VESSEL TRAFFIC-MANAGEMENT SCENARIOS BASED ON THE NATIONAL MARINE FISHERIES SERVICE'S STRATEGY TO REDUCE SHIP STRIKES OF [NORTH ATLANTIC] RIGHT WHALES

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A report submitted to the NMFS Northeast Implementation Team

Submitted by:

Bruce Russell[1], Amy R. Knowlton[2], and Jennifer Beaudin Ring[3]

[1]Maritime consultant
[2]New England Aquarium
[3]GIS consultant

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Executive Summary

This report is a revision to the preliminary analysis of *Vessel Traffic Management Scenarios Based on Recommended measures to Reduce Ship Strikes of Northern Right Whales*, (Russell, et al, November 2003). In their June 1, 2004 Advanced Notice of proposed rulemaking (ANPR), the National Marine Fisheries Service (NMFS) proposed a strategy to reduce ship strikes of North Atlantic right whales right along the U.S. East Coast from Maine to Florida. The objectives of this report are to:

- Examine the impact on vessels calling at major ports to comply with proposed vessel operating restrictions;
- Lay out analytical approaches and provide solid estimates for the impacts measured in additional time it would take for vessels to comply with proposed vessel operating restrictions.
- Revise analyses and estimates to reflect the NMFS strategy -exceptions/exclusions are noted as necessary.
- Provide corrected time frames for proposed seasonal management areas in the Wilmington and Morehead City, North Carolina approaches timeframe to be consistent with Georgetown and Charleston just to their south.
- Revise estimates based on two additional years of right whale sightings data; and
- Correct a technical error in one of the underlying spreadsheets.

In this paper we examine how vessels slow down and speed back up prior to entering a seasonally or dynamically management area. We examine how vessels enter port to embark a pilot, and model how much net additional time a vessel would take to transit through seasonally or dynamically managed areas to account for how a vessel currently operates and would operate under speed and /or routing restrictions.

Several comments we received on the November 2003 report indicated that we did not address the impact on small passenger vessel operations. We believe we provided a sufficient analytical framework for policy makers, economists and vessel owners/masters to assess the impacts on small passenger vessel operations. We do not however draw any conclusions as to the impact of how 2 additional hours for a round trip transit for a vessel to comply with the proposed measures would have on the viability of a small passenger vessel service on a particular route, as this type of assessment is beyond the scope of this report.

We retrospectively applied the dynamic management area (DMA) concept when right whales are sighted in high concentrations to compute an annualized expected duration (number of days) and annual average number of vessel miles per DMA for which operating restrictions would be in force. We reviewed the geographic extent and duration of all proposed SMAs on the basis of our recent work, *Right Whale Sightings and Survey Effort in the Mid Atlantic Region: Migratory Corridor, Time Frame, and Proximity to Port Entrances*, (Knowlton, A. Beaudin Ring, J, and Russell, B.A., 2002), and *GIS Presentation of Survey Tracklines, Right Whale Sightings and Right Whale Movements: 1978-2000, (*Knowlton, A., Beaudin Ring, J, Kenney, R.D., and Russell, B.A., 2002); updated in June 2005; see www.marinegis.org).

Finally, we examined the impact of restrictions in Cape Cod Bay and Massachusetts Bay on vessels using Cape Cod Canal, but not calling Boston or Gulf of Maine ports. The summary of findings is presented in tabular format by geographic area, as most areas could be impacted by more than one operating restriction.

We did not provide comprehensive estimates for the Block Island Sound approaches and ports approaches in the Southeast U.S. critical habitat.

- The seasonal management area (SMA) proposed for the approaches to Block Island Sound by NMFS in their strategy will not effect vessels enroute New Haven, Bridgeport and New London, Connecticut from points west and Southwest.
- At the date of our writing, NMFS was still completing final analyses necessary to define specific recommended routes within the Southeast U.S. seasonal management area.

Major Findings, Limitations, and Considerations

- In our recent paper**, Right** *Whale Sightings and Survey Effort in the Mid Atlantic Region: Migratory Corridor, Time Frame, and Proximity to Port Entrances*, July 2002, we compiled and analyzed all available right whale sighing data in the right whales migratory corridor from the northern New England south to the southern calving grounds off northern Florida and southern Georgia. There were few new data points available from the previous effort to warrant a reanalysis of temporal and spatial boundaries of SMAs in this region.

- The ANPR proposes December through April as the seasonal timeframe for SMAs around Wilmington and Morehead City, NC. However, proposed seasonal timeframes are October through April for SMAs around ports to the south. Due to right whale migration movements and as the result of comments received at the ANPR meetings, NMFS may want to consider a seasonal timeframe of October through April for the North Carolina ports. The SMA duration for each port would then be reflected as follows:
    - Savannah - 181 days
    - Charleston to Morehead City - each 212 days
    - Chesapeake Bay Approaches - 150 days
    - Philadelphia - 181 days
    - New York and New Jersey - 150 days
    - Block Island - 150 days

- The ANPR suggests December through April, but based on migration timing and the months included for ports just to their south, the months should be October through April. This change is reflected in the following list of SMA duration by port:

- For the purposes of this report, we used the trigger for Dynamic Management areas described in the white paper on the NMFS ship strike web site: http://www.nero.noaa.gov/shipstrike/. However, it should be noted that NMFS has yet to formulate the final triggering mechanism/s for a DMA to be implemented under the ship strike reduction strategy.

- We studied all available right whale sighting data and retrospectively applied the dynamic management trigger mechanism. We believe that for the most part, where possible, most masters would choose to route around most dynamic management areas. This will not be possible in the Great South Channel or Cape Cod Bay because of the proposed ATBA's and/or designated (or mandatory) routes to be imposed.

- For the Great South Channel, unlike the previous report, we did not consider and therefore retroactively impose a DMA for sightings outside of the lanes but within 15 nm east of the lanes. Based on communications with NMFS, it was determined that whales seen to the east of the lanes would be provided protection by the SMA. In addition, the general movement of right whales during the springtime feeding season is from west to east. For any sightings to the west of the lanes, a DMA was imposed if the trigger was met. This revised method resulted in a reduction in the number of years with DMAs. These revised criteria eliminated all DMAs in two of the early years (1980 and 1987) in which there were a total of 5 DMAs. It also eliminated seven other DMAs (two in 1981, and one in 1988 and 1998 through 2001). The impact of this revised criteria on traffic passing through the southern Boston lanes was not significant when averaged out over time (previous mean of 39 days and 27 nm changed to 41 days and 18 nm). The mean annual expected number of DMAs changed from 3.8 to 3.6 per year.

- The number of DMAs observed in 2002 in the previous report was only 4 but with the additional data, this number increased to 15. In 2003, the number of DMAs was 10. The addition of almost two years of data increased the maximum duration and distances for most areas but this increase was most dramatic in the southern Gulf of Maine. The mean changed from 7 days and 10 nm to 46 days and 26 nm and the mean annual expected number of DMAs increased from 0.4 to 2.3 DMAs per year. This increase is likely due to a change in the level of survey effort by NMFS with the implementation of broad-scale surveys on a year-round basis.

- The seasonal management area (SMA) proposed for the approaches to Block Island Sound by NMFS in their strategy will not be effective vessels enroute New Haven, Bridgeport and New London, Connecticut from points west and southwest. The western boundary of the proposed SMA is a line drawn south from Montauk Point, 20-23nm south and east. Vessels on courses on easterly and northeasterly courses from points west would transit through the right whale migratory corridor outside the SMA with the exception of the last 3 or 4 nautical miles. Accordingly we did not develop vessel traffic management scenarios for Block Island Sound approaches. We did however include in Appendix Ib the table from our earlier report that would be useful in understanding potential vessel traffic management scenarios for vessels enroute Providence, New Bedford, Buzzards Bay (and points north of the Cape Cod Canal) and Martha's Vineyard and Nantucket.

- Vessels calling at the port of New York and New Jersey that are required to carry a state pilot slow to on average of about 10 knots. We therefore recalculated the additional time required to transit the proposed SMA on the basis of 10 knots versus the 8 knots used in our earlier report. While some masters do attempt to increase the speed of their vessels to sea speed after embarking their pilot, we understand that the pilots do direct that the vessel return to maneuvering speed.

- The Virginia and Maryland pilots provided us detailed information on how vessels depart/approach the entrances to the Chesapeake Bay and enter the traffic lanes. There are three northbound approaches, one eastbound approach and one southbound approach. The three northbound approaches are driven in large part by a vessel's draft. The southern set of traffic lanes has a slight dogleg. The net results are:
  - northbound vessels with drafts of greater than 28 feet would be in the proposed SMA for approximately 36.7nm an increase of 6.7nm from our earlier calculations;
  - deeply laden vessels would be in the proposed SMA for 34.6nm an increase of 4.6nm from our earlier calculations;
  - Eastbound vessels would be in the proposed SMA for 32.7nm and increase of 2.7nm from our earlier calculations; and.
  - the increased transit distance for the southern route is negligible.

  The tables for the ports of Hampton Roads and Baltimore have been redrafted to account for these increased transit distances.

- All the tables for the seasonal management areas in the mid-Atlantic and the Southeast U.S. have been revised due to a *technical error in the underlying spreadsheets (but not in the analytical framework provided in this report). While the differences are not large, they may be significant to some operators*.

- NMFS is still completing analyses from which recommendations will be made regarding lanes. Therefore we did not develop vessel traffic management scenarios for the ports of Brunswick, GA, Fernandina Beach, FL and Jacksonville, FL. We did however include in Appendix Ic the tables that would be useful in understanding potential vessel traffic management scenarios based on a speed restriction only, which in turn could be used in calculations to examine the increased time based on both a speed restriction and new designated approaches.

Background and Assumptions

In November 2003 we submitted a report to the Northeast Implementation Team, *Vessel Traffic-Management Scenarios Based on Recommended Measures to Reduce Ship Strikes of Northern Right Whales (Russell, et al).* In that report, potential management options, including international and domestic regulations, which would restrict vessel operations through speed restrictions, ship routing and other measures to reduce the risk of vessel collisions with right whales. To the extent that we were able to, we based our analyses on what we understood would be the NMFS' right whale ship strike reduction strategy. The operating restrictions in NMFS right whale ship strike reduction strategy would apply to all vessels operating in high-risk areas on the U.S. and east coast from Port Canaveral, Florida to and including Savannah, Georgia, to Charleston, South Carolina, North Carolina ports, the entrances to Chesapeake and Delaware Bays, the NY, NJ approaches, Block Island Sound, the Great South Channel, Cape Cod Bay, and the Gulf of Maine to the Bay of Fundy. There are two types of management areas that are proposed along the eastern seaboard – Seasonal Management Areas (SMA) and Dynamic Management Areas (DMA). SMAs are those areas where management measures would be imposed over a pre-defined timeframe and geographic area that are based on the best information about right whale movements and distribution. DMAs are those areas where measures would be imposed based on the identified presence (via visual or acoustic surveillance) of a minimum number of animals within that area.

Our November 2003 report was posted on the Internet at http://www.nero.nmfs.gov/whaletrp/ and widely distributed to provide stakeholders a better understanding of the potential impacts of the proposed operating measures. We also solicited comments on the assumptions and techniques employed on our analyses. There are some subtle differences in the strategy that we analyzed and that which has been proposed. Several respected mariners who provided the following feedback and comments reviewed our November 2003 report:

John Mauro, U.S. Coast Guard aids to navigation office in the First Coast Guard District, and Captain Larry Palmer Northeast Pilots, independently reviewed the report from a nautical science perspective and advised that our analytical techniques were solid.

Captain Larry Palmer Northeast Pilots provided detailed diagrams of how vessels approach and transit Block Island Sound enroute their ports of call.

Captain Andrew McGovern, Sandy Hook Pilots provided information on the average speed at the Ambrose pilot station (10 knots) and speeds after vessels embark a pilot (maneuvering speeds)

Captain Bill Cofer, Virginia Pilots and Captain Eric Neilsen, Maryland pilots provided detailed information on vessel approaches the Chesapeake Bay.

Pat Gerrior, formerly of NMFS Northeast Region, provided a chartlet showing potential designated routes in Cape Cod Bay she developed with Captain Andrew Beaver, National Oceans Service and Captain Larry Palmer Northeast Pilots. These routes are being considered in the Coast Guard's Port Access Route Study.

In their February 2005 paper report*, Analysis of Risk to North Atlantic Right Whales (Eubalaena glacialis) from Shipping Traffic in Cape Cod Bay,* Owen Nichols, Center for Coastal Studies and Hauke L. Kite-Powell, Woodshole Oceanographic Institute, developed a shipping traffic data base d on information provided by the US Army Corps of Engineers (USACE) for vessels transiting the Cape Cod Canal. They also aggregated this data and identified de facto routes through Cape Cod Bay based on origin/destination information.

Since publishing our November 2003 report, we received requests from several shipping companies for the report and supporting analyses to assist the companies in understanding the impact of the proposed measures on their fleets operations.

In 2004, the members and participants of Northeast Implementation Team recommended that we update the November 2003 report based on the feedback we were receiving and the interest of the shipping industry in the report.

All the tables for the seasonal management areas in the mid-Atlantic and the Southeast U.S. have been revised due to a *technical error in the underlying spreadsheets (but not in the analytical framework provided in this report). While the differences are not large, they may be significant to some operators.*

These risk reduction measures would cause economic impacts on the regulated industries that ultimately extend down the supply chain to consumers. It is therefore important for regulators and economists to understand the complexity of the shipping industry and to consider the potential economic impact before implementing management options.

Assumptions:

- Feedback for the shipping industry advised that most vessels take as many as 60 minutes to decelerate from sea speed to maneuvering speed and as many as 60 minutes to accelerate back up to sea speed.

- Most vessels requiring state pilotage must reduce speed to embark/debark a pilot at speeds ranging from 6-10 knots anywhere from 3-12 or so miles offshore and then do not return to sea speed. We interviewed maritime interests at most ports and determined that 8 knots would be a good number to use in our calculations with the exception of the ports of New York and New Jersey (10 knots).

- The geographic extent of proposed SMAs in the mid Atlantic originally assumed that the radial extent would be from 20-30 nautical miles offshore. This was based on a preliminary analysis of data available at that time. This information has ***not*** been further refined.

- DMA scenarios are provided for the Gulf of Maine, Cape Cod Bay, and Block Island Sound areas for 6 years (1998 – 2003). For the Great South Channel, DMA scenarios are provided for a total of 13 years between 1979 and 2003 when survey effort was adequate.

- Information provided by the Northeast Pilots (personal communication, Pat Gerrior, NMFS) indicate that there are deep draft vessels using the Cape Cod Canal that would be affected by the proposed routing measures and or SMA (regulated navigation area (area to be avoided)) on the east side of Cape Cod Bay, and the proposed SMA in the Boston sea lane approaches off Race Point. The potential impacts are discussed.

Analytical Approach and Results

1. Application of Speed Restrictions

a) Accounting for vessels' need to take as much as one hour to slow from sea speed to maneuvering speed before entering a right whale management area.

Analytical Approach

We originally assumed that a vessel could slow immediately to the prescribed speed restriction when entering seasonal management areas (SMA) as well as dynamic management areas

(DMA)[1]. Feedback from the shipping industry advised that most vessels take as many as 60 minutes to decelerate from sea speed to maneuvering speed and as many as 60 minutes to accelerate back up to sea speed. For the purposes of this analysis we are assuming proposed speed restrictions of 10, 12 and 13 knots; these proposed speed restrictions are within the range of maneuvering speed for many of the large commercial vessels transiting right whale waters.

Accounting for a vessel's net time, $\Delta T_{VS\text{-}RS}$, to slow from sea speed to maneuvering speed is quite simple. We must first determine the distance, *RD,* over which a vessel travels to reduce speed from sea speed to maneuvering speed, and then determine the time, $T_{VS,}$ it would take a vessel to travel this distance without having to reduce speed. Note that *MS* is the mean or average speed over one hour that a vessel makes when reducing speed from sea speed, *VS,* to the proposed speed restriction, *RS:* $MS = (VS + RS) \div 2$.

Variables defined:

> *VS* is the vessel's sea speed.
> *RS* is the proposed speed restriction.
> $\Delta T_{VS\text{-}RS}$ is a vessel's net time, to slow from sea speed to maneuvering speed.
> *RD* is the distance, over which a vessel travels to reduce speed from sea speed to maneuvering speed.
> T_{VS} is the time, it would take a vessel to travel this distance without having to reduce speed.
> T_{MS} is the time to slow from sea speed to maneuvering speed.
> *MS* is the mean or average speed over one hour that a vessel makes when reducing sea speed, *VS* from to the proposed speed restriction, *RS:*

$RD = MS * T_{MS}$

Where, $T_{MS} =$ Time to slow from sea speed to maneuvering speed: assume 1 hour.

$T_{VS} = RD \div VS$

$\Delta T_{VS\text{-}RS} = T_{MS} - T_{VS}$

For example:

If, VS = 20 knots and *RS* = 12 knots,

then, *MS* = 16 knots, and *RD* = 16 nm,

then, $\Delta T_{VS\text{-}RS} = 1hour - (16nm \div 20knots$[2]$) = .2$ *hours or 12 minutes.*

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1 We made this assumption understanding that most vessels must slow to take on a pilot and that this would in part offset this additional time. We also deliberately over-estimated the annual duration and average size of DMAs.

2 1 knot equals 1 nautical mile per hour, and 1 nautical mile is 2000 yards.

Therefore, a vessel traveling at a sea speed, *VS*, of 20 knots would need to voyage plan for an additional 12 minutes to reduce speed from sea speed to a proposed speed restriction, *RS*, of 12 knots, and 12 minutes to accelerate back to sea speed, absent any other factors. Other factors might include: vessels in bound to a port do not accelerate back to sea speed. Most large commercial vessels inbound to a port must take on a pilot and therefore must reduce speed to take on a pilot.

Results

As shown in Table 1, the time necessary to account for a vessel to slow from sea speed to maneuvering speed ranges from: no additional time (tug/barge) to 14 minutes (large container ship or large cruise ship) at a proposed speed restriction of 13 knots; and, to as much as 5 minutes (tug/barge) to 18 minutes (large container ship or large cruise ship) at a proposed speed restriction of 10 knots. This effects dynamic and seasonal management areas as follows.

Dynamic management: The net additional time necessary to transit a DMA would be the distance traveled though the DMA, D_{DMA}, divided by the difference between the vessels sea speed and the proposed speed restriction, *VS-RS*, plus 2 times the additional transit time, $\Delta T_{VS\text{-}RS}$, for both entering and departing the DMA to return to sea speed: $\Delta T_{NET} = (D_{DMA} \div (VS\text{-}RS)) + (\Delta T_{VS\text{-}RS})*2$. Note: Masters would assess the total additional time when considering whether it is possible to route around a DMA versus steam at a reduced speed through the DMA. Our recommended vessel traffic-management scenarios do not account for a master choosing to route around versus steam slowly through a DMA. Our recommended vessel traffic-management scenarios also assume that a vessel would be transiting the full diameter of the DMA.

For a vessel entering a proposed SMA within the mid Atlantic region and Southeast U.S. critical habitat, the additional transit time, $\Delta T_{VS\text{-}RS}$, for entering and later when departing would be added to the additional time a vessel would take to transit the SMA at the proposed restricted speed. For vessels cutting across any proposed SMA, (e.g., coastwise traffic not calling at a port with a SMA in-force), additional transit time, $\Delta T_{VS\text{-}RS}$, would be added for both entering and departing the SMA (i.e., additional transit time x 2). Note: Masters would assess the total additional time when considering whether it is more cost effective to route around a SMA, versus steam at a reduced speed through a SMA. Our recommended vessel traffic-management scenarios do not account for a master to route around versus steam slowly across a SMA.

For a vessel transiting through the proposed SMA around the Boston approach sea-lanes off Race Point, additional consideration of how vessels transit this area is necessary. For vessels enroute Boston sailing from the east, the additional transit time, $\Delta T_{VS\text{-}RS}$, to enter and later depart Boston and exit the SMA would be added to the additional time a vessel would take to transit the SMA at the proposed speed restriction. Because the western edge of the SMA is within the immediate approaches to the area where vessels take on a pilot, inbound vessels would not return to sea speed. Also, outbound vessels would not increase speed to sea speed until they clear the SMA. For vessels transiting across the SMA (northerly or southerly), for example coming from or going to the Cape Cod Canal, additional transit time

$\Delta T_{VS\text{-}RS}$, would be added for both entering and departing the SMA (i.e., additional transit time x 2). We expect that these vessels would route around this SMA, which is to the west of the SMA, before heading north and east.

For a vessel *transiting through the proposed SMA in the approaches to Block Island Sound to the east and south of Block Island,* vessels do not have to slow to embark a pilot. Additional transit time $\Delta T_{VS\text{-}RS}$, would be added for both entering and departing the SMA (i.e., additional transit time x 2).

Table 1 shows the average sea speed for various vessel types calling at US East Coast Ports (Kite-Powell and Hoagland, March 2002); and the additional transit time, ΔT_{VS-RS}, as a function of proposed speed restrictions, for vessels to slow from sea speed to maneuvering speed. A vessel departing a DMA would also incur this additional time when departing the DMA. For most ports only a subset of this vessel types call.

Vessel Type or Category	Average Vessel Speed, knots	Additional Transit Time, ΔT_{VS-RS}, minutes, for a vessel to slow from sea speed to maneuvering speed		
		10 Knot speed restriction	12 Knot speed restriction	13 Knot speed restriction
Dry bulk----handy	14	9	4	2
handymax	14	9	4	2
Panamax	14.5	9	5	3
Cape	14.5	9	5	3
tanker--product	14	9	4	2
Aframax	15	10	6	4
Suezmax	14.5	9	5	3
VLCC				
Containership--1000TEU	15	10	6	4
1500TEU	15	10	6	4
2000TEU	24	18	15	14
3000TEU	24	18	15	14
4000TEU	24	18	15	14
LNG	20	15	12	11
Car Carrier	16	11	8	6
Cruise ship	25	18	16	14
tug/barge--freight	12	5	0	0
--tank	12	5	0	0

***b)* Accounting for the requirement for vessels to take on a pilot when entering port: mid Atlantic ports (except the Block Island Sound approaches) and ports within the Southeast U.S. critical habitat**

Analytical Approach

When entering port, vessels, in the absence of proposed speed restrictions, vessels reduce speed to embark a pilot. Many vessels that require pilotage must reduce speed to embark/debark a state or federal pilot at speeds ranging 6-10 knots anywhere from 3-12 or so miles offshore. This location is often referred to as the "pilot buoy." These vessels then do not return to sea speed, but likely to a speed of 10-12 knots. On an outbound transit they do not speed up until they debark their pilot. As noted earlier, many vessels' to take as much as one hour to slow from full sea speed to maneuvering speed and conversely to increase from maneuvering to full sea speed. Further, these vessels then do not return to sea speed after embarking the pilot, but likely do increase speed to a speed of 10-12 knots to the harbor entrance. Therefore, we have also assumed in our calculations and traffic-management scenarios that proposed speed restrictions would only impact vessels from the outer limit of the SMA to the pilot buoy. *Note that, in our calculations and traffic-management scenarios, we assume that proposed speed restrictions would only impact vessels from the outer limit of the SMA to the pilot buoy.* Tug/barges, large recreational vessels, and vessels engaged in U.S. and coastwise commerce, typically do not take on a state or federal pilot.

Calculating the amount of time it takes a vessel to slow to embark the pilot is a simple calculation; the time ΔT_{PB}, is a function of the vessel speed at the pilot buoy, VS_{PB}, and the sea speed of the vessel, VS. However this is only part of the equation to determine the net additional time, ΔT_{NET}, it would take for a vessel to comply with the speed restriction, RS. There are several variables that make this calculation more difficult:

- The location of the pilot buoys varies from port to port, as does the speed at which vessels must slow to embark the pilot.
- The speed at the pilot buoy, VS_{PB}, (see Table 2), is less than proposed speed restrictions, RS.
- Most importantly, the location of the pilot buoy, PD, relative to the outer limit of the proposed seasonal management area, D_{SMA}, (see Table 2).

To determine the additional time on a one-way transit, ΔT_{NET}, it would take for a vessel to comply with the speed restriction, RS, we must first determine the time it would take a vessel to enter port with speed restrictions, ΔT_{RS}, which includes accounting for the vessel slowing to take on a pilot. This equals the time, $\Delta T_{VS\text{-}RS}$, for a vessel to slow from sea speed to maneuvering speed, plus the time, T_{RS}, it takes for a vessel to travel at the proposed speed restriction from the outer limit of the SMA to the location, D'_{PB}, at which the vessel must begin slowing to take on the pilot, plus one hour to slow from the speed restriction, RS to the speed at the pilot buoy, VS_{PB}. In some scenarios the value T_{RS} is by definition zero; this occurs when the location, D'_{PB}, at which a vessel needs to start slowing to take on the pilot is beyond the outer limit, D_{SMA}, of the seasonal management area, and the vessel is already within the range of maneuvering speed.

Variables defined:

VS is the vessel's sea speed.
VS_{PB}, is the vessel speed at the pilot buoy.
RS is the proposed speed restriction.
MS is the mean or average speed over one hour that a vessel makes when reducing sea speed, VS from to the proposed speed restriction, RS.
RD is the distance, over which a vessel travels to reduce speed from sea speed to maneuvering speed.

PD is the distance from the harbor entrance to the pilot buoy,
D_{SMA} is the outer limit, of the seasonal management area, SMA.
$D'_{PB,}$ is the distance from the outer limit of the SMA to the location at which the vessel must begin slowing to take on the pilot.
ΔT_{VS-RS} is a vessel's net time, to slow from sea speed to maneuvering speed.
T_{VS} is the time, it would take a vessel to travel this distance without having to reduce speed.
T_{MS} is the time to slow from sea speed to maneuvering speed.
ΔT_{PB} is the additional time it takes a vessel to slow to embark the pilot.
$\Delta T_{NET,}$ is the additional time it would take for a vessel to comply with the speed restriction, *RS on a one-way transit.*
T_{RS} is the time it takes for a vessel to travel at the proposed speed restriction from the outer limit of the SMA to the location, $D'_{PB,}$ at which the vessel must begin slowing to take on the pilot.
$T_{W/O}$, is the time, it takes for a vessel to enter port without speed restrictions. $T'_{VS,}$ is the time, it takes for a vessel to travel from the outer limit of the SMA without a speed restriction to the location at which the vessel must begin slowing to take on the pilot.

$\Delta T_{NET} = \Delta T_{RS} - T_{W/O}$

$\Delta T_{RS} = \Delta T_{VS-RS} + T_{RS}$ + 1 hour

- Where $T_{RS} = (D_{SMA} - D'_{PB}) \div RS$; *IF* $D'_{PB} > D_{SMA}$, then T_{RS} = ZERO
- Where $D'_{PB} = PD + (RS + VS_{PB}) \div 2$

Second in order to determine the time, $T_{W/O}$, it takes for a vessel to enter port without speed restrictions, we must determine the time, $T'_{VS,}$ it takes for a vessel to travel from the outer limit of the SMA without a speed restriction to the location at which the vessel must begin slowing to take on the pilot; and then and add to this to the time, T_{MS} (always one hour), it takes for a vessel to reduce speed to take on the pilot at the pilot buoy, *PD*. This must be determined for two reasons. First the distance, D_{PB}, over which the vessel is currently traveling to reduce speed to take on the pilot, would overlap all or part the distance, *RD,* over which the vessel travels to reduce speed to enter the SMA. And second, the distance D_{PB}, may also overlap all or part of the distance, D_{SMA}, over which the speed restriction applies, that is, from the outer limit of the SMA to the pilot buoy. For reasons similar to the computation for a vessel with speed restrictions discussed above, in some scenarios the value T'_{VS} is by definition zero; this occurs when the location, $D_{PB,}$ at which a vessel needs to start slowing to take on the pilot is beyond the outer limit, D_{SMA}, of the seasonal management area, and the vessel is already within the range of maneuvering speed.

$T_{W/O} = T'_{VS} + T_{MS}$

- *Where* $T'_{VS} = (D_{SMA} - D_{PB}) \div VS$; *IF* $D_{PB} > D_{SMA}$, then T'_{VS} = ZERO
- Where $D_{PB} = (PD + (VS + VS_{PB}) \div 2) * T_{MS}$.
- Where, T_{MS} equals the time to slow from sea speed to maneuvering speed: assume 1 hour.

In summary:

$\Delta T_{NET} = \Delta T_{RS} - T_{W/O}$

$\Delta T_{RS} = \Delta T_{VS\text{-}RS} + T_{RS} + 1$ hour
$T_{W/O} = T'_{VS} + 1$ hour

Shown in the third column of Table 2, is the maneuvering speed, VS_{PB}, which regional pilot's associations ask that vessels maintain for boarding a pilot. (Source: U.S. Coast Pilots 2,3, and 4 and communications with regional pilots' associations). Note that some pilots associations do not specify a speed. It is generally understood that masters should reduce the speed of their vessels' speed to fewer than 8 knots. For the purposes of this analysis we used 8 knots for all port approaches in our calculations.

In the fourth column of Table 2, note that for Fernandina Beach, FL there are two distances specified for the location of the "pilot buoy" relative to the harbor baseline or closing line. Some inbound vessels defer embarking a pilot until they are in an area about 4 nm from the harbor entrance. For purposes of this report, we assumed that the location of the pilot buoy is 10.9 nm for all vessels approaching Nassau Terminals at Fernandina Beach, FL

Note that for a vessel transiting through the proposed SMA in the approaches to Block Island Sound to the east and south of Block Island, vessels do not have to slow to embark a pilot. Therefore only additional transit time $\Delta T_{VS\text{-}RS}$, would be added for both entering and departing the SMA (i.e., additional transit time x 2).

Table 2 shows the location of the pilot embarkation point, typically in the vicinity of a buoy, the so called "pilot buoy;" and the maneuvering speed, $VS_{PB,}$ that the local pilots' association ask that vessels maintain for boarding a pilot. (Source: U.S. Coast Pilots 2,3,4 and communications with regional pilots' associations). Note that some pilots associations do not specify a speed; it is generally understood that masters should reduce the speed of their vessels' speed to fewer than 8 knots in most conditions. The last column shows the distance from the harbor entrance to the "pilot buoy." There is no closing line across Block Island Sound. As currently proposed the lighted buoy "MP" is in close proximity to the western boundary of the SMA for Block Island Sound. To the east of Block Island, most vessels embark a pilot after well after entering Block Island Sound and therefore the proposed SMA for the approaches to Block Island Sound.

Port Entrance	Pilot embarkation	Speed at Pilot Buoy, VS_{PB}	Location of "Pilot Buoy" relative to harbor baseline or closing line
Block Island Sound, west	LB "MP"	8 Knots	Authors recommend revisions to SMA
Block Island Sound, east	None	Not applicable	Not applicable
NY/NJ	Triangular cruising area west of Ambrose Light	10 knots	6.8 nm
Delaware Bay	2.5nm SE of Cape Henlopen, DE	5 knots	2.5 nm
Chesapeake Bay	LWB "C"	8 Knots	2.85 nm
Wilmington, NC	1nm east of LBB "2CF"	6-8 knots	4.1 nm
Morehead City, NC	LBB "2BI"	5 knots	6.7 nm
Georgetown, SC	LWB "WB"	No speed specified	5.6 nm
Charleston, SC	LWB "C"	8-10 knots	12.5 nm
Savannah, GA	LWB "T"	8 knots	9.7 nm
Brunswick, GA	LWB "STS"	5-9 knots	6.7 nm
Fernandina Beach, FL	LB "STM"	6 knots	10.9nm (& 4nm)
Jacksonville, FL	LWB "STJ"	8 knots	4.2 nm

Results

The net additional one-way transit time, ΔT_{NET}, a vessel would take to comply with the SMA is not a simple calculation and requires the input of vessel speed, restricted speed, location of pilot buoy, and buffer distance. Tables 3a-j, Appendices Ia & b, summarize the computations of the additional time, $\Delta T_{NET,}$ it would take for various vessel types to comply with the proposed seasonal management area (20, 25 and 30 nautical miles) and potential speed restrictions (10, 12, and 13 knots) for mid Atlantic ports (except as described below for Block Island Sound, and the approaches to the Chesapeake Bay (Virginia ports and Baltimore). (Average vessel sea speeds can be found in Table 1, column 2). A null value across all columns indicates that no vessels of the type listed called at the port in CY 1999. Net additional time to comply with the SMA vary from port to port. Ports with the pilot buoy closest to the harbor would be impacted the most.

Vessels entering Block Island Sound from the east and south of Block Island take on a pilot well after transiting the proposed SMA; therefore there is no need to account for this requirement in these calculations. However, many vessels entering Block Island Sound from the west and south of Block Island take on a pilot within a few miles of the western boundary of the SMA and would experience negligible increases in net transit time under the proposed SMA. The seasonal management area (SMA) proposed for the approaches to Block Island Sound by NMFS in their strategy will not be effective vessels enroute New Haven, Bridgeport and New London, Connecticut from points west and Southwest. The western boundary of the proposed SMA is a line drawn south from Montauk Point, 20-23nm south and east. Vessels on easterly and northeasterly courses from points west and southwest would transit through the right whale migratory corridor outside the SMA with the exception of the last 3 or 4 nautical miles. Accordingly we did not develop vessel traffic management scenarios for Block Island Sound approaches. We did however include in Appendix Ib a table that would be useful in understanding potential vessel traffic management scenarios for vessels enroute Providence, New Bedford, Buzzards Bay (and points north of the Cape Cod Canal) and Martha's Vineyard and Nantucket using the approach east of Block Island.

The Virginia and Maryland pilots provided detailed information on how vessels depart/approach the entrances to the Chesapeake Bay and enter the traffic lanes. There are three northbound approaches, one eastbound approach and one southbound approach. The three northbound approaches are driven in large part by a vessel's draft. The southern set of traffic lanes has a slight dogleg. The net results are:

- northbound vessels with drafts of greater than 28 feet they would be in the proposed SMA for approximately 39.6nm an increase of 9.6nm from our earlier calculations;
- deeply laden vessels would be in the proposed SMA for 34.6nm an increase of 4.6nm from our earlier calculations.
- Eastbound vessels would be in the proposed SMA for 32.7nm an increase of 2.7nm from our earlier calculations.
- The increased transit distance for the southern route is negligible.

The tables for the ports of Hampton Roads and Baltimore have been redrafted to account for these increased transit distances.

NMFS has not completed analyses on which recommendations of lanes will be based, therefore we did not develop vessel traffic management scenarios for the ports of Brunswick, GA, Fernandina Beach, FL and Jacksonville, FL. We did however include in Appendix Ic tables 4a-c that would be useful in understanding potential vessel traffic management scenarios based on a speed restriction only, which in turn could be used in calculations to examine the increased time based on both a speed restriction and new designated approaches. Also included in Appendix Ic is a chartlett showing the de facto shipping lanes.

Note that All the tables for the seasonal management areas in the mid-Atlantic and the Southeast U.S. have been revised due to a technical error in the underlying spreadsheets (but not in the analytical framework provided in this report). While the differences are not large, they may be significant to some operators.

2. Retrospective Modeling of Dynamic Management Areas

Analytical Approach

A retrospective review of right whale sightings collected from 1979 through 2003 was carried out to assess the timeframes and duration of right whale distributions that overlapped with areas of known vessel traffic, i.e., shipping lanes and shipping routes, and for which a Dynamic Management Area (DMA) would be imposed. Because the distribution of right whales can vary from year to year, the potential impacts to vessel traffic could vary significantly on an annual basis. This project was carried out to gain a better understanding of the extent of potential DMAs, how different shipping lanes and routes would be affected, and what level of annual variability exists.

To determine the most adequately surveyed years, annual plots of right whale sightings data found at http://marinegis.org/rwhale_gis.html were reviewed to assess the level of survey coverage. Twelve years for which survey coverage was considered adequate to be useful for this project were utilized for the Great South Channel critical habitat area in the vicinity of the Boston shipping lanes since effort was primarily limited to that area but was sporadic over that time period. The 13 years are: 1979-1981, 1987-1989, 1991, and1998-2003. Only the latter six years of survey effort, 1999-2003 are adequate for the Gulf of Maine, Cape Cod Bay and Block Island Sound. No data was determined to be adequate for the NY/NJ area, though there are opportunistic sighting reports of right whales feeding in the southern approaches.

Right whale sightings data for these years were acquired from the Right Whale Consortium database curated at the University of Rhode Island. The sightings data utilized include both opportunistic sightings and those collected during surveys.

The area covered for this project includes the Gulf of Maine west of the Hague Line (i.e., U.S. / Canadian boundary of the U.S. Exclusive Economic Zone) and the coasts of Maine to New York. The latitude/longitude range from 38.0° to 45.5°N and 65.0° to 75.0°W.

The sightings data were queried using a GIS program, ARCVIEW, to determine when a Dynamic Management Area (DMA) could have be enacted based on trigger events. For the purposes of this project and as recommended in our report, *Recommended Measures to Reduce Ship Strikes of North Atlantic Right Whales,* a trigger event, which could initiate a DMA, is defined as, for a given day:

- a single sighting/detection of 3 or more animals;

- two or more sightings/detection within one day totaling three or more animals with the sightings within 10 miles of each other;
- in southern Boston shipping lanes during SMA timeframe, same as above if at least one of the sightings was within the lanes and other sightings were to the east of the lanes;
- a sighting/detection of a mother/calf pair within 15 nm of a shipping lane;
- a sighting/detection of 2 or more animals closer than 10 miles to each other within a designated shipping lane if those animals are thought to be resident or feeding (note: this trigger was not used in this report since the historical data were not clear about feeding or resident behavior); and
- a sighting/detection of one or more animals in the Cape Cod Canal or any harbor area.

Potential DMAs were determined for all areas and times except when a SMA is otherwise in force. If the SMA was NOT in force, and a DMA was triggered, we imposed the DMA. The areas and the associated time frames of SMAs include:

- Great South Channel east of the shipping lanes leading to Boston – April 1 – July 31. This area is proposed as an Area to be Avoided (ATBA). (An ATBA already exists to the west of the lanes in the Nantucket Shoals for commercial shipping.)
- Cape Cod Bay critical habitat – seasonal ATBA January 1 through April 30.
- 35 nm portion of Boston shipping lanes near Race Point – April 1 – May 15.
- The offshore approaches to Block Island Sound – September, October, and February - April.
- The approaches to the ports of NY/NJ – September, October, February - April

When a trigger event was identified on a given day, a buffer circle was placed 15 nm around the periphery of sightings to define the extent of a potential DMA. The time duration of the potential DMA was extended for 13 days beyond the initial date of the sightings. If additional sightings were observed within those 13 days that met the trigger criteria, and those sightings were still within the buffer area, the buffer area remained the same but the duration of the area was extended for 13 days beyond the later sighting. If no sightings occurred within the 13-day period, the DMA was suspended at the end of the period. For this project, we did not review the data to determine whether a subsequent survey of a DMA determined that right whales were no longer present within the 13-day timeframe.

For this project, we described all trigger events that occurred outside of the SMA areas and/or timeframes as DMAs. All sightings that fit the trigger criteria were placed into an ARCVIEW table and an ARCVIEW shape file for each potential DMA was created. Each DMA was mapped by year, labeled with start and end date, total number of days, number of animals sighted over the duration of the DMA (note: this included sightings that would have been covered by the DMA but would not necessarily count as a trigger), the diameter of the DMA in nautical miles, and the lateral distance of the DMA along any shipping lanes that were within the DMA.

We reviewed how often these retrospective DMAs overlapped with shipping lanes as well as areas where vessel traffic would likely intersect the right whale areas (e.g., the Gulf of Maine). For each sighting year, a tally of the distance and duration of those DMAs that specifically intersected shipping lanes was compiled. For each shipping lane or shipping area, the total annual duration and the average distance of DMAs imposed were calculated for each year for which that lane or area was reviewed. For each discrete area, the median, mean, maximum, minimum were then calculated using the annual tallies for each lane/area to provide an estimation of best and worst case scenarios and a mean and median annual expected value for each lane/area.

In our initial report, developed prior to the publication of the ANPR, we opted to use a cautious approach and placed a 15 nm buffer to the east of the southern Boston shipping lanes and placed a DMA around any animals within 15 miles of the lanes that fit the trigger criteria. During the stakeholder meetings with industry and after further discussion with NMFS, it was determined that this east of the lanes buffer concept was not necessarily appropriate and that those animals would be provided protection under the Great South Channel SMA. In addition, the general pattern of right whale movements during the springtime tends to be from west to east, thus animals to the east of the lanes may not be likely to shift back into the lanes. These revised criteria eliminated all DMAs in two of the early years (1980 and 1987) in which there were a total of 5 DMAs. It also eliminated seven other DMAs (two in 1981, and one in 1988 and 1998 through 2001). The impact of this revised criteria on traffic passing through the southern Boston lanes was not significant when averaged out over time (previous mean of 39 days and 27 nm changed to 41 days and 18 nm). The mean annual expected number of DMAs changed from 3.8 to 3.6 per year.

The number of DMAs observed in 2002 in the previous report was only 4 but with the additional data, this number increased to 15. In 2003, the number of DMAs was 10.
The addition of almost two years of data increased the maximum duration and distances for most areas but this increase was most dramatic in the southern Gulf of Maine. The mean changed from 7 days and 10 nm to 46 days and 26 nm and the mean annual expected number of DMAs increased from 0.4 to 2.3 DMAs per year. This increase is likely due to a change in the level of survey effort by NMFS with the implementation of broad-scale surveys on a year-round basis.

The discrete areas that were reviewed are: Portland, ME approach-lanes, Boston approach traffic lanes, Providence/Buzzards Bay traffic lanes, and the New York/Ambrose approach sea- lanes. The Gulf of Maine, where there are no designated lanes, was also reviewed. For Cape Cod Bay, we examined two areas, an area west of the critical habitat and an area within the critical habitat but outside the historic timeframe of the proposed SMA for the critical habitat.

The distance of the designated shipping lane covered by the DMA was determined by measuring the maximum extent of the arc of the circle if the circle crossed any portion of the traffic lanes. This results in an over estimation of the number of DMAs imposed that would impact designated shipping lanes. However, for the Boston approach traffic lanes south of the Race Point SMA, within which right whales may be more consistently present on an annual basis, we developed and used a second method for determining the lateral distance along the axis of the lanes to impose the DMA. For this alternate method, the Boston approach traffic lanes were segmented into 5 nm increments (23 sections) beginning in the turn in the lane near Race Point then the southern extent of the lanes to the precautionary area. The lateral distance along the sea within the DMA was dependent on how the arc of the buffer crossed the lanes: a line was drawn from the top and bottom of the arc perpendicular to the lanes. The distance was determined to be the number of segments included by the drawn lines, rounding to whichever segment the arc was closest to and multiplying the number of segments by 5 nm for the total distance. This results in a small estimation of the geographic extent of DMAs imposed that would impact designated shipping lanes. Figure 1 describes the shipping lane segments and the process used to calculate segments covered by the buffer.

Figures 2 and 3 are examples of the DMAs determined; these examples are for 1998 and 2003. The plots of all years are found in Appendix II.

Figure 1 illustrates how the Boston approach shipping lanes in the Great South Channel were segmented into 5 nm increments in order to determine the longitudinal extent of a DMA encompassing part of the lanes.

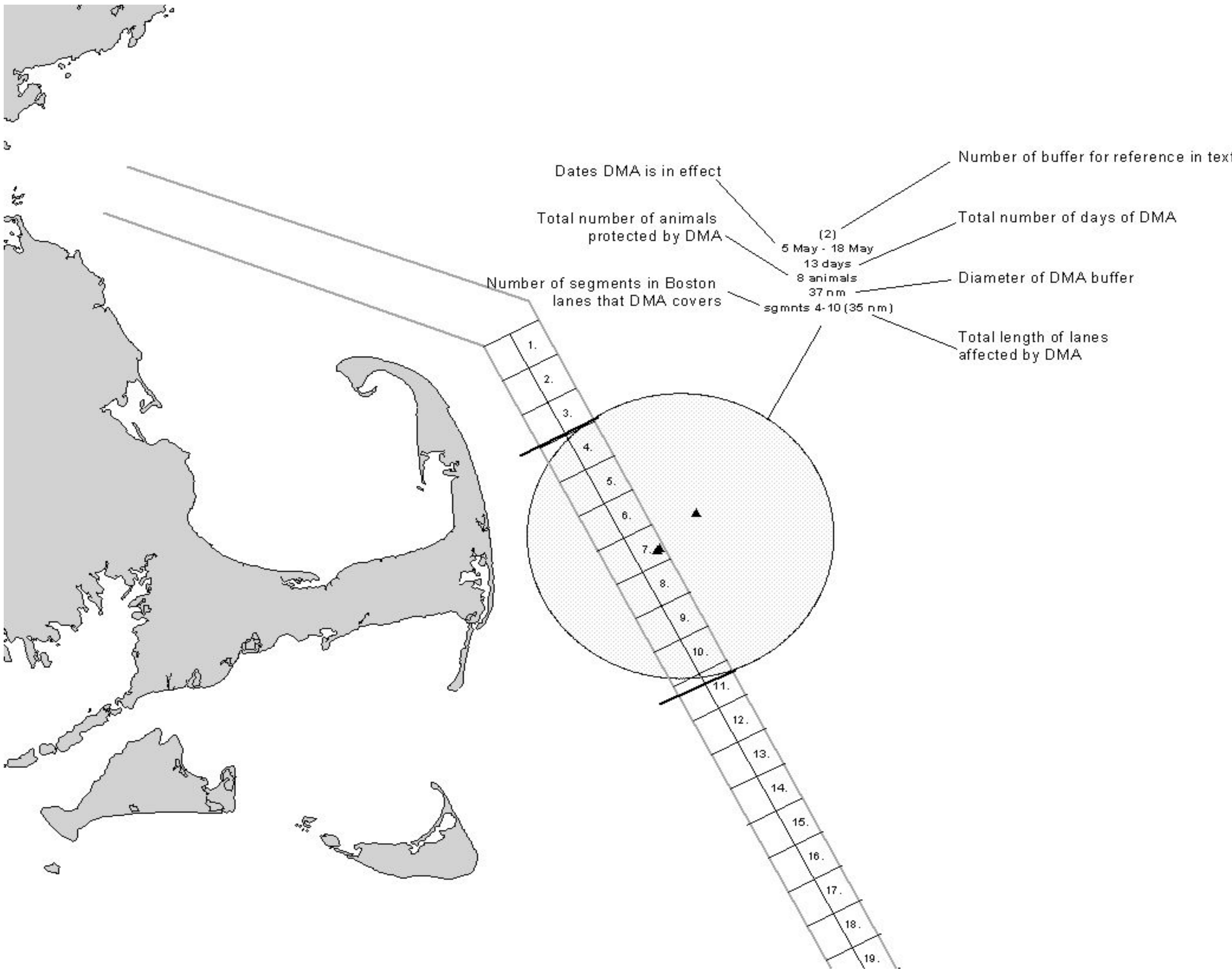


Figure 2 is an example of the DMAs determined; this example is for 1998. The plots of all years are found in Appendix II.

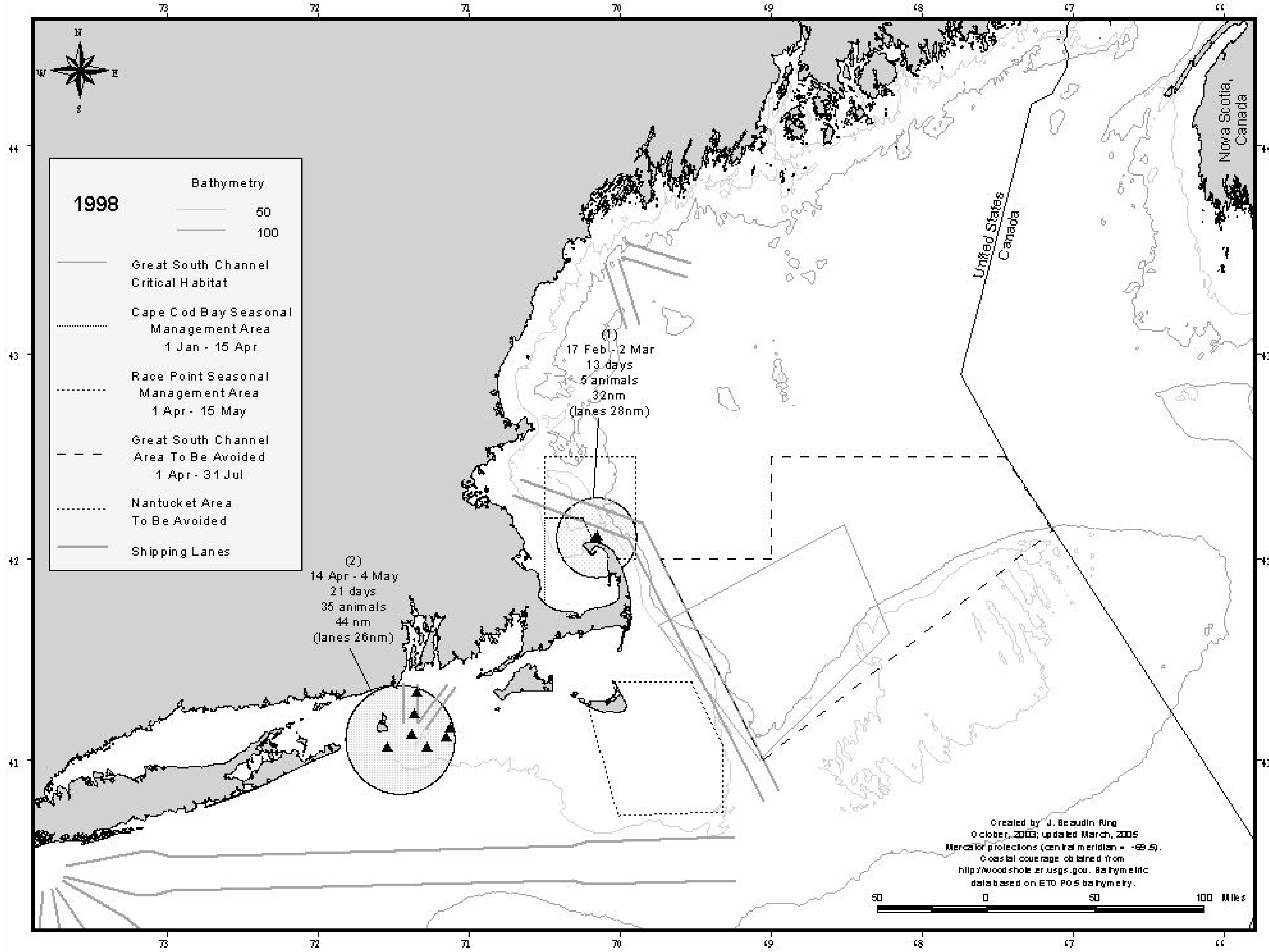
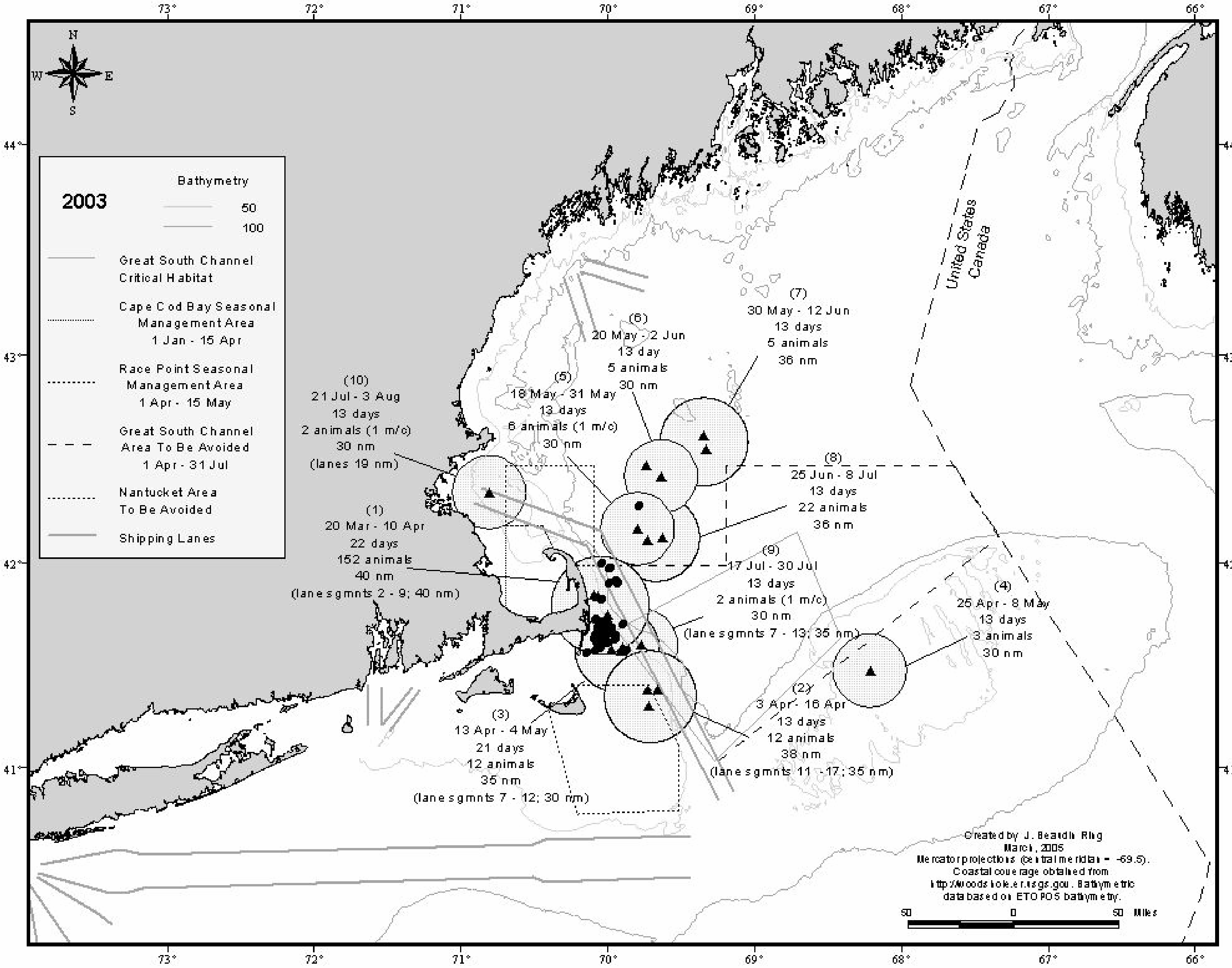


Figure 3 is an example of the DMAs determined; this example is for 2003. The plots of all years are found in Appendix II.



Tables 5a-c are the compilations and calculations for each geographic area of the:

- ➢ mean, median, maximum, and minimum annual duration in days per year of potential DMAs;
- **mean, median, maximum, and minimum average-annual geographic distance of DMAs in the identified areas and the** number of years for which DMAs occurred;
- ➢ total number of DMAs over the study period; and
- ➢ average number of DMAs per year during the study period.

A median of zero (0) implies irregular frequency of occurrence of a DMA in the geographic area. A mean number of DMAs provides an expected annual value of DMA occurrences. The number of years that a DMA was imposed in the region gives insight into the variability of occurrence in the given region. The maximum values provide the worst-case scenario that could occur within a given year (although it should be noted that the maximums for annual duration and average-annual geographic distance could have occurred in different years). In Notes 1A&B and Notes 2A&B we further refine the compilation and calculations in the Gulf of Maine area and for the Boston Approach sea-lanes. For example, masters regularly traveling from Canada, south to Boston would plan a voyage to encounter a DMA at the frequency provided for the entire Gulf of Maine, Table5A. Similarly, masters operating solely in the Southern Gulf of Maine would base voyage planning on the smaller figure in Table 5B, Note 1B. Another example: a master regularly calling Portland, ME routing through the Great South Channel would base voyage planning on potential DMAs in three areas: Great South Channel, Gulf of Maine and Portland Approaches. Information on the seasonal occurrence of right whales can be found in the U.S. Coast Pilots 1-4. Appendix II, the plots of DMAs by year, are useful in understanding historical temporal and geographic occurrence of DMAs.

Tables 5a-c are the compilations and calculations for each geographic area of the mean, median, maximum, and minimum annual duration in days per year of potential DMAs; mean, median, maximum, and minimum average-annual geographic distance of DMAs in the identified areas, # of years with DMA events, total number of DMAs over the study period; and average number of DMAs per year during the study period.

Table 5a

Area/Port	Portland, ME)		Gulf of Maine (Note 1A&B)		Cape Cod Bay, western side		Cape Cod Bay ATBA (outside of ATBA timeframe)		Boston Sea Lanes (Note 2A&B)		Block Island Sound	
	Duration, days	Distance, nm	Duration, days	Distance, nm	Duration, days	Distance, nm	Duration, days	Distance, nm	Duration, days	Distance, nm	Duration, days	Distance, nm
Median	13	6	46	36	0	0	0	0	26	26	0	0
Mean	11	6	53	33	2	5	10	10	41	18	6	5
Minimum	0	0	0	0	0	0	0	0	0	0	0	0
Maximum	24	14	144	95	9	30	48	34	125	71	20	30

Number of Potential Dynamic Management Areas

	Portland, ME	Gulf of Maine	Cape Cod Bay, western side	Cape Cod Bay ATBA	Boston Sea Lanes	Block Island Sound
# of years (out of 6) with DMA events	4	4	1	2		1
6 year total	4*	16	1	5	See Notes 2A&B	1
mean number per year	.8*	2.7	.2	0.8		.2

Table 5b

Note 1	Note 1A		Note 1B	
	Northern Gulf of Maine		Southern GOM	
	Duration, days	Distance, nm	Duration, days	Distance, nm
Median	0	0	46	36
Mean	7	6	46	26
Minimum	0	0	0	0
Maximum	44	31	100	64
Number of Potential Dynamic Management Areas				
# of years (out of 6) with DMA events	1		4	
6 year total	2		14	
mean number per year	0.3		2.3	

Table 5c

Note 2	Note 2A		Note 2B	
	Great South Channel		Northern approaches	
	Duration, days	Distance, nm	Duration, days	Distance, nm
Median	13	29	13	22
Mean	26	17	16	20
Minimum	0	0	0	0
Maximum	87	50	41	31
Number of Potential Dynamic Management Areas				
# of years with DMA events	7 of 13		5 0f 6	
13 year total for GSC / 6-year total for northern approaches	24		10	
mean number per year	1.9		1.7	

3. Review of Sightings Data in the Mid Atlantic

Analytical Approach

A project to analyze all existing right whale sighting and survey effort data in the mid Atlantic region was completed in 2002. This report titled *Right Whale Sightings and Survey Effort in the Mid Atlantic Regions: Migratory Corridor, Time Frame, and Proximity to Port Entrances* by A. Knowlton, J. Beaudin Ring, and B. A. Russell is available from Amy Knowlton. The goal of this effort was to better understand right whale movements through this high-use shipping region. Detailed analyses of time frame, distance from shore and water depth of all right whale sightings were conducted. Buffers ranging from 10-40 nm were placed around each port entrance to determine which buffer distance would capture the majority of sightings near the given port entrance.

Results

The data indicate that buffers ranging from 20-30 nm, depending on the port entrance would capture the majority of animals migrating past the given port entrances. As discussed earlier a range of buffer distances, 20, 25 and 30nm were used when calculating the amount of time needed to transit SMAs at each port entrance.

For the mid Atlantic region, there were few new data points available from the previous effort to warrant a comprehensive re-analysis of port proximity and time frame of presence. However we are proposing that the windows be set at the maximums we originally proposed. Based on our analyses, the timeframes vary from 150-212 days per year, depending on the port. We note however, as complete and comprehensive as these analyses are, these results are based on a paucity of information of right whale occurrence in this area, and should only be considered as a starting point for further research. Further, our original estimates were predicated on managing the pulse of migrating whales; these time frames capture over 95% of the animals.

These results are presented in Table 6.

Table 6 shows the seaward limit of the area and annual duration of proposed seasonal management areas for mid Atlantic ports.

Port	Miles Offshore	Annual Duration
Block Island Sound Approaches	20-30nm	150 days
NY/NJ	30nm	150 days
Ports of Philadelphia	20-30nm	181 days
Norfolk / Hampton Roads	30nm	150 days
Baltimore, MD	30nm	150days
Morehead City, NC	20-25nm	212 days
Wilmington, NC	20nm	212 days
Georgetown, SC	20-30nm	212 days
Charleston, SC	20-25nm	212 days
Savannah, GA	25nm	181 days

Promising modeling research by Russell Leaper and Lex Hiby, *Preliminary Analysis of the Use of Photographic Capture Histories of Individually Identified North Atlantic Right Whales in the Southeast United States to Make Inferences about Whale Occurrence in the Mid-Atlantic Region,* may provide better insights on how whales migrate through the mid Atlantic.

It should be noted that some of the timeframes for certain ports presented in the ANPR were inaccurate. For example, Wilmington and Morehead City both had timeframes of December through April. When reviewing the data of port presence as well as month-by-month sightings along the coast, both of these ports should be changed to October to April timeframe to be consistent with Georgetown and Charleston just to their south. This change was made for the analyses in this report.

The timeframe for the Chesapeake Bay entrance warrants reconsideration in light of the mortality of a pregnant female, “Stumpy” on February 9, 2004. This data indicates a pregnant female was likely migrating southward in the January/February timeframe but January is not presently included in the Chesapeake SMA.

In the northern mid Atlantic, New York and Block Island timeframes warrants reconsideration to also include November as the data indicates that animals are moving through these areas on their way south from September through November.

Our recommended changes for Chesapeake Bay, New York, and Block Island were not included in the analyses for this report.

Finally, we note that many vessels transit coastwise along the eastern seaboard. Generally, northbound deep draft vessel traffic is well offshore using the Gulf Stream to add several knots to the speed over ground. South bound traffic runs near shore, as close as 7-10 nm off the coast, depending on the water depth and vessel draft. Masters of southbound vessels would likely route to the east of the proposed SMAs, (depending on the weather and other conditions), thus adding some additional mileage to their voyages. The shipping data is not available to document the cumulative impact on shipping.

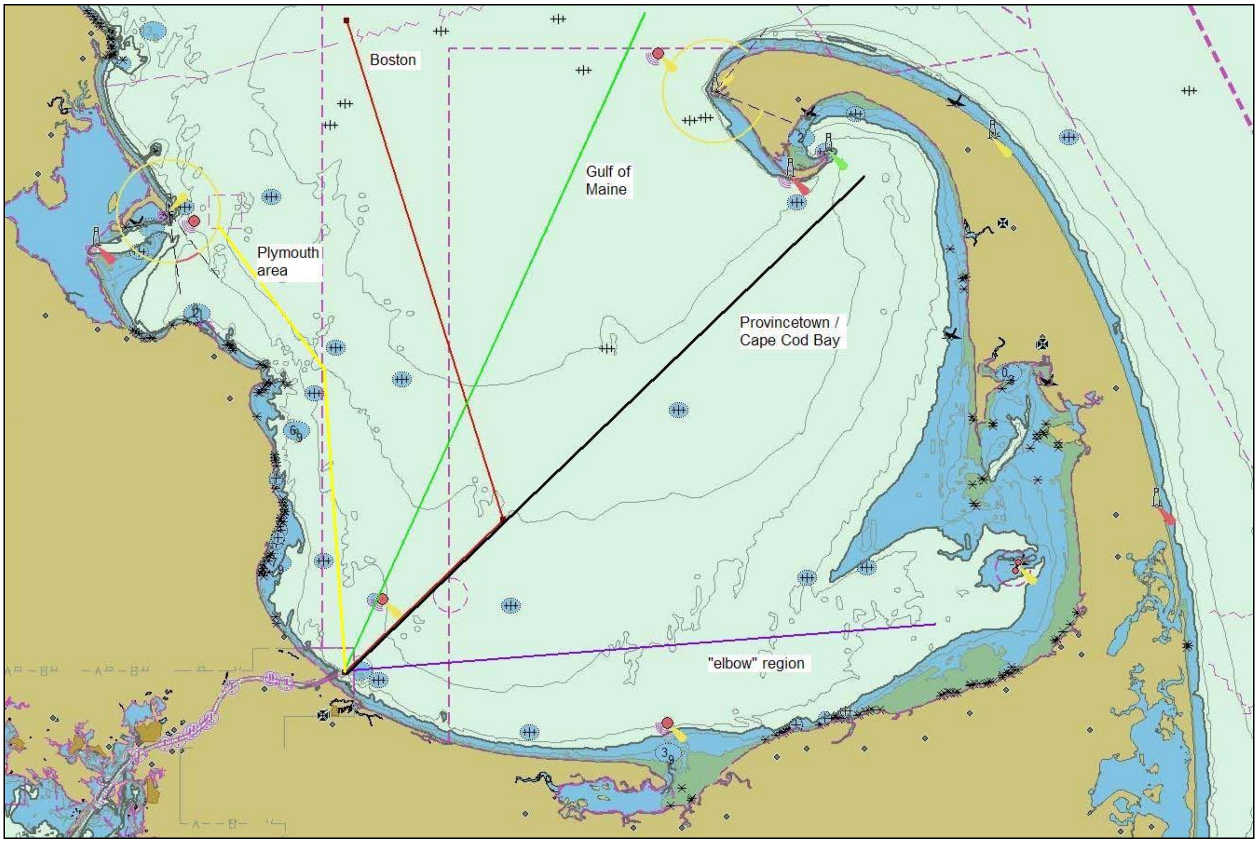
4. Review of Vessel Traffic in Cape Cod Bay

Analytical Approach and Results

In their February 2005 paper report*, Analysis of Risk to North Atlantic Right Whales (Eubalaena glacialis) from Shipping Traffic in Cape Cod Bay,* Owen Nichols, Center for Coastal Studies and Hauke L. Kite-Powell, Woodshole Oceanographic Institute, developed a shipping traffic data base d on information provided by the US Army Corps of Engineers (USACE) for vessels transiting the Cape Cod Canal. They also aggregated this data and identified de facto routes through Cape Cod bay based on origin/destination information. Figure 4 shows these de facto routes.

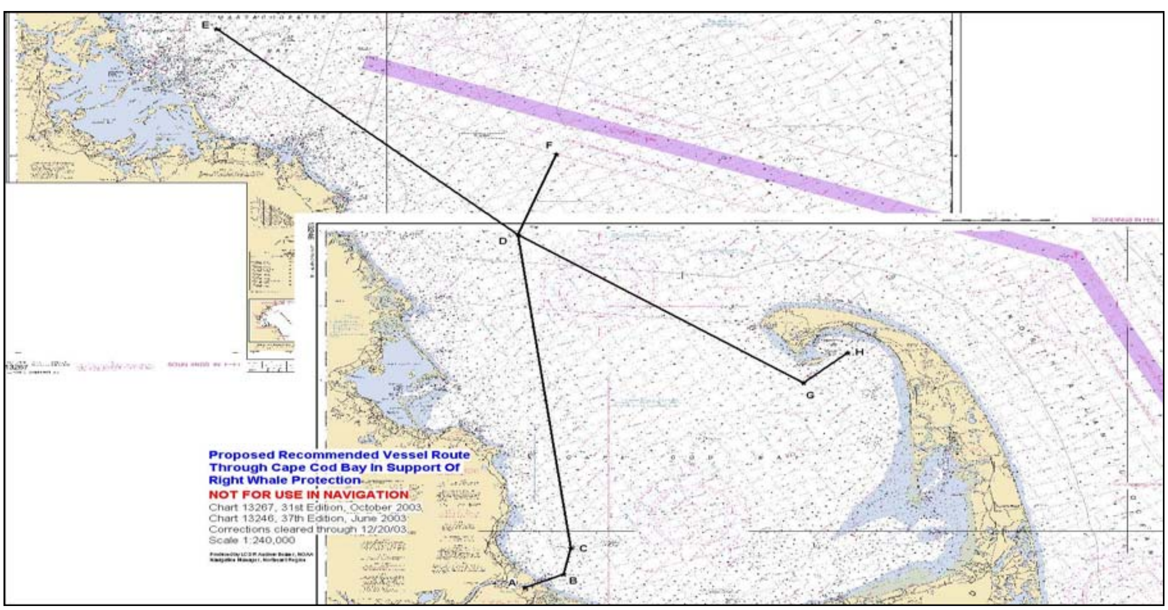
Pat Gerrior, formerly of NMFS Northeast Region, provided a chartlet showing potential designated routes in Cape Cod Bay she developed with Captain Andrew Beaver, National Oceans Service and Captain Larry Palmer Northeast Pilots. These routes are being considered in the Coast Guard's Port Access Route Study. Figure 5 shows these preliminary proposed routes.

Figure 4. De facto vessel traffic routes in Cape Cod Bay. Reproduced with permission from the authors.



Chartlett produced using Fugawi Marine ENC, Northport Systems, and NOAA ENC Coastal Charts.

Figure 5. Preliminary proposed routes – Boston, Gulf of Maine, and Provincetown traffic rerouted northwest from the Canal entrance. Reproduced with permission from the authors.



Chartlett produced by NOAA Fisheries, courtesy of P. Gerrior.

Data on the number or type/category of vessels that would be have been tabulated in Nichols, et al. Larry Palmer of the Northeast Pilots, indicated that the proposed SMA (regulated navigation area or designated routes in Cape Cod Bay and the proposed SMA in the Boston approaches sea lane off Race Point would impact a significant number of vessels using the Cape Cod Canal. Northbound vessels enroute Canada or Europe presently transit across the proposed Cape Cod Bay SMA and the SMA in the Boston approach se-lanes off Race Point. Southbound vessels are avoiding taking a longer route around Cape Cod.

Both northbound and southbound vessels that currently transit across the critical habitat and would be re-routed around the critical habitat. Vessels enroute/to Provincetown to/from the Cape Cod Canal would be routed north-by- northwest before entering the designated southwest lanes to Provincetown.

We simply measured the net increase in distances traveled between the de facto routes and the preliminary proposed routes.

<u>Results</u>

The net impacts are:

- Vessels enroute Boston and the Plymouth from the Cape Cod Canal (and the reverse): ***minimal impacts.***
- Vessels enroute ports north of Boston on the U.S. East Coast and the Bay of Fundy (and the reverse): ***minimal impacts.***
- Vessels enroute eastern Canada (and reverse): ***Approximately 10nm additional miles*** (one-way transit). (See following note.)
- Vessels rounding Cape Cod enroute enroute the Cape Cod canal (and the reverse): ***Approximately 10nm additional miles*** (one-way transit). (See following note.)
- Vessels enroute Provincetown from the Cape Cod Canal (and the reverse): a***pproximately 25nm additional miles*** (one-way transit), and a speed restriction over the last 18nm of their transit.
- Vessels enroute Provincetown from Boston (and the reverse): a speed restriction over the last 18nm of their transit. Pat Gerrior, formerly of NMFS, Northeast Region advised that passenger vessel service do not operate in the period of the proposed measures. Nichols, et al report that there is less than 1 transit per day on this route.

Note: We also expect that during the month of April when measures in Cape Cod Bay and the area off Race Point would both be in force, some of these vessels would not cut across the SMA in the Boston approach sea-lanes off Race Point, as the net transaction costs to slow and then speed up would be higher that steering to the north and west before heading north and east.

5. Review of Sightings Data off Boston Approach Sea-lane off Race Point.

<u>Analytical Approach</u>

A project to review right whale sightings in relation to survey effort was completed in 2001, *GIS Presentation of Survey Tracklines, Right Whale Sightings and Right Whale Movements: 1978-2000*, Knowlton, A., Beaudin Ring, J, Kenney, R.D. and Russell, B.A., 200 and was updated in 2005. This report is available at www.marinegis.org under the News section. One aspect of this project was to look at short term individual animal movements to gain a clearer understanding of how and when right whales migrate between feeding areas.

To understand the movement of right whales in the vicinity of the Race Point sea-lane area, individual animal sightings from Cape Cod Bay to points outside of Cape Cod Bay were reviewed. Little data exists documenting where right whales are arriving from when they enter the Bay in the beginning of the season so this was not reviewed. Shortest distance routes of right whales departing Cape Cod Bay were created to determine where along the sea-lanes; the animals might intercept in transit to offshore areas, especially during the early spring through early summer when their winter food supply in Cape Cod Bay depletes.

We reviewed our original estimates and decided to revisit our approach with the sole objective of determining the duration and longitudinal distance over which the proposed SMA would affect traffic using the Boston approach sea-lane. Thus we focussed only on the examining the eastern and western boundaries of the proposed SMA. We assumed that aggregations of right whales in these sea lanes or several miles to the north of the sea lanes in the Stellwagen Bank Marine Sanctuary, that do not occur regularly could be managed using the proposed DMA measures.

<u>Results</u>

Our original estimates were for 25-35 nautical miles for 30 days. Our analysis found that our high-end estimate, 35 nautical miles, would provide the maximum zone of protection. We also reviewed the duration and concluded that 45 days per year would preclude the need to manage early or late right whale movements dynamically.

Finding: Summary of results by geographic area and recommended vessel traffic-management scenarios for economic analyses

In the following tables, we provide our findings on a port by port basis, and for routes that would be impacted for vessels not necessarily calling at a U.S. port.

In the tables, we provide and note the following.

Second column. For DMAs, mean, median, maximum, and minimum duration and average distance; and, the number of trigger events for 6 or 13 years and the average number per year.

Third column. Where masters, voyage planners and analysts should consider the additional time necessary to slow from sea speed to maneuvering speed and then back to sea speed. (See Table 1). Our calculations for this ***are*** included for all mid Atlantic ports.

Fourth column. Where masters, voyage planners and analysts should consider impacts from other operational measures depending on a vessel's exact route. For example, a vessel calling in

Portland, ME and transiting through the Great South Channel should consider measures in the Great South Channel, the Gulf of Maine and the approaches to Portland. In doing so, Coast Pilots 1 and 2 should be consulted for the geographic and seasonal distribution of right whales. Also, Appendix II provides historical occurrences of DMAs. In this Portland example, it is important to note that on a single voyage a vessel would likely encounter no more than one DMA due to the widespread seasonal distribution of congregating right whales.

Table 7a: Columns 2-4, summary of revised vessel traffic scenario results for Gulf of Maine ports.

Port(s)	Dynamic Management Areas[3]	Seasonal Management Areas[5]	Other factors that may impact vessel traffic
Penobscot River, and Searsport and Portland, ME **Portland, ME**	**Gulf of Maine DMAs** **Mean 53 days, 33 nm** **Median 46 days, 36 nm** **Min 0 days, 0 nm** **Max 144 days, 95 nm** **6 year total: 16** **# of years w/DMAs: 4** **Mean #/year: 2.7** **------------------------------** **In addition, Portland approach sea lanes:** **Mean 11 days, 6 nm** **Median 13 days, 6 nm** **Min 0 days, 0 nm** **Max 24 days, 14 nm** **6 year total: 4** **# of years w/DMAs: 4** **Mean #/year: .8**	**None**	**For vessels calling via Cape Cod Bay or the Great South Channel, see Boston, MA area Great South Channel/Massachusetts Bay approach and Southern approach (to/from Cape Cod Canal).**
Portsmouth, NH and Salem, MA	**Gulf of Maine DMAs** **Mean 53 days, 33 nm** **Median 46 days, 36 nm** **Min 0 days, 0 nm** **Max 144 days, 95 nm** **6-year total: 16** **# of years w/DMAs: 4** **Mean #/year: 2.7**	**None**	**For vessels calling via Cape Cod Bay or the Great South Channel, see Boston, MA area Great South Channel/Massachusetts Bay approach and Southern approach (to/from Cape Cod Canal).**

[3] Speed restrictions must account for additional time to slow from sea speed to maneuvering speed.

Table 7b: Columns 2-4, summary of revised vessel traffic scenario results for the port of Boston.

Port(s)	Dynamic Management Areas[5]	Seasonal Management Areas	Other factors that may impact vessel traffic
Boston, MA area: ***northern approach (to/from Gulf of Maine)***	**Gulf of Maine DMAs:** **Mean 53 days, 33 nm** **Median 46 days, 36 nm** **Min 0 days, 0 nm** **Max 144 days, 95 nm** **6-year total: 4** **# of years w/DMAs: 4** **Mean #/year: 2.7**	**None**	
Boston, MA area: ***Great South Channel / Massachusetts Bay approach***	**Mean 41 days, 18 nm** **Median 26 days, 26 nm** **Min 0 days, 0 nm** **Max 125 days, 71 nm** **13/6-year total: 34** **# of years w/DMAs (of 13/6): 7/5** **Mean #/year: 3.6**	**SMA off Race Point:** **Speed restriction over 35nm for 45 days/year. April 1-May 15**	**Parts of the Great South Channel east of the TSS would be an area to be avoided.** **April 1-July31.**
Boston, MA area: ***Southern approach from Cape Cod Canal*** ——— **Vessels enroute Provincetown from Boston (and the reverse): a speed restriction over the last 18nm of their transit.**	**Mean 2 days, 5 nm** **Median 0 days, 0 nm** **Min 0 days, 0 nm** **Max 9 days, 30 nm** **6-year total: 1** **# of years w/DMAs: 1** **Mean #/year: .2**	**The eastern side of the Cape Cod Bay would be a seasonal area to be avoided and/or designated traffic lanes.** **January 1-April 30** ——— **Vessels would be required to follow a designated route through the critical habitat and to comply with a speed restriction over the last 18nm of their transit.** **January 1-April 30**	**Vessels enroute Boston and the Plymouth from the Cape Cod Canal (and the reverse) should experience minimal impacts.** ———

Table 7c: Columns 2-4, summary of revised vessel traffic scenario results for the port of Boston.

Port(s)	Dynamic Management Areas[5]	Seasonal Management Areas	Other factors that may impact vessel traffic
Southern approach (to/from Cape Cod Canal) to points north and east (e.g. Canada and Europe), south and west (mid Atlantic and Southeast US ports)	**CCB Critical Habitat:** **Mean 8 days, 5 nm** **Median 0 days, 0 nm** **Min 0 days, 0 nm** **Max 48 days, 34 nm** **6-year total: 4** **# of years w/DMAs: 1** **Mean #/year: 0. 7**	**The eastern side of the Cape Cod Bay would be a seasonal area to be avoided and/or designated traffic lanes.** **January 1-April 30**	**-Vessels enroute ports north of Boston on the U.S. East Coast and the Bay of Fundy (and the reverse):** ***minimal impacts.*** **-Vessels enroute eastern Canada (and reverse):** ***Approximately 10nm additional miles*** **(one-way transit). (See following note.)** **-Vessels rounding Cape Cod enroute enroute the Cape Cod Canal (and the reverse):** ***Approximately 10nm additional miles*** **(one-way transit). (See following note.)** **Note: We also expect that during the month of April when measures in Cape Cod Bay and the area off Race Point would both be in force, some of these vessels would not cut across the SMA in the Boston approach sea-lanes off Race Point.**
Vessels enroute Provincetown from the Cape Cod Canal (and the reverse)		**Vessels would be required to follow a designated route to the west of the critical habitat and then east through the critical habitat and to comply with a speed restriction over the last 18nm of their transit.** **January 1-April 30**	**The total additional mileage would be a*pproximately 25nm additional miles*** **(one-way transit), and a speed restriction over the last 18nm of their transit**

Table 7d: Columns 2-4, are summaries of revised vessel traffic scenario recommendations for Block Island Sound Atlantic. The authors are recommending that NMFS revise their proposed strategy to extend the western boundary of the SMA west 20-30nm.

Port(s)	Dynamic Management Areas[5]	Seasonal Management Areas	Other factors that may impact vessel traffic
Block Island Sound and approaches (east of Block Island), including New Bedford, Fall River, MA, and Providence, RI,	**Within Block Island Sound:** **Mean 6 days, 5 nm** **Median 0 days, 0 nm** **Min 0 days, 0 nm** **Max 20 days, 30 nm** **6-year total: 1** **# of years w/DMAs: 1** **Mean #/year: .2**	**For vessels entering BIS from the Atlantic Ocean:** **Speed restriction over 20-30 nm 150 days/year for vessels calling from the Atlantic. Additional time to slow from sea speed to maneuvering speed must be considered.** **March-April & September-October**	**Vessels that approach via the Cape Cod Canal should factor in additional time to transit Cape Cod Bay, depending on their route through Cape Cod Bay. See Table 7b & c.**
Block Island Sound and approaches(east of Block Island), including, New London, CT, New Haven, CT, and Bridgeport, CT		**Speed restriction over 20-30 nm 150 days/year for vessels calling from the Atlantic.** **March-April & September-October**	

Figure 7e: Columns 2-4, are summaries of revised vessel traffic scenario recommendations for mid Atlantic.

Port(s)	Dynamic Management Areas[5]	Seasonal Management Areas	Other factors that may impact vessel traffic
New York / New Jersey	**Approaches subject to DMA**	**Speed restriction over 30 nm 150 days/year February-April & September-October**	**Two or more feeding/foraging right whales (i.e. resident right whales or a mother calf pair) have been sighted in the southern approaches.**
Ports of Philadelphia	**Approaches subject to DMA**	**Speed restriction over 20-30 nm 181 days/year February-April & October-December**	
Baltimore, MD	**Approaches subject to DMA**	**Speed restriction over 30 nm 150 days/year February-April & November-December**	
Hampton Roads area	**Approaches subject to DMA**	**Speed restriction over 30 nm 150 days/year February-April & November-December**	**Current vessel approaches would have vessels transit within the SMA from 30nm to 36.7nm.**

Table 7e (continued) Columns 2-4, are summaries of revised vessel traffic scenario recommendations for mid Atlantic.

Port(s)	Dynamic Management Areas[5]	Seasonal Management Areas	Other factors that may impact vessel traffic
Morehead City, NC	Approaches subject to DMA	Speed restriction over 20-25 nm 150 days/year October-April	
Wilmington, NC	Approaches subject to DMA	Speed restriction over 20 nm 150 days/year October-April	
Georgetown, SC	Approaches subject to DMA	Speed restriction over 20-30 nm 212 days/year October-April	Two or more feeding/foraging right whales (i.e., mother-calf pairs) have been sighted in the approaches.
Charleston, SC	Approaches subject to DMA	Speed restriction over 20-25 nm 212 days/year October-April	Two or more right whales (i.e., surface active groups, and mother-calf pairs) have been sighted in the approaches.
Savannah, GA	Approaches subject to DMA	Speed restriction over 25 nm 181 days/year November-April	Two or more right whales (i.e., surface active groups, and mother-calf pairs) have been sighted in the approaches.

Figure 7f: Columns 2-4, are summaries of revised vessel traffic scenario recommendations for ports within the Southeast U.S. critical habitat

Port(s)	Dynamic Management Areas	Seasonal Management Areas	Other factors that may impact vessel traffic
Brunswick, GA	Approaches subject to DMA	Speed restriction over 22 nm 120 days/year December 1-March 31	Our Analyses do not address rRouting options currently under study.
Fernandina Beach, FL	Approaches subject to DMA	Speed restriction over 22 nm 120 days/year December 1-March 31	Our Analyses do not address Rrouting options currently under study.
Jacksonville, FL	Approaches subject to DMA	Speed restriction over 22 nm 120 days/year December 1-March 31	Our Analyses do not address Rrouting options currently under study.

References

All of these references can be found at: http://www.nero.noaa.gov/shipstrike/

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