

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

**Transportation & Navigation  
Work Group Report**

**2021 Massachusetts Ocean Management Plan Review**

February 23, 2021

## TABLE OF CONTENTS

SECTION ONE:	WORKGROUP MEMBERSHIP	1
SECTION TWO:	INTRODUCTION	2
SECTION THREE:	DATA RESOURCES AND RECOMMENDATIONS	3
SECTION FOUR:	MAP PRODUCTS	6
SECTION FIVE:	TABLES	17
APPENDIX A:	FISHERIES NOT COVERED BY THE VESSEL MONITORING SYSTEM IN MA	22

### LIST OF FIGURES

Figure 1.	Transportation Routes and Navigation Uses	6
Figure 2.	Automatic Identification System Vessel Density for 2018-2019	7
Figure 3.	Proposed Concentrated Commerce Traffic Water-Dependent Use Areas for 2021 Plan Update	8
Figure 4.	Cargo Automatic Identification System Vessel Density for 2018-2019	9
Figure 5.	Fishing Automatic Identification System Vessel Density for 2018-2019	10
Figure 6.	Passenger Automatic Identification System Vessel Density for 2018-2019	11
Figure 7.	Pleasure Automatic Identification System Vessel Density for 2018-2019	12
Figure 8.	Tanker Automatic Identification System Vessel Density for 2018-2019	13
Figure 9.	Tug and Tow Automatic Identification System Vessel Density for 2018-2019	14
Figure 10.	Proposed Concentrated Commercial Fishing Traffic Water-Dependent Use Areas for 2021 Plan Update	15
Figure 11.	Proposed Concentrated Recreational Boating Activity Water-Dependent Use Areas for 2021 Plan Update	16

### LIST OF TABLES

Table 1.	Mapping Transportation and Navigation Uses: Comparison of 2015 Ocean Plan to Proposed 2021 Ocean Plan.	17
Table 2.	Concentrated Commerce Traffic Mapping of Automatic Identification System (AIS) Data: Comparison of 2015 Ocean Plan to Proposed 2021 Ocean Plan.	19
Table 3.	Concentrated Commercial Fishing Traffic Mapping of Vessel Monitoring System (VMS) Data: Comparison of 2015 Ocean Plan to Proposed 2021 Ocean Plan.	21

**SECTION ONE: WORK GROUP MEMBERSHIP**

Erikk Hokenson (Work Group Chair)  
Boston Harbor Regional Coordination  
Office of Coastal Zone Management

Greg Glavin  
Director  
Massachusetts Marine Trades Association

Dan Sampson (Work Group GIS Lead)  
GIS/Data Manager  
Office of Coastal Zone Management

Lieutenant Daniel Hubbard  
Chief, Maritime Energy and Marine Planning  
U.S. Coast Guard, First Coast Guard District

Tyler Soleau  
Assistant Director  
Office of Coastal Zone Management

Captain Mike Peddle  
Harbor Pilot  
Boston Harbor Pilot Association

Edward Anthes-Washburn  
Executive Director  
New Bedford Port Authority

Colleen Roche  
Northeast Navigation Manager  
National Oceanic and Atmospheric Administration

Lauren Beagen  
Maritime Project Manager  
Massachusetts Port Authority

Gregory Robbins  
Director, Waterways  
Department of Conservation and Recreation

Gregg Cademartori  
Planning Director  
City of Gloucester

Frank Taormina  
Regional Planner  
Department of Environmental Protection,  
Waterways Regulation Program

Wendy Gendron  
Chief, Civil Works  
United States Army Corps of Engineers, New  
England District

*Note from the Work Group Chair: I extend my sincere appreciation to the entire work group for contributing their time, expertise, and effort that resulted in the preparation of this document. A special thanks is given to Dan Sampson for his exceptional work in collating and analyzing the relevant data and producing the maps presented herein.*

## SECTION TWO: INTRODUCTION

The Massachusetts Oceans Act of 2008 (“Act”) required the creation of a comprehensive Ocean Management Plan (“Plan”) for Massachusetts waters by December 2009. The foundation of the Plan was the identification of management areas within state waters with specific siting and performance standards 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 Plan using the best data available at that time. The 12 SSU resources mapped in the 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 (formerly mapped as long-tailed 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

Five water-dependent uses were identified and concentrations thereof were mapped for the Plan using the best data available at the time. The five water-dependent uses whose concentrations are mapped in the Plan include:

- High commercial fishing effort and value
- Recreational fishing
- Commerce traffic
- Commercial fishing traffic
- Recreational boating

The Act requires the Plan, as amended, to be reviewed every five years. In order to inform the five-year review, CZM convened the Transportation & Navigation Work Group in 2019 for two meetings to discuss potential updates to mapped transportation and navigation uses. At the initial meeting, CZM staff presented background information on the development of the Plan; an overview of the existing SSU resources and concentrated water-dependent use areas within the planning area; a summary of the 2015 Plan; and the results of an ocean planning survey conducted by CZM at the start of the review process. Following this initial meeting, the work group focused on updating and identifying transportation and navigation trends and data; identifying and summarizing new science relevant to the transportation and navigation GIS data; and making recommendations for science and data priorities for the next five years.

### Transportation & Navigation Work Group Charge (2020)

The Transportation and Navigation Work Group included specialists in transportation and navigation from across the Commonwealth; municipal representatives; and relevant state and federal partners and regulatory agencies. The work group was charged with four primary tasks:

1. Identify any changes to the spatial extent of “protected areas” identified and mapped in the 2015 Plan: SSU resource areas and concentrations of water-dependent uses;
2. Identify and characterize other significant or notable trends in the status or condition of resources and uses, including (a) the protected SSU resource areas and concentrations of water-dependent uses 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 Plan);
3. Identify and summarize any new science that advances the characterization of the planning area and its uses and resources, especially applied science and spatial data;
4. Review the science and data priorities contained in Volume II, Science Framework of the 2015 Plan and work done to date to address those priorities and make recommendations for priority science and data actions for the next five years.

### **SECTION THREE: DATA SOURCES AND RECOMMENDATIONS**

#### Data Resources

For the 2009 Plan, the primary source for the data layers relevant to the Transportation & Navigation Work Group came from National Oceanic and Atmospheric Administration (NOAA) nautical charts. The layers used in the work group’s analysis included anchorage areas; anchorage berths; areas to be avoided; ferry routes; navigation aids; pilot boarding areas; precautionary areas; prohibited areas; separation zones; and shipping lanes. Ultimately, the anchorage areas and berths, ferry routes, pilot boarding areas, precautionary areas, separation zones, and shipping lanes were included in the Plan and shown as part of the Baseline Assessment. The 2009 Plan also included three other data layers to map concentrated areas of water-dependent uses in the planning area: Automatic Identification System (AIS), Vessel Monitoring System (VMS), and recreational boating data.

For the 2015 Plan, the work group updated the baseline map with data downloaded from NOAA’s Electronic Navigational Chart (ENC) Direct to Geographic Information System (GIS) viewer. These data layers included anchorage areas and berths, precautionary areas, separation zones, traffic lanes, and recommended routes. Ferry routes were created by the Massachusetts Department of Transportation’s Office of Transportation Planning (MassDOT-OTP), while the pilot boarding areas were produced by Applied Science Associates (ASA) and downloaded from the Northeast Ocean Data Portal. The 2015 Plan included more recent AIS, VMS, and recreational boating data and recommended consideration of a sensitivity test of state-only fisheries’ influence on concentrated commercial fishing traffic and of using Maritime Mobile Service Identity (MMSI) data to map recreational boating traffic.

For the current review, the work group updated the baseline map with data downloaded from NOAA’s ENC Direct to GIS Viewer. As in 2015, these data layers included anchorage areas and berths, precautionary areas, separation zones, traffic lanes, and recommended routes; ferry routes and pilot boarding areas were downloaded from the Northeast Ocean Data Portal. These layers are presented in Figure 1. A summary comparison between the data used for the baseline map in the 2015 Plan and this review is included in Table 1.

#### *Automatic Identification System Vessel Density*

In the 2015 Plan, AIS tracklines were used to create a vessel density dataset, from which areas of high trackline density for 2011-2012 were extracted, analyzed, classified, and mapped to update the concentrated commerce traffic water-dependent use layer. For the current review, AIS tracklines of commerce vessels from 2018-2019 produced by RPS Group and downloaded from the Northeast Ocean Data Portal were used to create a vessel density dataset that was then analyzed, classified, and mapped.

(See Table 2 for more information about the data analysis and for a comparison of the mapping methods used in the 2015 Plan and the current review.) Areas of high trackline density for 2018 and 2019 (Figure 2) were extracted and mapped to update the concentrated commerce traffic water-dependent use layer (Figure 3). As recommended by the previous work group, two or more years of trackline data were analyzed and AIS density by vessel type was also mapped. Figures 4, 5, 6, 7, 8, and 9 show the 2018-2019 vessel density for cargo, fishing, passenger, pleasure, tanker, and tug & tow vessels, respectively.

#### *Vessel Monitoring System Data*

In the 2015 Plan, commercial fishing vessel density data from 2006-2010 prepared by ASA for the Northeast Regional Ocean Council were classified into deciles and the densest decile was extracted as the concentrated commercial fishing traffic water-dependent use layer. Changes in the availability of the VMS data precluded using the same method to determine areas of concentrated commercial fishing traffic. Instead, VMS data from 9/1/2015-8/31/2016 provided by NOAA National Marine Fishery Service (NMFS) and prepared by RPS Group for the Northeast Ocean Data Portal for multispecies groundfish vessels were presented to the work group. The work group recommended including available data for vessels of each fishery from 2015-2016, including herring, monkfish, multispecies groundfish, pelagic species, scallop, squid, and surf clam & ocean quahog. The densest areas (by fishery) were extracted from each fishing vessel dataset as the concentrated commercial fishing traffic water-dependent use layer (Figure 10). (See Table 3 for more information about mapping the concentrated commercial fishing traffic in the 2015 Plan and the current review.)

As noted in the 2014 Transportation & Navigation Work Group Report, areas mapped as concentrated commercial fishing traffic are likely dominated by offshore, large fishing vessels. VMS data may not include fisheries present in state waters. Appendix A includes a table of fisheries not covered by VMS in Massachusetts.

#### *Recreational Boating Routes*

The 2015 Plan includes recreational boating routes developed from the 2010 Massachusetts Recreational Boater Survey, the 2012 Northeast Recreational Boater Survey, and the 2013 Massachusetts Marine Trades Association user survey (see Figure 11). The work group discussed the recreational boating routes identified in the planning area for the 2015 and did not recommend additional data collection based upon their expertise and knowledge of recreational boating activity. As recommended by the 2014 Transportation & Navigation Work Group, the current work group investigated the possibility of using MMSI data to map recreational boating activity, but their use was not recommended given the limited use of MMSI tracking systems.

#### Recommendations

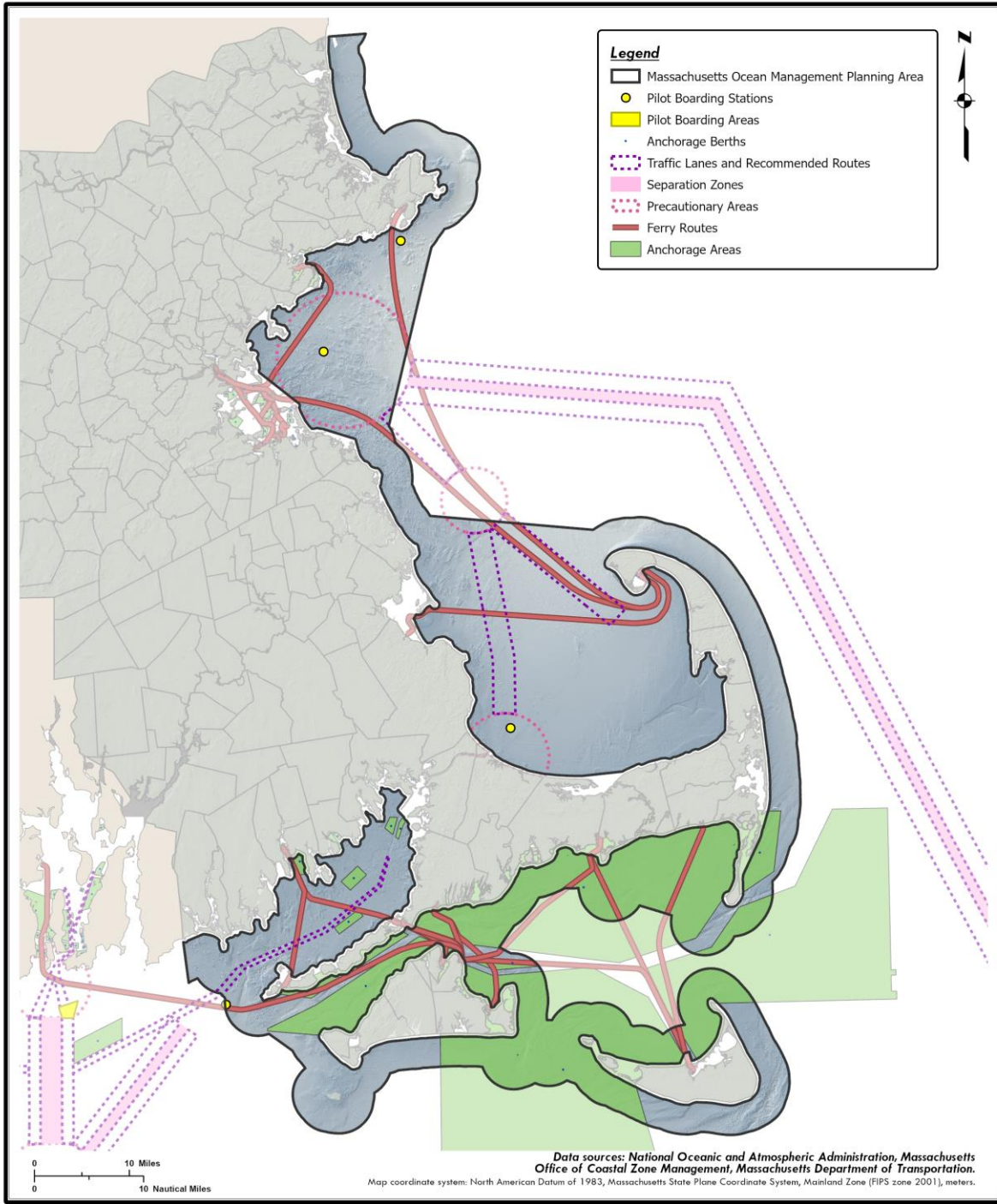
The discussions from the Transportation & Navigation Work Group were used to establish a list of recommendations to CZM to assist in updating the existing Plan and keeping the scientific foundation of the Plan current. The work group recommends:

- Updating the Plan with data and figures as presented herein;
- Considering a sensitivity test of state-only fisheries on concentrated commercial fishing traffic and identifying important in-state corridors for smaller vessels, as recommended in the 2014 Transportation & Navigation Work Group Report;

- Considering the possibility of forecasting changes in areas of concentrations of vessel traffic, e.g., vessels related to offshore energy production;
- Continuing to investigate the possibility of Maritime Mobile Service Identify (MMSI) data to map recreational boating activity;
- Ensuring that industry-driven changes that may reduce the density of certain vessel types disproportionately to their value to the region (e.g., a potential reduction in the number of container vessels calling in Boston Harbor because the Port of Boston has been dredged and expanded to accommodate larger vessels) are understood and appropriately reflected in future Plans.

**SECTION FOUR: MAP PRODUCTS**

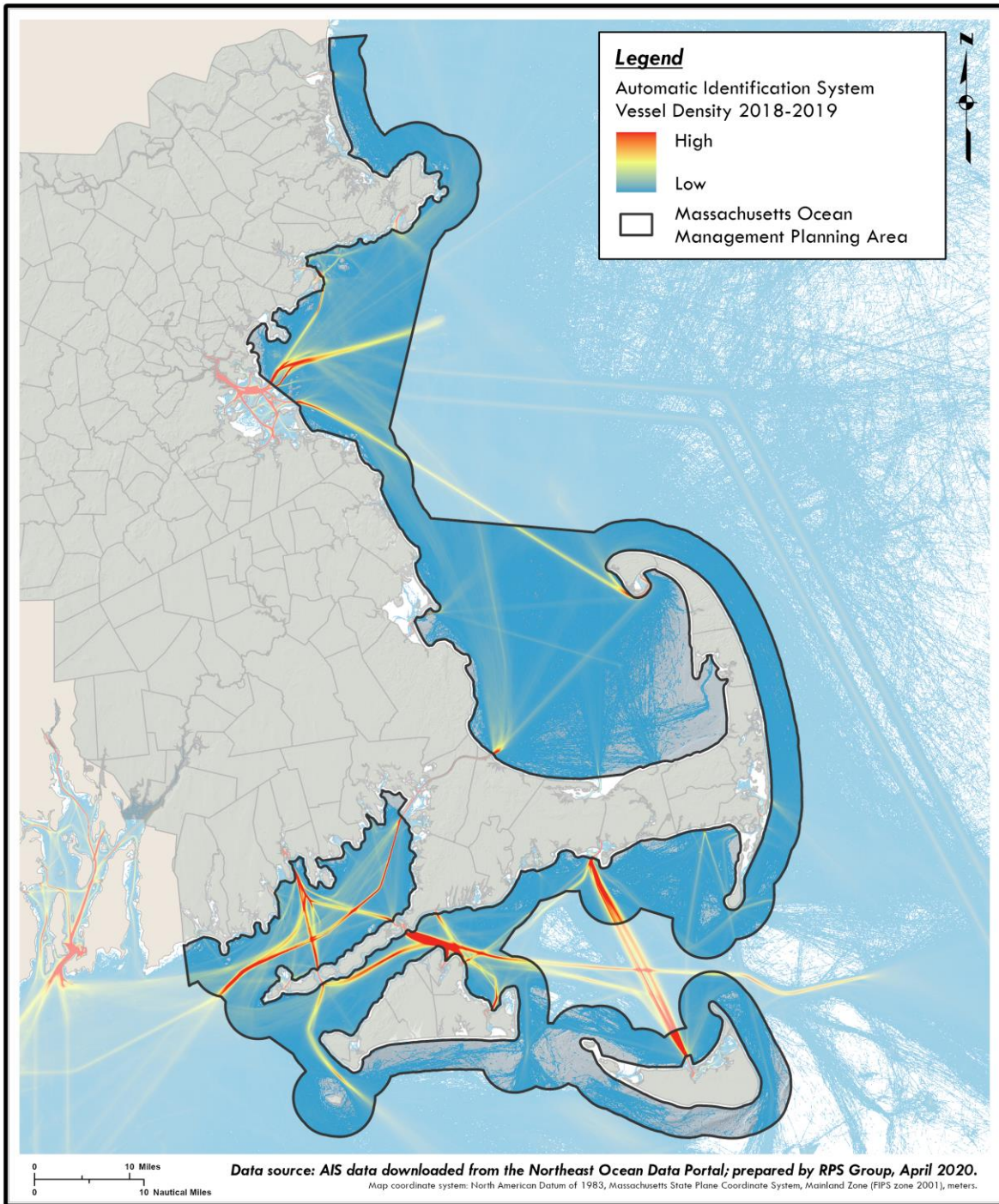
**Figure 1. Transportation Routes and Navigation Uses.**



	Massachusetts Office of Coastal Zone Management Executive Office of Energy & Environmental Affairs	<b>TRANSPORTATION AND NAVIGATION USES                  IN AND ADJACENT TO PLANNING AREA</b>	DRAFT
	2/2/2021		

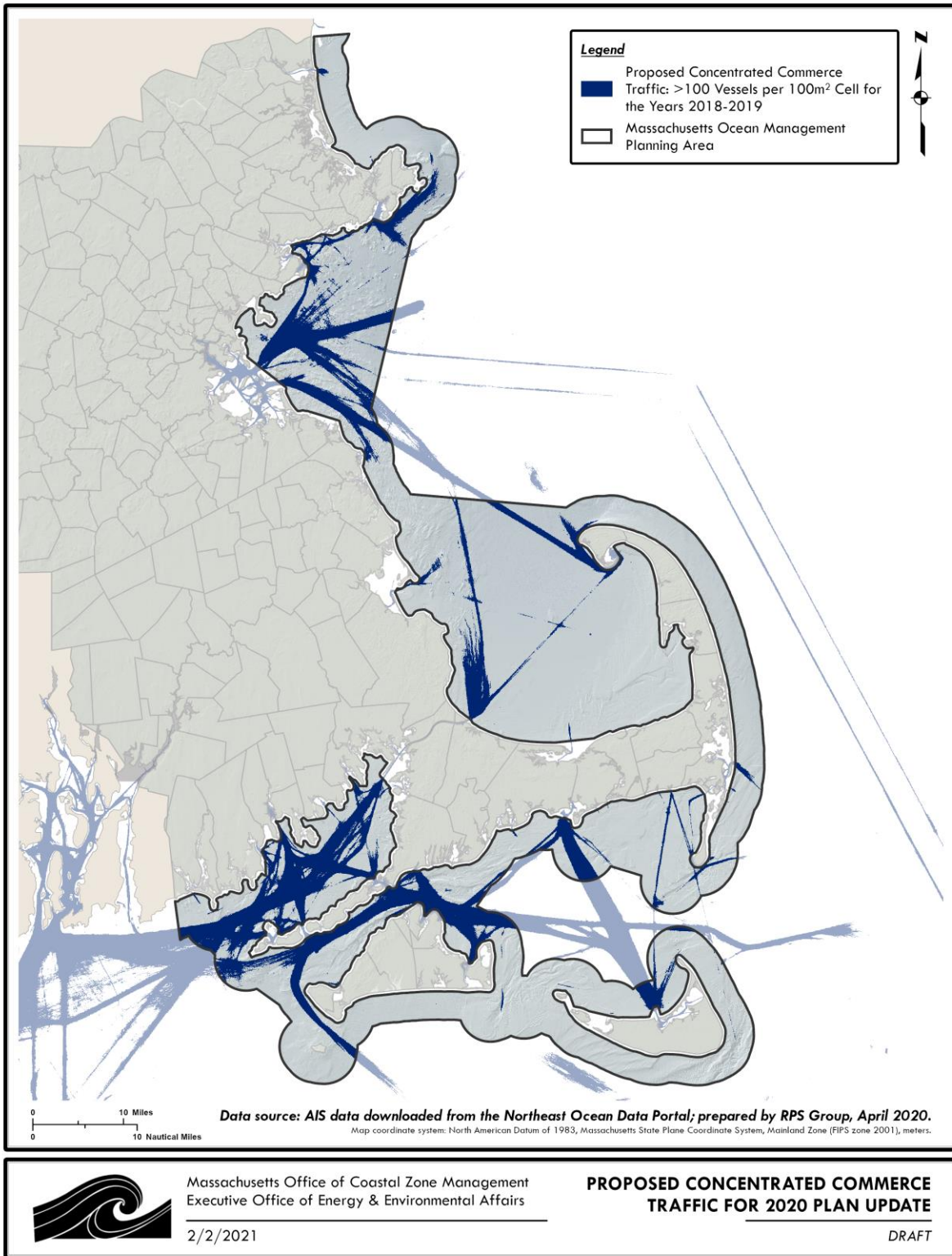


Figure 2. Automatic Identification System Vessel Density for 2018-2019



	Massachusetts Office of Coastal Zone Management Executive Office of Energy & Environmental Affairs 2/2/2021	<b>ALL VESSEL COUNTS IN AND                  ADJACENT TO THE PLANNING AREA</b> DRAFT
---	---	---

**Figure 3. Proposed Concentrated Commerce Traffic Water-Dependent Use Areas for 2021 Plan Update**



**Figure 4. Cargo Automatic Identification System Vessel Density for 2018-2019**

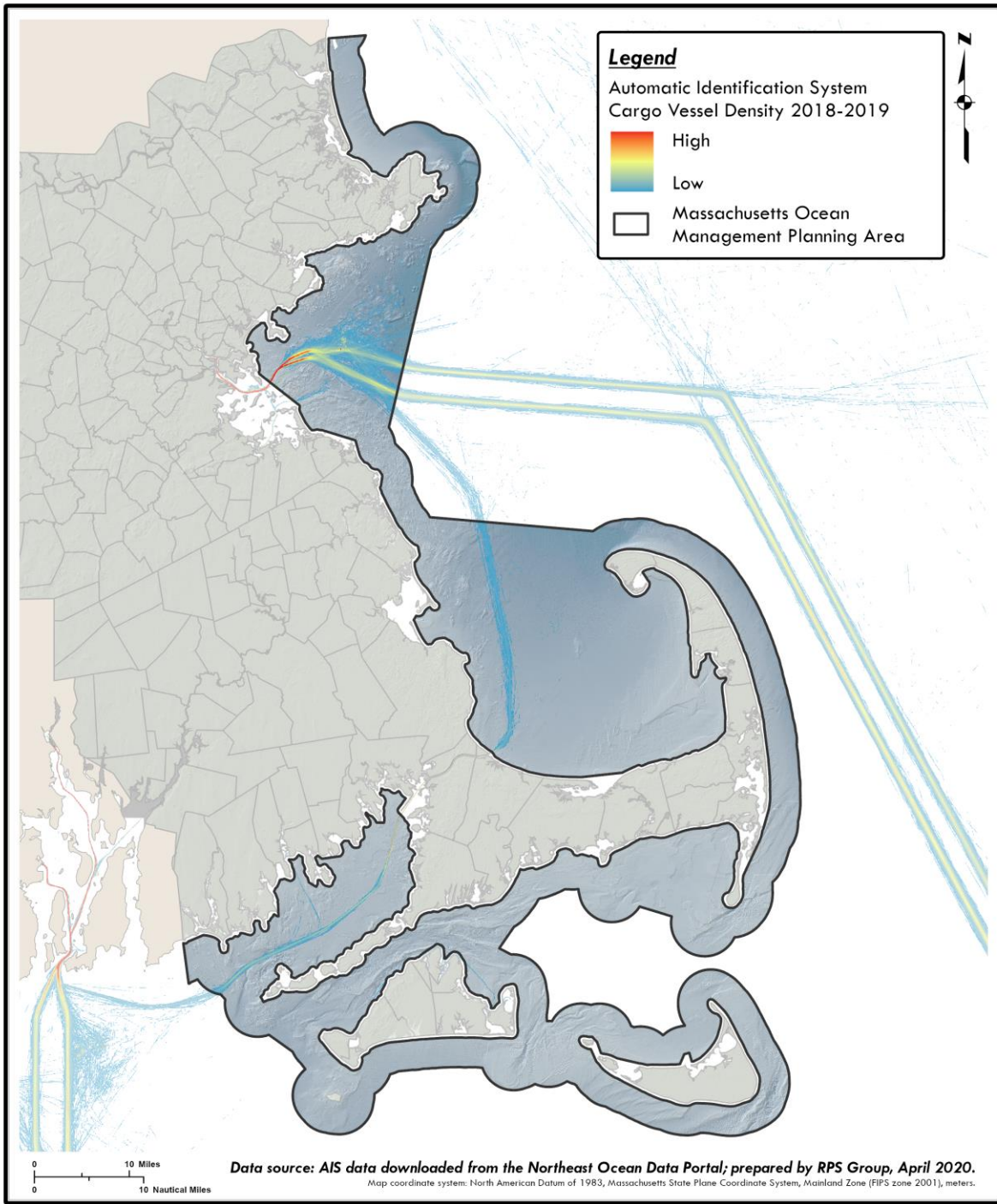
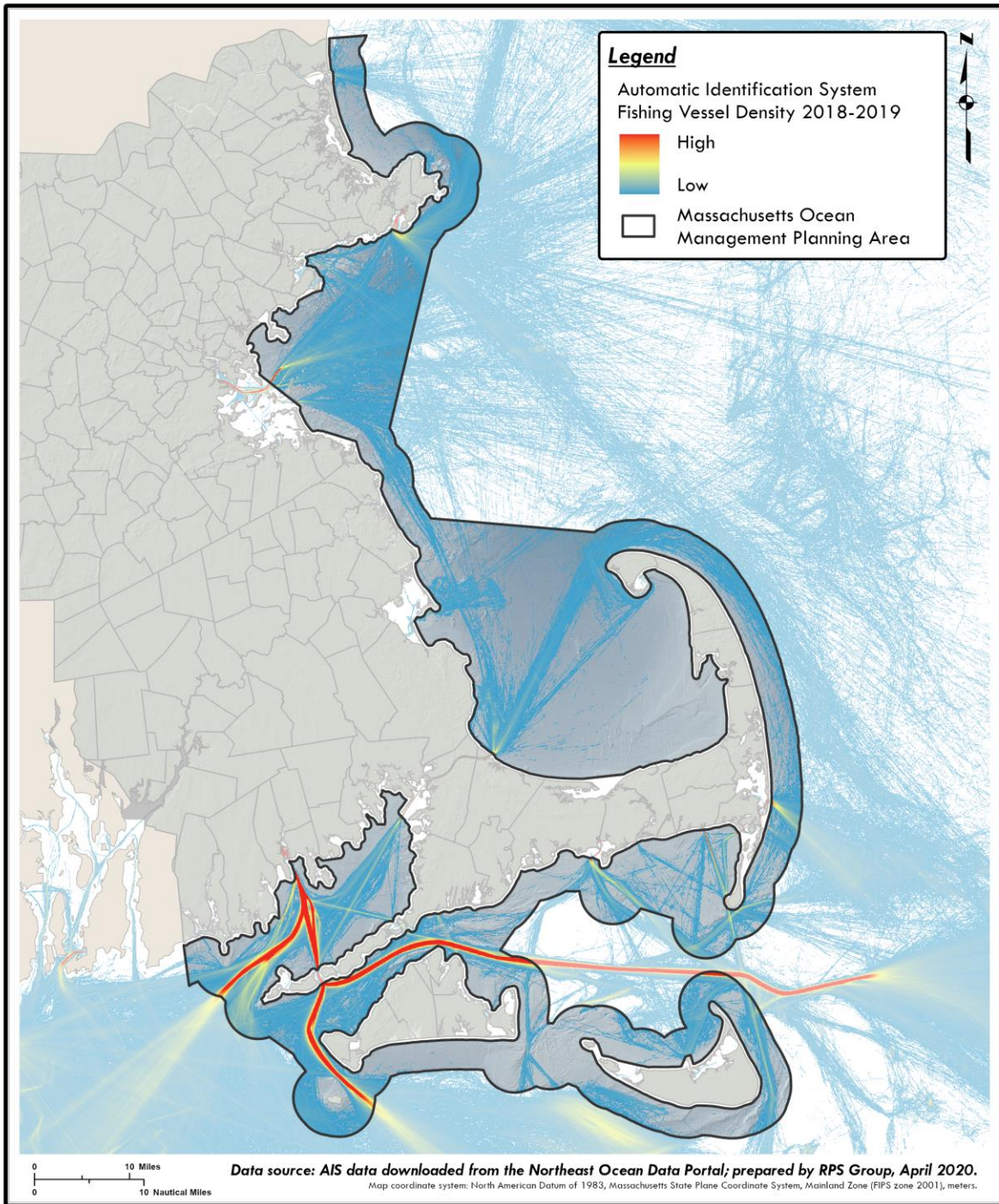


Figure 5. Fishing Automatic Identification System Vessel Density for 2015-2016



	<p>Massachusetts Office of Coastal Zone Management Executive Office of Energy &amp; Environmental Affairs</p> <p>2/2/2021</p>	<p><b>FISHING VESSEL COUNTS IN AND ADJACENT TO THE PLANNING AREA</b></p> <p>DRAFT</p>
--	---	---

Figure 6. Passenger Automatic Identification System Vessel Density for 2018-2019

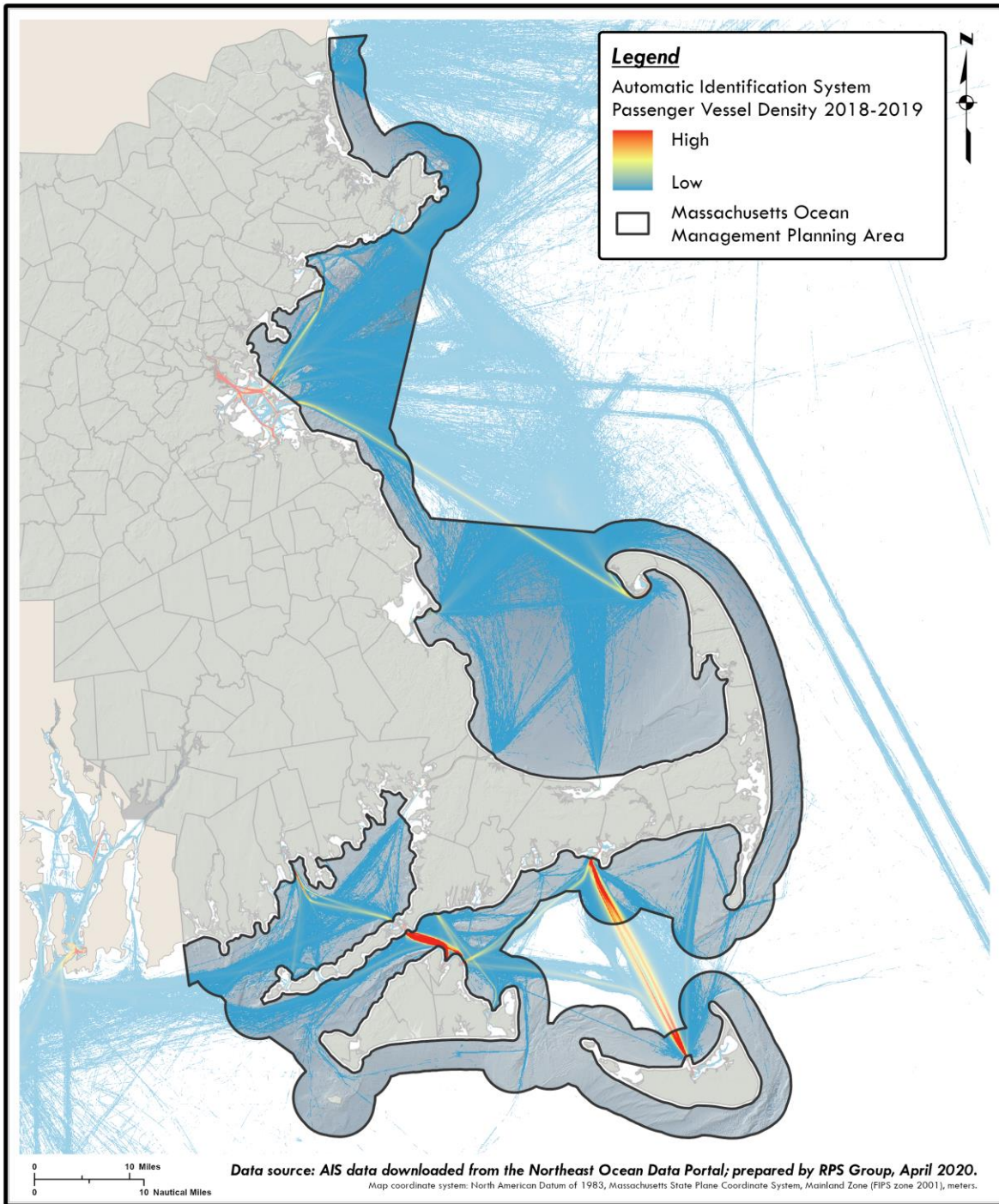
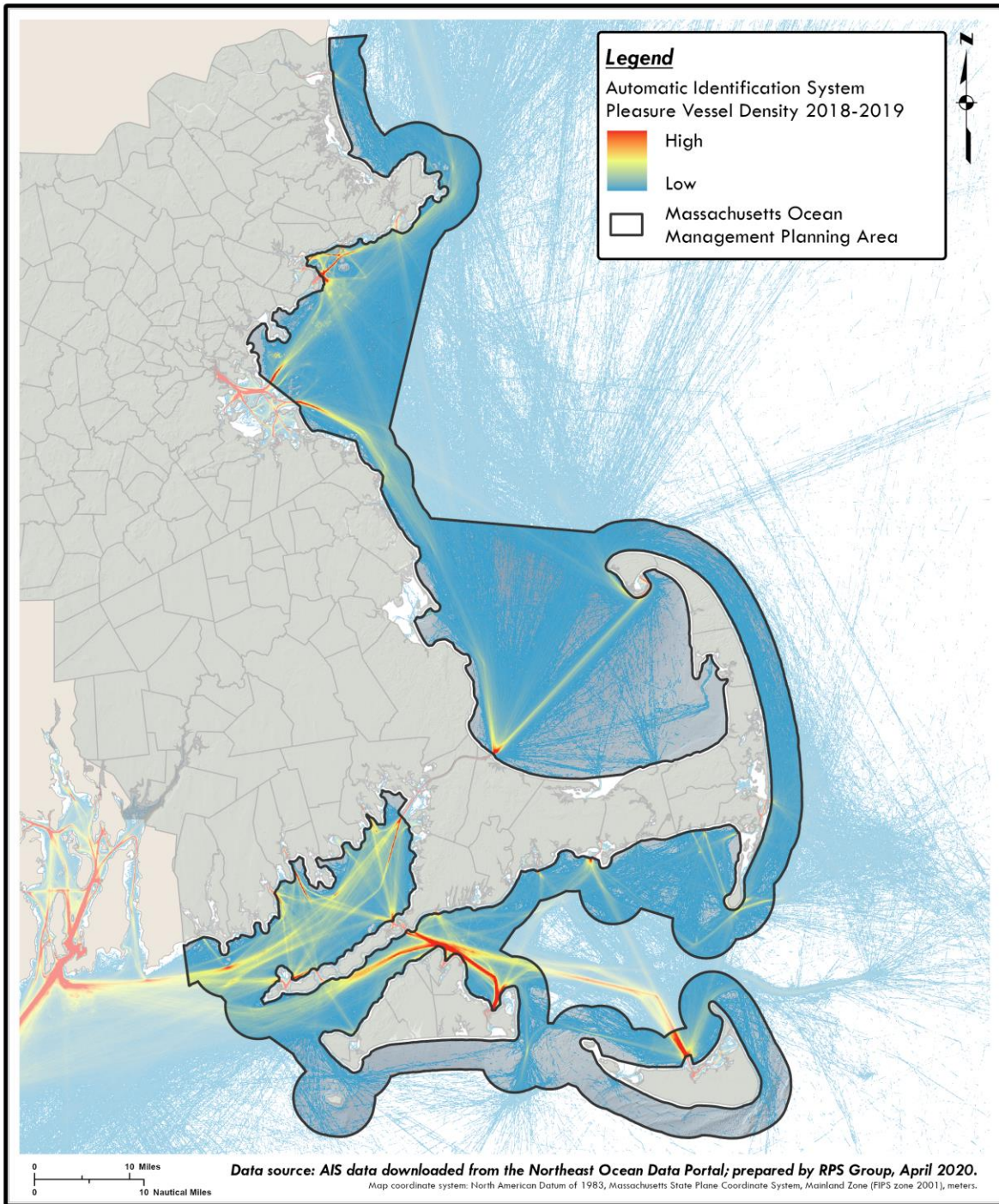


Figure 7. Pleasure Automatic Identification System Vessel Density for 2018-2019



	Massachusetts Office of Coastal Zone Management Executive Office of Energy & Environmental Affairs 2/2/2021	<b>PLEASURE VESSEL COUNTS IN AND ADJACENT TO THE PLANNING AREA</b> DRAFT
---	---	---

**Figure 8. Tanker Automatic Identification System Vessel Density for 2018-2019**

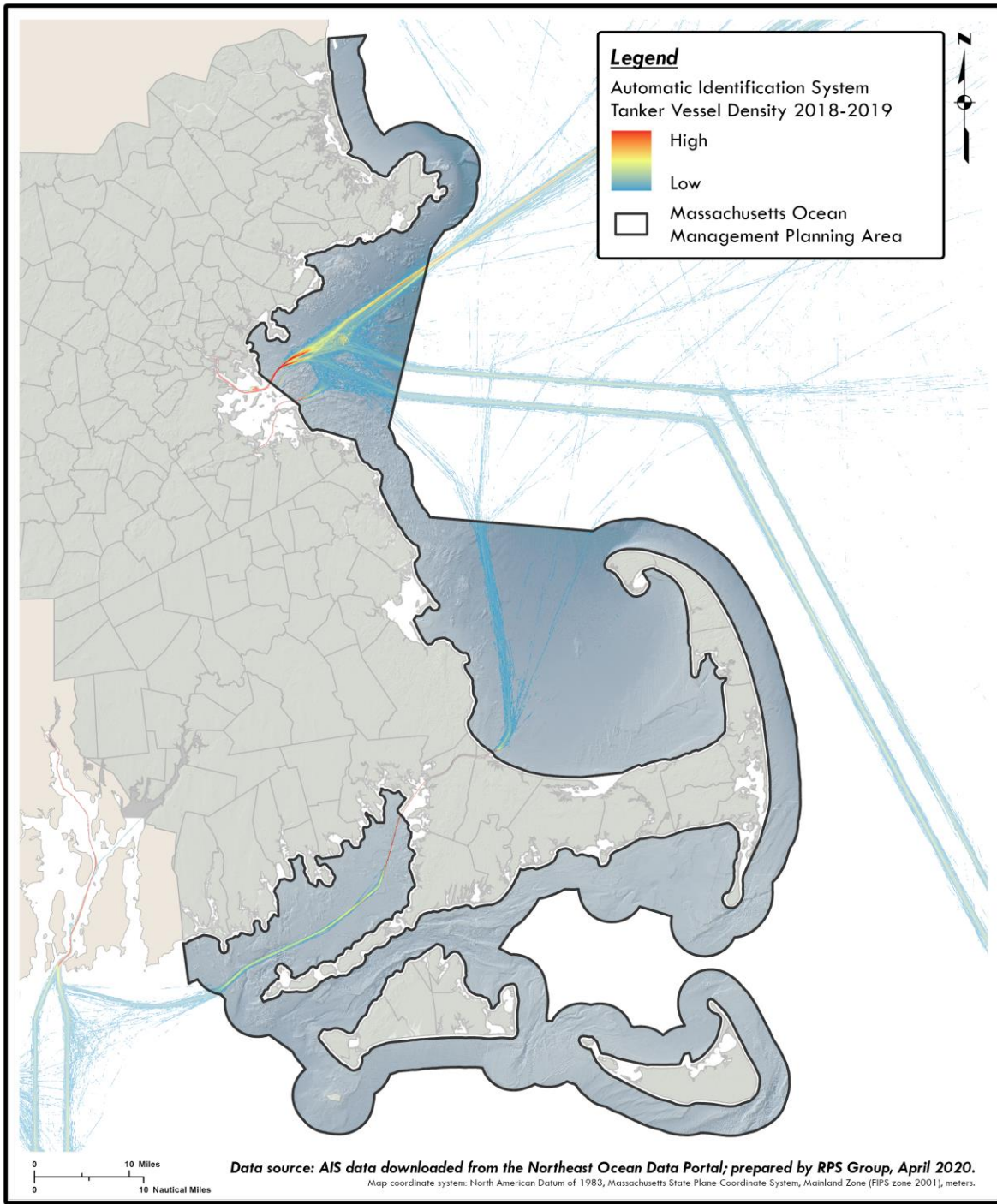
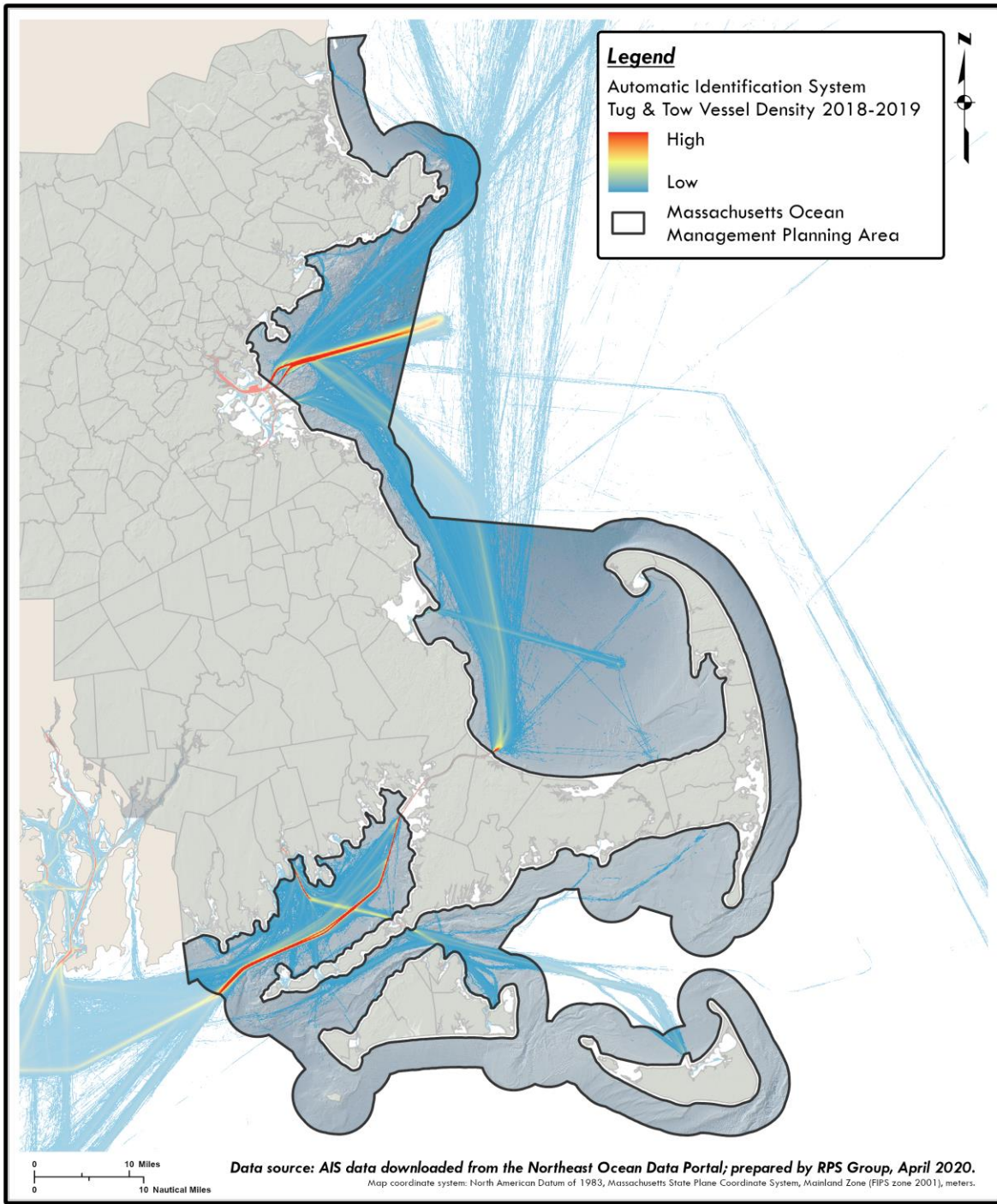
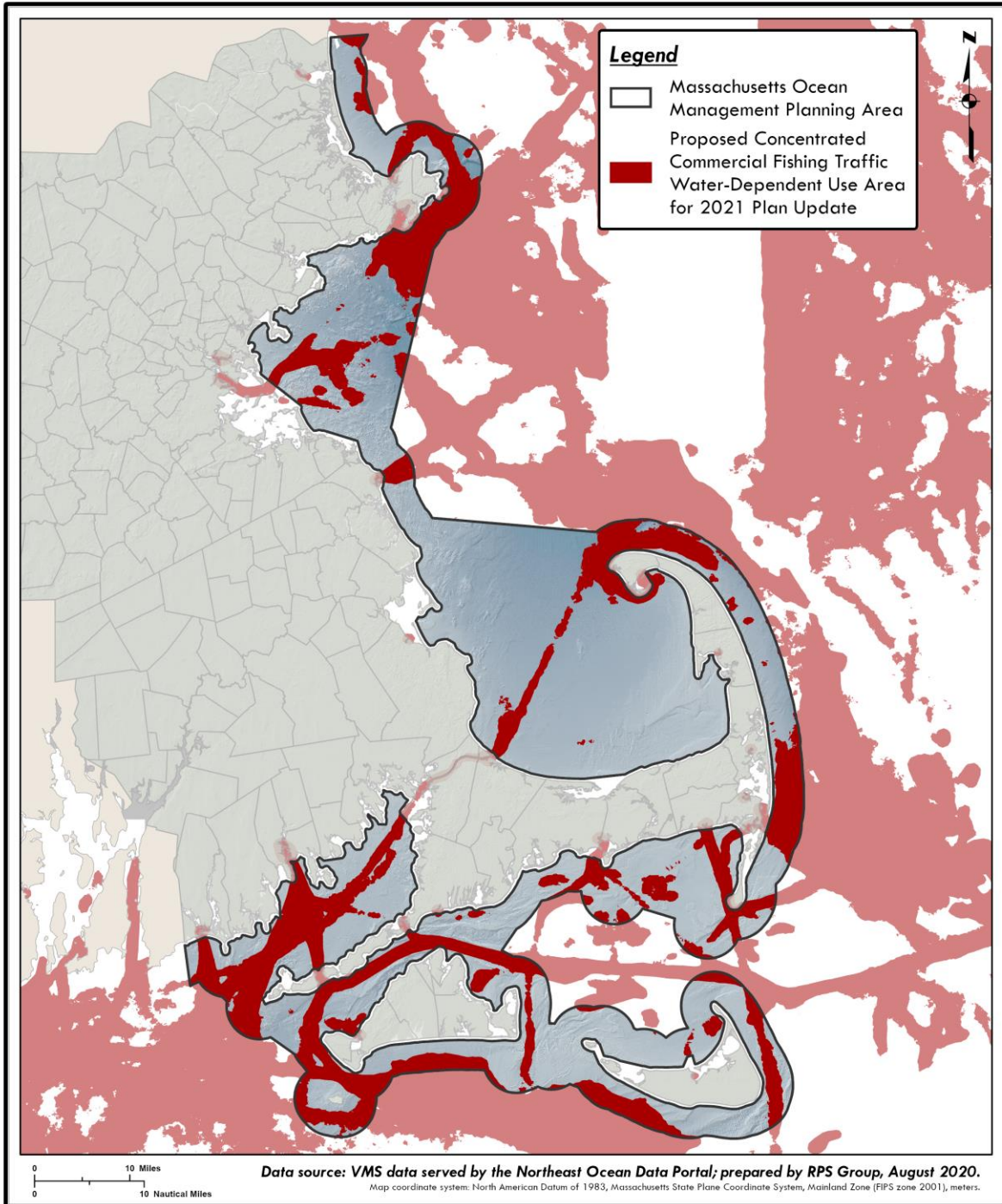


Figure 9. Tug and Tow Automatic Identification System Vessel Density for 2018-2019



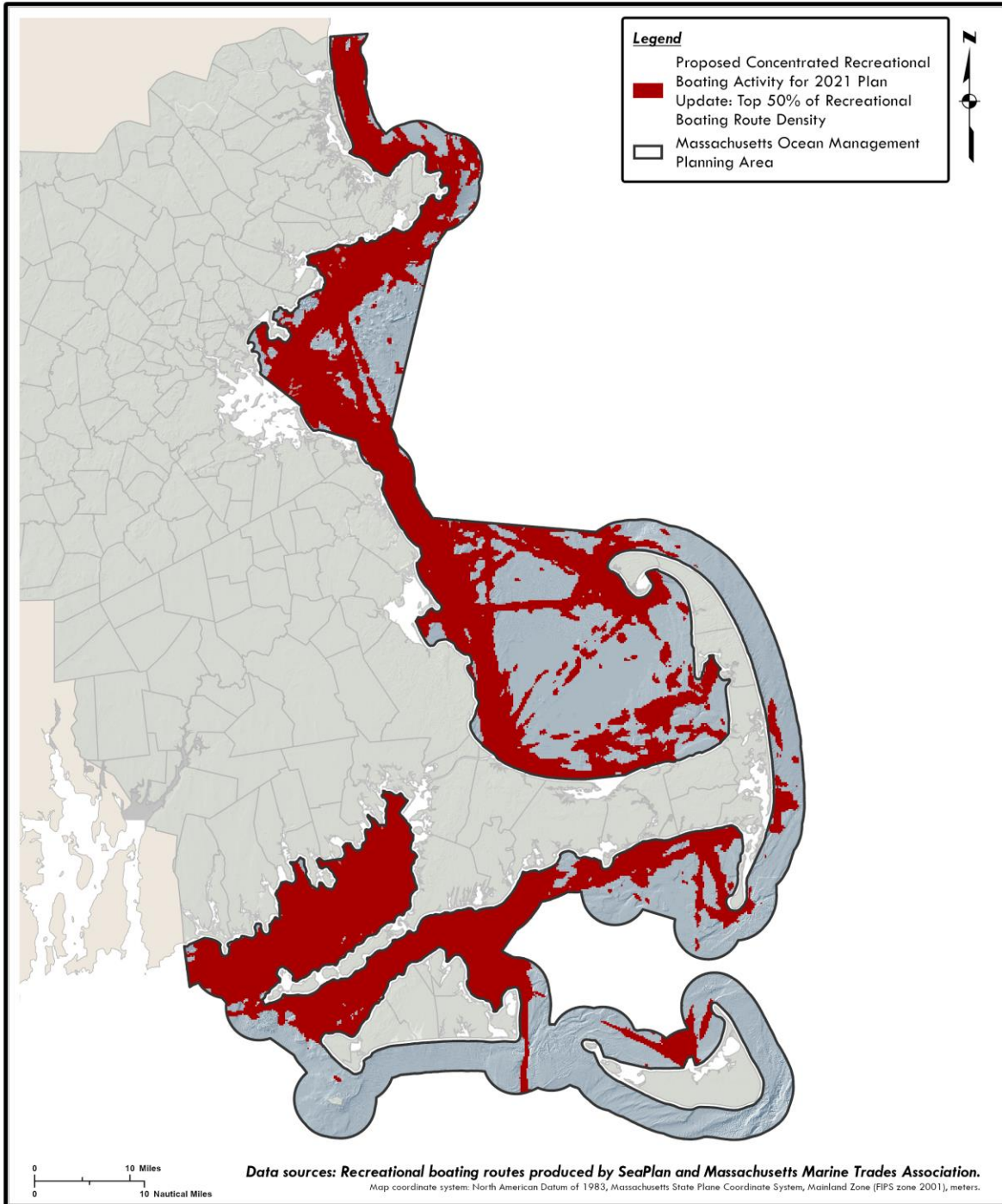


**Figure 10. Proposed Concentrated Commercial Fishing Traffic Water-Dependent Use Areas for 2021 Plan Update**



	<p>Massachusetts Office of Coastal Zone Management Executive Office of Energy &amp; Environmental Affairs</p>	<p><b>PROPOSED CONCENTRATED COMMERCIAL FISHING TRAFFIC</b></p>
	<p>2/2/2021</p>	<p>DRAFT</p>

**Figure 11. Proposed Concentrated Recreational Boating Activity Water-Dependent Use Areas for 2021 Plan Update**



	<p>Massachusetts Office of Coastal Zone Management Executive Office of Energy &amp; Environmental Affairs</p>	<p><b>PROPOSED CONCENTRATED RECREATIONAL BOATING ACTIVITY FOR 2021 PLAN UPDATE</b></p>
<p>2/2/2021</p>	<p>DRAFT</p>	

**SECTION FIVE: TABLES**

**Table 1. Mapping Transportation & Navigation Uses: Comparison of 2015 Ocean Plan to Proposed 2021 Ocean Plan.**

	<b>2015 Ocean Plan</b>	<b>Proposal for 2021 Ocean Plan</b>
<b>Data Source</b>	<p><i>Anchorage Areas:</i> Downloaded from NOAA ENC Direct to GIS on June 17, 2013.</p> <p><i>Anchorage Berths:</i> Downloaded from NOAA ENC Direct to GIS on June 17, 2013.</p> <p><i>Ferry Routes:</i> Created by MassDOT; latest update prior to 2015 Plan was January 2012.</p> <p><i>Pilot Boarding Areas:</i> Created by Applied Science Associated and downloaded from the Northeast Ocean Data Portal. Four of the six pilot boarding areas in Massachusetts state waters were mapped using information from U.S. Coast Pilot. The two remaining pilot boarding areas were derived from CZM’s pilot boarding areas dataset. The data were last updated January 18, 2013.</p> <p><i>Precautionary Areas:</i> Downloaded from NOAA ENC Direct to GIS on June 17, 2013.</p> <p><i>Separation Zones:</i> Downloaded from NOAA ENC Direct to GIS on June 17, 2013.</p> <p><i>Traffic Lanes and Recommended Routes:</i> Downloaded from NOAA ENC Direct to GIS on June 17, 2013.</p>	<p><i>Anchorage Areas:</i> Downloaded from NOAA ENC Direct to GIS on May 20, 2020.</p> <p><i>Anchorage Berths:</i> Downloaded from NOAA ENC Direct to GIS on May 20, 2020.</p> <p><i>Ferry Routes:</i> Created by MassDOT. The data were last updated in Sept. 1, 2020.</p> <p><i>Pilot Boarding Areas:</i> Created by Applied Science Associated and downloaded from the Northeast Ocean Data Portal. Four of the six pilot boarding areas in Massachusetts state waters were mapped using information from U.S. Coast Pilot. The two remaining pilot boarding areas were derived from CZM’s pilot boarding areas dataset. The data were last updated Dec. 12, 2012.</p> <p><i>Precautionary Areas:</i> Downloaded from NOAA ENC Direct to GIS on May 20, 2020.</p> <p><i>Separation Zones:</i> Downloaded from NOAA ENC Direct to GIS on May 20, 2020.</p> <p><i>Traffic Lanes and Recommended Routes:</i> Downloaded from NOAA ENC Direct to GIS on May 20, 2020.</p>
<b>Data Description</b>	These layers show the extent of various transportation uses in the planning area. These data were mapped and used in the Baseline Assessment (Volume II of the 2015 Ocean Plan).	These layers show the extent of various transportation uses in the planning area. These data will be used in the Baseline Assessment Five-Year Review.
<b>Data Extent</b>	In and adjacent to Massachusetts state waters	In and adjacent to Massachusetts state waters

<b>Data Adjustment and Pre-processing</b>	<p><i>Anchorage Areas:</i> Based on feedback from the work group in 2009, four of the anchorage areas (C, D, L, and M) were extracted and mapped.</p> <p><i>Anchorage Berths:</i> None.</p> <p><i>Ferry Routes:</i> None.</p> <p><i>Pilot Boarding Areas:</i> Based on recommendations from the work group, the Boston Harbor pilot boarding area was buffered by a one-nautical-mile radius and the remaining five pilot boarding areas were buffered by 0.5-nautical-mile radius to convert the data from points to polygons.</p> <p><i>Precautionary Areas:</i> None.</p> <p><i>Separation Zones:</i> None.</p> <p><i>Traffic Lanes and Recommended Routes:</i> None.</p>	<p><i>Anchorage Areas:</i> Based on feedback from the work group, all anchorage areas were extracted and mapped.</p> <p><i>Anchorage Berths:</i> None.</p> <p><i>Ferry Routes:</i> None.</p> <p><i>Pilot Boarding Areas:</i> Based upon feedback from the work group, pilot boarding areas approaching Provincetown and Nantucket Sound were included. Based on recommendations from the work group, the Boston Harbor pilot boarding area was buffered by a one-nautical-mile radius and the remaining five pilot boarding areas were buffered by 0.5-nautical-mile radius to convert the data from points to polygons.</p> <p><i>Precautionary Areas:</i> None.</p> <p><i>Separation Zones:</i> None.</p> <p><i>Traffic Lanes and Recommended Routes:</i> None.</p>
<b>Data Analysis</b>	None.	None.
<b>Data Classification</b>	Not applicable. The data were not classified	Not applicable. The data were not classified.
<b>Selection of Water-Dependent Use Area</b>	Not applicable. These data are not mapped as water-dependent use areas.	Not applicable. These data are not mapped as water-dependent use areas.

**Table 2. Concentrated Commerce Traffic Mapping of Automatic Identification System (AIS) Data: Comparison of 2015 Ocean Plan to Proposed 2021 Ocean Plan.**

	<b>2015 Ocean Plan</b>	<b>Proposal for 2021 Ocean Plan</b>
<b>Data Source</b>	Vessel tracklines were produced by National Oceanic and Atmospheric (NOAA) Coastal Services Center (CSC). The tracklines were created using raw AIS data from 2011 and 2012.	Vessel tracklines were produced by National Oceanic and Atmospheric (NOAA) Coastal Services Center (CSC). The tracklines were created using raw AIS data from 2018 and 2019.
<b>Data Description</b>	Trackline density (km/km <sup>2</sup> ) of vessels over 300 tons recorded in 2011-2012 within a 177-meter radius of a 250x250-meter grid cell.	Automatic Identification Systems (AIS) are a navigation safety device that transmits and monitors the location and characteristics of many vessels in U.S. and international waters. Vessel records are reported as a series of points during transit or dwell-times when within range of a receiving station. Individual vessel positions have been processed into tracks and then summarized at a 100-by-100-meter (10,000 m <sup>2</sup> ) cell resolution to characterize intensity of use. Note that vessel density does not discriminate between vessels so it's possible that a single vessel is counted more than once in the density calculation.
<b>Data Extent</b>	North Atlantic from Virginia to Maine.	North Atlantic from Virginia to Maine.
<b>Data Adjustment and Pre-processing</b>	None.	None.
<b>Data Analysis</b>	The 2015 Transportation & Navigation Work Group recommended analyzing two or more years of data, so AIS tracklines from 2011 and 2012 were analyzed by the Massachusetts Office of Coastal Zone Management (CZM). The line density of the 2011 and 2012 tracklines that fall within a 177-meter radius of each 250x250-meter grid cell in the North Atlantic was calculated. The 250x250-meter cell size was selected to be consistent with the grid used in the 2009 Plan. The radius was selected by calculating the radius of the smallest circle that would completely contain a grid cell, i.e., the 177-meter radius was chosen to match the length of half the diagonal of a grid cell (rounded to the nearest meter).	The 2021 Transportation & Navigation Work Group recommended analyzing two or more years of data, so AIS tracklines from 2018 and 2019 were summed by the Massachusetts Office of Coastal Zone Management (CZM).
<b>Data Classification</b>	CZM followed the example of the 2009 Plan and used an equivalent class break of 50 vessels per year per grid cell (i.e., 100 vessels per cell because two years of data were used). Since these data represent vessel density based upon the length of	CZM used a 2.5 standard deviation color ramp with Gamma set to 1; the color ramp ranges red (high vessel density) to blue (low density) with Dynamic Range, a contrast stretch that is only stretches the pixel values within the display extent.

	<p>tracklines, not counts of vessels, an equivalent to the 100 vessels class break was calculated using length. As a conservative estimate, 354 meters, which is the length of the diameter of the circle used to calculate the line density, was used as an approximation of one vessel. Therefore, 50 vessels per year per grid cell is approximately equal to 360 km/km<sup>2</sup> of trackline density for two years of data using the following equation:</p> $\frac{50 \text{ vessels} \times 0.354 \text{ km [1 vessel's trackline length]} \times 2 \text{ years}}{\pi \times 0.177^2 \text{ km [area of circle]}}$ <p>Thus, the data were divided into two classes: 1) ≤360 km/km<sup>2</sup> of vessel density in a 177-meter radius of a 250x250-meter grid cell and 2) &gt;360 km/km<sup>2</sup> of vessel density in a 177-meter radius of a 250x250-meter grid cell.</p>	
<p><b>Selection of Water-Dependent Use Area</b></p>	<p>Areas where &gt;360 km/km<sup>2</sup> of trackline density were recorded in 2011-2012 in a 177-meter radius of a 250x250-meter grid cell.</p>	<p>No threshold was used for the 2021 Plan.</p>

**Table 3. Concentrated Commercial Fishing Traffic Mapping of Vessel Monitoring System (VMS) Data: Comparison of 2015 Ocean Plan to Proposed 2021 Ocean Plan.**

	<b>2015 Ocean Plan</b>	<b>Proposal for 2021 Ocean Plan</b>
<b>Data Source</b>	The commercial fishing vessel density data were prepared by ASA for the Northeast Regional Ocean Council using VMS data from 2006-2010.	The commercial fishing vessel density data were prepared by RPS/ASA for the Northeast Regional Ocean Council using VMS data from 2015-2016.
<b>Data Description</b>	Standardized commercial fishing vessel density for 2006-2010 within a three-kilometer radius of a 250x250-meter grid cell.	VMS data broadly characterize the density of commercial fishing vessel activity for the various fisheries in the northeastern U.S. based on Vessel Monitoring Systems (VMS) from fishing vessels from 2015 to 2016. 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. Raw VMS data from NMFS were processed into geospatial point products and analyzed to create density grids for select fisheries.
<b>Data Extent</b>	North Atlantic from Connecticut to Maine.	North Atlantic from Connecticut to Maine.
<b>Data Adjustment and Pre-processing</b>	ASA removed points that represented individual and identifiable vessel positions to preserve privacy.	The point data were filtered by RPS/ASA to remove vessel positions which did not meet the "Rule of Three" criteria required by NMFS due to data confidentiality. The data were also split by RPS/ASA by speed over water in which vessels above a set speed (between 4 and 5 knots depending on fishery type) were considered to be transiting to or between fishing sites while vessels moving below a set speed were considered to be actively fishing. Since the Transportation and Navigation Workgroup Report is not focused on fishing, CZM used data related to transit only.
<b>Data Analysis</b>	ASA analyzed the VMS data to create a standardized raster grid of the commercial fishing vessel density. First, the point density of the VMS data from 2006-2010 within a three-kilometer radius of each 250x250-meter grid cell in the North Atlantic was calculated. Next, all zero values were set to null. Finally, the log-transformed z-score of each grid cell was calculated to standardize the values. In the final dataset, values of 0 indicate average fishing vessel density, while values between -1 and 1 indicate density within one standard deviation of the mean.	RPS/ASA analyzed the VMS data to create a standardized raster grid of the commercial fishing vessel density. Density was plotted onto a raster grid with a resolution of 100 meters. Values were generated for each 100-meter grid cell based on a search radius of 1,000 meters. A grid cell within 1000 meters of a VMS point would be assigned a density value. Cells within 1,000 meters of multiple VMS points would be assigned higher density values.  In order to preserve data confidentiality using the Rule of Three, a screening grid of 1,400 by 1,400 meters was used to remove VMS points from the analysis if fewer than three points occurred within a

		<p>screening grid cell. A 1,400-meter square is the largest square that fits entirely within a 1,000-meter radius (2,000-meter diameter) circle.</p> <p>Data were processed as follows:</p> <ol style="list-style-type: none"> <li>1. Raw data from NMFS were imported into ArcGIS.</li> <li>2. Create a 1,400-meter polygon grid for the Atlantic Coast within the Exclusive Economic Zone.</li> <li>3. Join VMS point feature classes with the 1,400-meter grid and identify grid cells with three or more VMS points</li> <li>4. Run POINT DENSITY to create a density surface using the selected and exported VMS points (Cell Size = 100, Neighborhood = Circle, Radius = 1,000, Area units = Square Kilometers)</li> <li>5. Standardize output density grids using a log transformation technique: ZONAL STATISTICS to determine the standard deviation (stdev) and mean (mean) of the transformed product (ln) that using RASTER CALCULATOR expression to produce standardized products <math>(\ln - \text{mean})/\text{stdev}</math></li> </ol>
<b>Data Classification</b>	<p>Because these data represent standardized vessel density, the 25 vessels class break used in the 2009 Plan cannot be used. In the 2009 Plan, the areas with &gt;25 fishing vessels covered 7% of the planning area. As an approximation of this, CZM classified the standardized vessel density data in the planning area into deciles so that the top 10% of can be extracted as the concentrated water-dependent use areas.</p>	<p>The final products show the standardized density of locations for vessels that use VMS for each fishery for three aggregate time periods. Data were log transformed and standardized as described previously. Data were then classified by standard deviation into five classes: Low (&lt;-1), Medium-Low (-1 - 0), Medium-High (0 - 1), High (1 - 2), and Very High (&gt;2).</p> <p>To produce a grid that represented all VMS fisheries, CZM dissolved the following layers: Multispecies (2015 – 2016), Herring (2015-2016), Monkfish (2015 – 2016), Pelagics (Herring/Squid/Mackerel) (2015 – 2016), Scallops (2015 – 2016), Squid (2015 – 2016), and Surfclam/Ocean Quahog (2015 – 2016).</p>
<b>Selection of Water-Dependent Use Area</b>	<p>Top 10% of standardized commercial fishing vessel density.</p>	<p>The top two classes selected for the water dependent use area are High (1 -2) and Very High (&gt;2).</p>



**APPENDIX A: FISHERIES NOT COVERED BY THE VESSEL MONITORING SYSTEM IN MASSACHUSETTS<sup>1</sup>**

Fisheries that occur in Massachusetts waters	VMS data in state waters?
Sea herring	Federal vessels only
Ocean quahog, surfclam	Federal vessels only
Scallops (dredge and diving)	Federal vessels only
Monkfish	Federal vessels only
Northeast multispecies/coastal access permit (large mesh groundfish; includes trawls, gillnets, hook and line)	Federal vessels only
Highly migratory species (tuna, sharks, swordfish; hook and line and purse seines)	Federal vessels only
Small mesh multispecies	Federal vessels only
Fish weir	Locations are known
Aquaculture	Locations are known
American eel	No VMS (river codes reported)
Pots (conch, lobster, black sea bass)	No VMS
Atlantic mackerel, squid, butterfish	No VMS
Summer flounder, scup, black sea bass	No VMS
Northern shrimp	No VMS*
White perch	No VMS
Smelt	No VMS
Bay scallop	No VMS
Other shellfish (razor clams, oysters, seaworms)	No VMS
Atlantic bluefish	No VMS
Horseshoe crab	No VMS
Inshore net	No VMS
Striped bass	No VMS
Surface gillnet	No VMS
Green crabs	No VMS
Sea urchin (dredge and diving)	No VMS
Menhaden	No VMS
Sand eels	No VMS
Skate	No VMS*
Cusk	No VMS*
Spiny dogfish	No VMS*
Tautog	No VMS
Recreational fishing	No VMS

\* A vessel that has a federal permit in a fishery that requires VMS (e.g., Monkfish, northeast multispecies, scallop) can also have state endorsements for other fisheries. In such a case, the vessel reports to the VMS system even when it is fishing under the state endorsement. However, it would be difficult or impossible to discern from the VMS data which fishery the individual was participating in other than what was declared on the VMS as required for the federal permit (the declaration codes can only accommodate the fisheries required to report under VMS). Federally permitted vessels fishing in state waters must comply with their federal permit and/or more restrictive state regulations. The fisheries that this is most problematic for (cusk, skate, dogfish, and shrimp) are indicated with an asterisk. There is also a directed spiny dogfish fishery in state waters in October and November that federal groundfish boats do not participate in. Since fishermen also report Vessel Trip Report (VTRs) with their catches, theoretically VMS tracks could be linked up to catch information. Since the VTR contains landings from an entire trip, when that trip spans multiple areas, including state and federal waters, it would be impossible to pinpoint where in the VMS track the landings occurred.

*Tilefish excluded since fishery occurs outside of state waters; salmon, river herring, shad excluded since they are not commercial fisheries at this time.*

<sup>1</sup> This table is from the draft 2021 Massachusetts Ocean Plan Fisheries Work Group Report.