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Seasonal Management Areas to Reduce Ship Strikes of Northern Right Whales in the Gulf of Maine

by

Richard L. Merrick

December 2005

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ABSTRACT

Northeast Fisheries Science Center staff evaluated the spatial and temporal distribution of northern right whales (*Eubalena glacialis*) within the Gulf of Maine to develop potential management areas to reduce ship strikes of these whales. The following management areas coupled with routing and speed restrictions should decrease the risk of right whale ship strikes in the Gulf of Maine:

1. A Cape Cod Bay Seasonal Management Area (SMA) to be coterminous with the existing Cape Cod Bay critical habitat (January 1- May 15).
2. A Gulf of Maine SMA extending eastward from Massachusetts Bay (70.50° W) to the Hague Line, and southward from 42.50° N to the Cape Cod Bay SMA and the southern edge of the Great South Channel critical habitat area. Time period for this SMA would be March 1 - July 31. If further temporal structuring of the SMA is desired then it could be split as follows:
    a. A Western Seasonal Management Area extending from Massachusetts Bay (70.50° W) eastward to 69.40° W, and from 42.50° N southward to the Cape Cod Bay SMA and Great South Channel critical habitat areas (March 1 - April 30)
    b. An Eastern Seasonal Management Area extending from 69.75° W eastward to the Hague line, and from 42.50° N southward to the southern edge of the Great South Channel critical habitat area (April 1 - July 31)
3. A modified Boston Traffic Separation Scheme (TSS) which includes moving the existing East-West leg of the lanes further north, and adding a new North-South TSS as a spur from the existing TSS. Realignment of the existing Boston TSS has the potential to reduce interactions between ships and large whales along the northern portion of the TSS by 50% or more by directing shipping traffic away from seasonal large whale concentrations within the existing TSS.

INTRODUCTION

NOAA Fisheries has used seasonal and spatial gear restrictions to reduce interactions between northern right whales (*Eubalaena glacialis*) and commercial fixed gear fisheries as part of the Atlantic Large Whale Take Reduction Plan (ALWTRP; http://www.nero.noaa.gov/whaletrp/). The most recent application of these restrictions was the Seasonal Area Management (SAM) and Dynamic Area Management (DAM) zones implemented in March 2002. Design of these zones was based in part on analyses conducted by the Northeast Fisheries Science Center (Clapham and Pace 2001, Merrick et al. 2001). Based on these analyses, Management Areas (MAs) were established to regulate fishery gear deployed in the Northwest Atlantic Ocean in areas occupied seasonally by right whales (Figure 1).

Since implementation of the MAs to reduce fishing gear interactions with right whales, a strategy has also been developed to reduce ship strikes of right whales in the same waters. In theory, MAs to reduce gear and ship strike interactions could be similar in time and space. Nonetheless, it would be prudent to review the design of the existing MAs before extending their application under the ship strike strategy. It may be necessary to modify the original fishing gear based MAs to meet the needs of ship strike reduction.

The goal of this paper is to evaluate Seasonal Management Areas for reducing ship strikes of right whales. The original MAs are updated with additional data, and then modified to accommodate shipping characteristics. An initial analysis is also provided of an alternative alignment of the Boston, MA Traffic Separation Scheme that allows shipping to continue but provides increased protection to right whales.

METHODS

Datasets

Right whale sightings data were obtained from the North Atlantic Right Whale database (NARW) curated at the University of Rhode Island (URI), which includes survey data from a variety of sources back to the 1960s. This dataset comprises all right whale sighting information from reliable sources collected on the East Coast of the US since at least the 1960s, and includes observations from fine- and broad-scale aerial and vessel surveys conducted in a variety of projects. Major sources of data for New England waters include the Cetacean and Turtle Assessment Program (1978-1982), the South Channel Ocean Productivity Experiment (1988-1989), and recent NOAA surveys (1999-2003). The NARW dataset is continually updated. The NARW dataset used in this analysis was distributed in December 2004, and includes sighting records through fall 2003. Areas surveyed (including track lines) can be found at http://www.marinegis.org/series1/index.html.

Right whale sighting records from ~1960 through 2003 collected within Northeast waters between latitude 40° and 45° N, and eastward of 71° N to the Hague Line were analyzed.

Analysis of the Boston Traffic Separation Scheme also included humpback (*Megaptera novaeangliae*) and fin whale (*Balaenoptera physalus*) sightings.

Recent NOAA Fisheries Service data

The only recent unbiased, broad-scale survey observations included in the NARW database are those from NOAA aerial surveys. Directed surveys for North Atlantic right whales were flown during March-November, 1999-2003 in the area from south of Nantucket, MA northward to the Bay of Fundy, and from the New England coast eastward to the Hague Line. Surveys were accomplished using two high-wing, twin-engine fixed wing aircraft. One was a NOAA DeHaviland Twin Otter, and the other was a chartered amphibious Grumman Widgeon (1999-2001) or Goose (2002-2003). Surveys were flown at ca. 230 m (1999-2000) or 310 m (2001-2003) altitude, and 100 kts (185 km/hr) by at least one aircraft on virtually all days when sighting conditions were Beaufort 3 or better. Flights typically were not conducted when visibility was obscured (snow, rain, or fog).

During 1999-2000, flights were either flown along tracklines developed for SCOPEX in the Great South Channel area, or directed towards areas of reported or suspected right whale concentrations. During 2001-2003, one aircraft flew a monthly series of east-west track lines over the entire study area, while the second aircraft focused on the Great South Channel and other offshore areas.

Analysis

Defining Seasonal Management Areas

The MAs developed in Merrick et al (2001) provided the baseline for the ship strike MAs, and the additional analyses focused on refining the temporal and spatial extent of the East and West Seasonal MAs (Figure 1) previously developed for the ALWTRP (Merrick et al. 2001). The Cape Cod Bay MA was not analyzed further, but was assumed to be coterminous with the existing Cape Cod Bay critical habitat management area defined as part of the northern right whale recovery plan and the ALWTRP.

Additional analyses[1] of right whale sightings prompted a potential spatial adjustment of the western Seasonal MA (Figure 2) to better reflect recent data on right whale seasonal distribution. This report provides a further update using the full 2003 dataset.

Analysis of DAM actions during 1999-2003: The predictability of right whale concentrations distinguish Dynamic from Seasonal MAs. Dynamic MAs were developed to address unpredictable concentrations (which could be because of a lack of knowledge or because the whales truly do represent an unusual aggregation), while seasonal MAs were designed to cover areas of known right whale concentrations. The Cape Cod Bay and Great South Channel

[1] Memo from Richard Merrick to Mary Colligan dated 31 October 2003. Avail. Protected Species Branch, NEFSC, 166 Water Street, Woods Hole, MA 02543

Management Areas are examples of Seasonal MAs, because they were drawn based on historical sightings of right whales in these areas.

Dynamic MAs may be candidates for Seasonal MAs if whales are observed in the same area during the same season during three or more years; the area would then be considered to have predictable concentrations of whales. If, however, whales were observed in 1-2 years or in different months in different years, then the area would not be considered as a candidate Seasonal MA. For analysis, this means that Dynamic MAs needed to be created for each sighting of 2+ whales during each analysis year, and boundaries drawn around applicable zones for the aggregate of years. In summary, the process was to:

1. Identify right whale sightings which met the trigger criteria (a sighting with 2+ whales)
2. Define 15 nm radius buffer around the core area
3. Join, as necessary, the circular buffer zones

Dynamic event were triggered whenever there was a sighting of 2+ right whales sufficiently close to each other to achieve a density of 0.04 right whales/nm^2 (Clapham and Pace 2001). Revised Seasonal MAs were then drawn to encapsulate all Dynamic areas exhibiting such whale concentrations during the same season for three or more years.

Analyses focused on sightings during March-July, because this is the time period when whales move out of Cape Cod Bay into offshore areas.

Gridded Analysis: Ideally, right whale sightings in an area would be corrected for sightings effort to evaluate spatial and temporal distributions. However, this is difficult given the varying levels and quality of the sightings survey efforts; at best, adjusting for effort would entail a long and complex process that would eliminate from consideration any sightings without associated effort data. GIS analyses by New England Aquarium staff (http://www.marinegis.org/series1/index.html) using only "good survey effort and sightings data" disclosed only a single sighting of one animal north and west of Cape Cod Bay during the month of May from 1978 through 1999. In contrast, during this same time period the URI right whale database contains a total of 19 sightings (mostly from surveys without associated effort data) representing 25 individual animals.

As an alternative, one can grid the data and then normalize the sightings within each grid cell (dividing by the cell's area). The normalized values ("densities") can then be compared between cells to evaluate the overall distribution of animals. Comparing relatively close cells should compensate, to a limited degree, for the lack of uniform survey effort over the entire Gulf of Maine. This assumes that sighting effort is relatively consistent for the area. For this reason, analyses were restricted to the March-July 1999-2003 period, the time interval when the NEFSC conducted systematic right whale surveys of the Gulf of Maine complementing the systematic surveys of Cape Cod Bay conducted by the Provincetown Center for Coastal Studies.

Using these datasets, ARCView was used to generate a monthly series of "density" plots in the SAM West area:

1. A rectangular grid was generated for the area between 40° and 45° N latitude from the Hague Line westward to the New England coast or 73° W longitude. Cells throughout the area were defined as 0.25 degree longitude and latitude squares.
2. Counts of individual right whales sighted in surveys conducted during 1999-2003 were then summed for the March-July period and by month for each grid cell.
3. Of the total 1,994 cells, 983 had no right whale observations during the 5-year, 5-month period. Four cells had very high right whale densities (e.g., Cape Cod Bay in March-April) that skewed the distribution. The remaining cells were all below 100 animals per cell for the entire period. Cells were grouped binned into six bins based on right whale densities: 0, 1, 2-4, 5-14, 15-99, and >99 sightings per cell for the period.
4. Using these categories, the data were plotted on a gridded, ARCView base map of the Gulf of Maine using shaded values to distinguish between ranges of values.

The resulting monthly plots were then compared to the Seasonal MAs prepared as part of the DAM analysis to provide an alternative assessment of the area.

Traffic Separation Scheme (TSS) Analyses

The existing TSS was designed prior to the availability of much of the data included in the analysis presented in this paper. Nonetheless, the existing TSS was evaluated, and an alternative configuration provided that reduces the potential for large whale ship strikes. This configuration was designed to address two issues: (a) to move the TSS to an area with the lowest densities of whales, and (b) to design a spur or "cutout" from the TSS to allow vessels to exit and enter the TSS from the north.

The analysis involved moving the lanes northward until the number of potential interactions (defined as the number of sightings which fell within the TSS) was minimized. This is only meant as a preliminary evaluation of the routing, as alternative evaluations are currently underway by staff of the Stellwagen Banks National Marine Sanctuary (pers. comm., David Wiley, 12 October 2005), and by the US Coast Guard as part of Port Access Route Study for the Boston area requested by NOAA.

RESULTS

Seasonal Management Areas

Simulated Dynamic MAs

The URI database includes 7,698 right whale sighting events (13,118 animals; Figure 3) recorded during 1960-2003 in Northeast waters. During March-July 1999-2003, there were 2,396 right

whale sighting events in Northeast U.S. waters, with 1,301 events recorded outside of Cape Cod Bay. Of these events, there were 155 sightings of groups of 2+ animals observed outside of Cape Cod Bay (Figure 4).

The DAM zones drawn using the five seasons of data are shown in Figure 5. Most of the zones, (particularly the overlapping zones) occur from Cape Cod Bay eastward across the Great South Channel and on the northern edge of Georges Bank. Temporally isolated (less than 3 years) sightings of 2+ animal groups occurred southwest of the Great South Channel (n = 2), west of the Cape Cod Bay critical habitat area (n = 3), and north of Wilkinson Basin (n = 2). A cluster of repeated sightings occurred in the Cashes Ledge area (n = 11); 9 of these occurred in 2000 and 2 in 2003. Because these sightings do not suggest a pattern of repeated inter-annual use of the area, they do not qualify for considerations as a Seasonal MA.

Consolidating the DAMs to produce single zones which included 3 or more seasons of overlapping buffers resulted in the rectilinear shape shown in Figure 6. This area encompasses 137 (88%) of the Gulf of Maine 2+ animal sightings during March-June 1999-2003. It also includes 1,095 (84%) of the 1,301 Gulf of Maine right whale sighting events outside of Cape Cod Bay for the March-July 1999-2003 period.

The rectilinear Gulf of Maine Seasonal MA includes the existing Great South Channel right whale critical habitat area. This MA expands protection for right whales during March-July in two general areas:

1. North (Stellwagen Bank) and east (Wilkinson Basin) of the Cape Cod Bay critical habitat and,
2. North and east (northern edge of Georges Bank) of the Great South Channel MA.

Sighting data were also analyzed for the months of April through July (Figure 7), the period after most right whales have moved out of Cape Cod Bay but still remain in the Gulf of Maine prior to moving to the Bay of Fundy. The analyses suggest that whales occur throughout the Gulf of Maine Seasonal MA during this time; alternatively, the zone could be split into a West zone during March through April (eastward to 69.40° W) and an East zone during April – July (eastward from 69.75° W).

Gridded Data

The gridded results for the March-July (n = 2,396 sightings; Figure 8) suggest that the Cape Cod Bay and Gulf of Maine Seasonal Management Areas encompass most of the animals sighted. The only obvious discrepancy is to the north in the central Gulf of Maine where right whale sightings occurred in June 2000 and 2003 (Figure 9). Otherwise, the distributional patterns generally follow the known seasonal movements of right whales through the Gulf of Maine. During March, animals are located at relatively high densities only within Cape Cod Bay, though scattered sightings exist outside the Bay. Animals begin moving out of the Bay in April, with densities still high there, but also moderately high to the north of the Bay, and in isolated areas of the Great South Channel. By May, most of the activity has shifted out of the Bay and into the

Great South Channel. Densities remain high there through June (Fig. 9), and then in July animals depart the Bay, reaching temporarily high densities north of Cape Cod Bay in July, before animals move to the Bay of Fundy.

Traffic Separation Scheme (TSS) Analyses

The current or original TSS has the unfortunate property of routing vessels through high whale density areas north of Race Point, MA (Figures 7 and 10). However, by moving the East-West portion of the TSS somewhat north, it is possible to avoid many of these animals (Figure 11). Analyses of the sighting data available through 2003 from the URI dataset suggest that encounter rates could be decreased by 46%, 58%, and 66% for right, humpback and fin whales, respectively (Table 1), by such a move. Also shown in Table 1 and Figure 11 is an alternative alignment of the East-West portion of the TSS proposed by the Stellwagen Bank National Marine Sanctuary ("NOS alternative"). Both alignments show the potential for significant reduction of ship strike risk for large whales.

DISCUSSION

Extension of the existing gear management areas (Cape Cod Bay, SAM West, SAM East, and the Great South Channel) in time and space would provide greater protection for right whales. Such an extension would also protect the concentrations of right whales observed in the Gulf of Maine during spring-summer in recent years. This includes groups of animals observed on Stellwagen Bank in April, in Wilkinson Basin in April-May, and in the northern Great South Channel in April-May. Right whale concentrations to the north of SAM East appear to be less predictable, but occur in areas with a lower likelihood of gear interactions due to the limited fishing there.

The simulated DAM and gridded density results both suggested that SAM West (Figure 1) should be expanded to the west and south to provide greater protection for right whales. The SAM East's southern boundary should also be modified to better encompass the known distribution of right whales on Georges Bank (e.g., Figure 8). The seasonal division on May 1 between the original SAM East and West zones is a significant problem in that aggregations of right whales have been repeatedly sighted in the eastern part of SAM West (Wilkinson Basin), after it has been reopened. This problem could be remedied by extending the SAM West Area to the end of May, or by extending the western boundary of SAM East to 69.75°W.

Finally, the existing Boston Traffic Separation Scheme could be realigned to pass through areas with lower concentrations of right, humpback and fin whales (Figure 11). Such a realignment would significantly reduce the likelihood of ship strikes in the area. Additional analyses being conducted cooperatively between Stellwagen Bank National Marine Sanctuary and NEFSC staff, and by the US Coast Guard as part of a current Boston Port Access Route Study, will further refine this alignment.

LITERATURE CITED

Clapham, P. J., and R. M. Pace, III. 2001. Defining Triggers for Temporary Area Closures to Protect Right Whales from Entanglements: Issues and Options. Northeast Fish. Sci. Cent. Ref. Doc. 01-06; 28 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Merrick, R. L., P. J. Clapham, T. V. N. Cole, P. Gerrior, and R. M. Pace, III. 2001. Identification of Seasonal Area Management Zones for North Atlantic Right Whale Conservation. Northeast Fish. Sci. Cent. Ref. Doc. 01-14; 18 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

ACKNOWLEDGMENTS

The efforts of the survey teams and pilots (NOAA, Provincetown Center for Coastal studies, and commercial pilots) are gratefully acknowledged. Without their efforts over the past three years this report would not have been possible to produce. Recent surveys by NOAA were authorized under MMPA/ESA permit 775-1600. I would also like to thank Dr. Fred Serchuk, Dr. Greg Silber, David Wiley, and David Gouveia for reviews of earlier versions of this report.

Table 1. Right, humpback, and fin whales sightings through 2003 in the original and two alternative configurations of the part of the Boston Traffic Separation Scheme which begins due east of Race Point and is aligned first northwest-southeast and then west-east. Original refers to the existing Traffic Separation Scheme (Fig. 10), NOS Alt. Refers to alternative routing suggested by NOS[2], and NMFS Alt. refers to NMFS alternative Traffic Separation Scheme (Fig. 11).

	Right whale			Humpback whale			Fin whale		
Lanes	Original	NOS Alt	NMFS Alt.	Original	NOS Alt.	NMFS Alt.	Original	NOS Alt.	NMFS Alt.
East-West	221	134	121	227	111	95	225	87	76
North-South[3]	>>0	5	5	>>0	4	4	>>0	8	8
Total	221+	139	126	227+	115	99	225+	95	84

[2] NOS Alternative as provided by staff of Stellwagen Bank National Marine Sanctuary

[3] Note that because under the present alignment of the TSS, commercial vessels can move North-South across the breadth of the Georges Bank, all of these vessels have the potential to pass through areas seasonally occupied by large whales. Thus, the potential for vessel interactions, while significantly greater than 0, is not easily calculated

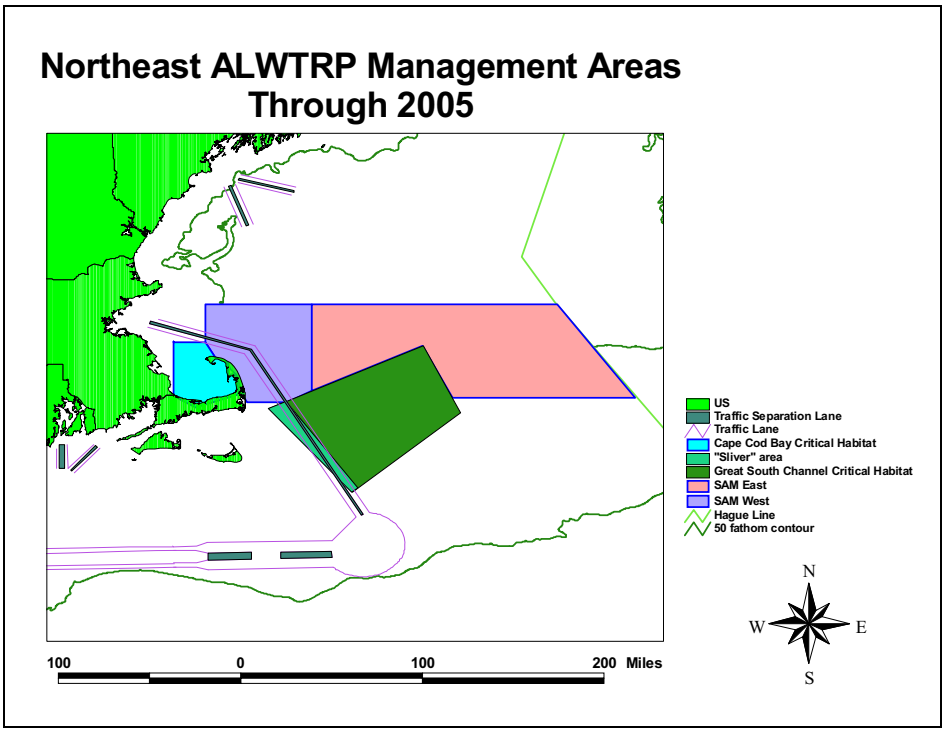

Figure 1. Northeast ALWTRP Management Areas through 2005.

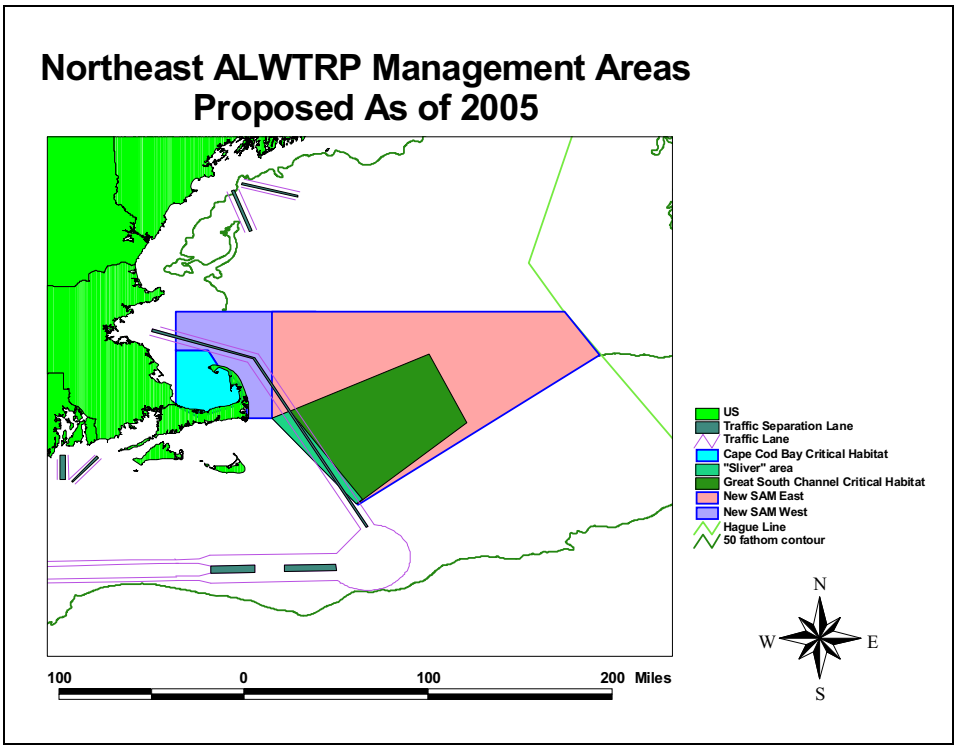

Figure 2. Northeast ALWTRP Management Areas proposed as of 2005.

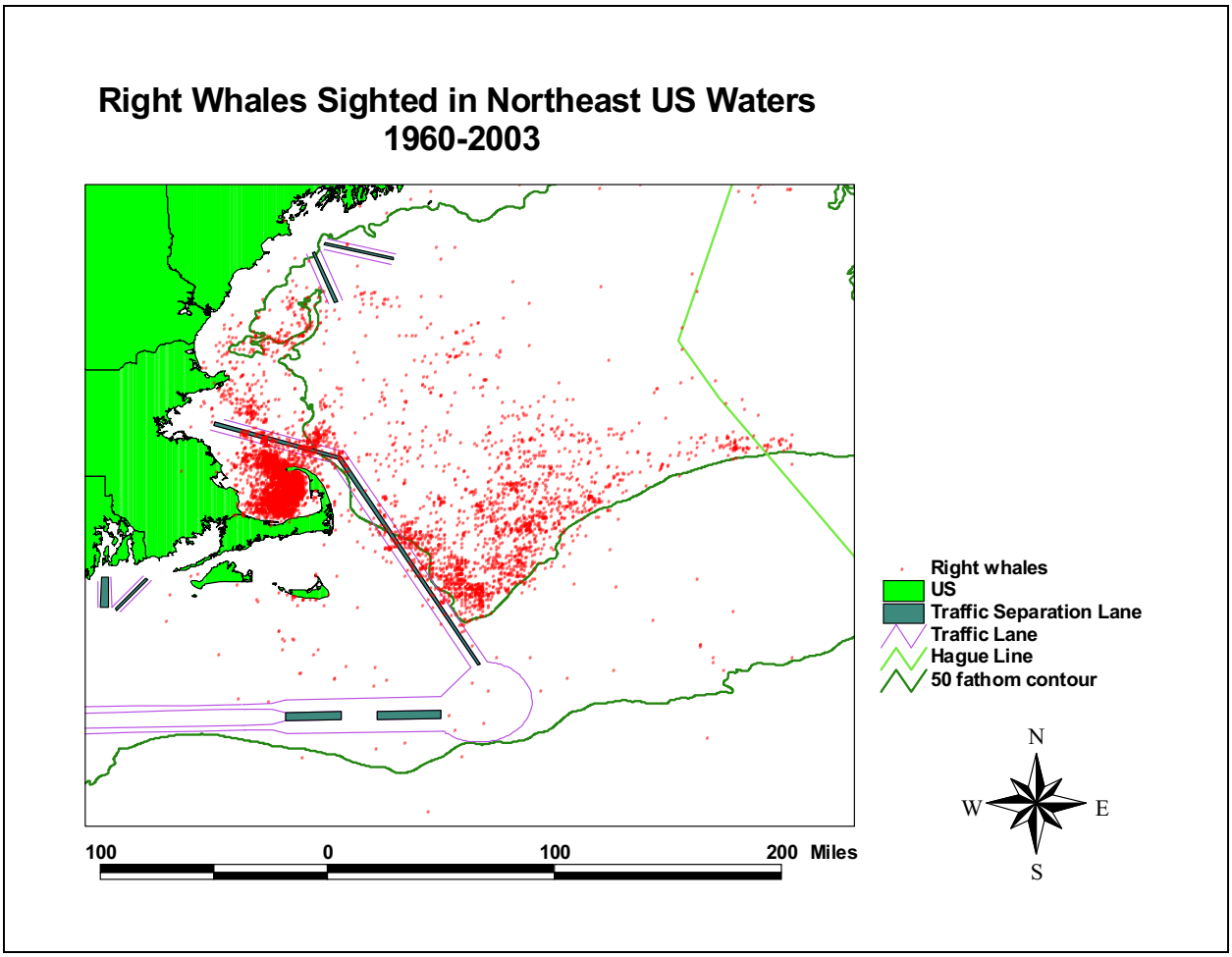

Figure 3. Right whale sightings in Northeast US waters, 1960-2003

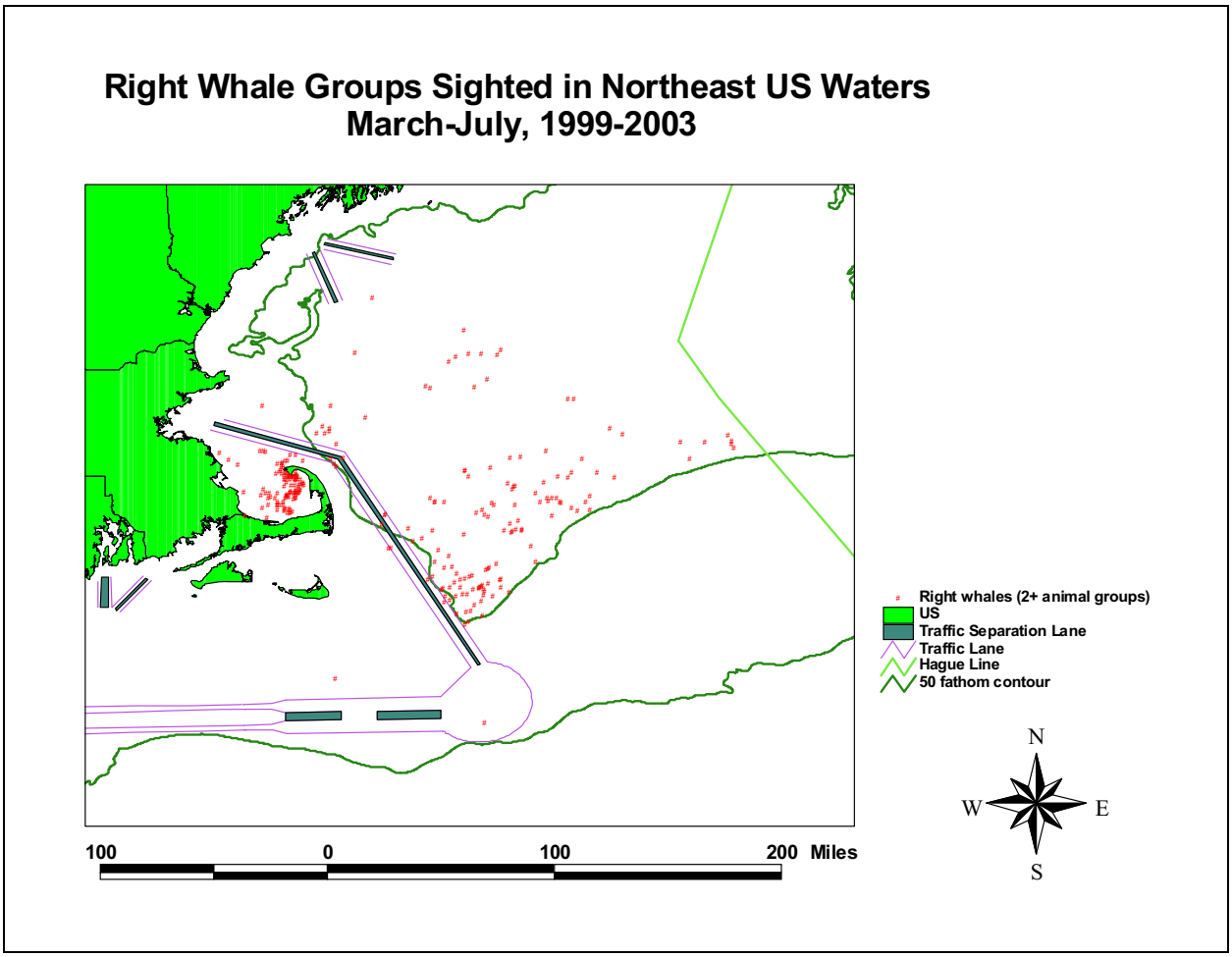

Figure 4. Right whale groups (2+ animals) sighted in Northeast US waters during March-July, 1999-2003.

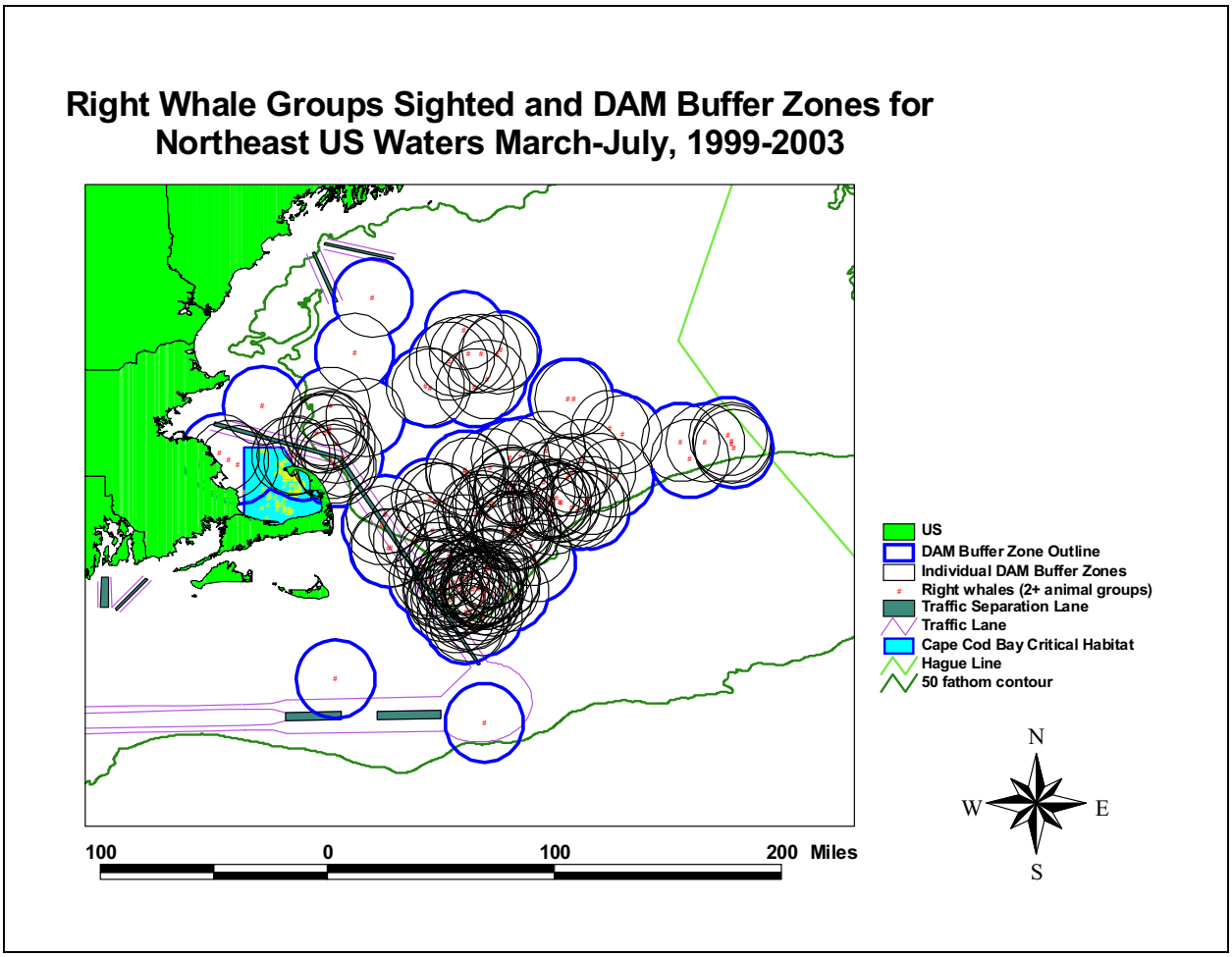

Figure 5. Right whale groups sighted and DAM buffer zones for Northeast US waters, March-July, 1999-2003.

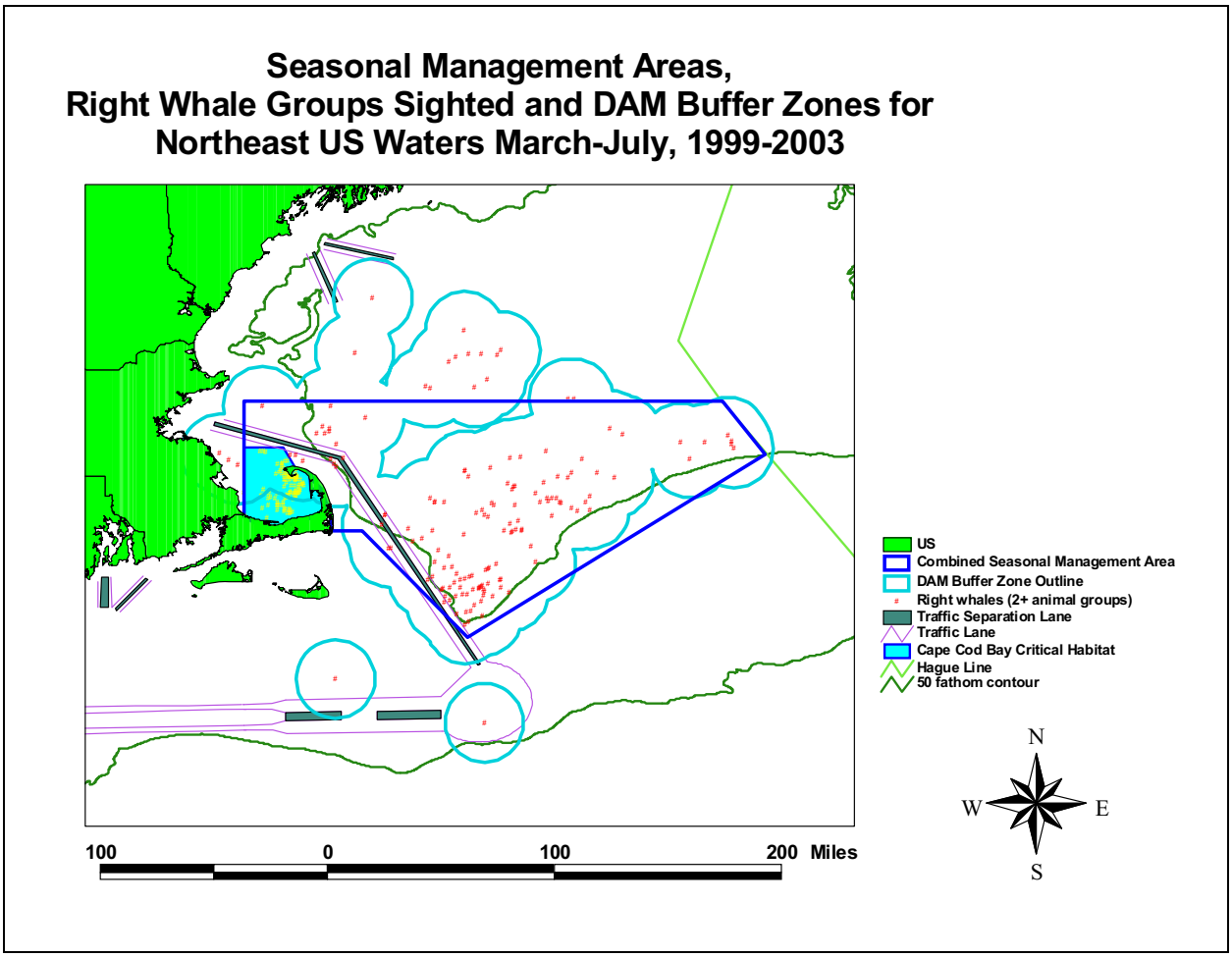

Figure 6. Gulf of Maine combined seasonal management area, right whale groups, and DAM buffer zones for Northeast US waters, March-July, 1999-2003.

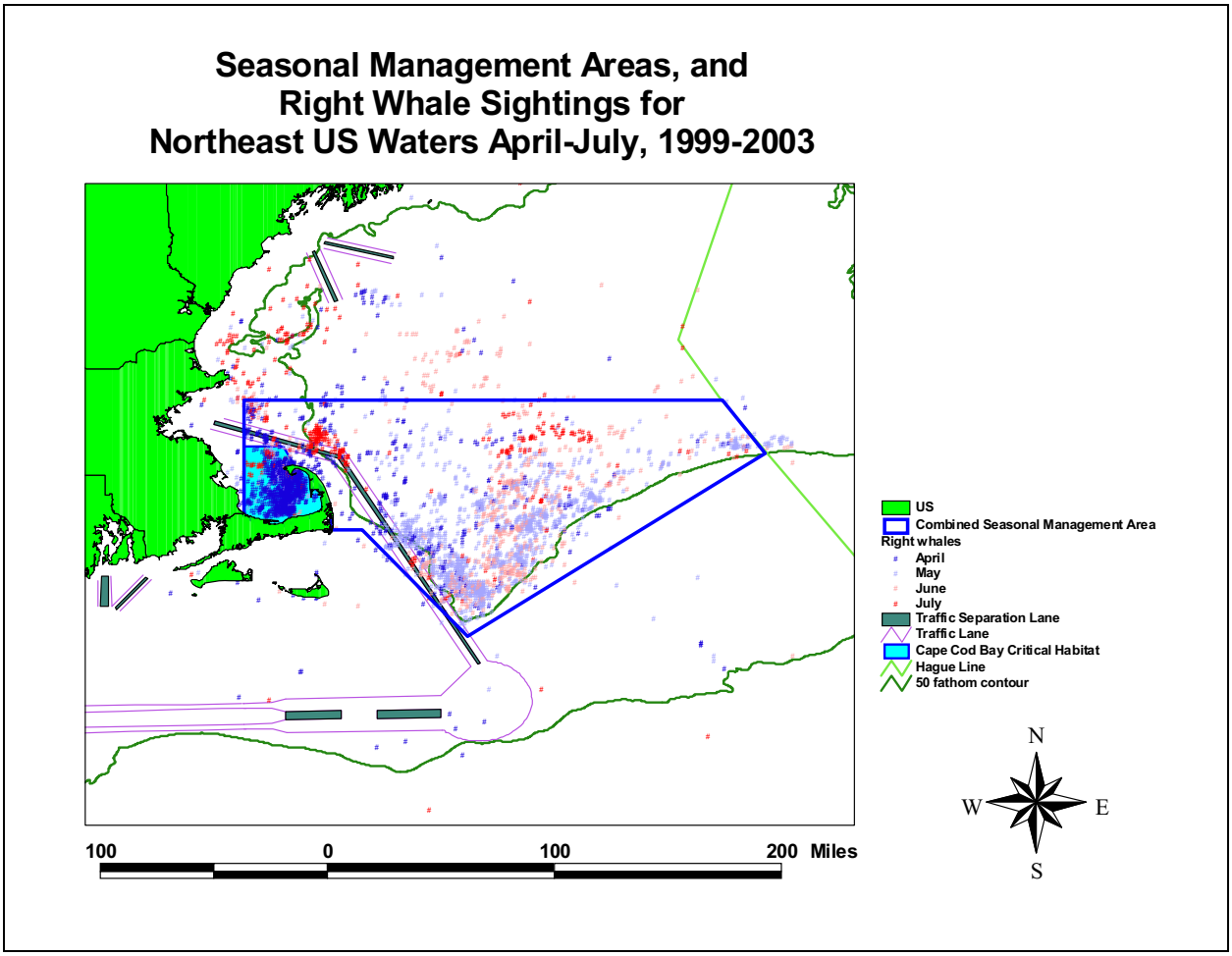

Figure 7. Seasonal management areas and right whale sightings for Northeast US waters April-July, 1999-2003.

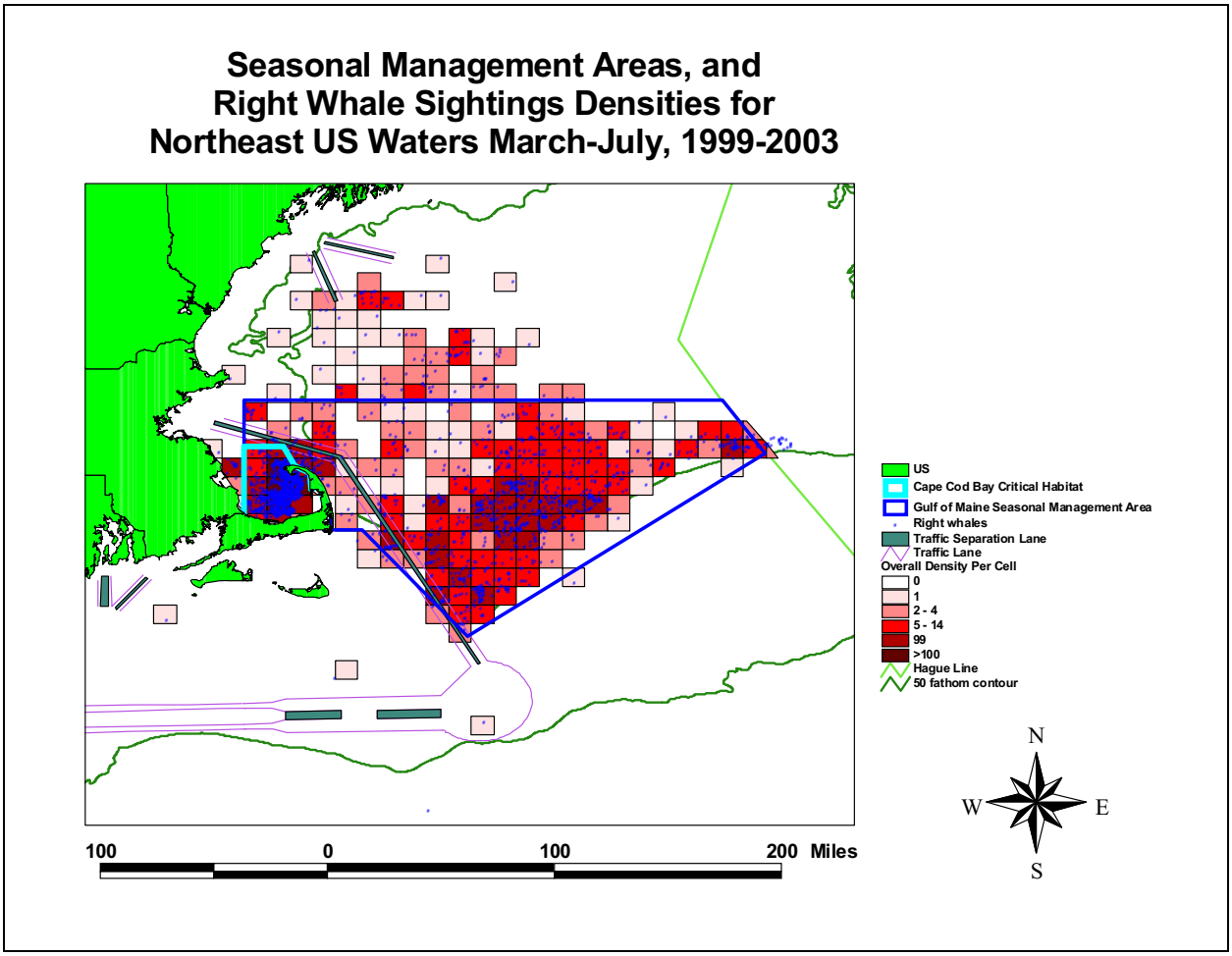

Figure 8. Seasonal management areas and right whale sightings densities for Northeast US waters, March-July, 1999-2003.

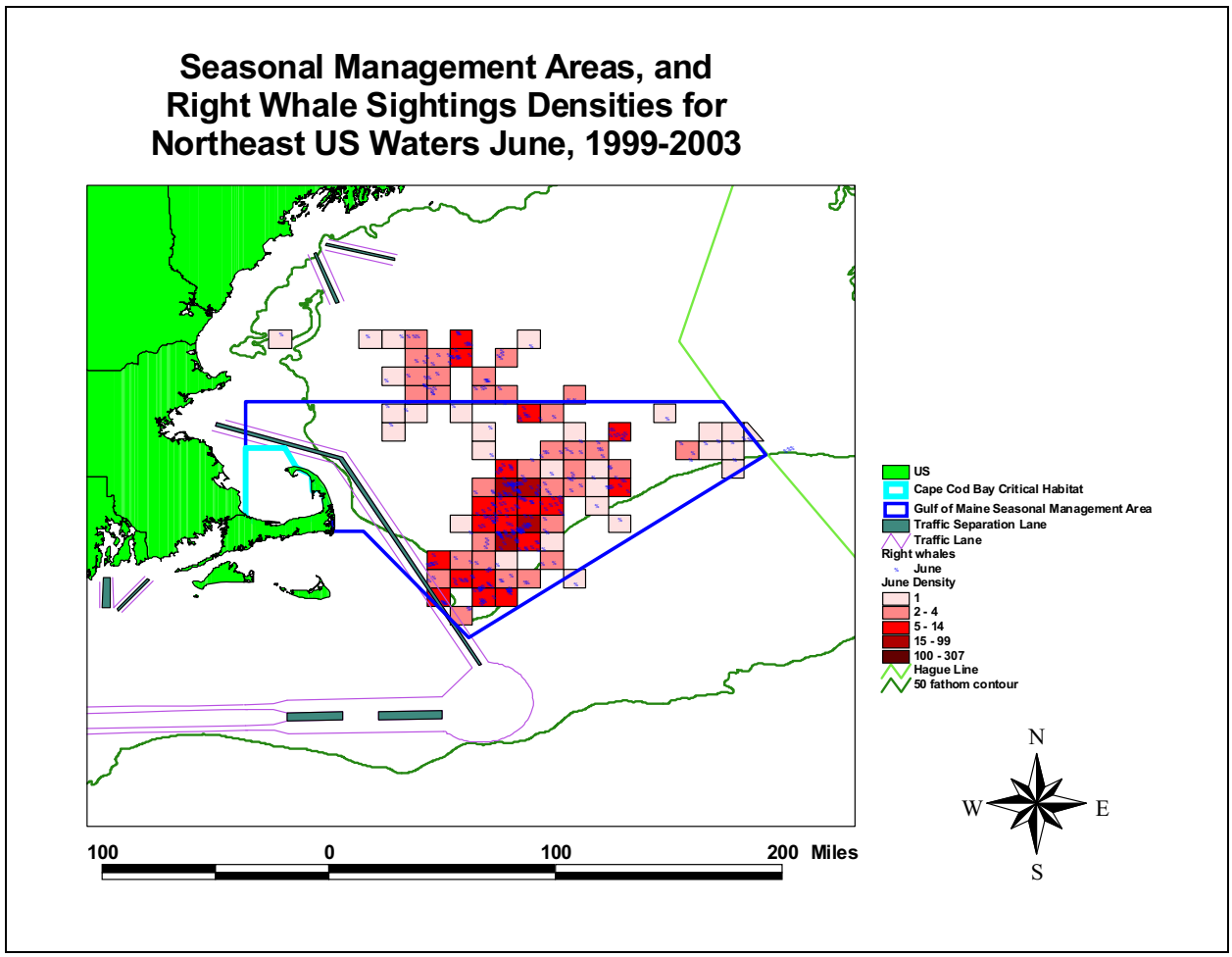

Figure 9. Seasonal management areas and right whale sightings densities for Northeast US waters, June, 1999-2003.

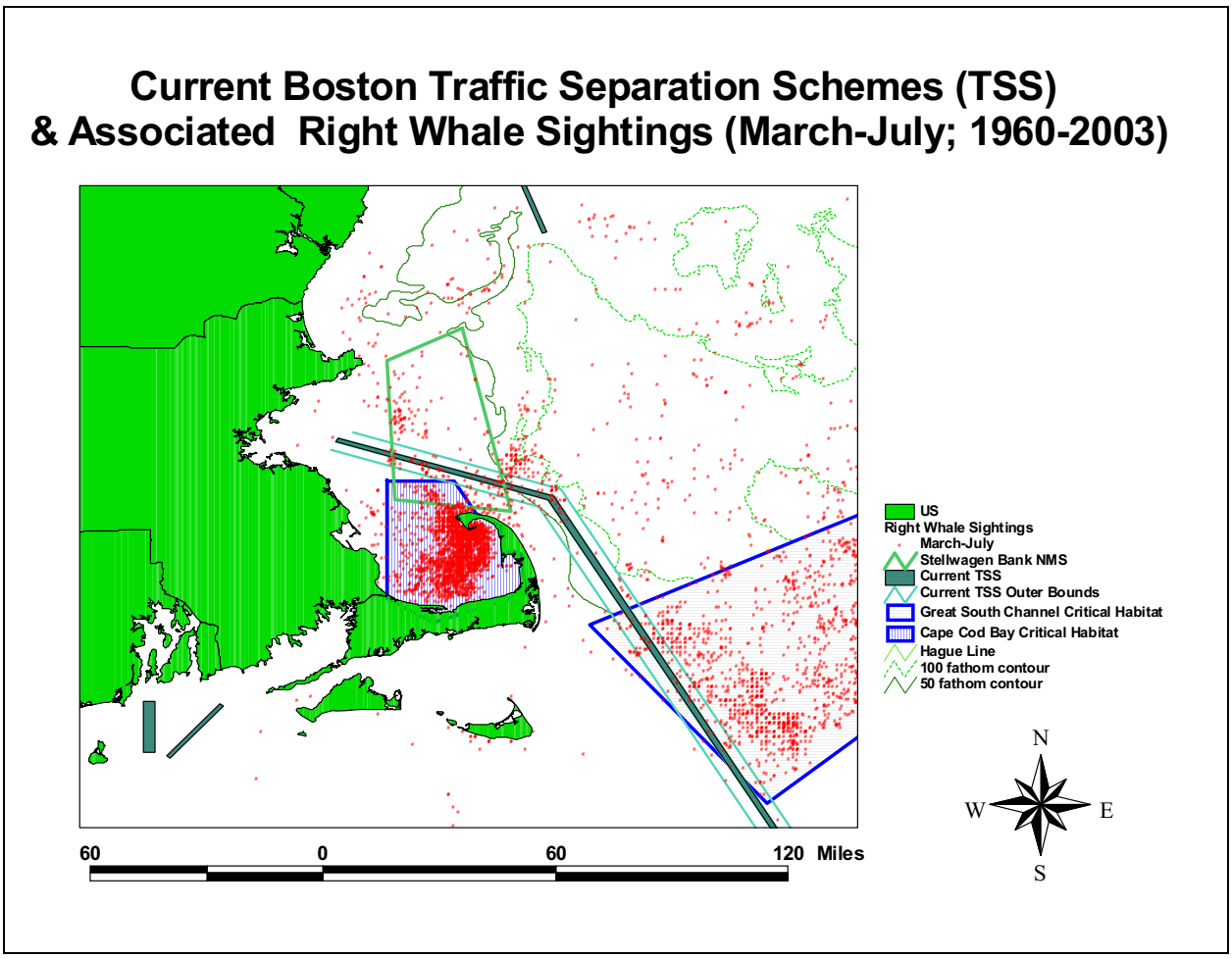

Figure 10. Existing Boston Traffic Separation Scheme (TSS) and associated right whale sightings.

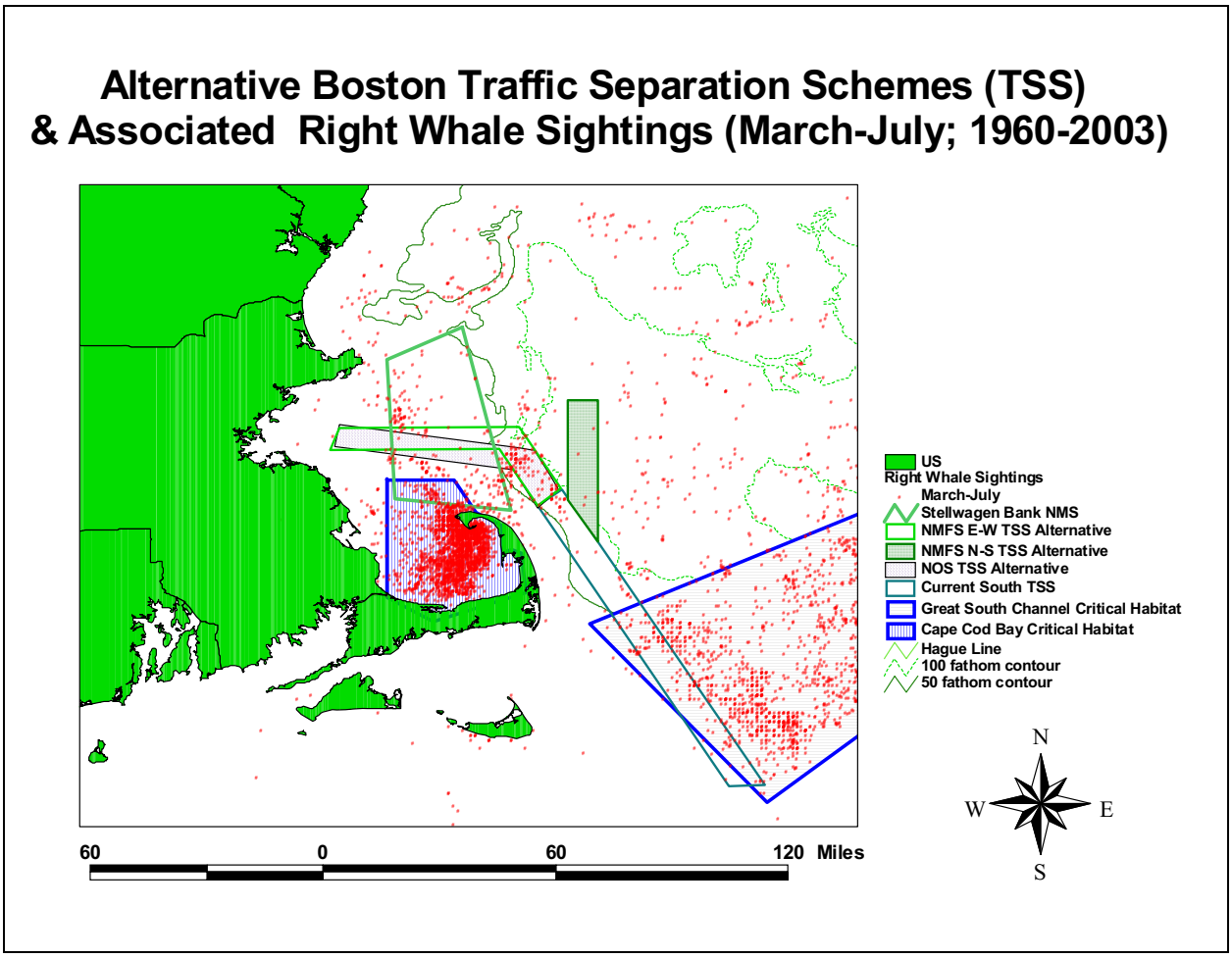

Figure 11. Alternative Boston Traffic Separation Scheme (TSS) and associated right whale sightings.

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