Energy Fund/Connecticut Green Bank (Barnett, 2007).

The only nuclear energy facility along LIS is Dominion Energy's owned and operated Millstone Power Station, situated on a peninsula just east of Niantic Bay in Waterford, CT (Weigold & Pillsbury, 2014). Made up of three units, of which two are currently in operation, it is the only multi-unit nuclear plant in New England. The impact of Millstone's electric generation is significant: In 2016, 45% of Connecticut's net electricity generation came from the Millstone Power Station (EIA, 2018). Millstone utilizes an outfall pond just south of the plant's premises, which flows into Long Island Sound at the base of the peninsula between Millstone Point and Fox Island.

The waters surrounding the Millstone Power Station fall within two U.S. Coast Guard regulated zones: the Long Island Sound Marine Inspection and Captain of the Port Zone (see [33 CFR § 3.05-35] and [33 CFR § 165.153]) and the Dominion Energy Millstone Power Station security zone (see [33 CFR § 165.154]) (Navigation and Navigable Waters, 33 CFR, 2017). The former is not spatially represented in this Inventory chapter but is fully captured by NOAA ENCs (NOAA, 2018); the latter is featured in Figure 26-2: Security and Regulated Zones of *Chapter 27 National Security*.

Seven energy facilities along LIS intake Sound water for cooling purposes and discharge water back into the Sound at higher temperatures than at intake (Weigold, 2004). These facilities are depicted in Figure 26-5. The Federal government and regulatory agencies in Connecticut and New York are responsible for ensuring energy and telecommunication infrastructure built in LIS are compatible with natural resource protection and human use. Connecticut Department of Energy and Environmental Protection (CT DEEP) officials have noted that there is no scientific evidence that water discharged from Connecticut plants into the Sound at a higher temperatures than at intake have any significant impact on the overall temperatures of the Sound (Hladky, 2015).

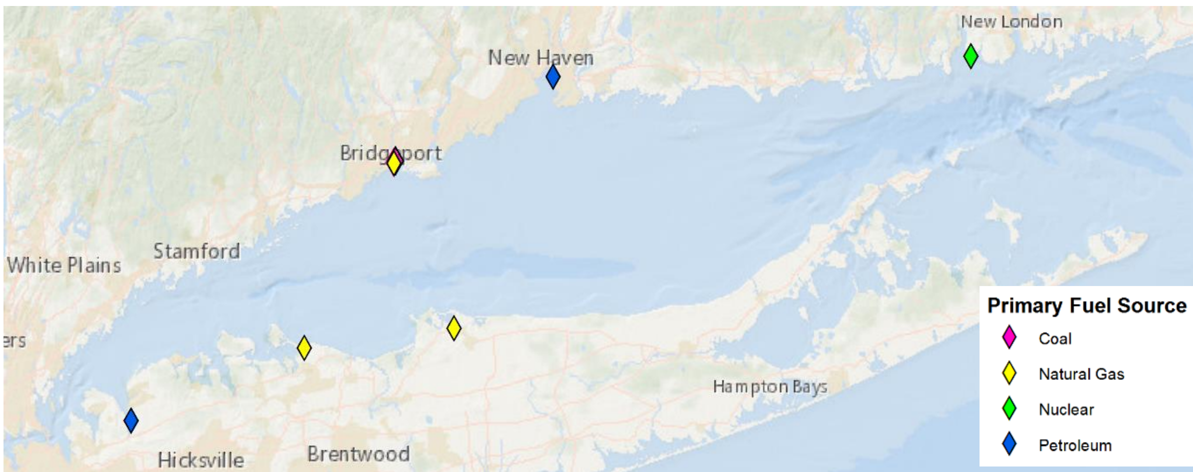


Figure 26-5: Coastal Energy Facilities around Long Island Sound that Intake Water from and Discharge Water into the Sound. Water is taken in as a cooling mechanism and are discharged back into the Sound at higher temperatures. This map is a combination of spatial information from the U.S. Energy Information Administration Connecticut Profile Overview and environmental monitoring records from the EPA (EIA, 2018; EPA, 2018).

Renewable Energy

While there are several existing renewable energy facilities near Long Island Sound, such as the Bridgeport Fuel Cell, Sommers Solar Farm, and East Lyme solar farm, these are mainly outside the scope of the Inventory, which focuses on Long Island Sound. This chapter will focus on potential sources of renewable energy directly focused on Long Island Sound.

The National Renewable Energy Laboratory (NREL) mapped out offshore wind speeds in Long Island Sound (Figure 26-6). Recent studies have shown that average wind speeds need to exceed

6-8 m/s in order for even small wind turbines to be economically viable in a certain location (ANL, 2017; Level, 2017). Figure 26-6 shows that at a 90 m height (a height often used to measure wind speeds for wind turbines), predicted mean annual wind speeds in the Sound range from 6-8.25 m/s with the greatest mean annual wind speeds concentrated in the center of the Sound between Bridgeport, CT, and Port Jefferson, NY. Additional offshore wind map products can be found in the Energy & Telecommunications Map Book (CT DEEP, 2017).

NREL also generated maps that would help to assess wave energy potential for LIS using four variables: Energy period, power density, significant wave height, and water depth. For nearly all of LIS across all variables, the calculated values were minimal. These wave energy map products can be found in the Energy & Telecommunications Map Book (CT DEEP, 2017).

Furthermore, NREL generated maps that would help to assess tidal energy potential for LIS using two variables: mean current and mean power density (Figure 26-7). Mean current and mean power density were of greater magnitude on the eastern end of the Sound, with greatest values being found in The Race. Moreover, a 2007 study by environmental consulting firm E3, Inc. considered 483 potential tidal energy sites off the shores of Long Island, Rhode Island, and New Jersey; 20 priority sites were determined, many of which fell in areas that NREL data noted to be of higher mean current and mean power density, particularly in The Race (Figure 26-8).

The Race has certainly been considered as a potential tidal energy location. A 2011 study by the Georgia Tech Research Corporation, funded by the U.S. Department of Energy, included Block Island Sound among its list of "theoretical available tidal stream density hotspots" along the U.S. coast (Georgia Tech Research Corporation, 2011, p. 23). While there are no current plans in place for tidal power generation in the Sound, an alternative energy company did obtain a preliminary permit from the Federal Energy Regulatory Commission (FERC) in 2012 to conduct ecological and physical studies in The Race to determine tidal power suitability (Benson, 2013). The FERC permit was later cancelled in early 2014 (FERC, 2013).

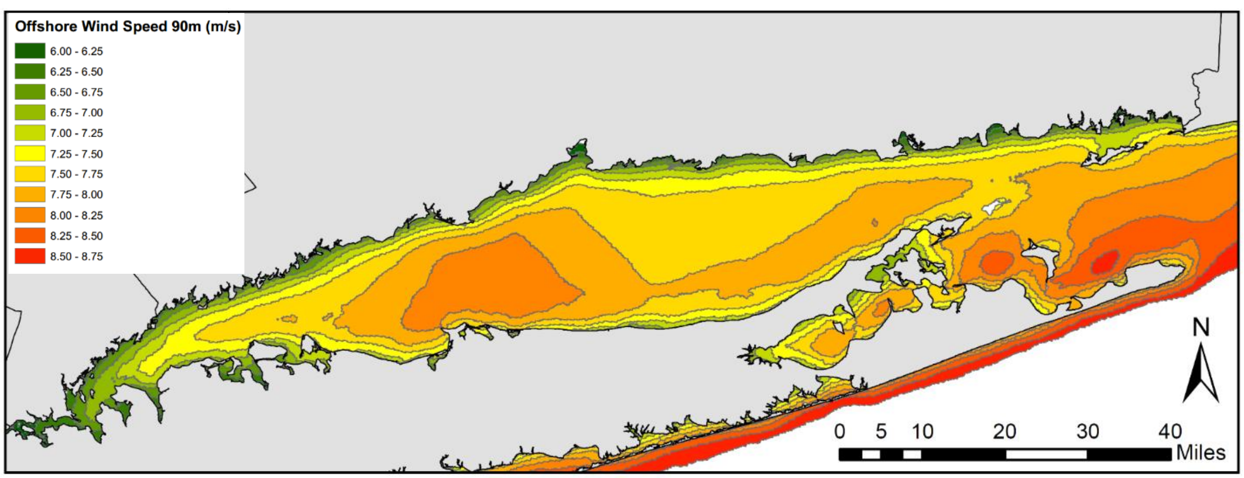


Figure 26-6: Predicted Mean Annual Wind Speeds at 90-m Height at a Resolution of 200 m. According to NREL, areas with annual average wind speeds of 7 m/s and greater at 90-m height are generally considered to have a wind resource suitable for offshore development. Access available via the National Renewable Energy Laboratory (NREL, 2012).

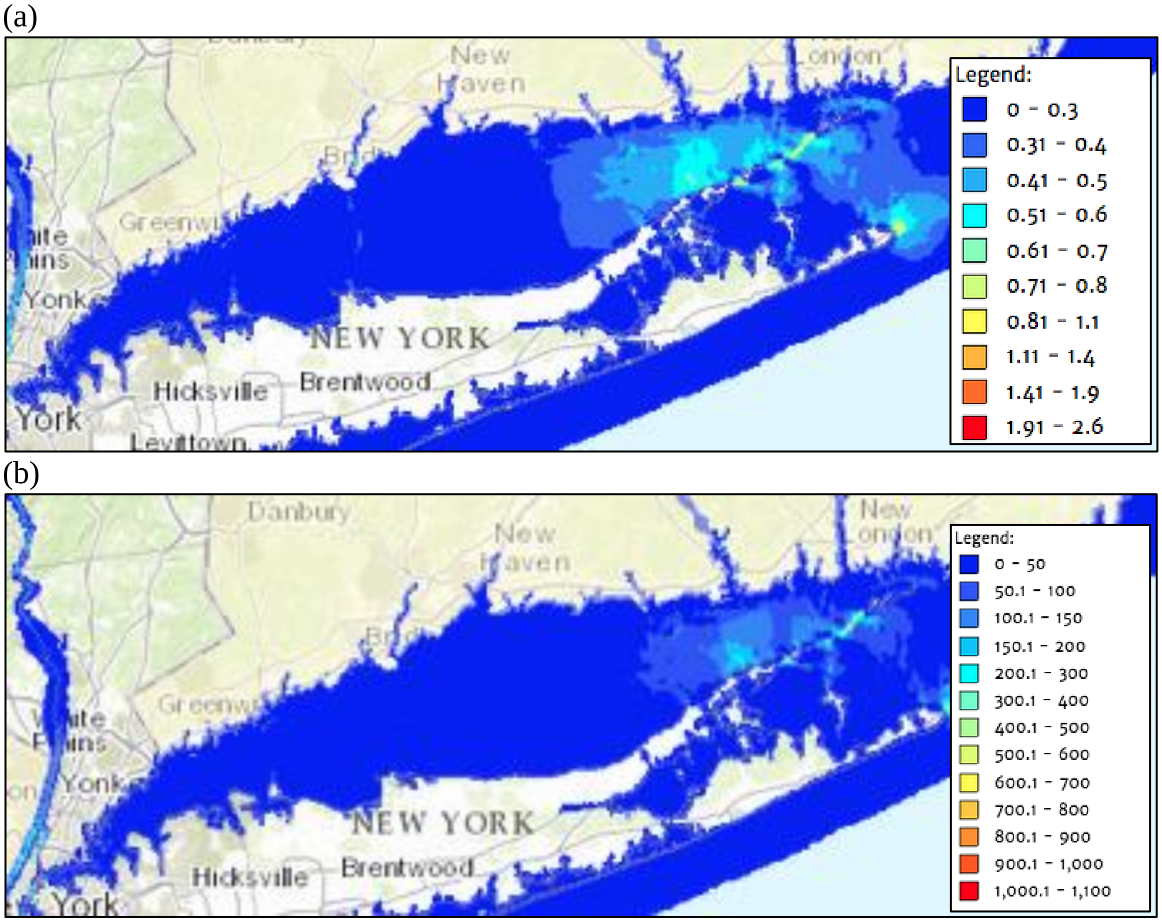


Figure 26-7: [Maps of Tidal Energy Potential in Long Island Sound](). (a) Mean current potential (m/s), and (b) Mean power density (W/m^2*). Access available via NY Geographic Information Gateway (NY Geographic Information Gateway, 2017).*

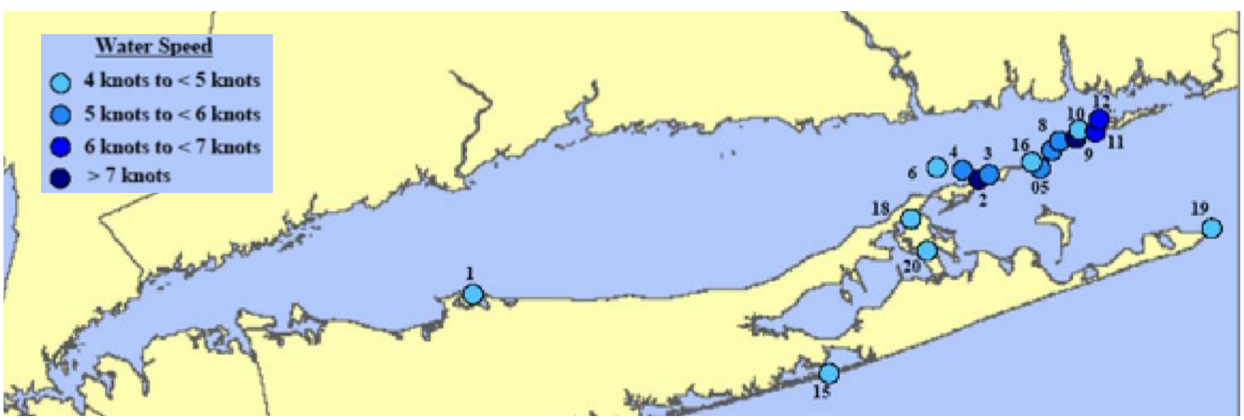


Figure 26-8: [Potential Tidal Energy Sites in Long Island Sound](). Access available via Long Island Tidal and Wave Energy Study (E3, Inc., 2007).

26.2 Assessment of Data Quality

26.2.1 Sources of Data and Metadata

Spatial data derives from the Northeast Ocean Data Portal, NOAA ENCs, Argonne National Laboratory Energy Zones Mapping Tool, NY Geographic Information Gateway, Mid-Atlantic Ocean Data Portal (MARCO, 2017), U.S. Energy Information Administration, U.S. Environmental Protection Agency, National Renewable Energy Laboratory, Long Island Power Authority, and the Town of Branford. Metadata can be found on the corresponding data portals or information sources and in the corresponding reports from which the spatial data products were taken. More information on the Sources of Data and Metadata can be found in the Energy & Telecommunications Map Book (CT DEEP, 2017).

26.2.2 Accuracy, Representativeness, and Relevance of Map Products

The spatial data included in this chapter and in the Energy & Telecommunications Map Book, was considered to be the most accurate and representative spatial data available at the time of collection, notably because all the data was collected from either official government websites or from map portals specifically aimed at providing data to be used for planning purposes. The large majority of this spatial data was provided to sector stakeholders before and during a December 2017 webinar, with addition map products posted in an updated Map Book to the CT DEEP website following the webinar (CT DEEP, 2017). See *Section 26.5.2 Notes on Stakeholder Engagement* for more information on stakeholder outreach practices for this sector.

None of the stakeholders engaged challenged the accuracy, representative, and relevance of the map products displayed. This could well be because the existing energy and telecommunications infrastructure in the Sound is fairly well known. Energy or telecommunications infrastructure projects in the Sound, after all, become fairly prominent public knowledge even at the earliest of proposal stages, often because of the comprehensive nature of the siting and permitting processes.

Stakeholders did, however, mention that more information about individual in-Sound cables and pipelines – such as when they were constructed, how deep they are buried, and who owns them – would augment the existing spatial data to provide a more representative picture of the energy and telecommunications sector for marine spatial planning purposes.

26.2.3 Data Gaps and Availability of Data to Address Gaps

As mentioned above, none of the stakeholders engaged noted any prominent spatial data gaps. However, stakeholders did mention the lack of more detailed information that would help to place the spatial data in context. As such, the Blue Plan team considered this lack of contextual information to be a data gap.

Subsequent to webinar, the Blue Plan team collected much of the stakeholder-requested contextual information and consolidated it into Tables 26-1 through 26-5. The information provided in these tables are not necessarily complete. As such, these tables would benefit from further stakeholder review to determine if the information provided is sufficiently accurate, representative, and relevant in its supplemental nature to the spatial data products.

Finally, while not an explicit data gap, a utility company stakeholder felt it was important, going forward, to create a streamlined process for documenting and providing as-built drawings of historic and new energy and telecommunications infrastructure to the Blue Plan. This comment anticipates the need for proactively ensuring that the data being used for marine spatial planning purposes does not fall out of the realm of accurate, relevant, or representative. However, it should be noted that certain gas pipeline and electric transmission cable information may be considered "critical energy infrastructure information" and thus may have limited disclosure for certain Blue Plan purposes.

26.3 Relevance

26.3.1 Relative Historical Importance

Much of the early intensive energy use in the LIS region was that related to activities on and around the Sound (e.g., industrial urban development, fire-powered steam boats, cars, railroads) (Weigold M. E., 2004; Weigold & Pillsbury, 2014). As noted in Table 26-3, utilization of the Sound itself began late in the 19th century, with the placement of cables in The Race and around Fishers Island, though most of the major infrastructure in the Sound today did not exist prior to the mid-to-late 20th century.

Yet, even beyond the usage of the Sound's submerged lands as a substrate for energy transfer, the waters of the Sound and its tributaries have also historically been utilized as a resource for energy development. Power plants (whether hydroelectric, fossil fuel, or nuclear-based) often require large amounts of water for electric generation purposes, so it is not surprising that many such plants, both former and current, are strategically placed along the LIS shoreline and its tributaries (CT DEEP, 2017; Weigold & Pillsbury, 2014). Dominion Energy's Millstone Power Station began construction on the first of three reactors in 1966, around the time when nuclear power was seen as the solution to the region's growing energy needs (Hladky G. B., 2015; Miller, 2014; Weigold M. E., 2004; Weigold & Pillsbury, 2014). In fact, around and since the time of the Millstone Power Station's opening, a handful of nuclear plants were proposed (but failed to be built) along the Sound's shorelines, notably a plant in Lloyd Harbor, NY, in the 1960s, and a four-reactor plant on David's Island, NY, in the 1970s (Weigold & Pillsbury, 2014). A nuclear plant in Shoreham, NY, first proposed in 1966 (and constructed beginning in 1973), was completed but never officially opened, due to concerns over emergency evacuation plans (Weigold M. E., 2004; Weigold & Pillsbury, 2014).

Yet, as populations in Connecticut and Long Island continued to grow – along with energy demand – utility companies were on the lookout for ways to ensure adequate energy supply, emergency backup supply, or simply lower cost energy for local residents. For example, with the official closure of the Shoreham Power Plant in 1994, the Long Island Power Authority (LIPA), throughout the late 1990s and early 2000s, built several small traditional fossil-fueled power plants, and worked with TransEnergie Hydro Quebec to install the Cross-Sound Cable in 2002 as a back-up energy supply to Long Island (Fairley, 2005; Weigold M. E., 2004; Weigold & Pillsbury, 2014).

Presumably, coincident with the population and economic growth in Connecticut and Long Island, other energy and telecommunications infrastructure was developed and placed in the Sound throughout the 20th and 21st centuries. It is feasible to imagine, for instance, that as demand for faster telecommunications connections and worldwide reach grew in the densely populated LIS region, fiber optic and other modern infrastructure became attractive considerations for development in submarine areas of LIS.

Still, not all energy development projects have been as successful. The proposed, 22-mile Islander East liquefied natural gas pipeline (designed to transport natural gas between Branford, CT, and Wading River, NY) failed to secure the necessary permits from Connecticut and New York, and the project was abandoned in February 2009 (CT DEEP, 2006b; Doan, 2009; Zaretsky, 2009). Moreover, the proposed Broadwater offshore terminal and pipeline route (which would have connected to the Iroquois Gas Transmission System pipeline mid-Sound) failed to receive the required permits from the U.S. Commerce Department and the State of New York, causing the Broadwater project team to stop pursuing the project in March 2012 (Benson, 2012; FERC, 2008, Section 3; Weigold & Pillsbury, 2014). Notable public opposition, combined with changing energy sector dynamics, accompanied these project proposals and may have been contributing factors to these infrastructure projects not being successful. *Section 26.3.2 Socio-Economic Context* provides further context on the oft-controversial nature of energy infrastructure projects in the Sound.

26.3.2 Socio-Economic Context

If history is any indication, proposals for new energy or telecommunications infrastructure in the Sound are bound to be controversial and require lengthy lead times for implementation. As developers pursue the necessary permits to start construction, proposals are reviewed, commented upon, and/or evaluated by various regulatory and advisory agencies, programs, committees, tribal nations, and the general public, often over a period of years.

The reason for such great attention to these proposals is the fact that energy and telecommunications infrastructure in the Sound may seem incompatible with other resources, be they natural (e.g., benthic habitat) or cultural (e.g., archaeologically-sensitive submerged lands), as well as with other human uses (shellfish harvesting, visual resources, emergency management, community health, fishing, transportation, and recreation, to name a few). For example, environmental concerns played a large role in the failure of both the Islander East and Broadwater proposals from receiving permits that would have allowed for their development (CT DEEP, 2006b; Rather, 2008). Moreover, CT DEEP, in its Water Quality Certification ruling on the Islander East proposal, cited that the project, as proposed, would have negatively impacted both shellfish habitat and active and potential shellfish operations (CT DEEP, 2006b). The

Cross-Sound Cable was also controversial among environmental and shellfishing groups (Fairley, 2005; Grant, 2003; Rather, 2007; Weigold M. E., 2004).

However, even after infrastructure is built, concerns over incompatibility with resources and other human uses remain. The discharge of warm waters following use for cooling purposes from coastal energy facilities, for example, may be a concern for how if might affect resident species. As previously mentioned, federal government and regulatory agencies in Connecticut and New York are responsible for ensuring energy and telecommunication infrastructure built in LIS are compatible with natural resource protection and human use. In terms of conflicts with other human use sectors, as noted in Table 26-3, marine transportation has more than once encountered submerged cable lines, especially during anchoring accidents. These situations have resulted in the temporary leaching of dielectric fluid into Sound waters, constrained energy loads across compromised wires, expensive repair costs, and even litigation.

Human and environmental health and security have also been raised as concerns with regards to energy infrastructure. For example, concerns over the potential discharge of radioactive materials and evacuation plans have been raised with regards to nuclear power plants, the latter effectively ending the Shoreham Power Plant project (Weigold M. E., 2004; Weigold & Pillsbury, 2014). Further, fossil fuel power plants emit greenhouse gases that contribute to a changing climate, which has resulted in states making commitments to seek an increasing proportion of their energy from renewable sources.

Human and environmental safety has furthermore been a concern with regards to the transport and temporary storage of petroleum products in and around the Sound. Because the Sound is a "well-sheltered body of water with a large urbanized area surrounding it and no harbors equipped to handle large tankers", petroleum products are generally carried by medium and small ships; in fact, it is believe that 80% of the cargo transported across the Sound consists of oil or oil products (Weigold M. E., 2004, p. 217). For some, this may not only be a direct cause for concern, as it relates to oil spills, but there may also be concerns over indirect impacts, such as the persistent disturbance of contaminated sediment due to regular harbor dredging (necessary to provide appropriate draft for ship moorings) (Weigold & Pillsbury, 2014). Even the presence of two offshore platforms in the Sound have caused members of the public to worry about dangers, such as unexpected fires and blasts (e.g., a 1988 explosion on the Northport Terminal Platform was reportedly felt as far as 20 miles away) and the storage of especially volatile petroleum products (e.g., Bakken Shale oil at the United Riverhead Terminal) (Civiletti, 2015; McQuiston, 1988).

Socio-political issues have also arisen when it comes to energy infrastructure. The Cross-Sound Cable, for instance, was historically contentious due to differing beliefs over who would be the net beneficiary of the Cable's services. Prior to the Cable's construction in 2002, Connecticut politicians were concerned that the state would not benefit with the Cable in place, potentially raising energy costs for Connecticut residents (Fairley, 2005; Weigold M. E., 2004). The Cable remained contentious even in the years following its initial construction and its recent replacement. For instance, prior to August 2003, the State of Connecticut had kept the cable from service, noting that parts of the Cable had not been buried as deeply as required by permit, which, according to the State, was an environmental and safety liability. However, after the

Northeast blackout of 2003, an emergency order was issued for the cable to be energized (Fairley, 2005; Grant, 2003). When the cable remained on through early into 2004, it was later turned off over economic and environmental concerns (Salzman, 2004). While issues between Connecticut and LIPA eventually settled with an agreement that included the replacement of the original 1385 Cable, the Cross-Sound Cable situation demonstrates how socio-political issues can come into play in energy infrastructure projects. Another example of the need for cross-Sound energy sharing occurred in 1996, when all three reactors at the Millstone Power Station had to be shut down for safety reasons, and the 1385 Cable allowed Long Island to help supply Connecticut with power (Weigold M. E., 2004; Weigold & Pillsbury, 2014). Overall, energy sharing between Connecticut and New York via submerged infrastructure in LIS has shown itself to be beneficial and the ability to energy-share may become of more immediate relevance and importance in the future.

Finally, beyond concerns, some positive environmental monitoring outcomes have emerged from energy and telecommunication infrastructure projects. One example is the Millstone Power Station's environmental monitoring program, which began in 1976 as a permit requirement. The program monitors the marine environment around the Station by tracking and reporting a variety of physical, chemical, and ecological parameters, represent a rich and unique dataset; the Millstone Environmental Laboratory releases an annual report with the results of these reporting requirements (CT DEEP, 2006a; CT DEEP, 2010; Falcone, 2016). Another example is the Cross Sound Settlement Agreement Fund, which originated from a $6 million fine, but has resulted in a comprehensive and collaborative Long Island Sound seafloor mapping initiative in support of a better informed decision making process. More information about the seafloor mapping initiative can be found in *Chapter 24 Research, Monitoring, and Education*.

26.3.3 Other Notes

Regulatory Considerations

Connecticut and New York have both recently released comprehensive energy strategies which outline each state's goals to meet future energy demand and sustainability initiatives:

- Connecticut – CT DEEP's Comprehensive Energy Strategy (CT DEEP, 2018b)
- New York – New York State Energy Research and Development Authority's New York State Energy Plan (NYSERDA, 2016)

These plans provide goals that will shape the future energy generation mix into the future. Notably, both plans include a goal of reducing carbon emission by 80 percent by the year 2050 to meet global warming goals. Future energy portfolios in both states will require a dramatic shift from current energy sources to achieve these goals.

Offshore wind interconnections have been documented as a way to potentially achieve such goals in Connecticut and Long Island (ESS Group, Inc., Energy Initiative Group LLC, and Power Systems Consultants, 2014). A recently-released Request for Proposals (RFP) by CT DEEP is a demonstrative example of current and future demand for offshore wind that could play a role in helping to meet the State's strategy to reduce greenhouse gas emissions (CT DEEP, 2018a). The RFP calls for proposals that would procure renewable energy from offshore wind, fuel cell, and anaerobic digestion resources. While there is currently no specific proposal to place wind turbines in LIS or to site a transmission cable from offshore wind farms in Connecticut, it is likely that future wind energy development projects may affect the resources and uses of the Sound, particularly regarding cable landings and port facility improvements.

Additional Resources

A two-part Comprehensive Assessment and Report on energy resources and infrastructure in Southwest Connecticut and in Long Island Sound was compiled and released by the Institute for Sustainable Energy at Eastern Connecticut State University on January 1, 2003 (Part I), and June 3, 2003 (Part II) (Task Force on LIS, 2003; Working Group on Southwest CT and Task Force on LIS, 2003). While some of the information in these documents are slightly dated, this two-part report represents the most complete understanding and analysis of the existing energy and telecommunications infrastructure currently in LIS. As such, both of these reports serve as a valuable supplement to this Inventory chapter.

Further socioeconomic context on historical energy and telecommunications sectors can be gleaned from two pieces written by Pace University historian Marilyn E. Weigold, an expert on the environmental and social history of Long Island Sound post-1614. These two pieces are Dr. Weigold's solo book, *The Long Island Sound: A History of Its People, Places, and Environment* and her chapter contribution (with collaborator Elizabeth Pillsbury) to the environmental management anthology, *Long Island Sound: Prospects for the Urban Sea* (Weigold M. E., 2004; Weigold & Pillsbury, 2014). This Inventory chapter summarizes much of the information from these two pieces, but further contextual information can be found by directly referencing these two resources.

26.4 References

ANL. (2017, December). *Energy Zones Mapping Tool*. Retrieved from Argonne National Laboratory (ANL): https://ezmt.anl.gov/mapping/viewer

Barnett, M. (2007). *Run-of-River Hydropower in Connecticut: Opportunities and Challenges for Developers and Recommendations for CCEF Support.* Prepared for the Connecticut Clean Energy Fund. Stamford: Connecticut Green Bank. Retrieved from http://www.ctcleanenergy.com/portals/0/hydropower_report_revised.pdf

Benson, J. (2012, March 7). Broadwater abandons LNG project in Long Island Sound. *The Day*. Retrieved from https://www.theday.com/article/20120307/NWS12/120309662

Benson, J. (2013, March 31). The Race for an alternative energy source. *The Day*. Retrieved from https://www.theday.com/article/20130331/NWS01/303319910

Cherau, S., Olausen, S., Robinson, D., Banister, J., Allegretto, K., & Stuart, Q. (2010). *Cultural Resources Inventory - Long Island Sound - Dredged Material Management Plan, Long Island Sound, Connecticut, New York, and Rhode Island - Volume I.* Prepared for the U.S. Army Corps of Engineers, New England District. Pal Report No. 2394. Pawtucket: PAL Publications. Retrieved from http://www.usace.army.mil/Portals/74/docs/Topics/LISDMMP/STID11-LIS-DMMP-CulturalResourceInventory.pdf

Civiletti, D. (2015, October 8). 'Extra-flammable' crude oil being stored at Riverhead oil tanks; town officials, first responders kept in the dark. *RiverheadLOCAL*. Retrieved from https://riverheadlocal.com/2015/10/08/extra-flammable-crude-oil-being-stored-at-riverhead-oil-tanks-town-officials-first-responders-kept-in-the-dark/

Colman, J., & Kleiman, G. (2010). *Discussion Paper for Potential Measures to Control Lightering.* Prepared for the Ozone Transport Commission. Washington, D.C.: Ozone Transport Commision. Retrieved from https://otcair.org/upload/Documents/Meeting%20Materials/Lightering%20White%20Paper%202.18.pdf

CT DEEP. (2006b, December 19). Declaratory Ruling on Water Quality Certification Application #200300937-SJ. Retrieved from http://www.ct.gov/deep/lib/deep/declaratory_rulings_other_decisions/islandereastdecision.pdf

CT DEEP. (2017, December). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635

CT DEEP. (2018a, January 31). Notice of Request for Proposals from Private Developers for Clean Energy. Hartford: Connecticut Department of Energy and Environmental Protection (CT DEEP). Retrieved from https://pierceatwoodwhatsup.com/26/369/uploads/ct-rfp--(w6550103.pdf-1).pdf

CT DEEP. (2018b, February 18). *Comprehensive Energy Strategy*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): www.ct.gov/energystrategy

Doan, L. (2009, February 29). Developer Gives Up On Islander East Pipeline. *Hartford Courant*. Retrieved from http://articles.courant.com/2009-02-26/news/islandereast0226.art_1_long-island-sound-spectra-energy-national-grid

E3, Inc. (2007). *Long Island Tidal and Wave Energy Study: An Assessment of the Resource.* Report prepared for the Long Island Power Authority. New York: E3, Inc. Retrieved from http://www.lipower.org/pdfs/company/papers/report-wave0107.pdf

EIA. (2018, April 19). *Connecticut: State Profile and Energy Estimates*. Retrieved from U.S. Energy Information Administration (EIA): https://www.eia.gov/state/?sid=CT

EPA. (2018). *Enforcement and Compliance History Online*. Retrieved from U.S. Environmental Protection Agency (EPA): https://echo.epa.gov/

ESS Group, Inc., Energy Initiative Group LLC, and Power Systems Consultants. (2014). *Offshore Wind Transmission Study: Final Report.* Prepared for the Massachusetts Clean Energy Center. East Providence: ESS Group, Inc. Retrieved from http://files.masscec.com/research/MassCECOSWTransmissionStudy.pdf

Fairley, P. (2005, April 1). TransÉnergie: Playing Two Power Games. *MIT Technology Review*. Retrieved from https://www.technologyreview.com/s/403882/trans-nergie-playing-two-power-games/

FERC. (2008). *Final Environmental Impact Statement on the Broadwater LNG Project.* Docket Nos. CP06-54-000, et al. Washington, D.C.: Federal Energy Regulatory Commission. Retrieved from https://www.ferc.gov/industries/gas/enviro/eis/2008/01-11-08-eis.asp

FERC. (2013, December 30). *Order cancelling preliminary permit re Natural Current Energy Services, Inc. under P-14333.* Federal Energy Regulatory Commission (FERC) Accession Number 20131230-3008, Citation Number 145FERC62,230. Washington, D.C.: Federal Energy Regulatory Commission, Division of Hydropower Licensing.

Georgia Tech Research Corporation. (2011). *Assessment of Energy Production Potential from Tidal Streams in the United States.* Report prepared under U.S. Department of Energy Contract No. DE-FG36-08GO18174. Atlanta: Georgia Tech Research Corporation. Retrieved from https://www1.eere.energy.gov/water/pdfs/1023527.pdf

Grant, S. (2003, November 22). Cross-Sound Cable Effects Unclear: Tests Continue To Assess Long-term Environmental Impact. *Hartford Courant*. Retrieved from http://articles.courant.com/2003-11-22/news/0311220659_1_long-island-sound-energy-bill-cross-sound-cable/2

Hladky, G. B. (2015, June 22). Are Millstone's Nuclear Plants Adding To The Sound's Warming Problems? *Hartford Courant*. Retrieved from http://www.courant.com/politics/hc-millstone-hot-water-20150622-story.html

Level. (2017, June 23). *Wind Turbine Systems*. Retrieved from Level: http://www.level.org.nz/energy/renewable-electricity-generation/wind-turbine-systems/

LISS. (2018). *Population Within 50-Mile Radius of LIS*. Retrieved from Long Island Sound Study (LISS): http://longislandsoundstudy.net/2010/08/population-within-50-mile-radius-of-lis/

Lust, J. B., & Kardos, J. M. (2008). *Map of Town of Branford Thimble Islands.* Prepared for the Town of Branford. Branford: Thimble Islands Work Group.

MARCO. (2017). *Mid-Atlantic Ocean Data Portal*. Retrieved from Mid-Atlantic Regional Council on the Ocean: http://portal.midatlanticocean.org/visualize/

McCarthy, K. E. (2010). *Pros and Cons of Hydropower.* OLR Research Report 2010-R-0401. Hartford: Connecticut Office of Legislative Research (OLR). Retrieved from https://www.cga.ct.gov/2010/rpt/2010-R-0401.htm

McQuiston, J. T. (1988, September 1). Workman Lost in Blast Off L.I. *The New York Times*. Retrieved from https://www.nytimes.com/1988/09/01/nyregion/workman-lost-in-blast-off-li.html

Miller, C. (2014, November 21). Is Millstone power plant killing lobsters in the Sound? *Suffolk Times*. Retrieved from http://suffolktimes.timesreview.com/2014/11/54100/is-millstone-power-plant-killing-lobsters-in-the-sound/

National Research Council. (1998). *Oil Spill Risks from Tank Vessel Lightering.* Washington, D.C.: The National Academies Press. doi:10.17226/6312

Navigation and Navigable Waters, 33 CFR (2017).

NOAA. (2018, February). *NOAA ENC Direct to GIS*. Retrieved from National Oceanic and Atmospheric Administration (NOAA) Office of Coast Survey: https://encdirect.noaa.gov/enc_direct/encdirect_download.html

Northeast Regional Planning Body. (2018). Retrieved from Northeast Ocean Data Portal: http://www.northeastoceandata.org/data-explorer/

NREL. (2012, June 26). *Wind Data*. Retrieved from National Renewable Energy Laboratory (NREL): https://www.nrel.gov/gis/data-wind.htm

NY Geographic Information Gateway. (2017). *New York Geographic Information Gateway*. Retrieved from http://opdgig.dos.ny.gov/

NYSERDA. (2016). *New York State Energy Plan*. Retrieved from New York State Energy Research and Development Authority (NYSERDA): https://energyplan.ny.gov/

Rather, J. (2007, January 21). A Power Infusion Comes to Long Island by Land and by Sea. *The New York Times*. Retrieved from http://www.nytimes.com/2007/01/21/nyregion/nyregionspecial2/21lineptune.html?pagewanted=print

Rather, J. (2008, January 27). Long Island Sound Proposal Awaits Crucial Ruling. *The New York Times*. Retrieved from http://www.nytimes.com/2008/01/27/nyregion/nyregionspecial2/27energyli.html

Salzman, A. (2004, May 8). Energy Secretary Orders the Cross-Sound Cable Turned Off. *The New York Times*. Retrieved from http://www.nytimes.com/2004/05/08/nyregion/energy-secretary-orders-the-cross-sound-cable-turned-off.html

Task Force on LIS. (2003). *Comprehensive Assessment and Report, Part II: Environmental Resources and Energy Infrastructure of Long Island Sound.* Pursuant to Public Act No. 02-95 and Executive Order No. 26. Willimantic: Institute for Sustainable Energy at Eastern Connecticut State University. Retrieved from https://cdm15019.contentdm.oclc.org/digital/collection/p128501coll2/id/154777

The State of New York. (1982, May 10). Deeded Easement. *Volume 338 Page 159*. New York, New York: The State of New York.

USCG. (1999, July 16). Long Island Sound Policy Letter (03/99): Lightering Zones. New Haven: U.S. Coast Guard (USCG), Captain of the Port Long Island Sound.

USCG. (2017, February 22). Sector Long Island Sound Policy Letter 3170: Lightering and Ship to Ship Transfer Operations. New Haven: U.S. Coast Guard (USCG), Captain of the Port Long Island Sound.

Weigold, M. E. (2004). *The Long Island Sound: A History of Its People, Places, and Environment.* New York: New York University Press.

Weigold, M. E., & Pillsbury, E. (2014). Long Island Sound: A Socioeconomic Perspective. In J. S. Latimer, M. A. Tedesco, R. L. Swanson, C. Yarish, P. E. Stacey, & C. Garza (Eds.), *Long Island Sound: Prospects for the Urban Sea* (pp. 1-46). New York: Springer.

Working Group on Southwest CT and Task Force on LIS. (2003). *Comprehensive Assessment and Report, Part I: Energy Resources and Infrastructure of Southwest Connecticut.* Pursuant to Public Act 02-95 and Executive Order No. 26. Willimantic: Institute for Susainable Energy at Eastern Connecticut State University. Retrieved from http://worldcat.org/arcviewer/2/CZL/2009/05/07/H1241727069096/viewer/file2.pdf

Zaretsky, M. (2009, February 26). State hails victory with demise of Islander East pipeline. *New Haven Register*. Retrieved from https://www.nhregister.com/news/article/State-hails-victory-with-demise-of-Islander-East-11632222.php

26.5 Appendices

26.5.1 List of Maps Used to Inform the Chapter

Below is a list of all maps used to inform this chapter, including maps presented above in the narrative and additional maps used to support chapter findings. Maps listed below are organized by the online data portal on which they are hosted (URL links to data portals are noted in *Section 26.4 References* above). Map products not accessible by online data portal are also noted below.

Northeast Ocean Data Portal

- Alternative Fuel Stations
- Cable and Pipeline Areas
- New England Electrical Transmission Lines
- New England Electrical Transmission Substations
- Submarine Cables

New York Geographic Information Gateway

- Tidal Stream Resource Potential – Mean Current
- Tidal Stream Resource Potential – Mean Power Density

Mid-Atlantic Ocean Data Portal

- Offshore Wind Technology Zones

Energy Zones Mapping Tool (must sign up for an account)

- Biodiesel Plants
- Mineral Resources
- Pipelines – Natural Gas
- Pipelines – Petroleum Product
- Wave Energy – Energy Period
- Wave Energy – Power Density
- Wave Energy – Significant Wave Height
- Wave Energy – Water Depth

U.S. Energy Information Administration Connecticut Profile

- Coastal Energy Facilities

U.S. Environmental Protection Agency, Enforcement and Compliance History Online

- Facility Search – Type: Water Facilities – Geographic Location: State - Connecticut, New York; Facility Characteristics: SIC Code 2-digit selection – 49 - Electric, Gas, and Sanitary Services; Pollutant: 12371 - Temp. diff. between intake and discharge, 12389 - Temperature, water deg. Fahrenheit

NOAA ENC Direct to GIS

- Approach – Aids to Navigation – Beacon – Lateral (Point)
- Approach – Aids to Navigation – Beacon – Special Purpose General (Point)
- Approach – Aids to Navigation – Light (Point)
- Approach – Offshore Installations – Offshore Platform (Point)
- Approach – Offshore Installations – Pipeline – Submarine On Land (Line)

- Approach – Ports and Services – Mooring – Warping Facility (Point)
- Approach – Regulated Areas and Limits – Restricted Area (Area)

Non-Portal Map Products

- Cables and Pipelines Surrounding the Thimble Islands
- Potential Tidal Energy Sites Around Long Island, NY
- Potential Tidal Energy Sites with Depth < 50 ft, Long Island
- Potential Tidal Energy Sites with Depth > 50 ft, Long Island
- Offshore Wind Speed 90m
- U.S. Army Corps of Engineers LIS Dredged Material Management Plan Historic Resources Inventory

More information on some of the map products presented in this chapter, including URL links to data and metadata, can be found in the Energy & Telecommunications Map Book (CT DEEP, 2017). Not all products showcased in the map book may be addressed in this chapter or utilized to inform the final Blue Plan.

26.5.2 Notes on Stakeholder Engagement

Initial rounds of spatial data review took place throughout the fall of 2017 with a team of at least three representatives from Eversource Energy, along with two representatives from the Connecticut Siting Council. These initial rounds of review consisted of overview preliminary assessments of the accuracy, relevance, and relevance of collected spatial data and identification of other stakeholders in the sector who may also want to review the spatial data.

Over 75 stakeholders in the energy and telecommunications sector were identified and invited to take part in a spatial data review webinar on December 18, 2017, including being sent the Energy & Telecommunications Map Book (CT DEEP, 2017). Approximately 21 people participated on the webinar, 14 of whom represented organizations within the energy and telecommunications sector. Webinar topics covered included a basic overview of the Inventory and Blue Plan policy development processes, summary of the spatial data products collected by the Blue Plan team, and an open discussion on whether the spatial data was accurate, relevant, and representative for marine spatial planning purposes.

Stakeholder engagement outside of the webinar also took place. In September 2017, CT DEEP staff members met with representatives from Deepwater Wind for informational purposes to discuss the process of wind energy development on the Atlantic coast. (According to CT DEEP members present at the meeting, Deepwater Wind has no current plans to pursue permits for wind turbine placement in LIS.) Moreover, representatives from Eversource Energy, the Connecticut Siting Council, and Dominion Energy Millstone Power Station's Environmental Lab aided in the review of an earlier version of this Inventory chapter in March and April 2018.

A few stakeholders from the general public raised questions about the aforementioned February 2018 RFP released by CT DEEP to procure renewable energy from offshore wind, fuel cell, and anaerobic digestion resources (CT DEEP, 2018a). Most questions dealt with whether the RFP anticipated the construction of offshore wind turbines in the Sound and how project proposals submitted in response to the RFP would relate to the Blue Plan. Stakeholders were assured that this RFP simply addressed transmission of offshore wind-, fuel cell-, and anaerobic digestion-generated energy into the Connecticut electrical grid and that there is currently no specific proposal to place wind turbines in LIS or to site a transmission cable from offshore wind farms into the Sound's waters. Moreover, stakeholders were informed that the RFP contained specific language mentioning that any offshore wind proposal that includes activity within LIS must demonstrate consistency with the goals and policies set forth in the Blue Plan legislation.

Further opportunities for stakeholder engagement include engaging more stakeholders at industry meetings and facilitating more in-depth review of the information provided in Tables 26-1 through 26-5.

Chapter 27

National Security

Chapter Table of Contents

Chapter List of Figures and Tables

Figures

Tables

27.1 Key Data and Map Products

The National Security sector concerns those activities and facilities associated with national defense and law enforcement, predominantly the responsibilities of the U.S. Navy and U.S. Coast Guard (USCG).

There are a few map products that help to show the distribution and diversity of national security activities in Long Island Sound. These maps illustrate data surrounding topics of regulated zones, anchorage areas, and warfare testing ranges.

Anchorage Areas (Figure 27-1) is a map that displays polygons identifying where boats and ships can safely drop anchor. Special anchorage areas are described in subpart A of 33 U.S. Code (U.S.C.) Part 100. Anchoring data can be found in [33 Code of Federal Regulations (CFR) Part 110] (Navigation and Navigable Waters, 33 CFR, 2017).

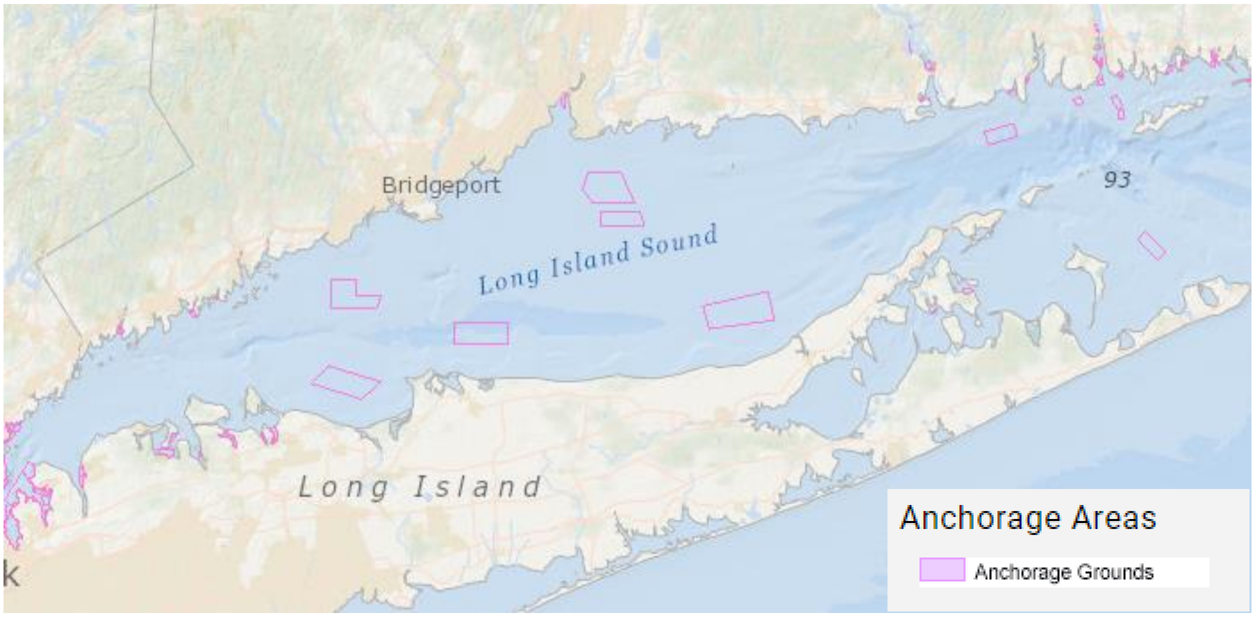


Figure 27-1: Anchorage Areas. Map displaying where ships and boats can safely drop anchor. Access available via the Mid-Atlantic Data Portal (MARCO, 2018).

The Safety, Security, and Regulation zones map (Figure 27-2) is a data layer that identifies what regions are in permanent or coniditonal security zones, and what regions lie within regulated navigation areas. The goal of the layer is to display where vessel access is limited or restricted, or if special regulations apply. Safety and security zones that are associated with special events or construction are not shown on this map, but are included in the dataset.

(a)

(b)

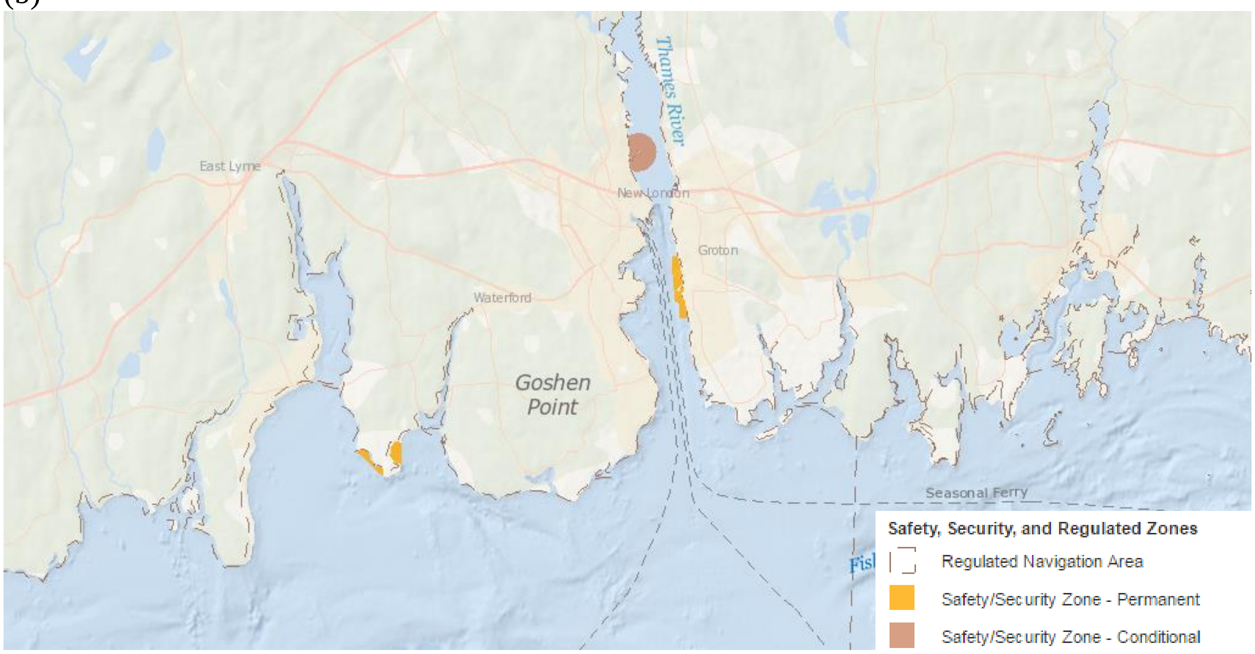


Figure 27-2: Security and Regulated Zones. (a) Map displaying regulated navigational area in Long Island Sound. (b) Map displaying regulated security zones around the Thames River region. Access available via the Northeast Ocean Data Portal (Northeast Regional Planning Body, 2018).

The Human Use Data Synthesis Theme – Security Data map (Figure 27-3) is an integrative data layer that combines 15 other data layers to see how much information lies in a given cell. Security layers include regulatory zones, danger zones, and restricted areas. If an individual were to click on a cell, a pop-out box would appear identifying how many data layers are in a cell and what those data layers are. The legend separates the cells by the number of data layers and assigns those numbers a color. The cells over Long Island Sound contain one data layer, being the Naval Undersea Warfare Testing Range presented below, and therefore are identified by a blue color.

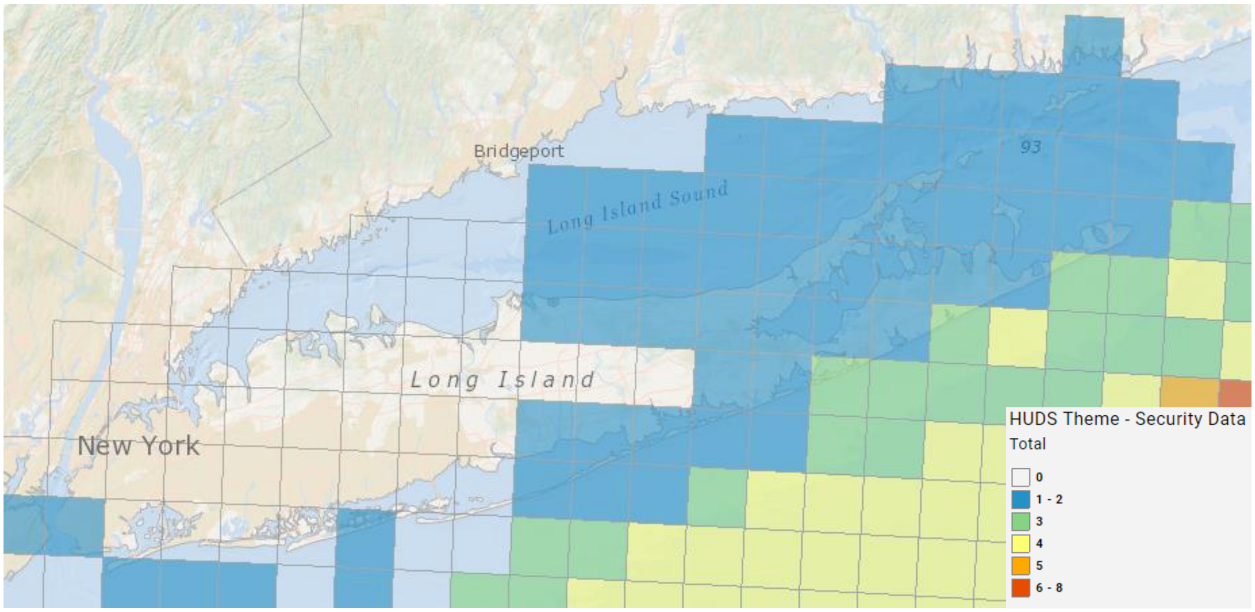


Figure 27-3: Human Use Data Synthesis Theme – Security Data. Map analyzing the different amount of security data layers in a given cell, classified by color. Access available via Mid-Atlantic Ocean Data Portal (MARCO, 2018).

The Naval Undersea Warfare Testing Range map (Figure 27-4), which is also accounted for in the HUDS data in Figure 27-3, displays an area where research, development, testing, and evaluation of undersea warfare technology can occur. This area can also support other Navy or Department of Defense activities. The Naval Undersea Warfare Center (NUWC), headquartered in Newport, RI, is known to use areas within the Sound for classified research and testing activities and maintains an installation on Fishers Island.

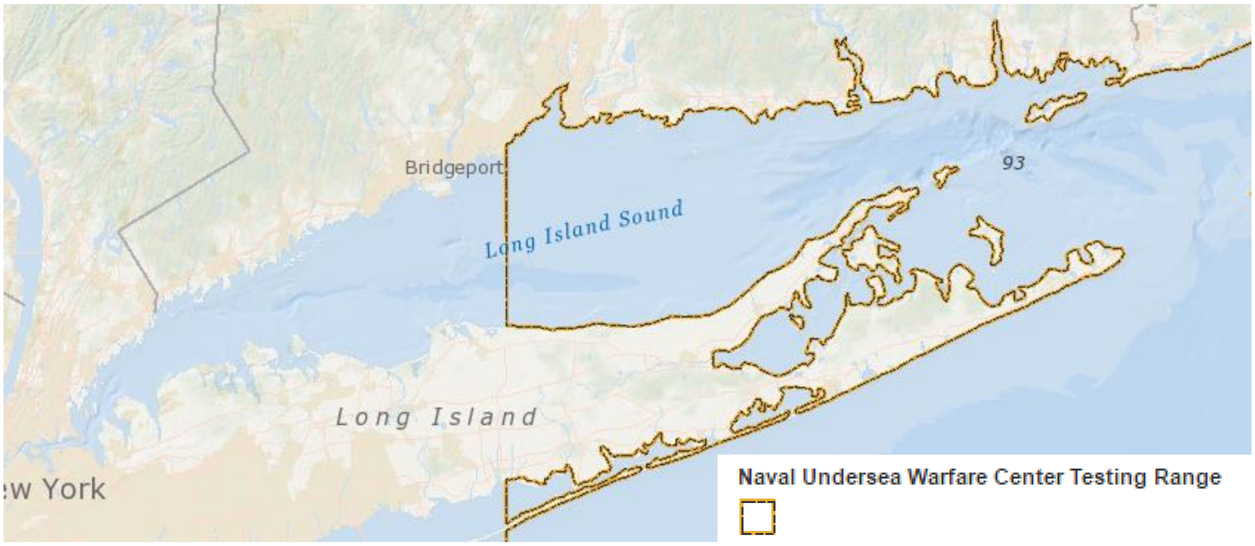


Figure 27-4: Naval Undersea Warfare Center Testing Range. Map that shows the extent of U.S. Navy research, testing, and evaluation of undersea warfare technology. Access available via the Northeast Ocean Data Portal (Northeast Regional Planning Body, 2018).

Other Authorities (State, County, and Local)

Stakeholder engagement with the USCG indicated that it is important to acknowledge other law enforcement and first responder authorities that make use of the Sound's waters and help manage on-water uses of other human uses sectors, such as commercial shipping (see *Chapter 25 Marine Transportation, Navigation, and Infrastructure*) and recreational boating (see *Chapter 19 Recreational Boating*). Such authorities include state and county police, local police and fire departments, harbormasters, and the USCG Auxiliary. Table 27-1 provides a list of known authorities that fall under this category in both Connecticut and New York.

Table 27-1: Known Connecticut and New York State, County, and Local Law Enforcement Agencies and First Responders that Operate in Long Island Sound

Connecticut

Town Harbormasters
- Branford Harbormaster
- Bridgeport Harbormaster
- Clinton Harbormaster
- Darien Harbormaster
- East Haven Harbormaster
- East Lyme/Niantic Harbormaster
- Fenwick Harbormaster (Old Saybrook)
- Greenwich Harbormaster
- Groton Harbormaster
- Groton Long Point Harbormaster
- Guilford Harbormaster
- Lords Point Harbormaster (Stonington)
- Madison Harbormaster
- Milford Harbormaster
- Mystic Harbormaster
- New Haven Harbormaster
- New London Harbormaster
- Noank Harbormaster (Groton)
- Norwalk Harbormaster
- Old Lyme Harbormaster
- Old Saybrook Harbormaster
- Ram Island/Masons Island Harbormaster (Stonington)
- Stamford Harbormaster
- Stonington Harbormaster
- Stratford Harbormaster
- Waterford Harbormaster
- West Haven Harbormaster
- Westbrook Harbormaster
- Westport Harbormaster

Police Departments
- Connecticut State Police, Emergency Services Unit, Marine Unit
- Connecticut State Environmental Conservation Police
- Branford Police Department, Marine Unit
- Bridgeport Police Department, Marine Unit
- Darien Police Department, Marine Division
- East Lyme Police Department
- Fairfield Police Department, Marine Unit
- Greenwich Police Department, Marine Operations Section
- Groton Police Department, Marine Patrol
- Milford Police Department, Marine Unit
- New Haven Police Department
- New London Police Department, Marine Patrol
- Norwalk Police Department, Marine Unit
- Norwich Police Department
- Old Saybrook Police Department, Marine Division
- Stamford Police Department, Harbor Unit
- Stonington Police Department
- Stratford Police Department, Marine Division
- Waterford Police Department
- West Haven Police Department, Shore Patrol Unit
- Westport Police Department, Marine Division

Fire Departments
- Branford Fire Department
- Bridgeport Fire Department
- Clinton Volunteer Fire Department
- Fairfield Fire Department
- Goshen Fire Department (Waterford)
- Greenwich Fire Department
- City of Groton Fire Department
- Guilford Fire Department
- Madison Hose Company No. 1
- Milford Fire Department, Marine Unit
- Mystic Fire Department
- Naval Submarine Base Firefighters Local F-219 (New London)
- New Haven Fire Department
- New London Fire Department

Fire Departments (cont.)

- Niantic Fire Department (East Lyme)
- Noroton Fire Department (Darien)Norwalk Fire Department
- Old Lyme Fire Department
- Old Saybrook Fire Department
- Stamford Fire Department
- Stratford Fire Department
- West Shore Fire District (West Haven)Westbrook Fire Department, Marine Unit
- Westport Fire Department

Other

- U.S. Coast Guard Auxiliary

New York

Town Divisions and Harbormasters (including some Bay Constables)

- Town of Brookhaven, Division of Harbors and Waterways (includes Harbormasters and Bay Constables)
- Glen Cove Harbor Patrol
- Hempstead Bay Constables
- Town of Huntington, Maritime Services Department (includes Bay Constables)
- Village of Mamaroneck Harbormaster's Office/Harbor Patrol Unit
- Town of North Hempstead, Division of Harbor Master and Marine Enforcement (includes Harbormaster, Harbor Patrol, and Bay Constables)
- Town of Oyster Bay, Division of Marine Enforcement (includes Bay Constables)
- Port Chester Harbormaster (Rye)
- Town of Smithtown, Waterways & Navigation Division (includes Harbormaster and Bay Constables)

Police Departments (including some Bay Constables)

- East End Marine Task Force (partnership of 18 federal, state, county, and town/village police agencies)
- Suffolk County Police Department, Marine Bureau
- Suffolk County Sheriff's Office, Marine Unit
- Asharoken Police Department (Huntington)
- Village of Mamaroneck Police Department, Marine Unit (includes Bay Constables)
- Nassau County Police Department, Marine Bureau
- New Rochelle Police Department, Harbor Unit (includes Harbormasters)
- New York State Environmental Conservation Police, Marine Enforcement Unit
- New York State Police, Marine Detail
- Northport Police Department, Marine Unit (Huntington)
- Port Chester Police Department (Rye)
- Riverhead Police Department, Patrol Division (includes Rescue/Scuba Team and Bay Constables)
- Rye Police Department, Marine Division (includes Bay Constables)
- Southold Police Department, Marine Division (includes Bay Constables)

Fire Departments

- Westchester County Police Department, Marine Unit
- Atlantic Steamer Fire Company (Oyster Bay)
- Bayville Fire Department (Oyster Bay)
- Brookhaven Technical Rescue (partnership of nine fire departments)
- Centerport Fire Department (Huntington)
- Cold Spring Harbor Fire Department (Huntington)
- East Marion Fire Department (Southold)
- Fishers Island Fire Department, Sea Stretcher Crew
- Glen Cove Fire Department
- Halesite Fire Department (Huntington)
- Harrison Fire Department
- Huntington Fire Department
- Huntington Fire Department
- Kings Park Fire Department (Smithtown)
- Town of Mamaroneck Fire Department
- Village of Mamaroneck Fire Department, Marine Division
- Mattituck Fire Department, Water Rescue Team (Southold)
- Mt. Sinai Fire Department (Brookhaven)
- New Rochelle Fire Department
- Northport Fire Department, Marine Rescue Company (Huntington)
- Orient Fire Department (Southold)
- Port Washington Fire Department (North Hempstead)
- Riverhead Volunteer Fire Department, Water Rescue Team
- Rocky Point Fire Department, Company 1 (Brookhaven)
- Rye Fire Department
- Setauket Fire Department (Brookhaven)
- Sound Beach Volunteer Fire Department (Brookhaven)
- Southold Fire Department, Water Rescue Squad/Marine Unit
- Stony Brook Fire Department, Marine Rescue Squad (Brookhaven)
- Wading River Fire Department (Riverhead/ Brookhaven)

Other

- U.S. Coast Guard Auxiliary

27.2 Assessment of Data Quality

27.2.1 Sources of Data and Metadata

Data is available through a series of online data portals including the Northeast Ocean Data Portal and Mid-Atlantic Ocean Data Portal. The National Oceanic and Atmospheric Administration (NOAA) charts are also a prominent source of maritime transportation, boating, and security information, particularly for features such as safety and security zones which must be taken into account by other users of Long Island Sound. Metadata information is available through the online portals. Most of the data is collected via the USCG and U.S. Navy.

27.2.2 Accuracy, Representativeness, and Relevance of Map Products

In terms of accuracy, the most up-to-date information can be found via NOAA Navigation Charts, which are available in both electronic and raster forms (Electronic Navigation Charts and Raster Navigation Charts, respectively) (NOAA, 2017). Certain data layers like the Aids to Navigation map product (see *Section 27.5.1 List of Maps Used to Inform the Chapter*) may not be as useful in a static form; however, NOAA Electronic Navigation Charts display their latest locations, updated as often as daily (see Figure 21-3: Example Display of NOAA Charts in *Chapter 20 Harbors and Marinas*). Aids to Navigation information may also be supplemented with the Weekly Light List to improve navigation and data accuracy. The weekly light list is meant to provide more complete information concerning aids to navigation that cannot be shown on charts (USCG, 2018). This list is supplied annually, and corrections are made as needed (USCG, 2018).

In relation to representativeness and relevance, again the NOAA Navigation Charts will be the best way to understand spatial concerns of National Security. For example, the spatial aspects of naval operations in the Sound essentially comprise submarine transits through existing navigational channels between the Sub Base and open ocean waters, which are of course reflected on the NOAA charts. National Security also has strong ties to the Marine Transportation, Navigation, and Infrastructure sector (see *Chapter 25 Marine Transportation, Navigation, and Infrastructure*) and should be referred to while understanding this sector.

27.2.3 Data Gaps and Availability of Data to Address Gaps

Not all national security-related data may be depicted in a spatial data layer. Stakeholders suggested that providing a link to the 33 CFR would provide further information on specific anchorage areas, rules about using lights, and other relevant regulations (Navigation and Navigable Waters, 33 CFR, 2017).

Other data gaps of the National Security sector may include emergency response, infrastructure and environmental sensitivity. Additional resources from stakeholders were suggested to fill in some of those gaps and to have a robust variety of data. These include federal datasets such as Homeland Infrastructure Foundation-Level Data, which provides spatial datasets on maritime transportation, jurisdiction boundaries, ports, and USCG districts (DHS, 2017a). Other federal datasets include the Emergency Response Management Application from NOAA, which is an online mapping toolset that can provide datasets on ship locations, weather, ocean currents, and Environmental Sensitivity Indexes (NOAA, 2018b). NOAA Environmental Sensitivity Index data provide essential information on coastal resources that may be at risk to spilled oil (NOAA, 2018a).

One last data gap presented may be the lack of spatial representation of marine events. To fill this gap, it was suggested to refer to the USCG Local Notices to Mariners, which can provide information on marine events, dredging projects, construction, etc. that are not spatially catalogued (USCG, 2017).

27.3 Relevance

27.3.1 Relative Historical Importance

Connecticut's naval tradition goes back to the earliest days of the Republic, when a shipyard in what is now Essex built a frigate for the Continental Navy. Today, submarines are built at Electric Boat (EB) in Groton and based upriver at the Naval Submarine Base New London (Sub Base). The USCG Academy, with extensive docks and the home of the tall ship *Eagle*, is nearby in New London, and USCG Sector Long Island Sound is headquartered in New Haven. Within the Sound, there are other USCG stations at Fort Trumbull in New London and Eaton's Neck, NY. The Sub Base, the Academy, and EB are facilities of national importance that contribute significantly to the security of the United States. In addition, the Naval Undersea Warfare Center, based in Newport, RI, and with a facility on Fishers Island, NY, occasionally conducts classified research and testing activities in Long Island Sound.

Currently there is little conflict between national security activities and other uses of Long Island Sound. Submarine operations, generally transiting between the Sub Base and offshore deployments, are restricted to existing navigational channels. NUWC activities take place only occasionally within the Sound, and NUWC has referred to the Northeast Ocean Data Portal, among other data sources, to ensure that there will be no interference with other users.

27.3.2 Socio-Economic Context

From an economic perspective, the Sub Base and EB each constitute two of the largest employers in Southeastern Connecticut. The Sub Base hosts 6,500 military personnel and over 2,000 civilian employees and contractors and plays an essential role in the state and regional economy (CNIC, 2018; Southeastern CT Council of Governments, 2017). In 2005, when the Sub Base was threatened with closure under the Pentagon's "Base Realignment And Closure" process, Connecticut state agencies and business groups mobilized to document the economic and security values that were at stake (State of Connecticut, 2005). As a result of this study's findings, the closure recommendation was overturned and the base remains open. In addition, the U.S. Navy's plans for procurement of new submarines in the coming decades have prompted EB to boost its employment to 15,000 people (Bergman, 2017). The indirect and multiplier effects of all submarine-related employment and expenditures are integral to the entire regional economy.

27.3.3 Other Notes

In terms of spatial requirements, both the Sub Base and EB are protected by designated security zones and require periodic dredging of the navigational channel of the Thames River in order to function. EB is of greatest concern in this respect, since projected increases in submarine construction will necessitate additional dredging, for which a permit application is forthcoming, and may affect other maritime traffic. Moreover, EB is within the statutorily specified Blue Plan policy area and will need to be taken into account in policy development. It should also be noted that the USCG describes New London as a National Security Port based its on proximity to the Sub Base and EB facilities (which are located in the adjacent Groton) and to the USCG Academy in New London (upstream of the Goldstar Bridge).

In terms of marine spatial planning for potential new uses, virtually all human activities in Long Island Sound will depend to a greater or lesser extent on navigation by ship or boat. As such, any future uses and the navigational traffic patterns they generate will need to accommodate national security considerations such as restricted zones around sensitive facilities and naval operations.

27.4 References

Bergman, J. (2017, January 9). *Electric Boat poised to invest $1.5 billion to meet demand for more subs.* Retrieved from The Day, Military News: http://www.theday.com/article/20170109/NWS09/170109316

CNIC. (2018). *Total Force Power*. Retrieved from Commander, Navy Installations Command (CNIC): Naval Submarine Base New London: https://www.cnic.navy.mil/regions/cnrma/installations/navsubbase_new_london/about/total_force_manpower.html

CT DEEP. (2018). *Long Island Sound Blue Plan Webinars*. Retrieved from Connecticut Department of Energy and Environmental Protection (CT DEEP): http://www.ct.gov/deep/cwp/view.asp?a=2705&q=593814&deepNav_GID=1635

DHS. (2017a). *HIFLD Open Data*. Retrieved from Homeland Infrastructure Foundation-Level Data (HIFLD): https://hifld-geoplatform.opendata.arcgis.com/

MARCO. (2018). Retrieved from Mid-Atlantic Ocean Data Portal: http://portal.midatlanticocean.org/visualize/

Navigation and Navigable Waters, 33 CFR (2017).

NOAA. (2017). *Office of Coast Survey*. Retrieved from http://www.charts.noaa.gov/InteractiveCatalog/nrnc.shtml

NOAA. (2018a). *Download ESI Maps and GIS Data*. Retrieved from Office of Response and Restoration: https://response.restoration.noaa.gov/maps-and-spatial-data/download-esi-maps-and-gis-data.html

NOAA. (2018b). *Environmental Response Management Application (ERMA)*. Retrieved from Office of Response and Restoration: https://response.restoration.noaa.gov/maps-and-spatial-data/environmental-response-management-application-erma
Northeast Regional Planning Body. (2018). Retrieved from Northeast Ocean Data Portal: https://www.northeastoceandata.org/data-explorer/
Southeastern CT Council of Governments. (2017, December 12). *Subase New London Joint Land Use Study*. Retrieved from http://www.seccog.org/pdfs/SNL_JLUS_ProjectOverview_Final_2017-12-06.pdf
State of Connecticut. (2005). *The Contribution of the Groton Naval Sub Base and the Electric Boat Company to the Economies of Connecticut and Southeastern Connecticut.* Department of Economic and Community Development Economic Impact Analysis, Executive Summary. Retrieved from http://www.ct.gov/ecd/lib/ecd/Sub_Base_Executive_Summary_5.4.05.pdf
USCG. (2017). *Local Notice to Mariners*. Retrieved from U.S. Coast Guard (USCG) Navigation Center: https://www.navcen.uscg.gov/?pageName=lnmDistrict&region=1
USCG. (2018). *Weekly Light Lists*. Retrieved from U.S. Coast Guard (USCG) Navigation Center: https://www.navcen.uscg.gov/?pageName=lightListWeeklyUpdates

27.5 Appendices

27.5.1 List of Maps Used to Inform the Chapter

Below is a list of all maps used to inform this chapter, including maps presented above in the narrative and additional maps used to support chapter findings. Maps listed below are organized by the online data portal on which they are hosted (URL links to data portals are noted in *Section 27.4 References* above). Map products not accessible by online data portal are also noted below.

Northeast Ocean Data Portal
- Safety, Security, and Regulated Zones
- Naval Undersea Warfare Testing Range

Mid-Atlantic Ocean Data Portal
- Anchorage Areas
- Human Use Data Synthesis Theme – Security Data
- Aids to Navigation
- Maintained Channels

Non-Portal Map Products
- NOAA Navigational Charts

More information on some of the map products presented in this chapter, including URL links to data and metadata, can be found in the National Security Map Book (CT DEEP, 2018). Not all products showcased in the map book may be addressed in this chapter or utilized to inform the final Blue Plan.

27.5.2 Notes on Stakeholder Engagement

In-person meetings were held with Connecticut State Environmental Conservation Police on October 12, 2017, with USCG personnel, including the Chiefs of Prevention, Waterways Management and Incident Management for Sector Long Island Sound, on December 1, 2017, and with personnel from the Navy Sub Base New London on January 24, 2018. A conference call with staff from NUWC and the Sub Base was held on February 8, 2018. On each occasion agency activities, data sources, and data needs were discussed, and provisions made for following up. Further engagement and coordinated was suggested with regional Port Security groups, which gather all relevant law enforcement agencies and relevant maritime stakeholders in periodic meetings.