Executive Office of Energy and Environmental Affairs
Massachusetts Office of Coastal Zone Management

Habitat

Work Group Report

In Support of the Massachusetts Ocean Management Plan

July 22, 2020

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SECTION ONE: HABITAT WORK GROUP MEMBERS

Habitat Work Group Staff

- Todd Callaghan, Massachusetts Office of Coastal Zone Management, Work Group lead
- Samantha Coccia-Schillo, Massachusetts Office of Coastal Zone Management, GIS analyst

Marine Mammals

- Diane Borggard,* National Marine Fisheries Service, whale specialist
- Erin Burke, Massachusetts Division of Marine Fisheries, whale (and sea turtle) specialist
- Peter Corkeron,** New England Aquarium, whale specialist
- Brooke Hodge, New England Aquarium, GIS analyst
- Bob Kenney,** University of Rhode Island, whale specialist
- Stormy Mayo,*** Center for Coastal Studies, whale specialist
- Jessica Redfern,** New England Aquarium, whale specialist
- Jooke Robbins,*** Center for Coastal Studies, whale specialist

Avifauna

- Jon Atwood,** Massachusetts Audubon, Director of Bird Conservation
- Pamela Loring,** U.S. Fish and Wildlife Service, Division of Migratory Birds
- Carolyn Mostello,** Massachusetts Natural Heritage and Endangered Species Program
- Wayne Petersen, Massachusetts Audubon, Important Bird Area specialist
- Kevin Powers, Retired
- Eve Schluter,** Massachusetts Natural Heritage and Endangered Species Program
- Joan Walsh,* Massachusetts Audubon, Roseate Tern specialist

Eelgrass

- Phil Colarusso, U.S. Environmental Protection Agency, seagrass specialist
- Tay Evans, Massachusetts Division of Marine Fisheries, seagrass specialist
- Michael McHugh, Massachusetts Department of Environmental Protection, seagrass specialist

Sea Turtles

- Kara Dodge,* New England Aquarium, sea turtle specialist
- Robert Prescott,* Massachusetts Audubon, sea turtle specialist
- Kate Sampson,** NOAA, sea turtle strandings specialist

*On phone during work group meeting
**Reached via email/phone for additional data or technical advice after the work group meeting
***2014 Habitat Work Group Member; contacted but was not able to participate in 2019/2020

SECTION TWO: INTRODUCTION

The Massachusetts Oceans Act of 2008 required the creation of a comprehensive ocean management plan (ocean plan) for Massachusetts waters by December 2009. The foundation of the ocean plan was the identification of management areas within state waters with specific siting and performance standards established to protect existing natural resources as well as commercial and recreational uses. Twelve habitat types were determined to be Special, Sensitive, or Unique (SSU) natural resources deserving of protection and were mapped for the ocean plan using the best data available at that time.

The 12 SSU resources mapped in the ocean plan are:

- North Atlantic right whale core habitat
- Humpback whale core habitat
- Fin whale core habitat
- Roseate Tern core habitat
- Special concern (Arctic, Least, and Common) tern core habitat
- Sea duck core habitat
- Leach's Storm-Petrel important nesting habitat
- Colonial waterbirds important nesting habitat
- Hard/complex seafloor
- Eelgrass
- Intertidal flats
- Important fish resource areas

The Oceans Act requires that the ocean plan be reviewed at least every five years. In order to inform the five-year review, in August 2019 the Massachusetts Office of Coastal Zone Management (CZM) convened two meetings of the Habitat Work Group to focus on the following nine SSU habitat areas (the remaining three SSU habitat areas were reviewed by other work groups):

- North Atlantic right whale core habitat
- Humpback whale core habitat
- Fin whale core habitat
- Roseate Tern core habitat
- Special Concern tern core habitat
- Sea duck core habitat
- Leach's Storm-Petrel important nesting habitat
- Colonial waterbirds important nesting habitat
- Eelgrass

The first meeting focused on whales, avifauna, and turtles while the second meeting focused on eelgrass. The group also discussed the current lack of a mapped sea turtle SSU and made some suggestions on how to capture sea turtle habitat in the ocean plan.

At both meetings, CZM staff presented background information on the creation of the ocean plan, a summary of the existing SSU and Water dependent Use (WDU) areas within the ocean plan, the use of siting and performance standards to protect SSUs and WDUs, and the 5-year planning cycle and current timeline for ocean plan review. CZM staff also presented an overview of the results of an ocean planning survey conducted by CZM at the start of the 2019 review process.

Habitat Work Group's Charge

The Habitat Work Group included specialists in the fields of marine mammal, avifauna, sea turtle, and eelgrass habitat mapping. The group was charged with four primary tasks:

1. Identifying any changes to the spatial extent of "protected areas" identified and mapped in the 2015 Massachusetts Ocean Management Plan: SSUs and WDUs.
2. Identifying and characterizing other significant or notable trends in the status or condition of resources and uses, including (a) SSUs and WDUs identified and mapped in the 2015 plan and (b) the topics and categories covered in the Baseline Assessment (contained in Volume II of the 2015 ocean plan).
3. Identifying and summarizing any new information that advances the characterization of the planning area and its uses and resources, especially applied science with spatial data.
4. Reviewing the science and data priorities in the 2015 ocean plan (Volume II, Science Framework) and work done to date to address those priorities, and making recommendations for the priority science and data actions for the next five years.

SECTION THREE: DATA SOURCES AND MAPPING RECOMMENDATIONS

The discussions from the Habitat Work Group were used to establish a list of recommendations to CZM to assist in updating the existing ocean plan as well as keeping the science behind the ocean plan current. Below are the recommendations by species groups.

Marine Mammals

Habitat Work Group members identified that the use of Massachusetts waters by North Atlantic right whales (*Eubalaena glacialis*) has increased in the last 10-15 years. In 2007, a significant increase in sightings in Cape Cod Bay was documented; a trend that has continued to the present time (2020). An increase in sightings in western Cape Cod Bay (from Cohasset to Plymouth) has been consistent since 2013. An increase in sightings in northwestern Massachusetts Bay (Boston to Gloucester) is a more recent phenomenon and it isn't clear at this time if this pattern will become a trend (Bob Kenney, URI-retired, personal communication). Additionally, acoustic receivers are documenting more North Atlantic right whale calls both within the peak season in Massachusetts Bay (late winter/early spring) and in the "off season" for sightings.[1]

Whale specialists on the work group believed that the whales are following concentrations of their food and that the locations of these food aggregations most likely are changing, thus whales are being sighted in some areas where they have not been seen historically. Jeff Runge from University of Maine has received funding to develop a model to explain the relationship between North Atlantic right whales and their preferred food that might help predict where and when aggregations of whales occur.

[1] R. A Charif, Y. Shiu, C.A. Muirhead, C.W. Clark, S.E. Parks, and A.N. Rice. 2019. Phenological changes in North Atlantic right whale habitat use in Massachusetts Bay. Global Change Biology. Wiley Online Library: **https://doi.org/10.1111/gcb.14867**.

Work Group Recommendations

Several recommendations for mapping the North Atlantic right whale, humpback whale (*Megaptera novaeangliae*), and fin whale (*Balaenoptera physalus*) data were made by the Habitat Work Group:

- When mapping core whale habitat, use data from the North Atlantic Right Whale Consortium from 1998-2018;
- Use the most recent New England Aquarium and National Oceanographic and Atmospheric Administration (NOAA) survey data from 2017 and 2018, which may not be in the Consortium database and would have to be requested directly from the researchers;
- After applying the whale sightings data to 5 minute x 5 minute squares and classifying them, present the sightings data as both interpolated and "blocked" to ensure that the interpolation process is not misrepresenting the true patterns in the data;
- Map and compare off-effort sightings data (e.g., whale watch observations) with on-effort (survey) sightings data;
- Create an effort map for whale sightings;
- Ensure that any mapped core habitat is consistent with the NOAA critical habitat map as well as the Massachusetts Division of Marine Fisheries (DMF) Large Whale Seasonal Trap Gear Closure from February 1 to April 30 of each year; and
- Include a map of non-core North Atlantic right whale habitat to ensure that regulators and planners take into account the corridors that whales need to travel among core areas.

While it was not brought up at the August Ocean Plan Habitat Work Group meeting, a subject that continues to be brought to the Executive Office of Energy and Environmental Affairs (EEA) Habitat Working Group on Offshore Wind is the monitoring of plankton in and adjacent to feeding North Atlantic right whales. The Massachusetts Clean Energy Center (MassCEC) funded two surveys (2017, 2018) identifying and enumerating the zooplankton adjacent to right whale sightings. At the December 2019 meeting, EEA Habitat Working Group member Stormy Mayo from the Center for Coastal Studies made a strong recommendation that the plankton surveys continue into the future and that the data be used to model and predict where North Atlantic right whales will occur relative to offshore development.

Additional recommendation:

- Continue plankton surveys in and adjacent to North Atlantic right whale sightings and develop a model to predict when and where right whales will occur.

Data Collection and Methods

In response to the Habitat Work Group's recommendations, CZM requested sightings data from the North Atlantic Right Whale Consortium, spanning 1998-2018. As in previous ocean planning analyses, the start date of 1998 was chosen for the analysis because regular aerial surveys of Cape Cod Bay by the Center for Coastal Studies (CCS) began in 1998 and work by CCS demonstrated a statistically significant increase in the use of Cape Cod Bay by North Atlantic right whales from 2002 to 2013 and that pattern is continuing.[1] Bob Kenney from the North Atlantic Right Whale Consortium (the "Consortium") provided CZM with Sightings Per Unit Effort (SPUE) data for North Atlantic right, humpback, and fin whales in an area covering Massachusetts and adjacent marine waters (as in the 2015 ocean plan). For each species, the SPUE data were binned into 5-minute x 5-minute grid cells (roughly 7 km x 9 km) with the sightings data assigned to the centroid of each cell (Figure 1). The gridded SPUE data were then interpolated using the Natural Neighbor tool in ArcGIS 10.2. The interpolated data were classified into five classes, including observations of zero whales (Figure 2). An effort map was created to depict how survey effort varies spatially (Figure 3).

In response to a Work Group recommendation, a map was made comparing off-effort (opportunistic) to on-effort (on survey) whale sightings to see how they differ (Figure 4). Off-effort observations may be important if there is an area that had a lot of opportunistic sightings recorded from whale watch vessels but did not have any dedicated survey effort. In this case, the area may show up as having "no data" or "0" observations in the Consortium's database when it in fact might be an important area. Figure 4 depicts that there are more off-effort observations in the Gulf of Maine and Georges Bank than on-effort observations, but within the ocean planning area the observations generally overlap. To further explore this issue, for each of the three species, maps were made comparing the interpolated on-effort sightings to the raw off-effort sightings (Figure 5). These maps demonstrate that generally the off-effort sightings tend to fall within the concentrated SPUE areas that are used to determine the ocean plan's whale SSUs (i.e., the red and orange areas). However, there are areas outside of the SSUs where whales do occur, especially closer to shore (e.g., Nantucket Sound and Buzzards Bay for North Atlantic right whales, inner Cape Cod Bay for humpback whales, and inner Cape Cod Bay and outer Massachusetts Bay for fin whales).

Because whale distributions in Massachusetts vary over time, four interpolated maps, each representing one of the four seasons, were created for each of the three whales (Figures 6-8). To be consistent with the recent New England Aquarium reports on whale sightings in the offshore Wind Energy Areas, the four seasons are defined as spring (April-June), summer (July-September), fall (October-December), and winter (January-March).

CZM's Proposed Updates to Whale SSUs

It is clear that more whales have been using the western side of Cape Cod Bay, especially closer to shore, and from Boston to Gloucester (Figure 2). As in 2015 ocean plan, the top two classes in the interpolated maps were selected to represent the core habitat SSU area for each of the whale species (Figures 9-11). The area of the proposed North Atlantic right whale SSU for the 2020 Plan is 617,920 acres or 45% of the ocean planning area; a 53% increase compared to the 2015 ocean plan. The area of the proposed humpback whale SSU is 249,578 acres or 18% of the ocean planning area; a 27% increase compared to the 2015 ocean plan. The area of the proposed fin whale SSU is 238,879 acres or 17% of the ocean planning area; a 47% increase compared to the 2015 ocean plan.

Additional Large Whale Protection Maps

While not part of the Massachusetts ocean planning process, three addition North Atlantic right whale habitat areas deserve noting. First, NOAA has established a North Atlantic right whale critical habitat called Northeastern U.S. Foraging Unit 1 (Figure 12). There is a companion critical habitat area designated for the Southeastern U.S. also. Second, U.S. Law (50CF 224.105) prohibits operating vessels 65 feet (19.8 meters) or greater in excess of 10 knots in Seasonal Management Areas (SMAs) along the east coast of the United States. Mariners are also requested to route around voluntary speed reduction zones (Dynamic Management Areas—DMAs) or transit through them at 10 knots or less (Figure 13. Updates to these areas can be found at the NOAA website at https://www.fisheries.noaa.gov/national/endangered-species-conservation/reducing-ship-strikes-north-atlantic-right-whales#vessel-speed-restrictions. Lastly, DMF enacts a Large Whale Seasonal

Trap Gear Closure from February 1 to April 30 of each year in order to reduce the incidence of North Atlantic right whales becoming entangled in buoy lines (Figure 14). Updates to this area can be found at the DMF website at https://www.mass.gov/orgs/large-whale-seasonal-trap-gear-closure-task-force. The proposed North Atlantic right whale core habitat map for the revision of the ocean plan is consistent with these NOAA and DMF maps in that it is a subset of these larger mapped areas.

Avifauna

Members of the Habitat Work Group discussed the recent efforts by MassCEC and the Bureau of Ocean Energy Management (BOEM) to survey various marine mammals, avifauna, sea turtles, and large fish in and around the offshore Wind Energy Areas via spotter plane-based observers and automated photography. However, it was noted that these survey flights have limited utility in identify smaller animals such as Roseate Terns (*Sterna dougallii*) to the species level. Members recommended that more work be done on documenting the movements of Roseate Terns and better defining their foraging habitats. It was also recommended that more effort be put into understanding where Long-tailed ducks (*Clangula hyemalis*) feed, as their distributions appear to be changing (Wayne Petersen, Mass Audubon, personal communication).

Work Group member Kevin Powers presented a few slides of data that he intends to publish showing feeding habitat preferences for Great Shearwaters (*Ardenna gravis)*. The data from 58 tagged individuals showed that they feed predominantly on sand lance in <100 m water depth and on sandy seafloors. A Great Shearwater concentration exists to the east of Cape Cod. A suggestion was made that a map of habitat for concentrated prey items such as sand lance, which are important to shearwaters, humpback whales, and terns, might be a good addition to the SSU maps in the ocean plan.

In the 2015 ocean plan, CZM mapped sea duck core habitat from U.S. Fish and Wildlife Service (USFWS) effort-corrected sightings data of Long-tailed Duck, Common Eider (*Somateria mollissima*), Black Scoter (*Melanitta americana*), Surf Scoter (*Melanitta perspicillata*), and White-Winged Scoter (*Melanitta deglandi*)from 2008-2012, as well as Mass Audubon Long-tailed Duck telemetry data from 2008-2009. At the 2019 Habitat Work Group meeting, CZM proposed using the Marine-Life Data and Analysis Team (MDAT) modeled annual relative density for Long-tailed Duck available on the Northeast Ocean Data Portal.[2] Many scientists and coastal managers contributed to the analysis and presentation of the MDAT data.[3] The models were developed using USFWS Northwest Atlantic Seabird Catalog and the Canadian Wildlife Service Eastern Canada Seabirds at Sea database.

The work group did not identify any new data or trends regarding Leach's Storm-Petrel (*Oceanodroma leucorhoa*) or colonial waterbirds nesting habitats in Massachusetts and therefore recommended that these two SSUs not change in the revision of the ocean plan.

Work Group Recommendations

- Leach's Storm-Petrel important nesting habitat and Colonial waterbirds important nesting habitat should remain the same;

[2] https://www.northeastoceandata.org/XR2nvMUk

[3] Curtice, C., Cleary J., Shumchenia E., Halpin P. (2019) Marine-life Data and Analysis Team (MDAT) technical report on the methods and development of marine-life data to support regional ocean planning and management. Prepared on behalf of The Marine-life Data and Analysis Team (MDAT). Accessed at: http://seamap.env.duke.edu/models/MDAT/MDAT-Technical-Report.pdf.

- Investigate using the MDAT data on the Northeast Ocean Data Portal to update the Sea duck core habitat SSU;
- Protect sea duck core habitat from tidal and wave energy siting (in addition to community-scale wind);
- Contact Pam Loring from the U.S. Fish and Wildlife Service and Kathy Parsons at Mass Audubon for research related to tagging and monitoring the foraging behavior of Roseate Terns. Use these data to adjust the boundaries of Roseate Tern core habitat SSU, if appropriate;
- Support additional research to better understand the movements and core habitats for Long-tailed Ducks, alcids, gulls, and Northern Gannets (*Morus bassanus*), the latter of which may be attracted to offshore wind structures;
- Map actual and potential habitat for sand lance using DMF trawl data, bathymetry, and seafloor sediment type.

Data Collection and Methods

As stated above, CZM attempted to use the MDAT data outputs to map core Long-tailed Duck foraging habitat (Figure 15). However, it was discovered that those model outputs are relative densities and as such, do not offer opportunities for data categorization and selection of core areas (e.g., as the whale data do). As a result, CZM is proposing that the Sea duck core habitat SSU remain unchanged in the revision of the ocean plan.

After the Habitat Work Group meeting, CZM contacted several avifauna specialists and received references, publications, and unpublished data that provided more information about nesting and staging, migratory pathways, and foraging of shorebirds. Together these sources provide useful information about recent trends in avifauna distributions and foraging habits, especially Roseate Terns, which is summarized in the bullets below.

- In 1988 the Roseate Tern population was 3,000 pairs. Concerted management actions allowed the population to grow to 4,300 pairs in 2000. There was another decline in population from 2000-2010 but the population was again increasing after 2013, with 4,100 pairs counted in 2016. It isn't clear if the Roseate Tern population fluctuations are due to fledging production or adult survival.[4] The current recovery goal in the U.S. is 5,000 pairs.
- The U.S. Fish and Wildlife Service Roseate Tern Habitat Model documentation states that suitable foraging habitat may be located generally within 15 km of nesting areas, but that more remote food sources may be accessed during migration.[5]
- Duffy (1986)[6] assumed foraging up to 22 km away from Great Gull Island, New York and most commonly within 5.5 km.
- Heinemann (1992)[7] observed 11 and 16 km flight distances between a major Roseate Tern nesting colony at Bird Island, Massachusetts and its two primary feeding sites (Figure 16). Roseate terns have been recorded foraging predominantly (71%) on sand lance but also anchovy (4-6%), herring (8-11%), and silversides (10-11%).
- Rock et al. (2007)[8] found an average foraging distance of 7 km from a colony in Country Island, Nova Scotia, Canada.
- According to Perkins et al. (2004)[9] Common and Roseate terns forage within or pass through Nantucket Sound between early May and late September as they move to and from their colonies, foraging areas, and staging sites (Figure 17).
- Althouse et al. (2019)[10] recommend a minimum buffer of 100 m around Roseate Tern staging sites but this was only to reduce disturbance of the land-based staging activity, while the aim of the ocean

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[4] Spendelow, J.A., J.E. Hines, J.D. Nichols, I.C.T. Nisbet, G. Cormons, H. Hays, J.J. Hatch, and C.S. Mostello. 2008. Temporal variation in adult survival rates of Roseate Terns during periods of increasing and declining populations. *Waterbirds*: 31(3):309-319. 309-319. https://doi.org/10.1675/1524-4695-31.3.309j

[5] https://www.fws.gov/r5gomp/gom/habitatstudy/metadata/roseate_tern_model.htm

[6] Duffy D.C. 1986. Foraging at patches: interactions between Common and Roseate Terns. Ornis Scandinavica 17:47-52.

[7] Heinemann, D. 1992. Foraging Ecology of Roseate Terns on Bird Island, Buzzards Bay, Massachusetts. Unpublished Report to U.S. Fish and Wildlife Service, Newton Corner, MA.

[8] Rock, Jennifer C., Marty L. Leonard and Andrew W. Boyne. 2007. Foraging Habitat and Chick Diets of Roseate Tern, *Sterna dougallii*, Breeding on Country Island, Nova Scotia. Avian Conservation and Ecology -Écologie et conservation des oiseaux 2(1): 4. [online] URL: http://www.ace-eco.org/vol2/iss1/art4/

[9] Simon Perkins, Taber Allison, Andrea Jones, and Giancarlo Sadoti. 2004. A survey of tern activity within Nantucket Sound, Massachusetts during the 2003 fall staging season. Final Report for Massachusetts Technology Collaborative. Massachusetts Audubon Society, Lincoln, MA.

plan SSU is to protect both the staging area and, more importantly, the foraging areas within and adjacent to the waters of the ocean planning area around those staging areas.

- Loring et al. (2019a)[11], using the flight paths of tagged terns, mapped Common Tern utilization areas in the Northeast (Figure 18).
- Loring et al. (2019b)[12] used tagged Roseate Terns to map flight track densities in the northeast (Figure 19).
- Burger et al. (2011)[13] stated that the greatest of risk wind turbines to Roseate Terns is within 25 km of nesting colonies.
- Loring et al. (2019b) recorded the movements of Roseate Terns and estimated their exposure to the five wind turbines of the Block Island Wind Farm (Figure 20).

After the work group meeting, CZM contacted Mass Audubon for geolocation data for the Roseate and Common Tern nesting and staging sites in and immediately adjacent to Massachusetts. Using the Roseate Tern nesting and staging sites and with the estimates of foraging distances from several published studies, CZM created several draft maps with radii of various distances around the nesting/staging locations as proposals for updating the Roseate Tern and Special Concern Tern SSU maps. At the same time, CZM began a conversation with the Massachusetts Natural Heritage and Endangered Species Program (NHESP) regarding the mapping of core tern habitat. NHESP's recommendation was to replace the existing tern SSU maps with the NHESP habitat maps for Roseate and Special Concern Terns in the revision of the ocean plan. The NHESP core tern habitat maps are based upon the most up to date locations of tern nesting and staging areas in Massachusetts, buffered by various distances dependent upon the greatest number of terns observed in any year over the last 10 years at each of the nesting/staging sites.

CZM's Proposed Updates to Avifauna SSUs

CZM is not recommending any changes to Leach's Storm-Petrel important nesting habitat, Colonial waterbirds important nesting habitat, or Sea duck core habitat SSUs. The area of the Roseate Tern core habitat SSU proposed for the revision of the ocean plan is 695,278 acres (51% of the ocean planning area) and is an almost six-fold increase over the 2015 ocean plan (Figure 21). The area of the Special Concern Tern core habitat SSU proposed for the revision of the ocean plan is 794,104 acres (58% of the ocean planning area) and is an almost four-fold increase over the 2015 ocean plan (Figure 22).

Sea Turtles

While their size makes them difficult to spot and identify via the traditional boat-based or aerial surveys (e.g., relative to whales), it is known that several species of sea turtles inhabit Massachusetts waters, including leatherback (*Dermochelys coriacea*), loggerhead (*Caretta caretta*), Kemp's Ridley (*Lepidochelys kempii*), and occasionally green turtles (*Chelonia mydas*). The Habitat Work Group noted the lack of a sea turtle SSU area in

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[10] Althouse, M. A., Cohen, J. B., Karpanty, S. M., Spendelow, J. A., Davis, K. L., Parsons, K. C. and Luttazi, C. F. 2019. Evaluating response distances to develop buffer zones for staging terns. *Journal of Wildlife Management* 83: 260-271.

[11] Loring, PH, LJ Welch, S. Williams, and KD Meyer. 2019. OCS Study BOEM 2019-017. Appendix J. P. 99/145.

[12] Loring PH, Paton PWC, McLaren JD, Bai H, Janaswamy R, Goyert HF, Griffin CR, Sievert PR. 2019. Tracking Offshore Occurrence of Common Terns, Endangered Roseate Terns, and Threatened Piping Plovers with VHF Arrays. Sterling (VA): US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2019-017. 140 p. Figure 15, p. 65/158.

[13] Burger, J., C. Gordon, L. Niles, J. Newman, G. Forcey, and L. Vlietstra. 2011. Risk evaluation for federally listed (roseate tern, piping plover) or candidate (red knot) bird species in offshore waters: A first step for managing the potential impacts of wind facility development on the Atlantic Outer Continental Shelf. Renewable Energy 36:338–351.

the ocean plan and recommended that one be developed. Several suggestions for data were given including: leatherback tracking data from Kara Dodge of the New England Aquarium (which CZM has acquired), data from the North Atlantic Right Whale Consortium database, and aerial survey data from New England Aquarium's directed surveys from August 2011 to June 2015. One of the ongoing challenges with creating a sea turtle map is that there have been a limited number of directed surveys in Massachusetts waters that have focused on sea turtle observations. Thus, the majority of observations in Massachusetts waters are opportunistic and might not reflect true sea turtle distributions.

As cold-blooded organisms, sea turtles become less active as ocean temperatures decrease and thus they migrate away from Massachusetts toward warmer waters in the fall. Rapid changes in ocean temperature make it particularly difficult for sea turtles to migrate to warmer waters. The location and shape of Cape Cod ensures that many sea turtles become cold stunned and eventually stranded along the shore every year. Sea turtles may also become stranded for other reasons such as vessel strike, entanglement, and natural poor health (Kate Sampson, NOAA, personal communication). There is a network of organizations and volunteers that locate, rescue, rehabilitate, and return stranded turtles to more favorable habitats. These activities generate a list of the times and locations of various stranded sea turtles. In addition, the Habitat Work Group noted that there are observational data within state waters that are served through a viewer (https://seaturtlesightings.org/maps.html), but the raw data would need to be made available to CZM in order to produce a draft SSU map.

Work Group Recommendations

- Acquire and map the leatherback turtle tagging data from Kara Dodge of the New England Aquarium.
- Acquire and map the sea turtle data from the North Atlantic Right Whale Consortium database.
- Acquire and map the Mass Audubon Wellfleet Bay Sanctuary (WBWS) opportunistic sea turtle sightings data.
- Acquire and map the sea turtle data from the New England Aquarium aerial surveys.
- Work with sea turtle specialists to determine if a sea turtle SSU can be created from the existing data.

Data Collection and Methods

In advance of the Habitat Work Group meeting, CZM acquired the leatherback turtle tagging data from Kara Dodge and mapped it in its native form (data not presented). Unfortunately, there were very few tracks and most of the observations were outside of Massachusetts waters. The Dodge data, as well as loggerhead tracks from several other tagging studies, were mapped in the Northeast ocean data portal, included in this report as Figure 23.

After the Habitat Work Group meeting, the NOAA sea turtle strandings program made several recent years of strandings data available to CZM from two of its programs. While strandings data are not viewed as adequate to represent core foraging habitats, because injured or dead turtles may drift along surface currents from many locations, they do provide an idea of what species may inhabit Massachusetts waters and generally what regions of Massachusetts waters they inhabit.

CZM also acquired the sea turtles observations from the North Atlantic Right Whale Consortium (NARWC). While these data are considered "on-survey" data and can be effort-corrected, Bob Kenney from the Consortium felt that the observations were sparse enough to map only as point data. CZM tried mapping the data by year to see if there were any trends over time but none was observed (data not presented). CZM mapped all data from NOAA and NARWC together (Figure 24).

CZM also reviewed previously-published maps of sea turtle sightings from several sources including: Sea Turtle Sightings Hotline (Figure 23), 2003 aerial surveys in Nantucket Sound related to the proposed Cape Wind project (Figure 24), and SPUE from New England Aquarium aerial surveys in the offshore Wind Energy Area (Figure 27).

Lastly, CZM acquired opportunistic ("off-survey") sea turtle sightings data for several years from WBWS. These data are important because they represent where sea turtles tend to be observed in Vineyard Sound, Nantucket Sound, and around the Islands, an area that is not well surveyed by the aerial flights designed for sighting whales in the offshore Wind Energy Area or Cape Cod Bay. WBWS asked that any use of its data be accompanied by the following narrative:

> The WBWS sea turtle sightings data described here and shown in the accompanying spreadsheets are primarily opportunistic sightings. Opportunistic sightings are skewed toward areas and times frequented by marine vessels and cannot be corrected for effort. They do not represent counts of turtles, but rather represent a minimum number of turtle/vessel encounters. Negative data does not mean no turtles, only that no vessel operators reported turtles from those areas.
>
> Four species of sea turtles forage in coastal waters off the northeast coast of the US in late spring, summer and fall: leatherbacks (*Dermochelys coriacea*), loggerheads (*Caretta caretta*), Kemp's ridleys (*Lepidochelys kempii*) and greens (*Chelonia mydas*). Since 2002, Mass Audubon's Wellfleet Bay Wildlife Sanctuary (WBWS), in Wellfleet, Massachusetts, has operated a hotline and website, **seaturtlesightings.org**, aimed at communicating with marine vessel operators about sea turtles.
>
> The goals of the hotline/website are: 1) to gather data points of where and when sea turtles are seen in these NW Atlantic foraging grounds, and 2) to reduce vessel strikes by educating vessel operators that sea turtles are present in local waters and by conveying information about how to spot them. Vessel strike may be a significantly under-reported cause of leatherback and loggerhead mortality in the coastal NW Atlantic.
>
> WBWS outreach to vessel operators includes: describing sea turtle species by text, photos and videos on the website; posting flyers at marinas, yacht clubs, bait and tackle stores and harbormaster offices; and giving talks to boating and fishing groups. Recreational fishermen are important sea turtle reporters, as they are often closely watching the water surface. In 2018, WBWS began a partnership with the Martha's Vineyard Striped Bass and Bluefish Derby, the oldest fishing derby in the US, which registers over 3,500 participants annually. The Derby organizers hand out seaturtlesightings.org flyers and key tags at their headquarters, use their newsletter and website to ask vessel operators to watch for and report sea turtles, and have invited WBWS staff to give talks at derby-related events.
>
> The WBWS database (in ACCESS) is qualified for accuracy of species identification and location. WBWS staff communicate with each reporting vessel operator via phone or email whenever contact info is given in the initial report, which occurs with the majority of reports.

The database includes thorough text of online or phone descriptions of the turtle(s) given by the vessel operator. Some sea turtle "strandings" are included in the database, whenever the report is of a dead, injured or entangled turtle, but the complete tally of reported strandings can be obtained through NOAA's Sea Turtle Stranding and Salvage Network (STSSN). The WBWS database contains over 2,200 credible reports of (mostly) live and dead sea turtles. Although these opportunistic sightings are not collected systematically and are not a count of turtles, they have become useful in showing temporal and spatial trends of occurrence, especially of leatherbacks. The live sightings also are a minimum count of vessel/turtle interactions in these highly trafficked waters.

Applications for sea turtle research and conservation from the WBWS sightings hotline/website include:

1) Vessel operators reporting entangled sea turtles, many of which are alive, are instructed to immediately call the Center for Coastal Studies' (CCS) hotline. CCS personnel are the designated sea turtle dis-entanglers off Massachusetts. Timely reports from vessel operators can result in more live disentanglements and releases.

2) The US Coast Guard issues "Notices to Mariners" based on sightings of clustered leatherbacks reported consistently in a feeding "hotspot" aimed at reducing vessel strikes.

3) Floating, dead sea turtles are photographed and reported by vessel operators to seaturtlesightings.org. WBWS documents these "floaters" as strandings and reports them to the National Oceanic and Atmospheric Administration's Sea Turtle Stranding and Salvage Network. If these carcasses do not wash ashore, they are counted as "unresolved floaters", enhancing the accuracy of total stranding numbers. Many floaters show clear evidence of vessel strike.

4) The WBWS sightings data have shown a temporal shift in leatherbacks occurring about a month later in recent years around Cape Cod, Massachusetts. Local sea turtle researchers use the opportunistic sightings data to schedule their field work with leatherbacks, both on a near real-time, day-by-day basis and in planning for future field work, grant proposals and permit applications.

WBWS considers the live leatherback and loggerhead sightings in the accompanying spreadsheets to be quite accurate for species identification. Any sighting reports which are inconclusive for species identification are not included in the spreadsheet data. Photos or videos provide conclusive id, but verbal or written turtle descriptions from vessel operators can accurately determine leatherbacks and loggerheads, based on detailed questions about turtle size, color, carapace description and any other details noted. Fortunately, leatherbacks by their size, color and longitudinal carapace ridges are readily identifiable. Loggerheads in our waters are mostly subadult, but are still identifiable by color (brown, with orange/yellow, etc.) and larger size relative to other hard-shells. Greens and Kemp's ridleys are difficult for vessel operators to see due their small size (juveniles), and they represent a relatively small number of credible sea turtle sightings in the WBWS database. They are only logged by species in the WBWS database when confirmed by photos or videos, when the report includes several key physical features, or when the reporting party is a sea turtle researcher. Thus, sightings of green sea turtles and Kemp's ridleys are not provided here.

Sighting locations are given with varying degrees of accuracy but typically are considered accurate within about one mile. "Reported latitude and longitude" columns on the spreadsheet give GPS coordinates provided by the vessel operator. "Assigned positions" are latitude and longitude assigned by WBWS staff from the vessel operator's verbal description of location.

WBWS staff have used the term "cluster" when three or more leatherbacks are reported in a small area for at least two days. "Three or more" are determined by the vessel operator reporting at least three leatherbacks surfacing simultaneously, or in different directions from the boat within a very short period. They often occur when sea surface is calm, when sighting conditions are best and, presumably, when prey (gelatinous organisms) are in dense patches. Clusters have occurred in a number of locations, including Lucas Shoal in Vineyard Sound. Lucas Shoal is a popular bottom-fishing (fluke, *Paralichthys dentatus*) site for recreational fishermen. Clusters have also been reported on or near Horseshoe Shoal in Nantucket Sound (in the triangular area bordered by commercial ferry routes between Hyannis, Oak Bluffs and Nantucket), north of Old Man Shoal south of Nantucket, and around the "hooter" buoy south of Muskeget Channel. Clusters of leatherbacks have repeatedly been reported off Sakonnet Point, Rhode Island. These are all popular recreational fishing areas. Frequent sightings, not "clusters", are reported on or near Middle Ground in Vineyard Sound, on or near the three shoals north and east of Oak Bluffs, Martha's Vineyard (Hedge Fence, Squash Meadow and L'Hommedieu Shoals), as well as near Woods Hole, especially off the Weepecket Islands in southern Buzzards Bay.

CZM's Proposed Use of Sea Turtle Data

After consultation with sea turtle specialists, CZM decided not to propose a sea turtle SSU at this time. However, CZM is still proposing that sea turtles be addressed in the revision of the ocean plan. As an alternative to an SSU, and with support from the work group participants, CZM is proposing that the narrative statement drafted by WBWS staff about the importance of certain areas of the ocean planning area to sea turtles be presented in the ocean plan.

Eelgrass

Specialists within the Habitat Work Group recommended that CZM continue to map eelgrass (*Zostera marina*) as it was mapped in the 2015 ocean plan, (i.e., aggregate the maps from all eelgrass surveys in Massachusetts). These data include the Massachusetts Department of Environmental Protection (MassDEP) aerial survey data from 1995, 2001, 2006, 2010-13, and various data from smaller surveys from DMF and the U.S. Environmental Protection Agency (USEPA). As in 2014, there was a discussion about whether or not open areas within mapped eelgrass polygons should be filled in the final SSU map. One argument for filling the gaps is that leaving them open, and thus available to development, might encourage proponents to site projects (e.g., aquaculture) in the sandy areas within eelgrass beds, potentially leading to bed degradation from the inside. In the end, the eelgrass specialists decided that CZM should keep the open areas when mapping eelgrass for the ocean plan. The reasoning is that: 1) it provides better fidelity to the original data and 2) concerns about aquaculture siting are probably unfounded since DMF asks aquaculturists to use the MassDEP eelgrass data layers (which do depict the open areas) when siting aquaculture facilities, not the CZM ocean plan layers (Chris Schillaci, DMF, personal communication).

Work Group Recommendations

- Continue to map the eelgrass SSU as an aggregation of all eelgrass that has ever been mapped.
- Do not fill the gaps in mapped polygons where no eelgrass was found.
- Map the eelgrass data in its native format without gridding.
- Use a 100 m buffer around all mapped eelgrass polygons to account for intra- and interannual changes in eelgrass boundaries.

Data Collection and Methods

CZM obtained the most up to date eelgrass data sets from MassDEP and DMF. Some beds were active restoration sites while others were relatively recently discovered beds. While all of the data were ArcGIS georeferenced shapefiles (geospatial polygons), some of the data were from aerial photographs, some were from diver surveys, and others were from vessel-based acoustic surveys.

An ongoing consideration for eelgrass maps is that eelgrass beds can annually increase or decrease in size, up to seven hectares per year, as noted in the 2014 Habitat Work Group report. In order to provide an adequate buffer, and ensure a margin of safety, in the 2009 and 2015 ocean plans eelgrass was mapped by interpolating within a 250 m x 250 m grid. A major methodological change proposed for this ocean plan update is to map eelgrass without gridding but with a 100 m buffer, consistent with the 100 m buffer around other mapped SSU habitats (e.g., bird nesting areas). A buffer of this size should provide a margin of safety around eelgrass beds for planning purposes. Additionally, all ocean development proponents that have project activities adjacent to eelgrass areas are required to do field surveys to confirm the location and extent of eelgrass beds so that they can be avoided.

CZM's Proposed Updates to Eelgrass SSU

CZM is recommending that the eelgrass SSU continue to be mapped as an aggregation of the multi-year eelgrass extent. Unlike in previous years, CZM is not recommending that the eelgrass data be gridded for the SSU map. Instead, CZM is recommending that a 100 m buffer be placed around mapped eelgrass. Using the 100 m buffer reduced the incidence of eelgrass being mapped in areas where it is not actually present (Figure 28). The area of the eelgrass SSU proposed for the revision of the ocean plan is 24,703 acres (2% of the ocean planning area) and is an 11% *decrease* in area from the 2015 ocean plan because the buffering methodology was changed (Figure 29).

Other Habitats

While the Habitat Work Group's focus is on the existing SSU areas, occasionally new data become available on other habitat resources that specialists think should be mapped in the ocean plan. Two recommendations that came from the Fisheries Work Group in 2019 were to consider mapping kelp and corals as SSUs. The 2015 ocean plan contained maps of both kelp and soft corals overlaid on the hard/complex seafloor SSU. An analysis of co-occurrence demonstrated that 78% of known kelp locations and 76% of known soft coral locations overlapped, and thus were already protected by the hard/complex seafloor SSU. Additional work on habitat characteristics that predict kelp and soft corals would be needed to produce maps that might capture greater than 80% of the known kelp and coral locations. Surveys directed toward the identification and mapping of kelp and soft corals would be useful for future ocean planning and the review of the potential impacts of ocean construction projects.

Another recommendation put forward by DMF suggested identifying the types of ocean construction activities that might affect soft-bodied and/or immobile fauna and life stages and creating a management framework for protecting these lesser known, yet still important, structure-forming organisms. The fauna of interest included: stony corals (*Astrangia),* soft corals (*Alcyonium, Gersemia*), high densities of Cerianthid anemones, stalked sponges (*Haliclona, Microciona, Isodictya, Phakellia*), rock-like sponges (*Cliona*), the stalked ascidian (*Boltenia*), and Asabellides worm reefs. The Habitat Work Group was not able to address this recommendation but suggests that it should be addressed in the ocean plan Science Framework.

SECTION FOUR: CZM's DRAFT PROPOSED SSU UPDATES

After responding to the Habitat Work Group's recommendations, which involved acquiring data and performing additional analyses, CZM brought its proposed SSU updates to the Science Advisory Council (SAC) for additional feedback. CZM's draft proposed updates to SSU areas integrate the most recently available data with the recommendations of resource experts on the Habitat Work Group, as well as the SAC.

SSU Resource	Mapped Area Change?	Summary of Change
North Atlantic Right Whale Core Habitat (Figure 9)	Yes	Used effort-corrected sightings data from 1998-2018. The SSU area increased 53%, including more area in western Cape Cod Bay and Massachusetts Bay.
Humpback Whale Core Habitat (Figure 10)	Yes	Used effort-corrected sightings data from 1998-2018. The SSU resource area increased 27%, including more area in western Cape Cod Bay and western Massachusetts Bay.
Fin Whale Core Habitat (Figure 11)	Yes	Used effort-corrected sightings data from 1998-2018. The SSU resource area increased 47%, including more area in western Cape Cod Bay and western Massachusetts Bay.
Roseate Tern Core Habitat (Figure 15)	Yes	Used NHESP core Roseate Tern habitat map. The SSU resource area increased almost six-fold to encompass most of Nantucket Sound, Vineyard Sound, and Buzzards Bay, and roughly half of Cape Cod Bay.
Special Concern (Arctic, Least, and Common) Tern Core Habitat (Figure 16)	Yes	Used NHESP core Special Concern Tern habitat maps. The updated SSU resource area increased almost four-fold to encompass most of Nantucket Sound, Vineyard Sound, and Buzzards Bay, and roughly half of Cape Cod Bay.
Sea Duck Core Habitat	No	Not updated because no new or higher quality data was identified.
Leach's Storm-Petrel Important Nesting Habitat	No	Not updated because no new or higher quality data was identified.
Colonial Waterbirds Important Nesting Habitat	No	Not updated because no new or higher quality data was identified.
Eelgrass (Figure 25)	Yes	Eelgrass was updated by incorporating new data from DMF. The polygons were kept in their native format (not gridded) and buffered by 100 m. The change (an 11% decrease) in the updated SSU map was minor.

SECTION FIVE: RECOMMENDED MANAGEMENT PRIORITIES

The Habitat Work Group made several recommendations that address the ocean plan's management framework.

- Ensure that ocean planning and permitting take into account the corridors that whales need to travel among core areas.
- Update the existing siting and performance standards for ocean activities in sea duck core habitat to protect it from tidal energy conversion activities.
- Consider establishing a sand lance SSU.
- Develop a new management framework that identifies classes of ocean construction that are incompatible with various vulnerable, structure-forming seafloor organisms.
- Develop a new management framework that prescribes opportunities for protecting sea turtles while engaging in certain ocean development activities in the ocean planning area.

SECTION SIX: RECOMMENDATIONS FOR THE SCIENCE FRAMEWORK

The Habitat Work Group made a series of recommendations, some of which have been already accomplished and others that could be added to the Science Framework priorities, for the next five years. Below are the recommendations for additional analysis or data collection.

- Continue collecting plankton data near feeding aggregations of North Atlantic right whales.
- Use plankton and North Atlantic right whale data to generate a predictive model to assist in real-time avoidance of whales.
- Have offshore wind companies conduct research on the distribution of Long-tailed Ducks, alcids, gulls, and gannets and how offshore wind structures and activities might affect them.
- Create a potential habitat map for sand lance.
- Conduct surveys and map vulnerable organisms, with a priority on kelp, soft corals, worm reefs, and emergent sponges.
- Conduct directed surveys to develop sea turtle core habitat maps.
- Use new bathymetric data to create and map geoforms in Massachusetts waters.

SECTION SEVEN: MAP PRODUCTS

Figure 1. North Atlantic Right Whale Sightings Per Unit Effort (SPUE) 1998-2018--data "blocked" in a 5 Minute x 5 Minute Grid

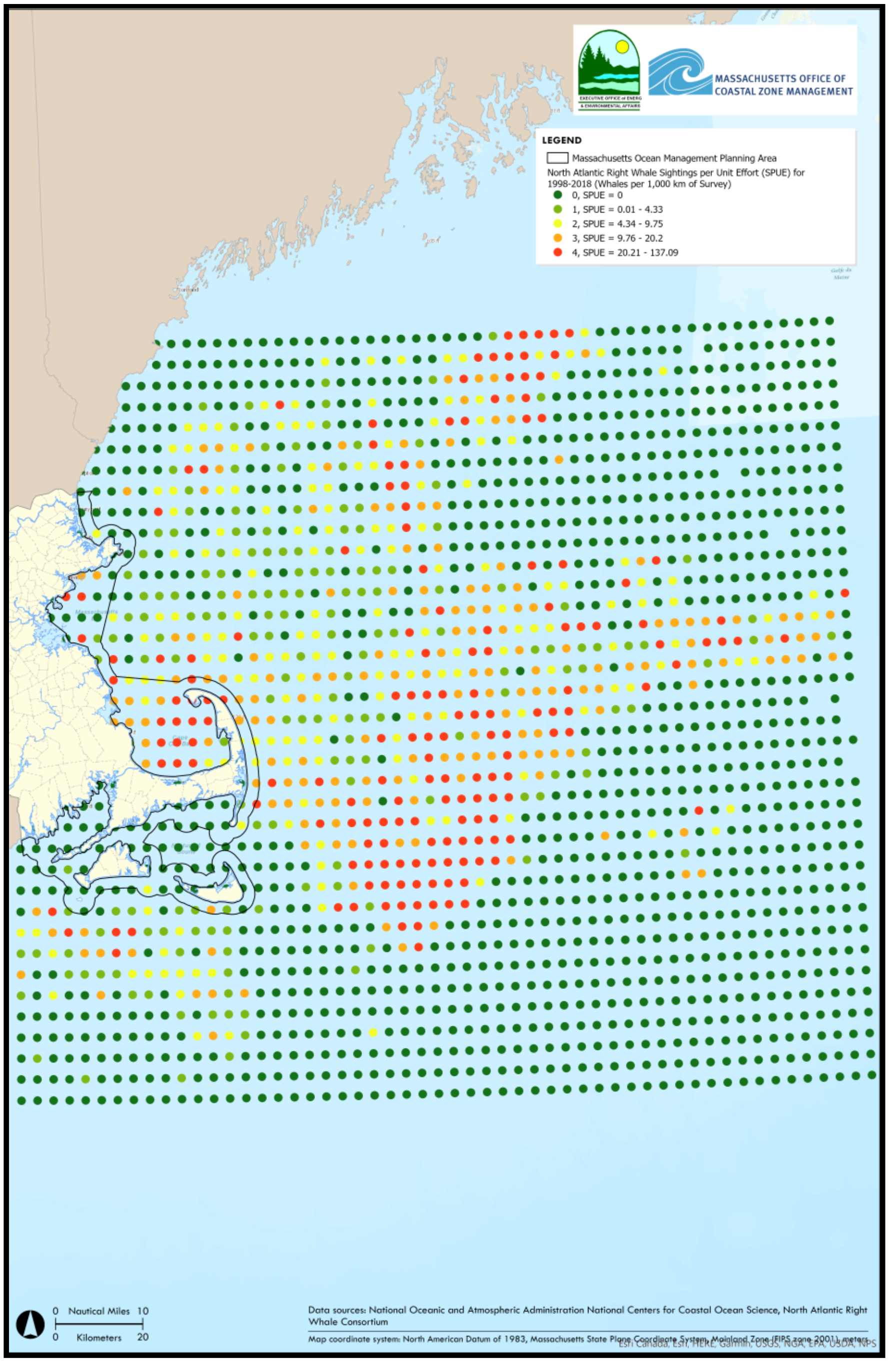


Figure 2. Interpolated Sightings Per Unit Effort (1998-2018) for North Atlantic Right Whales

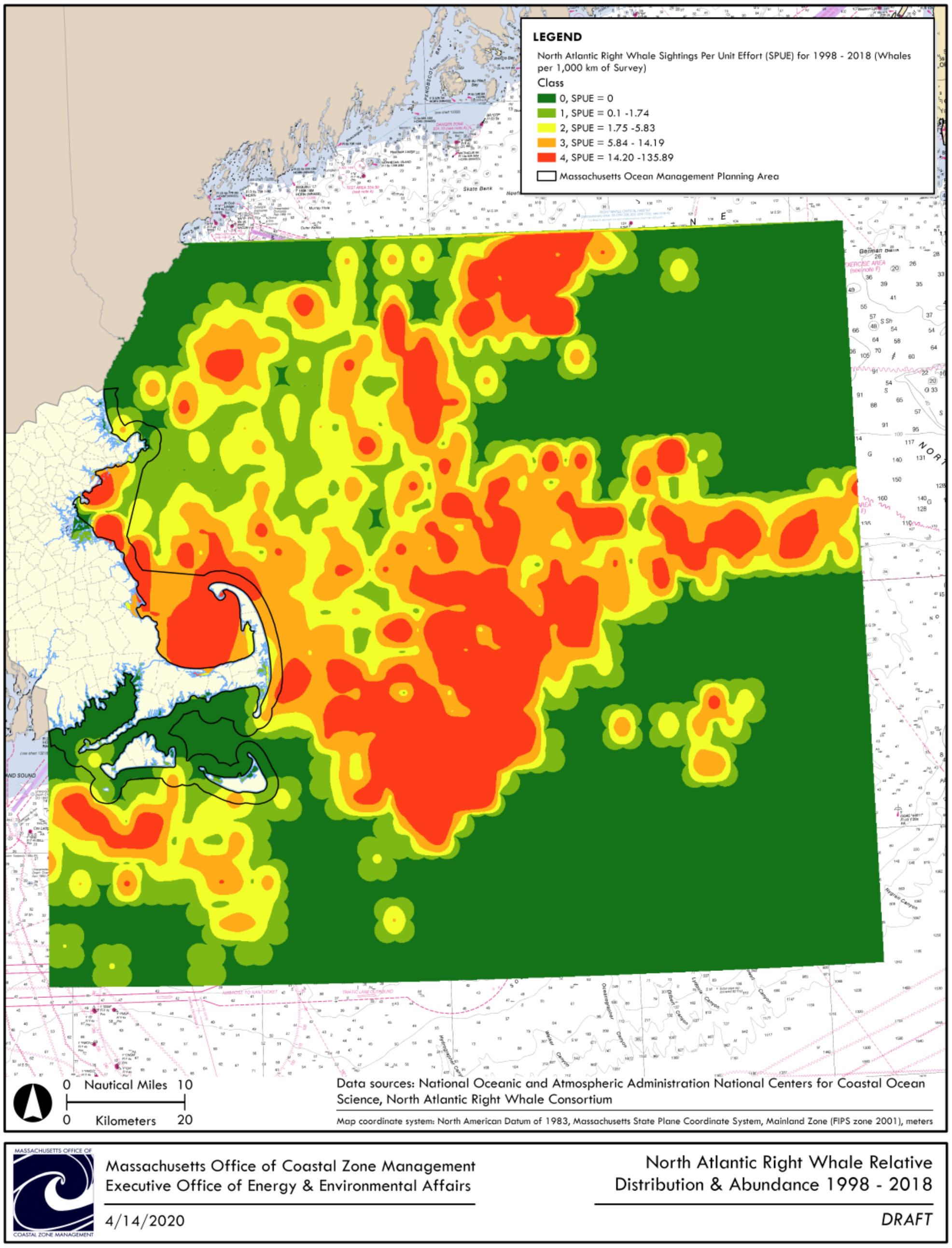


Figure 3. Survey Effort 1998-2018

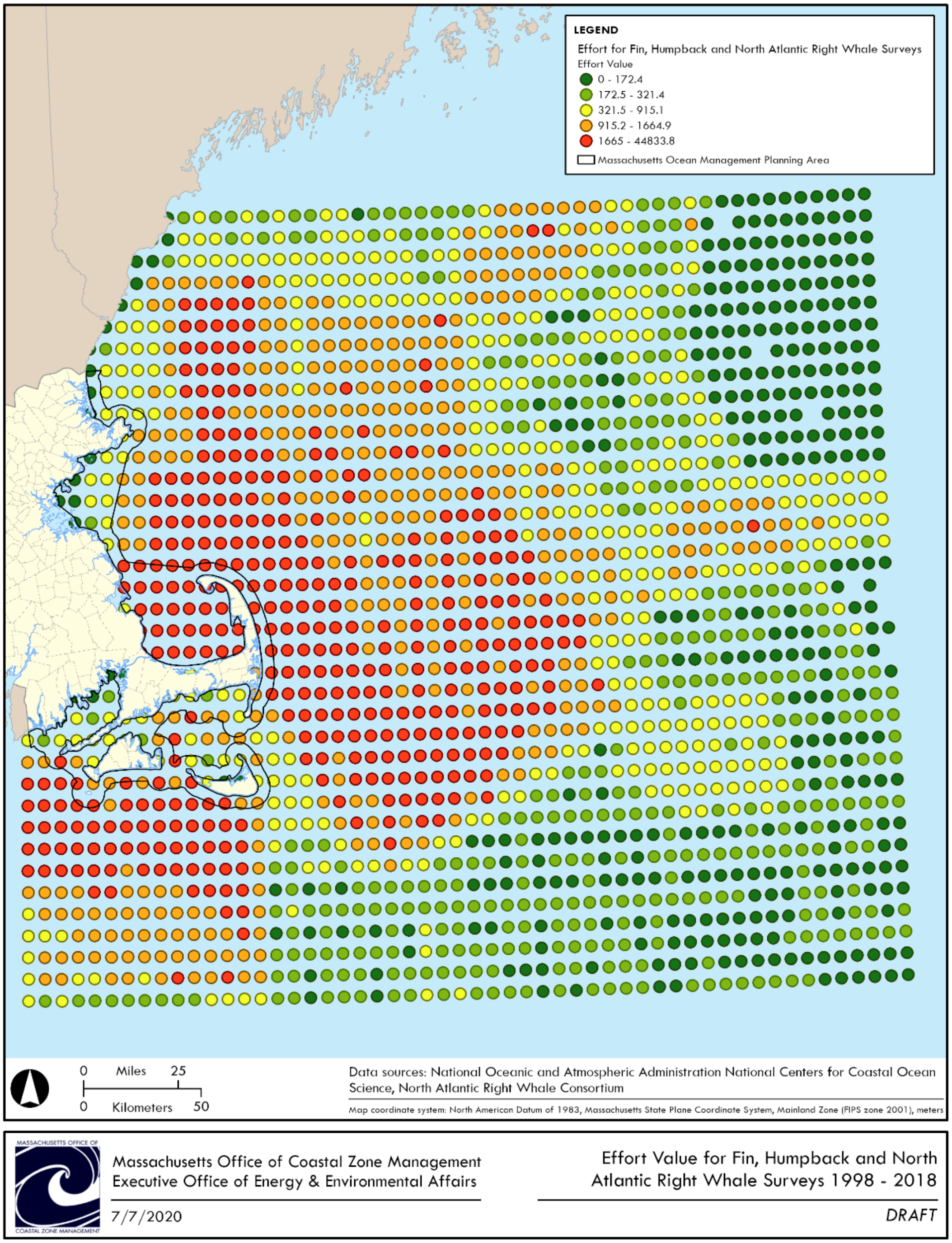


Figure 4. On-Survey and Off-Survey Effort 1998-2018.

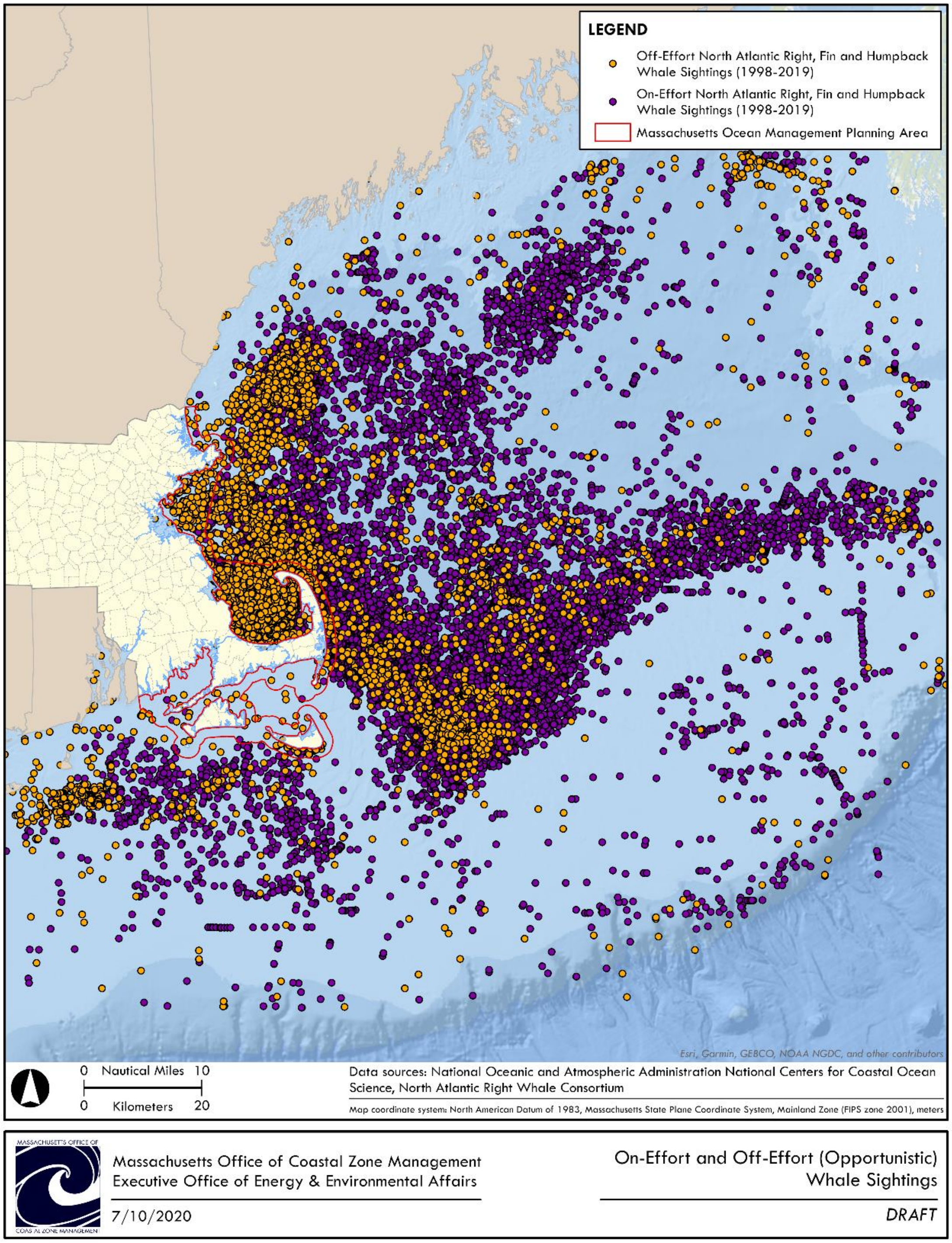
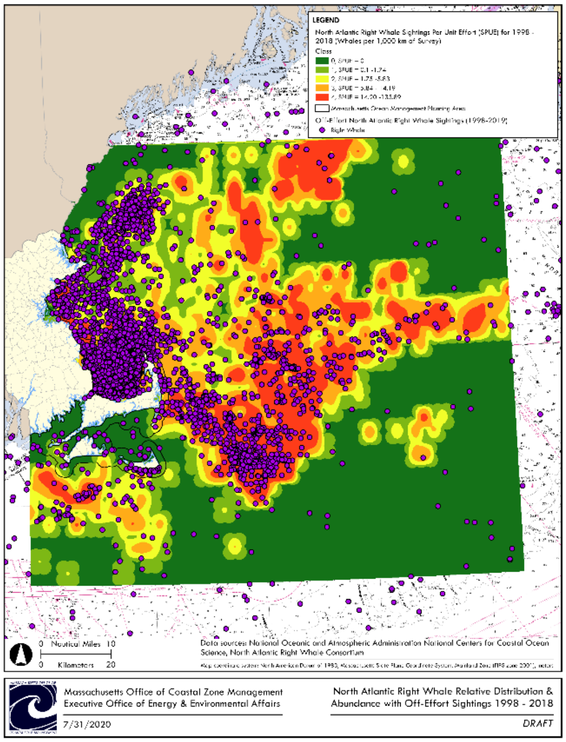
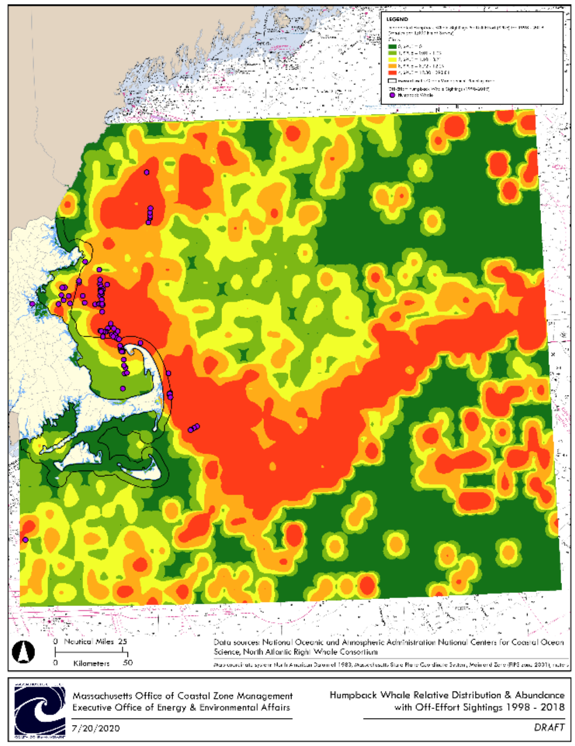


Figure 5. Comparison of Off-effort Observations to Interpolated On-effort Observations.





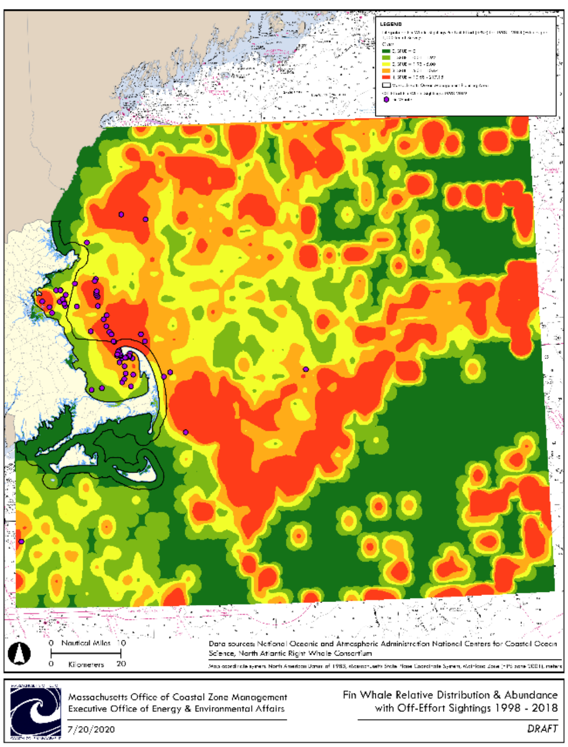


Figure 6. North Atlantic Right Whale Seasonal Distribution (Spring, Summer, Fall, Winter)

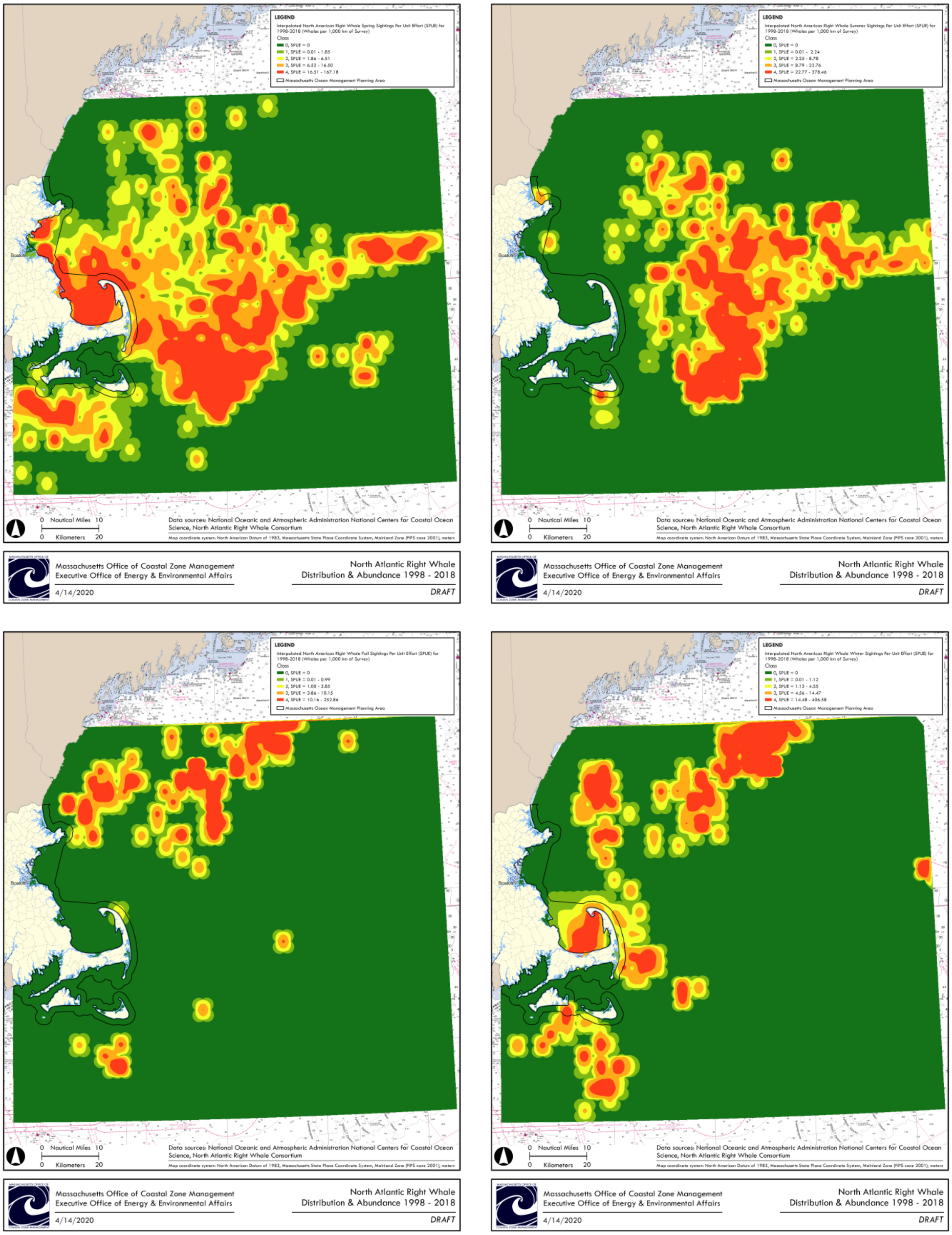


Figure 7. Humpback Whale Seasonal Distribution (Spring, Summer, Fall, Winter)

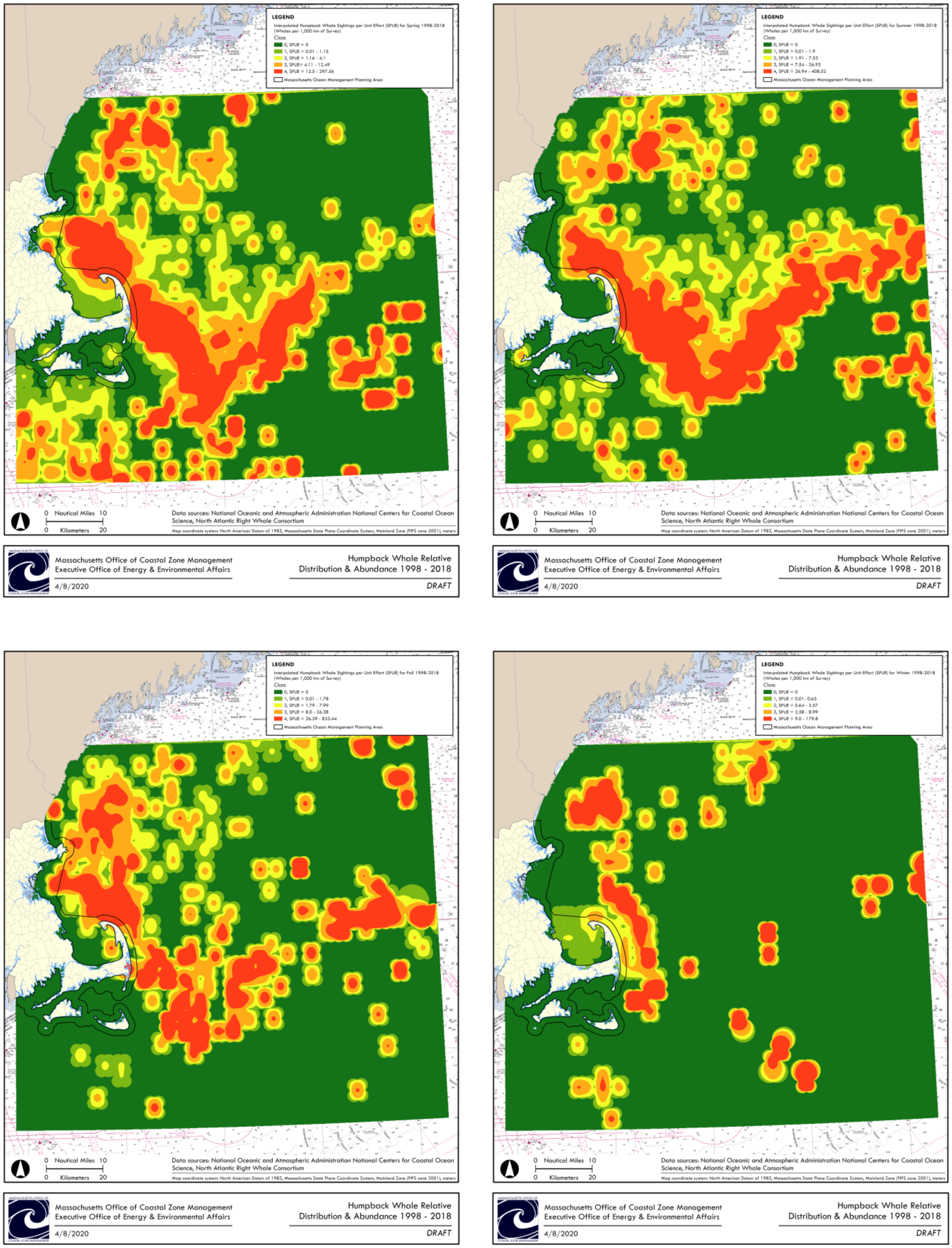


Figure 8. Fin Whale Seasonal Distribution (Spring, Summer, Fall, Winter)

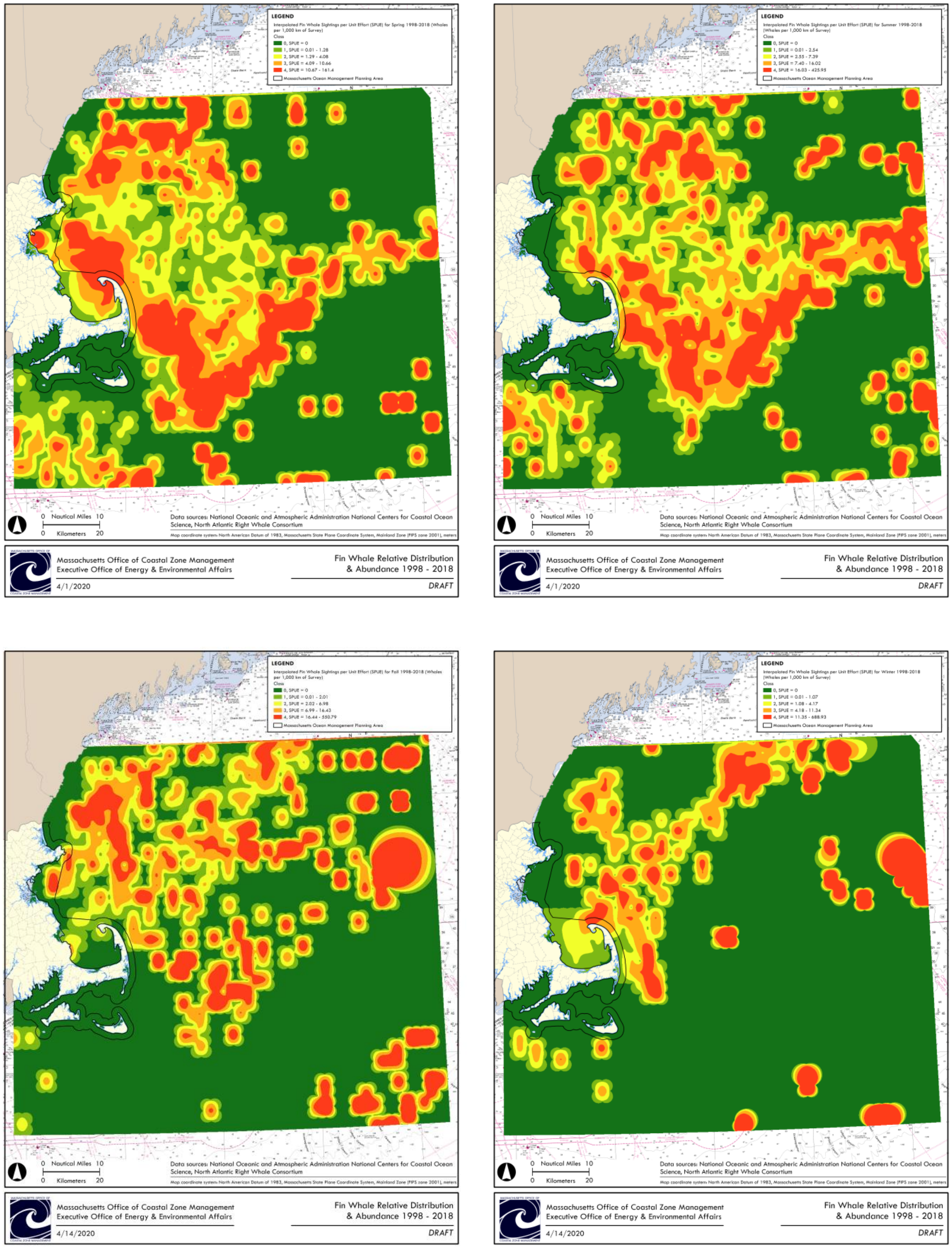


Figure 9. Proposed North Atlantic Right Whale SSU Map

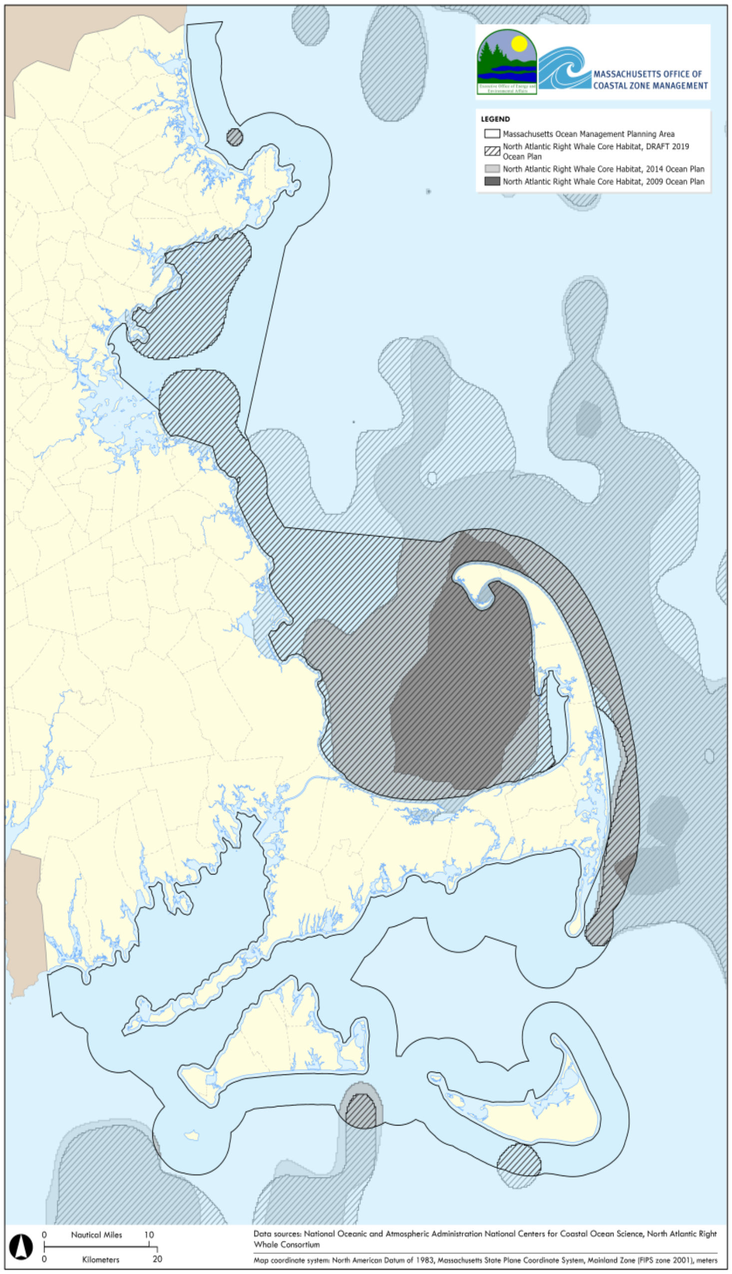


Figure 10. Proposed Humpback Whale SSU Map

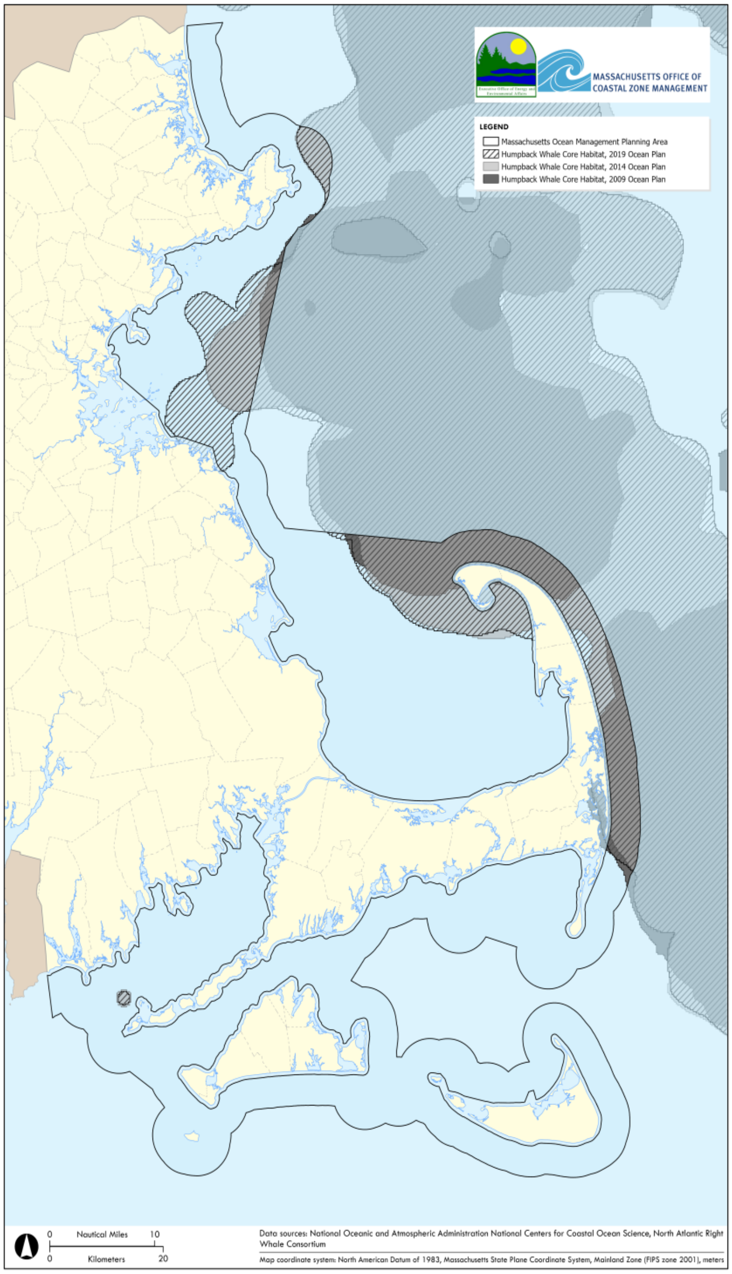


Figure 11. Proposed Fin Whale SSU Map

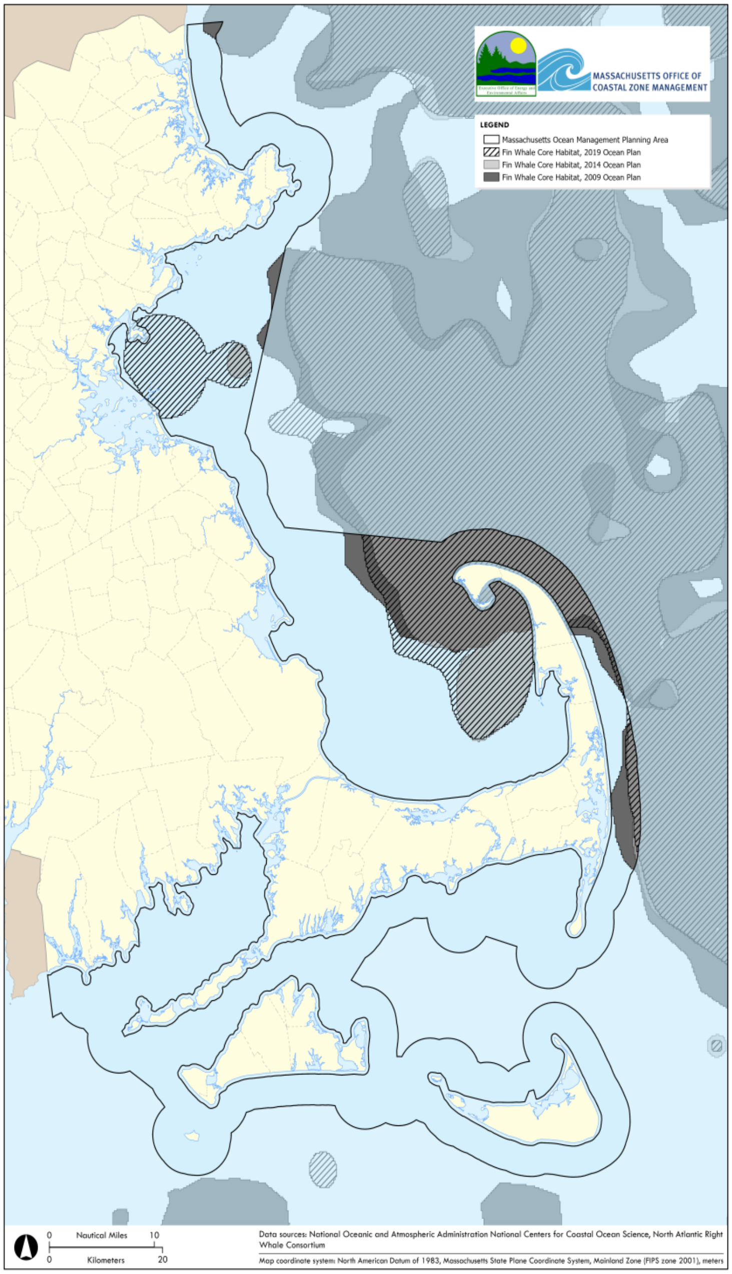
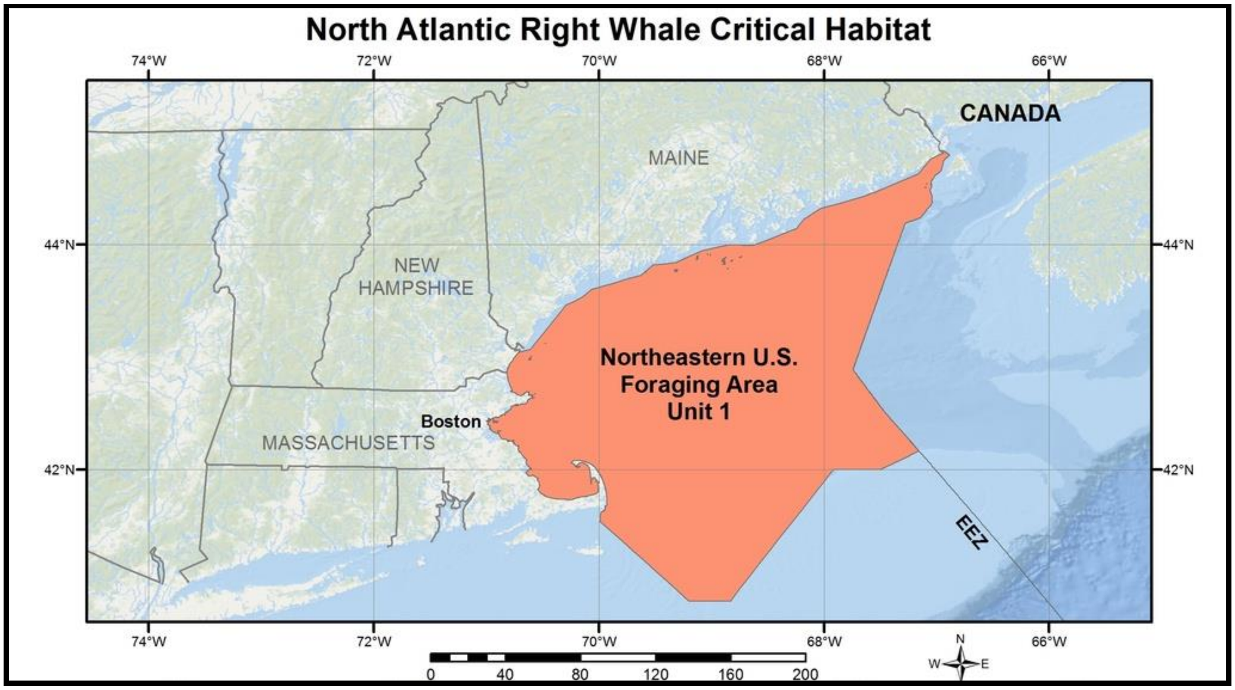
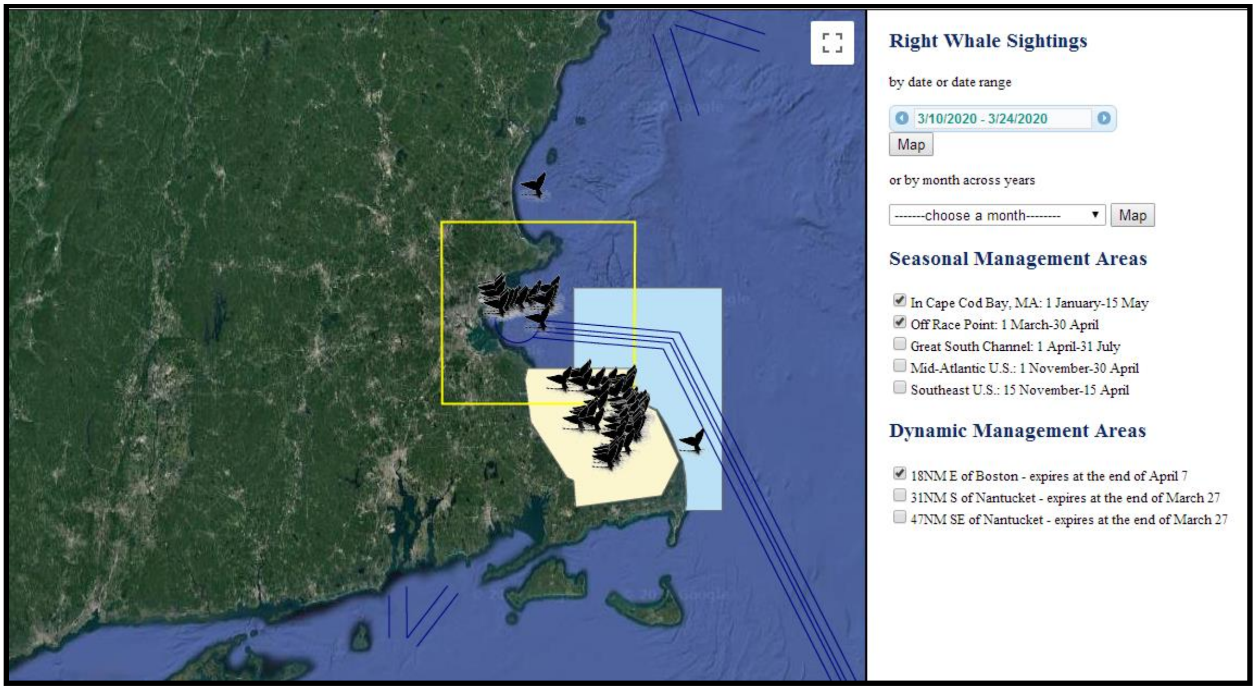


Figure 12. NOAA North Atlantic Right Whale Critical Habitat[14]



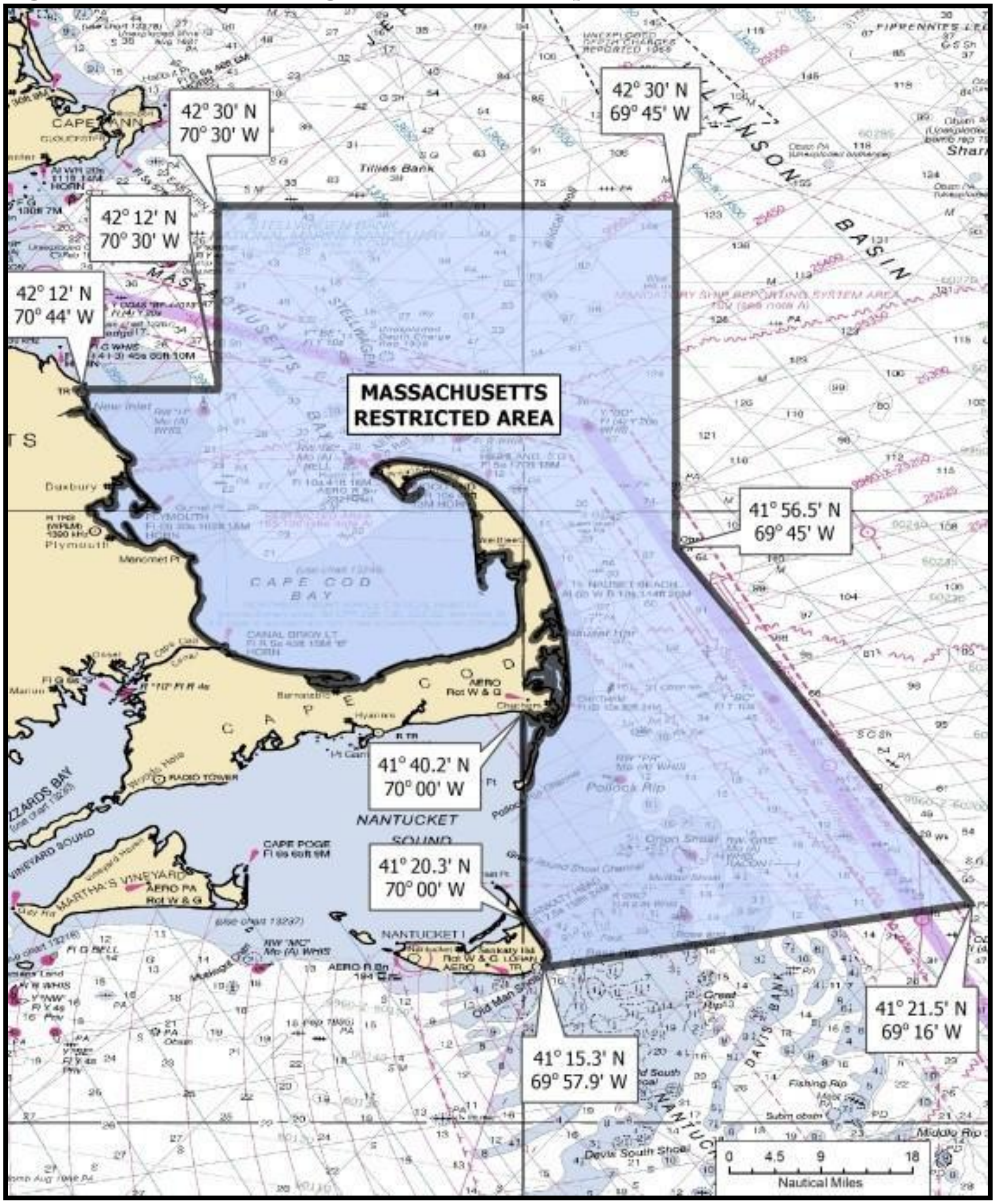
[14] https://www.fisheries.noaa.gov/action/critical-habitat-north-atlantic-right-whales

Figure 13. National Marine Fisheries Service North Atlantic Right Whale Management Areas[15]



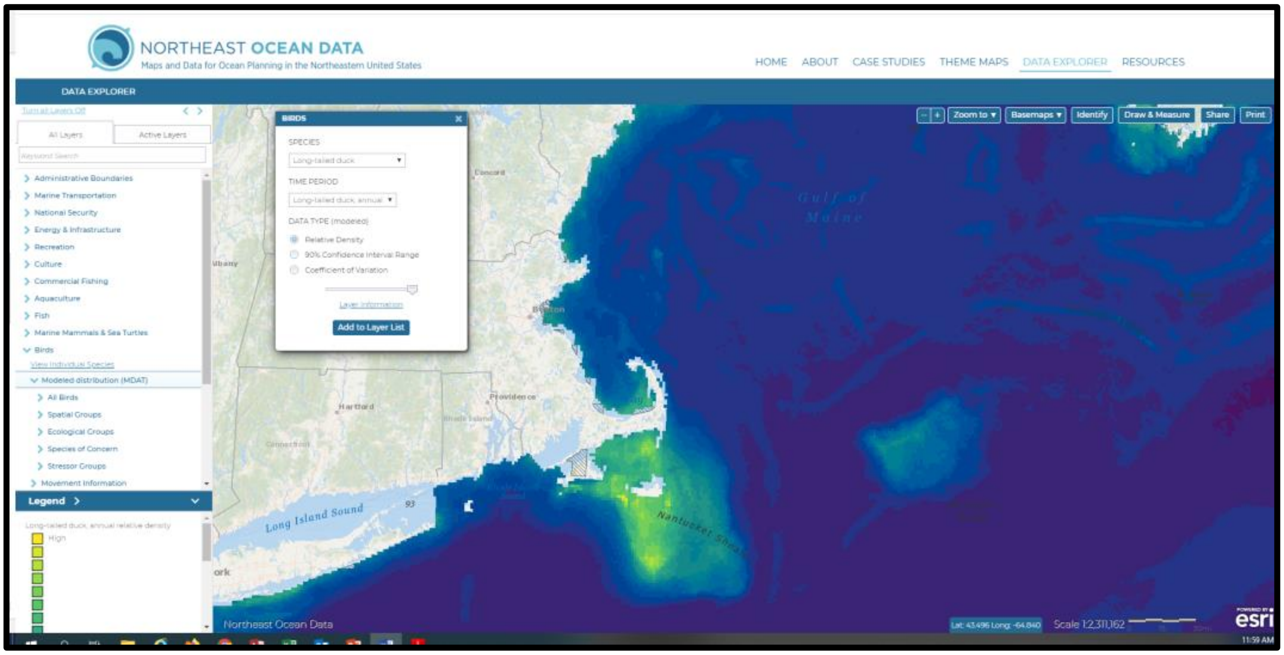
15 https://www.nefsc.noaa.gov/psb/surveys/MapperiframeWithText.html accessed 3/23/2020.

Figure 14. Massachusetts Large Whale Seasonal Trap Gear Closure[16]



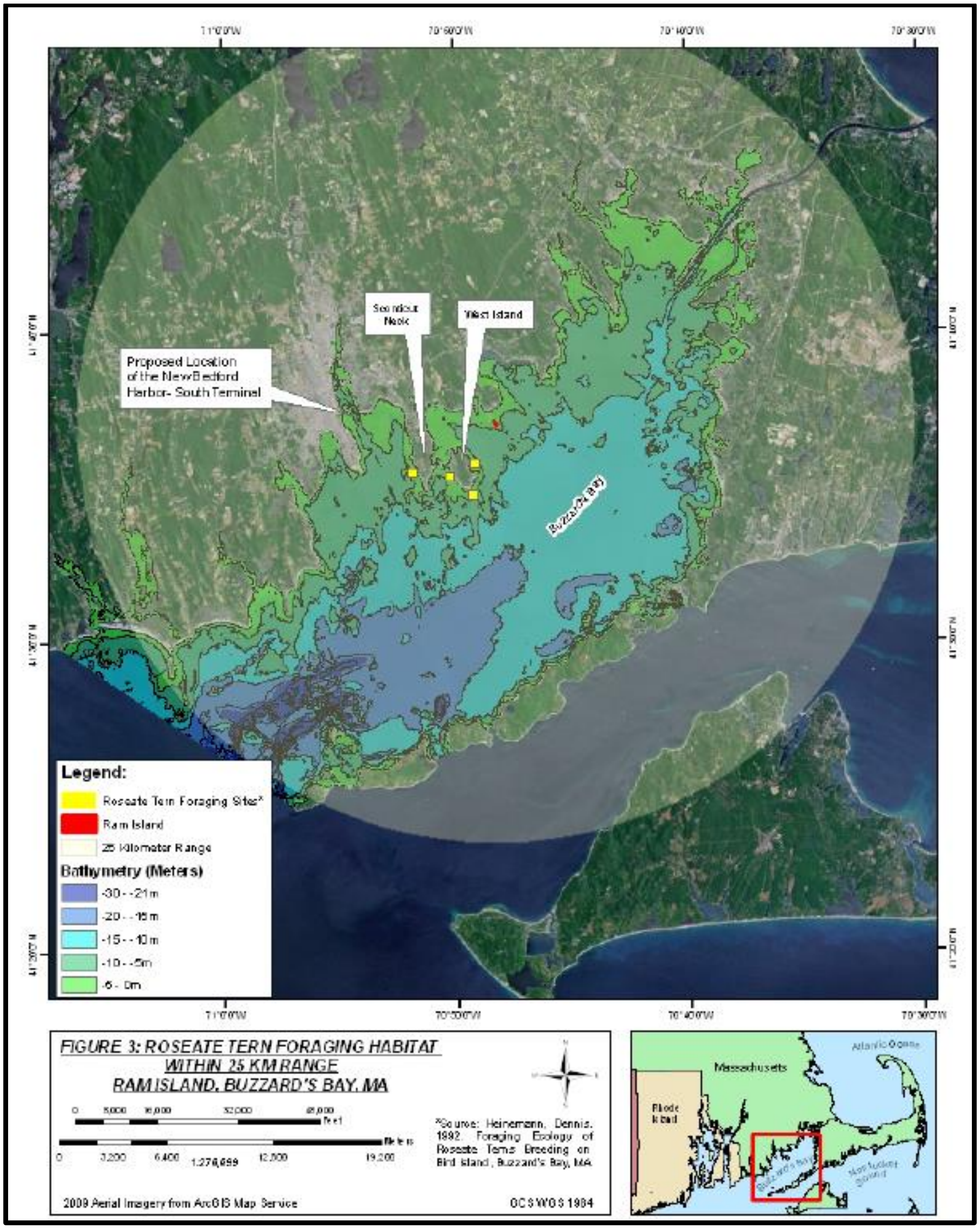
[16] https://www.mass.gov/orgs/large-whale-seasonal-trap-gear-closure-task-force

Figure 15. Sea Duck Modeled Distribution[17]



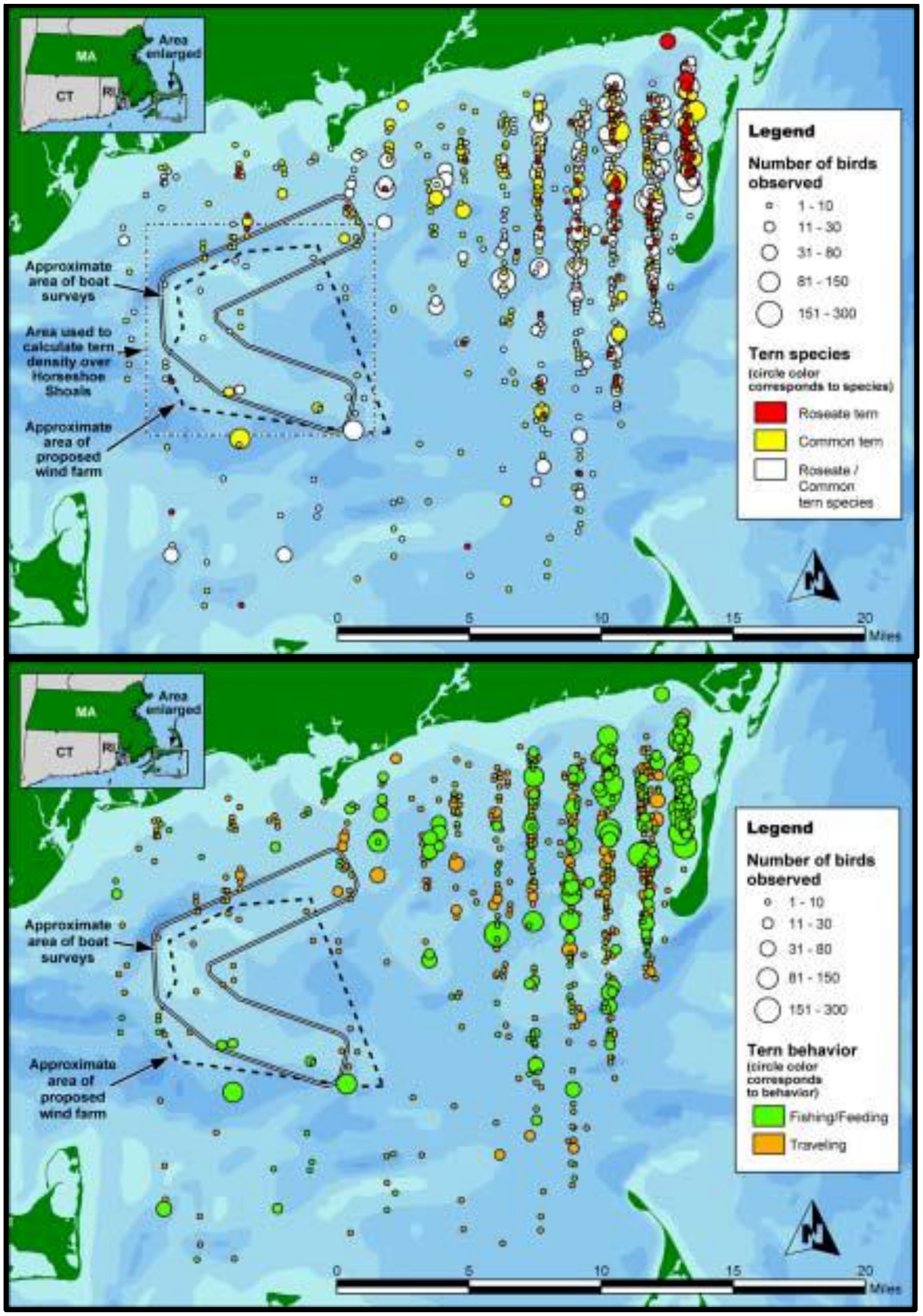
[17] https://www.northeastoceandata.org/MXVoF2t1

Figure 16. Roseate Tern Foraging Radius in Buzzards Bay[18]



[18] Heinemann, D. 1992. Foraging Ecology of Roseate Terns on Bird Island, Buzzards Bay, Massachusetts. Unpublished Report to U.S. Fish and Wildlife Service, Newton Corner, MA.

Figure 17. Roseate and Common Terns Observed in Nantucket Sound During the 2003 Migration and Staging Season[19]



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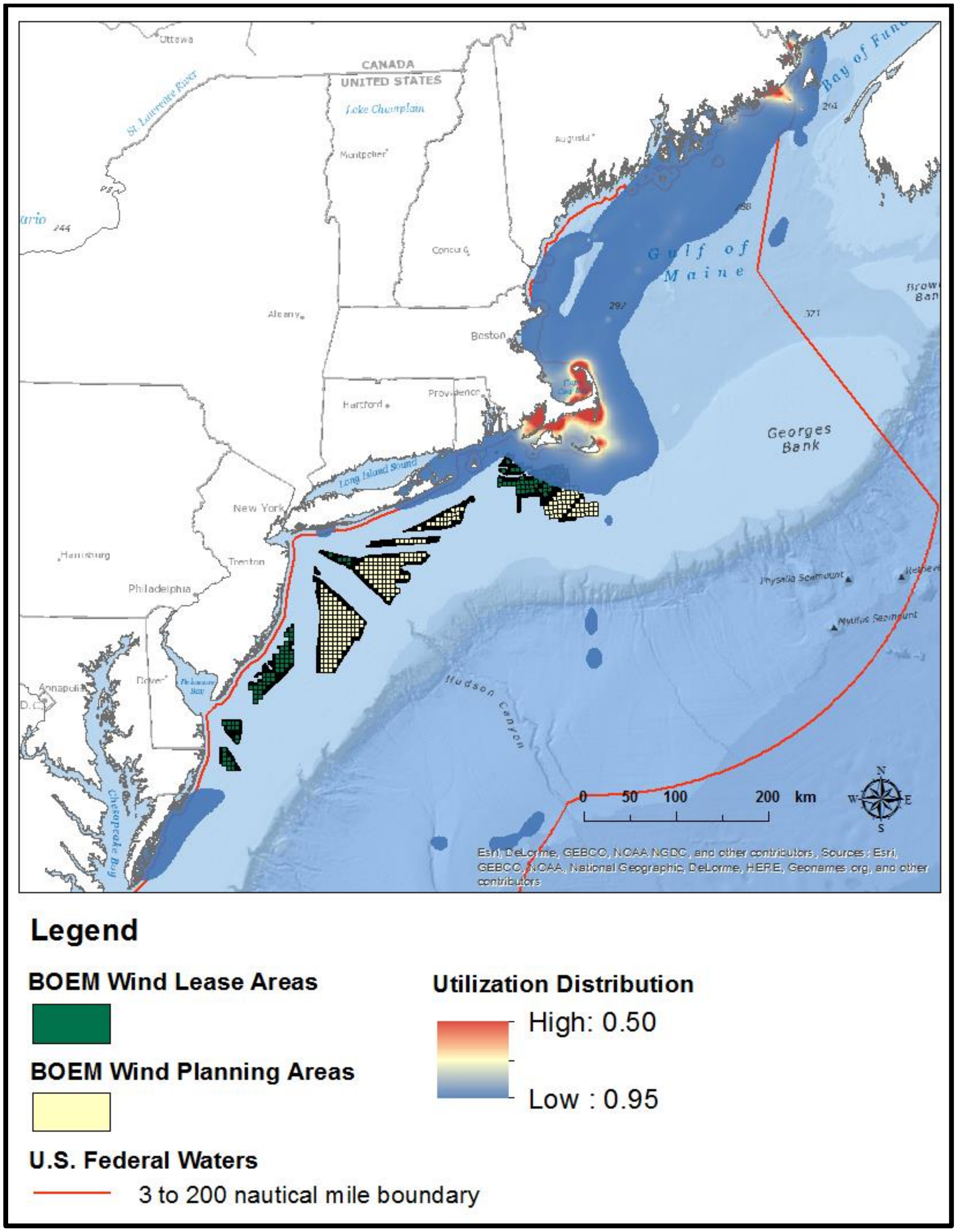
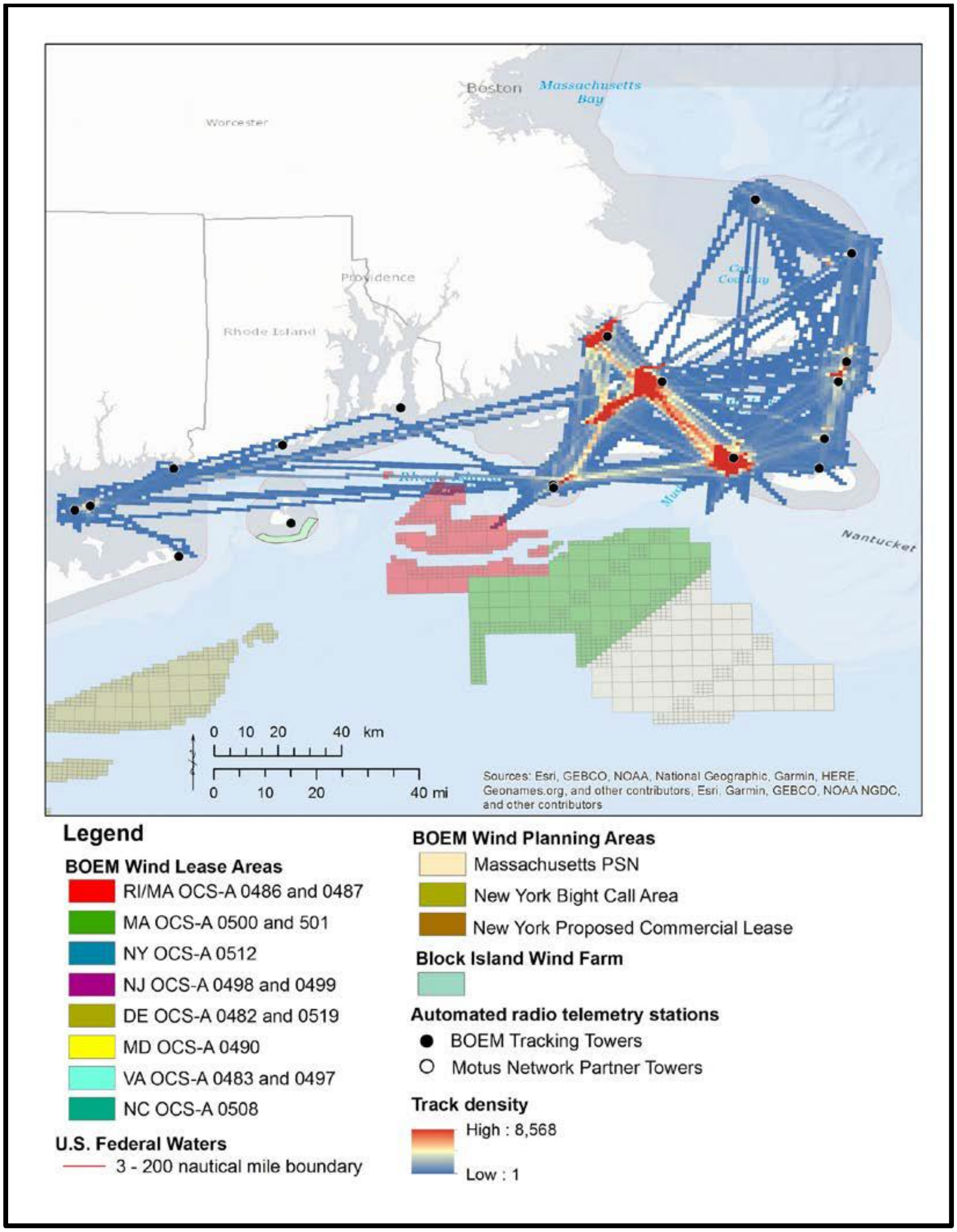
[19] Simon Perkins, Taber Allison, Andrea Jones, and Giancarlo Sadoti. 2004. A survey of tern activity within Nantucket Sound, Massachusetts during the 2003 fall staging season. Final Report for Massachusetts Technology Collaborative. Massachusetts Audubon Society, Lincoln, MA.

Figure 18. Common Tern Utilization Areas[20]



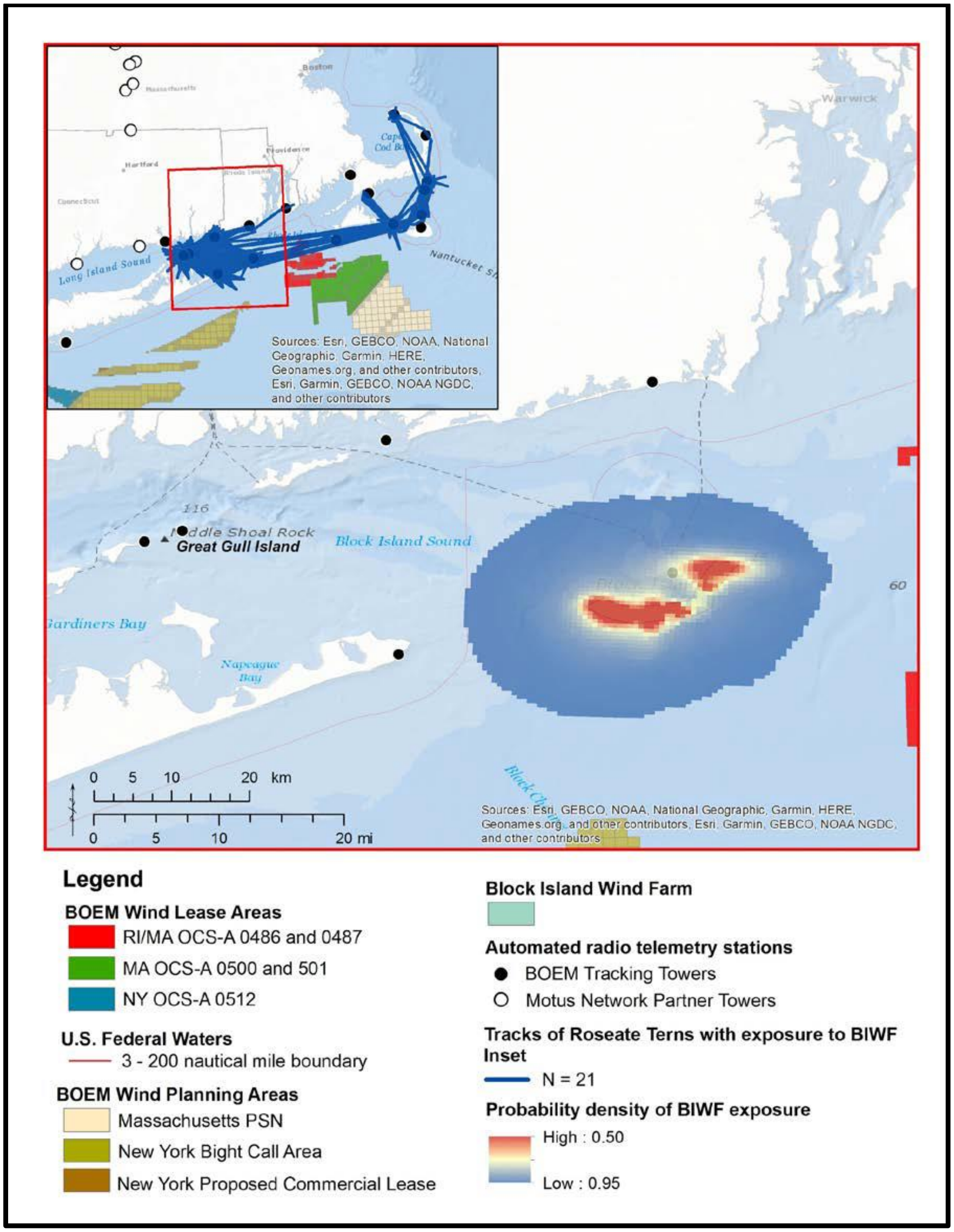
[20] Loring, PH, LJ Welch, S. Williams, and KD Meyer. 2019. OCS Study BOEM 2019-017. Appendix J. P. 99/145.

Figure 19. Tagged Roseate Tern Flight Paths:[21] Track densities (10-min tracks/km2) of Roseate Terns (n=60) from colonies in Buzzards Bay during the breeding and post-breeding periods in 2016 and 2017 (pooled).



[21] Loring PH, Paton PWC, McLaren JD, Bai H, Janaswamy R, Goyert HF, Griffin CR, Sievert PR. 2019. Tracking Offshore Occurrence of Common Terns, Endangered Roseate Terns, and Threatened Piping Plovers with VHF Arrays. Sterling (VA): US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2019-017. 140 p. Figure 15, p. 65/158.

Figure 20. Roseate Tern Movement tracks (inset) and composite probability density of locations with estimated exposure to the Block Island Wind Farm among Roseate Terns (n=21) tagged on Great Gull Island in 2015 to 2017 (pooled).[22]



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[22] Loring PH, P. Paton, JD McLaren, H. Bai, R. Janaswamy, HF Goyert, CR Griffin, and PR Sievert. 2019. Tracking offshore occurrences of Common Terns, endangered Roseate Terns, and Threatened Piping Plovers with VHF arrays. OCS Study BOEM 2019-017. Appendix K Summary of Exposure of Common and Roseate Terns at the Block Island Wind Farm. Figure K-3, p. 124/145.

Figure 21. Proposed Roseate Tern SSU Map

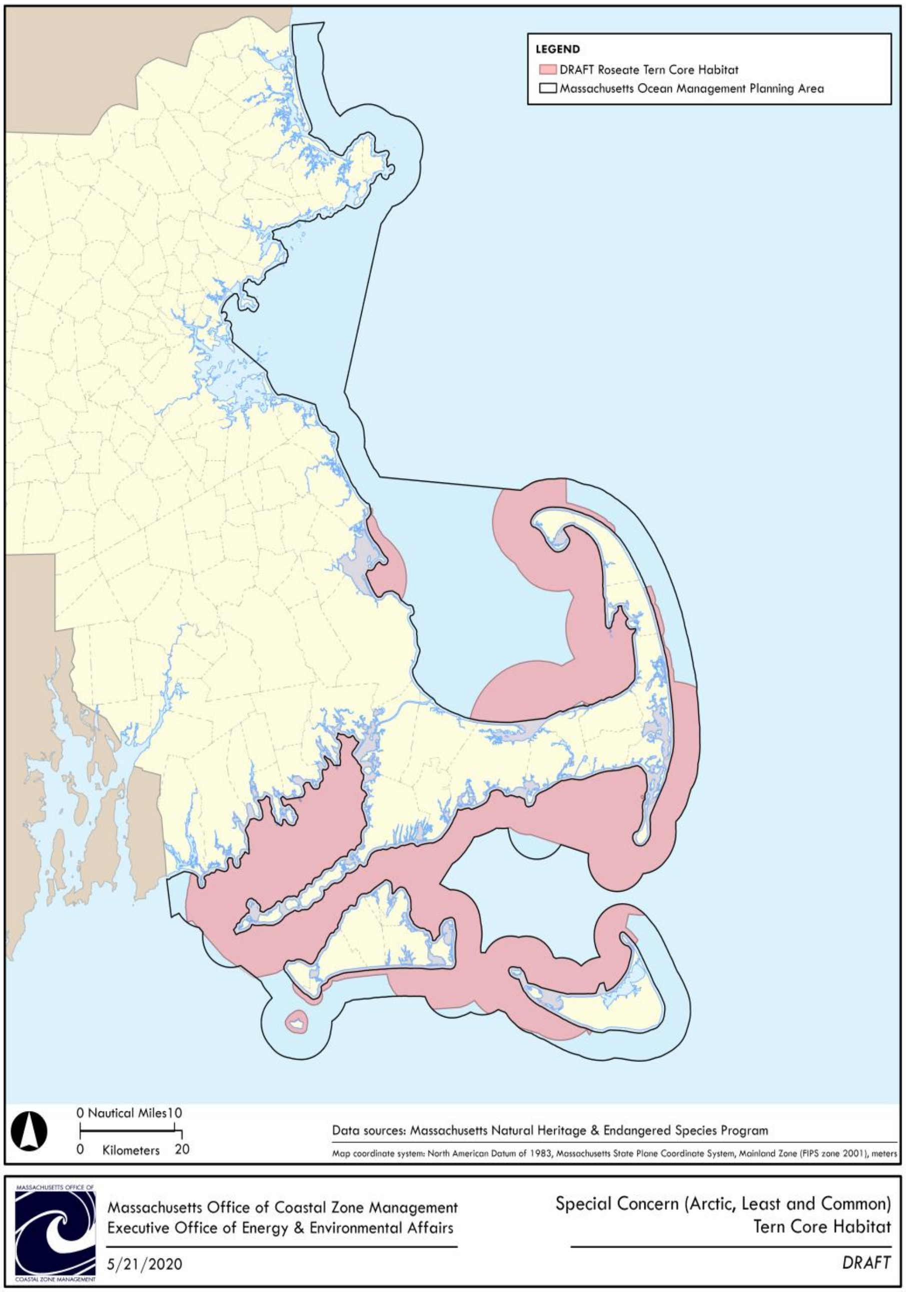


Figure 22. Proposed Special Concern Tern SSU Map

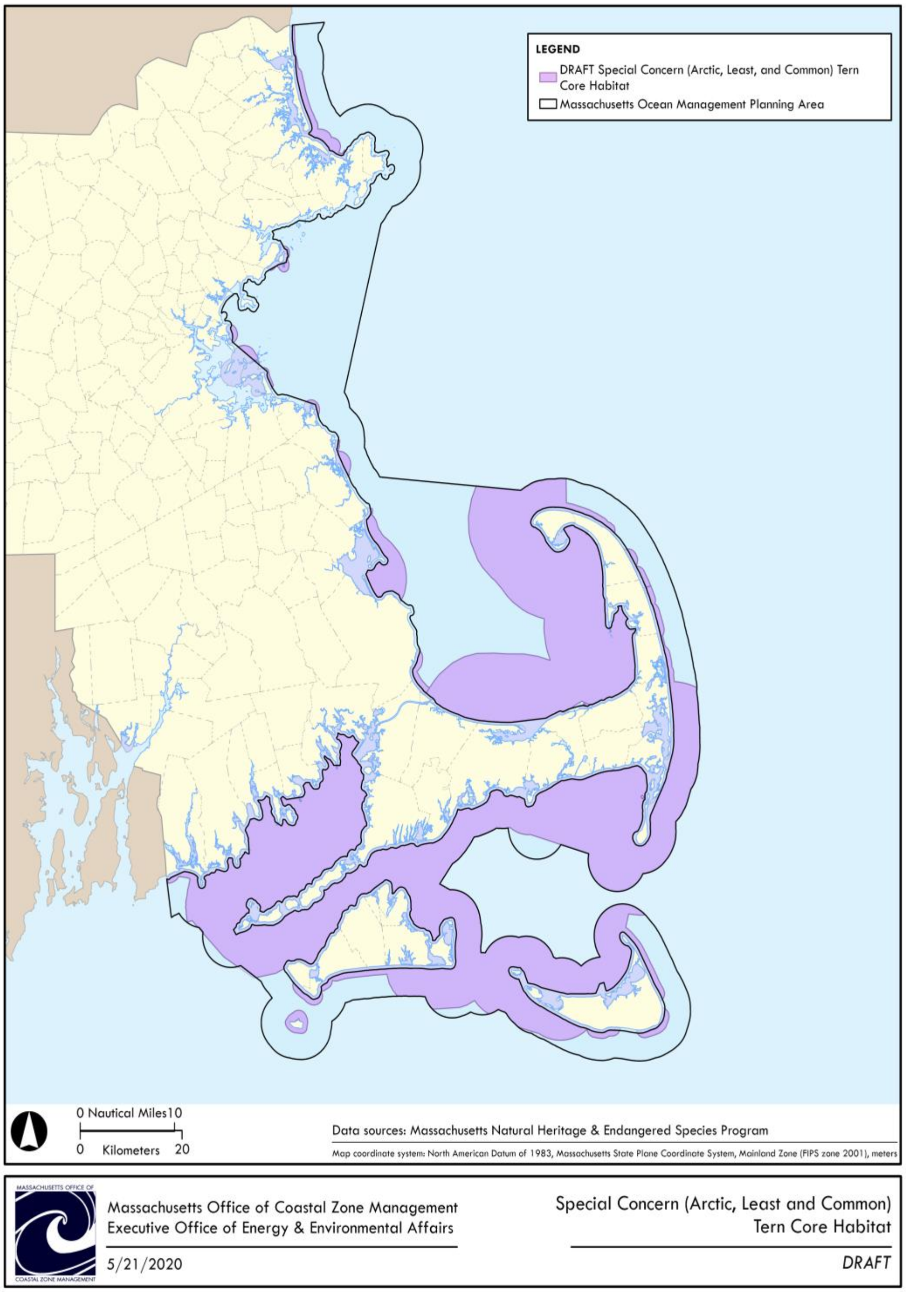
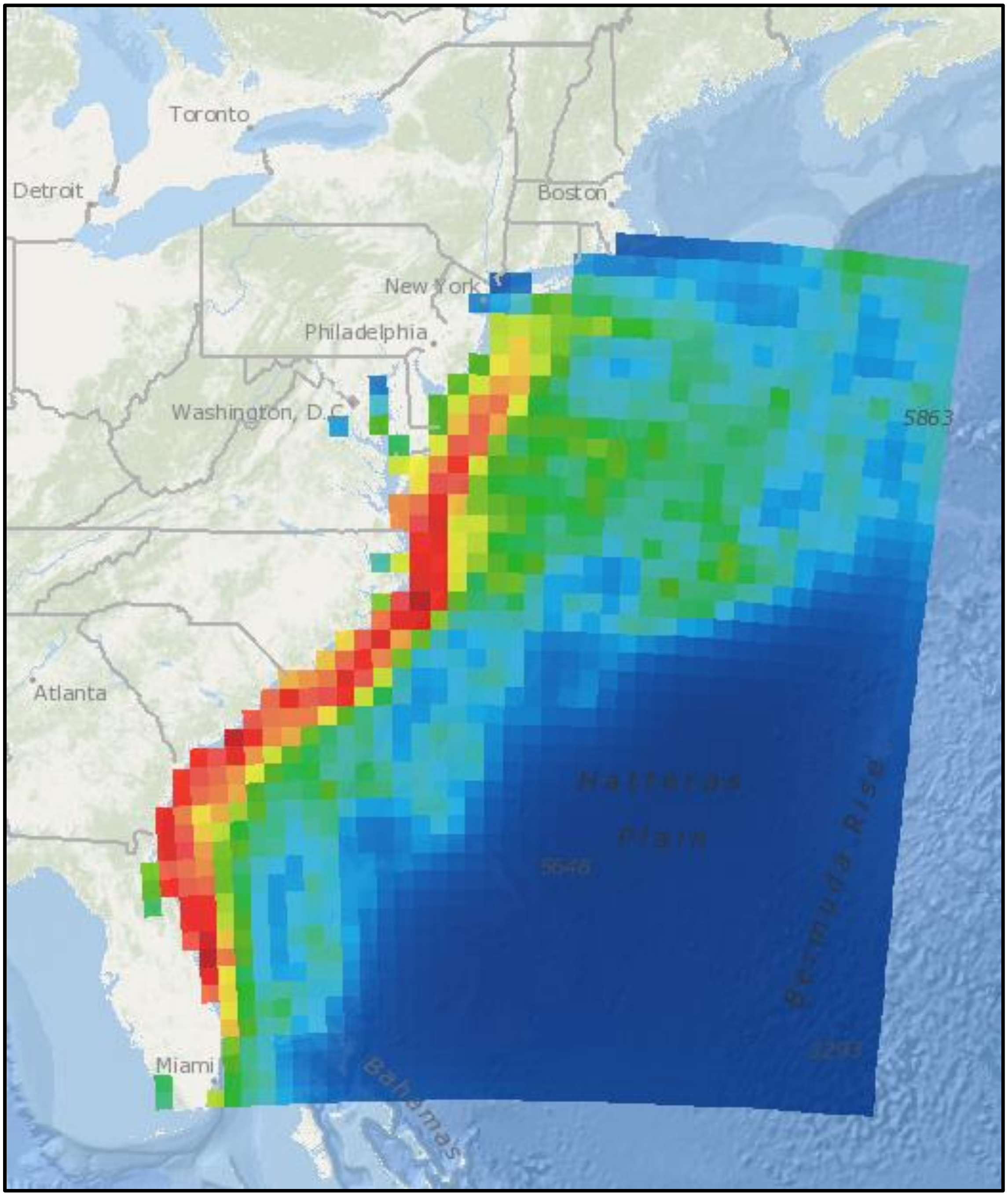
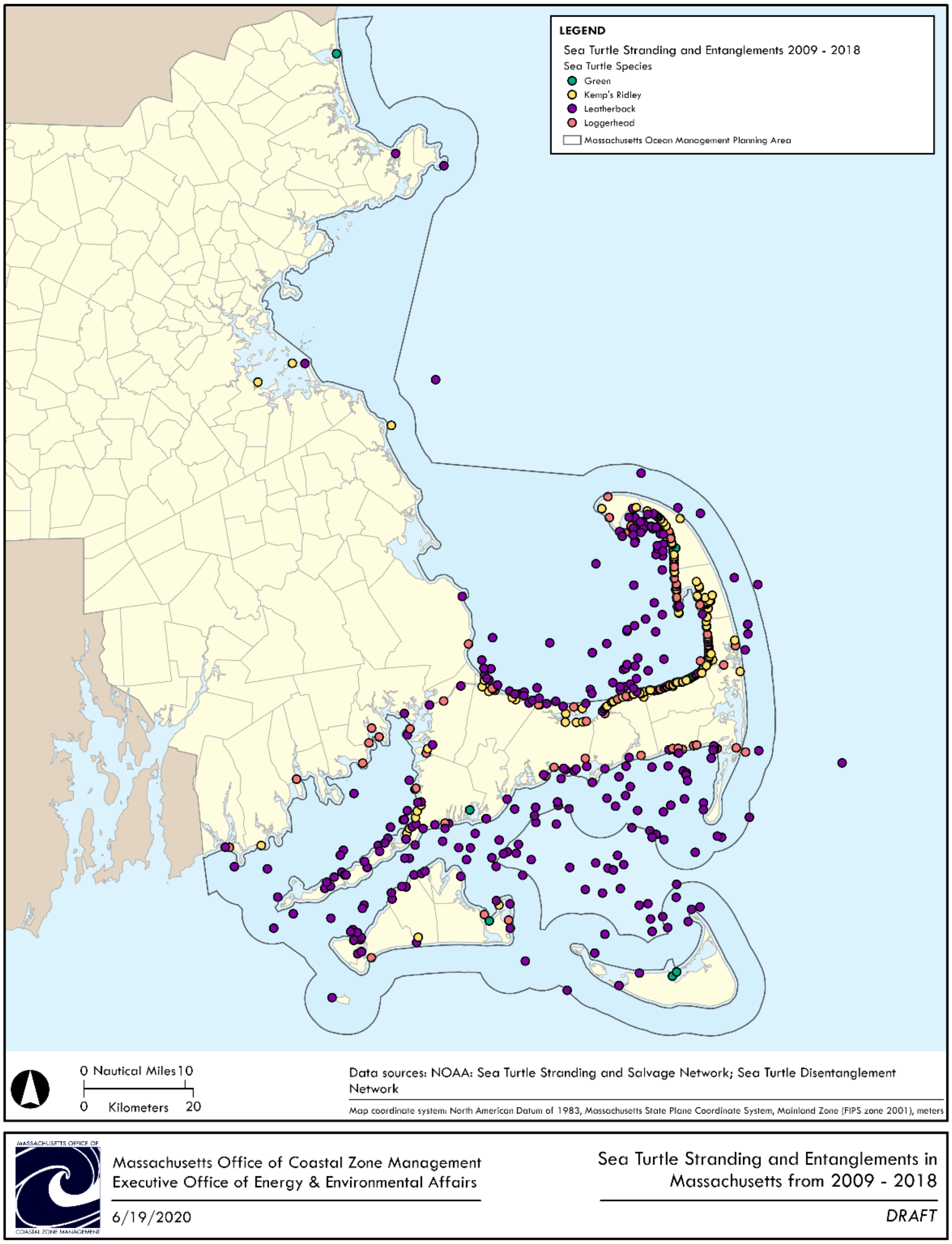


Figure 23. Density of Tagged Loggerhead Sea Turtles from the Northeast Ocean Data Portal[23]



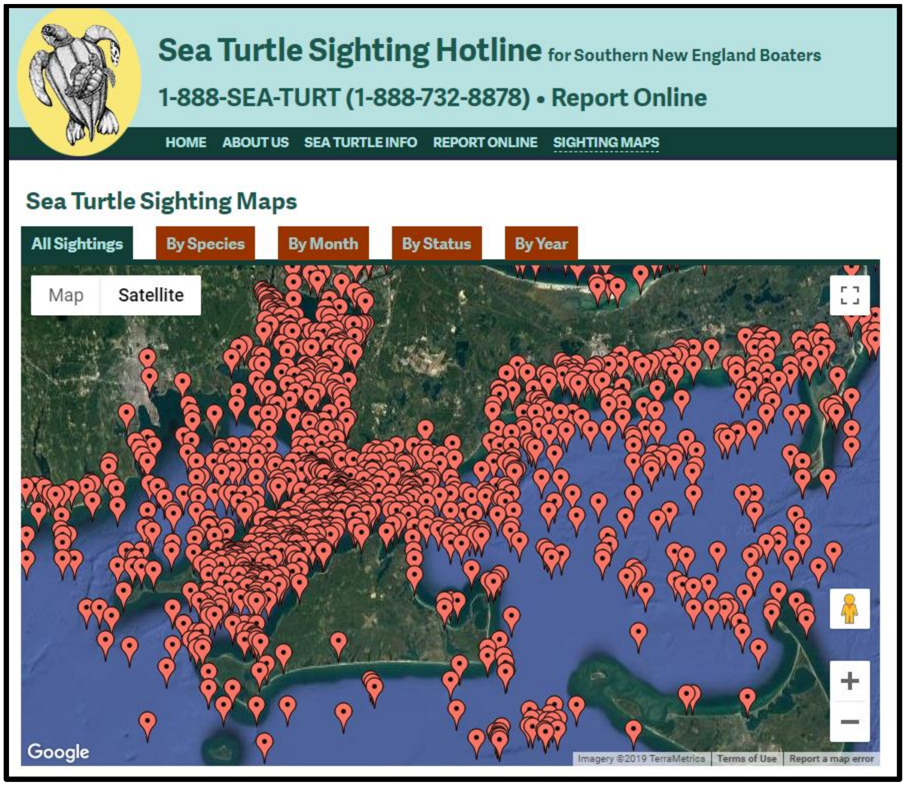
[23] https://www.northeastoceandata.org/Zt1oMPFZ

Figure 24. Sea Turtle Observations from North Atlantic Right Whale Consortium directed surveys (purple), and two separate NOAA sea turtle strandings network records (green and yellow, respectively)[24]



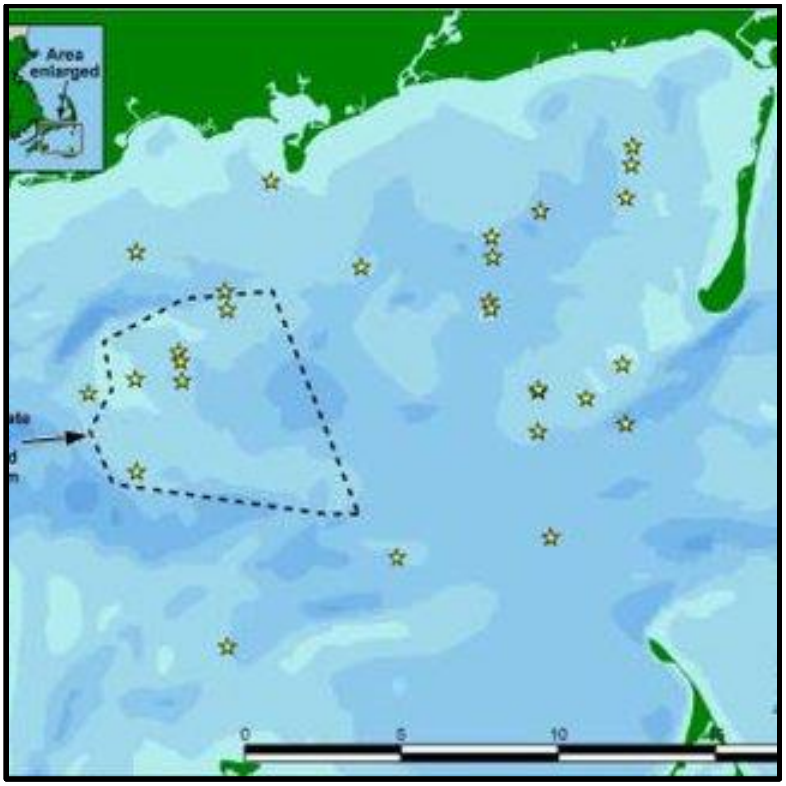
[24] CZM. North Atlantic Right Whale Consortium sea turtle data.

Figure 25. Sea Turtle Sightings Hotline Data[25]



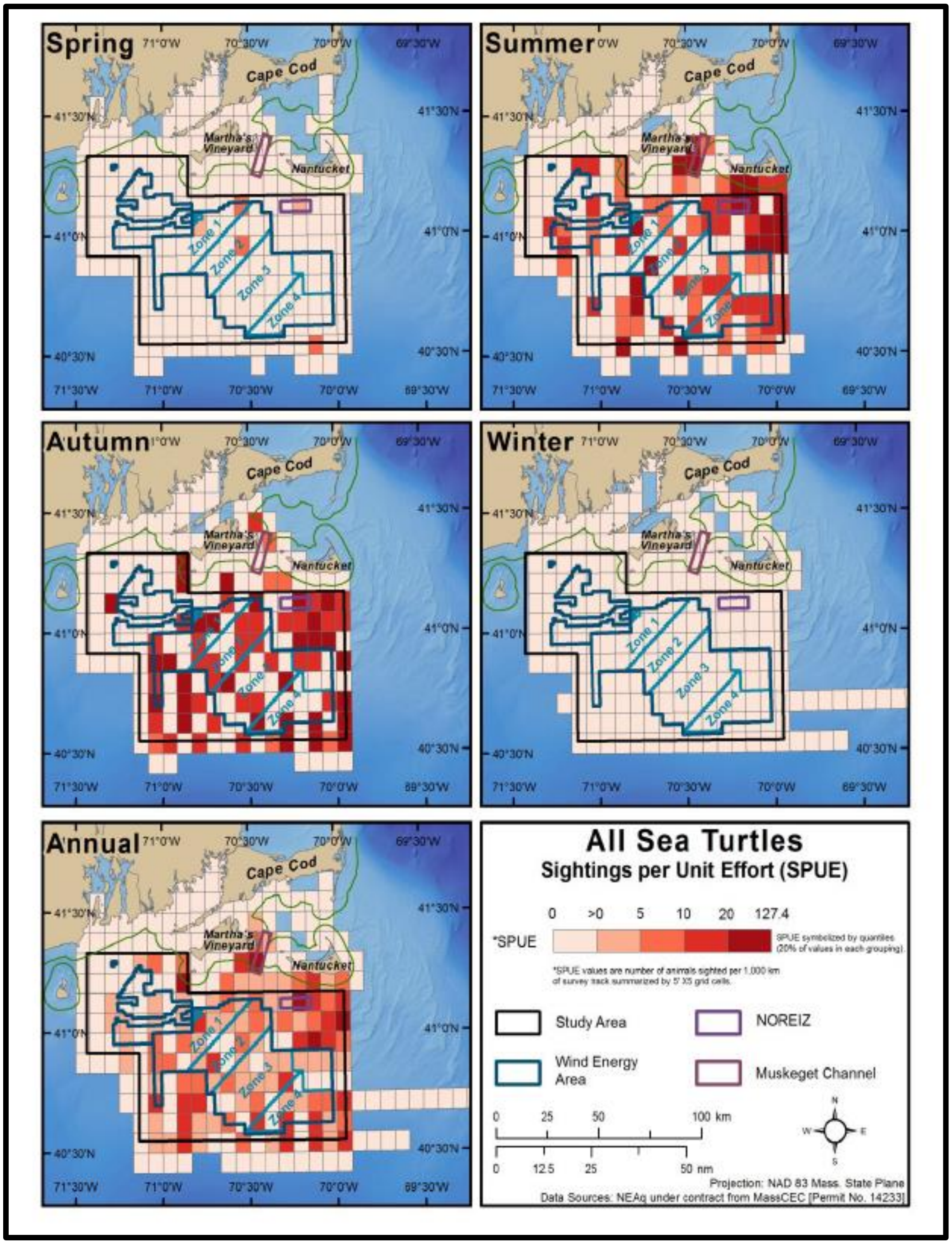
[25] https://seaturtlesightings.org/maps.html

Figure 26. Sea Turtle Sightings Via Aerial Surveys in Nantucket Sound in Fall 2003[26]



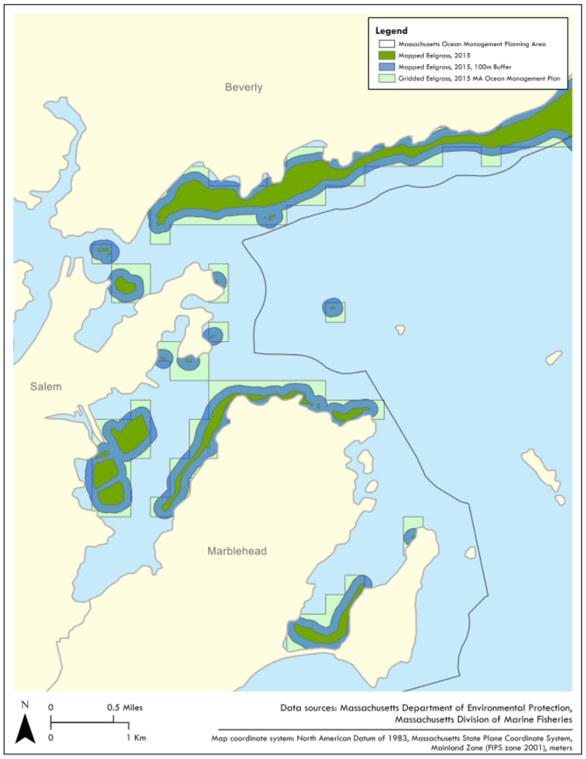
[26] [Note: The turtle data were incidental to the tern surveys]. Simon Perkins, Taber Allison, Andrea Jones, and Giancarlo Sadoti. 2004. A survey of tern activity within Nantucket Sound, Massachusetts during the 2003 fall staging season. Final Report for Massachusetts Technology Collaborative. Massachusetts Audubon Society, Lincoln, MA.

Figure 27. New England Aquarium Sea Turtle Sightings Per Unit Effort in and Adjacent to the Massachusetts Offshore Wind Energy Area[27]



[27] Figure 53, page 87 from Kraus, S.D., S. Leiter, K. Stone, B. Wikgren, C. Mayo, P. Hughes, R. D. Kenney, C. W. Clark, A. N. Rice, B. Estabrook and J. Tielens. 2016. Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles. US Department of the Interior, Bureau of Ocean Energy Management, Sterling, Virginia. OCS Study BOEM 2016-054. 117 pp. + appendices.

Figure 28. Comparison of 2015 vs. 2020 Eelgrass Mapping Methodology in Salem Sound and Buzzards Bay



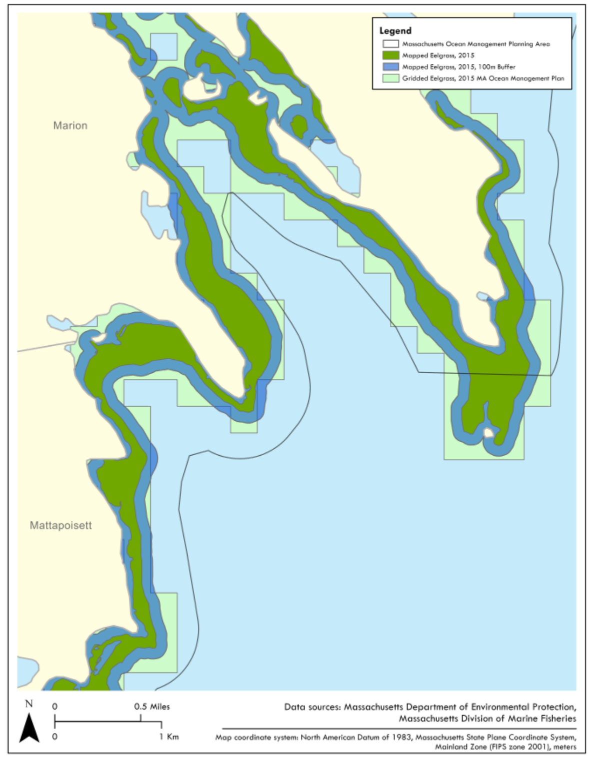
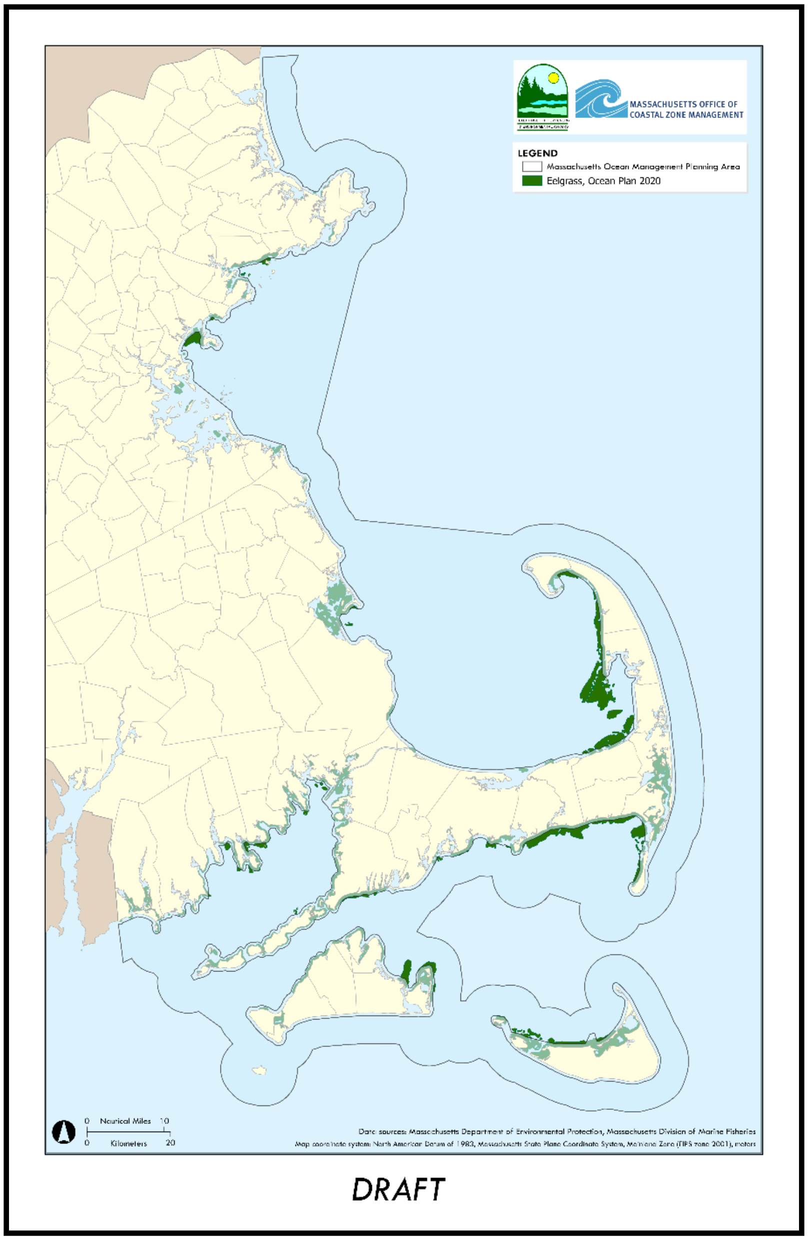


Figure 29. Proposed Eelgrass SSU Map



APPENDIX A

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