NROC White Paper: Overview of the Maritime Commerce Sector in the Northeastern United States

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1. Background

This white paper provides an overview of the maritime commerce sector in the northeastern region of the United States (the coastal waters from Maine to Connecticut). It describes the current status of the sector as well as key issues and trends that are relevant to ocean planning. The paper was commissioned by the Northeast Regional Ocean Council (NROC) to support NROC efforts to reach out to and engage with stakeholders in the maritime commerce sector. The paper's intent is to serve as a starting place for discussions between NROC and sector leaders and participants on key issues and challenges facing the sector, recognizing that the content of the white paper will likely be refined based on these discussions.

This draft paper was prepared by Dr. Hauke Kite-Powell[1], a Research Specialist with the Woods Hole Oceanographic Institution's Marine Policy Center, with input from NROC members. It is based on an analysis of key publications and reports on the sector; it has also been informed by interviews and a web-based survey involving 17 maritime commerce sector leaders conducted by NROC staff during summer 2012, as well as feedback provided by sector representatives at a series working sessions in Portland, ME, Portsmouth, NH, Boston, MA, Quonset, RI, and New Haven, CT in December 2012.

The white paper is organized into the following sections:

1. Background
2. Introduction
3. Status of Sector
4. Issues Facing the Sector
5. Available Data and Data Gaps
6. Conclusions – Implications for Ocean Planning
7. References

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2. Introduction

Commercial shipping is important to the region's and the nation's international and domestic coastal trade. Ships and barges carrying liquid and dry bulk goods, containers, and passengers require clear, safe, and efficient shipping lanes and ocean routes, and appropriate port facilities and infrastructure. Ocean planning activities must take into account the use of coastal waters by commercial vessels and ensure that the allocation of ocean space to other activities and objectives is compatible with safe and efficient maritime transport.

While this white paper focuses on maritime commerce in the waters of the US Northeast, maritime commerce activities intersect with and are affected by developments in other geographic regions and economic sectors. In particular, much of the maritime commerce in the northeast region, especially in the container and cruise ship segments, takes place within a competitive context that encompasses ports in Atlantic Canada, the US mid-Atlantic coast (New York/New Jersey), and international trade and shipping developments in the Pacific and in Europe. Also, commercial fishing vessels account for thousands of commercial vessel movements in northeastern coastal waters each year, but are not treated in detail in this paper.

3. Status of Sector

The commercial ports in the northeastern region of the United States handled about 67 million short tons of cargo in 2010 (Table 1), or 3% of the nation's waterborne trade. Portland and Boston together account for more than half of the cargo moved through the region's ports (in weight terms), and for nearly 70% of foreign imports to these ports. Foreign imports account for about two thirds of all cargo moving through northeastern ports; foreign export cargo is minimal in comparison. About 75% of all cargo (by weight) moved through northeastern ports is inbound crude oil (only to Portland, ME) and refined petroleum products (gasoline, diesel fuel, heating oil).

	foreign trade, 1,000s short tons		domestic coastal trade, 1,000s short tons	
	imports	**exports**	**inbound**	**outbound**
Searsport, ME	1,505	78	248	156
Portland, ME	16,509	20	1,509	8
Portsmouth, NH	2,277	133	545	9
Salem, MA	624	--	34	--
Boston, MA	11,722	1,231	5,847	152
New Bedford & Fairhaven, MA	38	--	46	231
Fall River, MA	593	--	1,524	14
Providence, RI	3,734	549	2,482	301
New London, CT	72	--	887	17
New Haven, CT	2,223	542	6,623	451
Bridgeport, CT	1,281	--	1,744	797
Stamford, CT	--	--	468	67

Table 1: Northeastern United States commercial ports and cargo movements for 2010 (source: US Army Corps of Engineers (2012))

Container traffic in the region is concentrated almost entirely in Boston, which handled about 185,000 TEUs in 2011. The Port of Boston also handled imports of more than 40,000 cars (80 car carrier vessel port calls) and processed more than 310,000 cruise passengers (110 cruise ship port calls) in 2011 (source: MassPort). (The cruise industry and other passenger services, such as ferries, are not included in the cargo statistics in Table 1.) Included in the foreign import trade for Boston is liquefied natural gas (LNG), with about 75 LNG carrier port calls per year. Boston ranks approximately 30th among US ports in total tonnage and TEUs handled per year, with TEU volumes equal to about 10% of the largest North American ports (American Association of Port Authorities).

Unlike bulk cargoes such as crude oil and petroleum products, containers and cars are also commonly moved on roads (via trucks) or on railroads. As a result, northeast regional ports compete for container traffic with ports including New York/New Jersey, Halifax, and Montreal. Unlike bulk carriers, container ships (and cruise ships) often operate on tight schedules and are sensitive to potential delays imposed by factors such as tides and channel depths, and areas closed to navigation because of marine mammals.

Table 2 shows the number of vessel transits for each northeastern region commercial port. Large commercial ship traffic in the region is concentrated in Portland (tankers) and Boston (tankers, container ships, and cruise ships). Most of the "dry cargo" transits are Handymax and Panamax dry bulk ships; in Boston, these also include about 180 container ship and 110 cruise ship port calls. The cruise ship segment is seen as a potential future growth area by several ports in the region, including Boston and Portland. The "tankers" are mainly product tankers; they also include some crude oil carriers in Portland and about 75 LNG tankers in Boston. There is significant barge traffic in Portland, Boston, New Bedford/Fairhaven, Providence, New Haven, Bridgeport, and Stamford.

	Dry cargo ships	Tankers	Dry cargo barges	Tank barges
Searsport, ME	25	92	--	51
Portland, ME	81	262	3	241
Portsmouth, NH	49	68	2	60
Salem, MA	68	--	--	1
Boston, MA	478	370	88	546
New Bedford & Fairhaven, MA	15	--	103	378
Fall River, MA	61	4	27	11
Providence, RI	82	128	22	316
New London, CT	14	2	72	20
New Haven, CT	31	106	55	712
Bridgeport, CT	31	2	552	145
Stamford, CT	--	--	378	34
totals	935	1,034	1,302	2,515

Table 2: Northeastern United States region, commercial vessel calls for 2010, excluding fishing vessels and local and regional ferry traffic (source: US Army Corps of Engineers (2012))

Since each port call involves two transits (one into and one out of the port), the commercial vessel traffic described in Table 2 represents about 4,000 transits of commercial ships and 8,000 transits of barges with tug/tow boats through northeast regional waters each year. Commercial fishing vessels account for perhaps an additional 10,000 transits per year. These numbers can fluctuate substantially with seasonal conditions (e.g. a cold winter increases heating fuel demand and associated vessel transits) and general economic conditions in New England.

4. Issues Facing the Sector

The main issues with ocean planning implications facing the maritime commerce sector in the northeastern region of the United States are related to ensuring safe and efficient shipping lanes and navigation channels. In particular:

- Container ships continue to increase in size due to scale economies and the expansion of the Panama Canal. This puts pressure on container ports (in this case, Boston) to deepen access channels and expand container-handling facilities. Limited availability of areas for dredge material disposal is a problem for some ports in the Northeast.
- Regulations related to ecological and environmental objectives, such as the prevention of ship strikes on Right Whales and the reduction of air pollution from ship engine exhaust, can affect the ability of shipping companies to operate in the preferred or established way. In some cases, the imposition of these regulations can make certain ports less attractive to shipping companies, and possibly put northeastern region ports at a competitive disadvantage.
- Energy industry developments (LNG import/export terminals, offshore wind power staging facilities), expansion of marine aquaculture operations, and the potential future development of coastal marine highways/short-sea shipping (cargo, ferries) may require port expansion in the northeastern region and could increase congestion and the level of commercial traffic.
- In the longer term, rising sea levels and increased storminess and coastal flooding due to climate change are likely to affect the coastal areas of the northeastern United States, including but not limited to facilities and infrastructure associated with maritime commerce.

Each of these issues is explored in greater detail in the sections below.

4.1 Container Ship Size and Channel Dredging

Achieving and maintaining adequate navigation channel depth is a challenge for most ports around the United States. As vessels have grown larger and deeper in response to economic pressures (larger ships tend to be more efficient than smaller ships, especially on longer voyages), ports have deepened and widened their navigation channels and loading/unloading berths. The trend toward bigger ships has largely stopped in the dry bulk and tanker segments of the maritime commerce industry, but continues in container and cruise ships.

A special impetus for deepening navigation channels in US east coast container ports comes from the present effort to increase the capacity of the Panama Canal (USACE 2008). Containers traveling between the Asian manufacturing centers in the Pacific and the US east coast today travel mainly through US west coast ports and via the railway and roadway "land bridge" from the west coast to the east coast. The expansion of the Panama Canal, due to be completed in 2014, will increase the draft that ships can carry through the Canal from 39.5 ft (today's "Panamax" draft) to 49.9 ft. The maximum container ship size capable of transiting the Canal will increase from 5,000 TEU today to about 13,000 TEU. It is widely expected that the ability to move containers between Asia and the US east coast via the Canal on these larger ships will provide a cost advantage over the "land bridge" option and lead to more container traffic on the waters off the US east coast.

For ports seeking to compete for this traffic, it is necessary to upgrade container terminal facilities and navigation channels to accommodate Post-Panamax vessels. Several east coast ports, including New York/New Jersey, Norfolk, and Baltimore, have increased their channel depth to 50 ft. Most of the larger northeastern region ports today have controlling channel depths of 35 to 40 feet. The Port of Boston seeks to deepen the access channel to the container terminals to 48 or 49 ft. Such dredging efforts are often difficult to implement because of the cost of dredging (estimated at more than $300 million for the Boston channel deepening project; and usually shared between the US Army Corps of Engineers and the port, therefore requiring allocation of federal funds) and because of environmental concerns arising from the dredging activity itself and from the disposal of the dredge materials, particularly if the sediments are contaminated.

Dredge material disposal sites are designated by the Environmental Protection Agency under the Marine Protection, Research, and Sanctuaries Act of 1972 (33 U.S.C. 1401-1445, 16 U.S.C. 1431-1447f, 33 U.S.C. 2801-2805), usually following an environmental impact assessment carried out by the US Army Corps of Engineers. Nine disposal sites for dredge material are currently active in the Northeast since the closure of the Cape Arundel site in 2010.[2] Areas that are not well served by nearby disposal sites include eastern Long Island Sound (New London), Buzzards Bay (Fall River and New Bedford), and (potentially) Portland ME, if the Cape Arundel site is not available (W. Hubbard, p.c. 2013).

Historically, less than 5% of dredge material from the Northeast has been contaminated so as to make it unsuitable for ocean disposal. Contaminated dredge material must be disposed of in landfills or, more commonly, in "confined aquatic disposal cells" that are excavated beneath the sea and "capped" with clean fill. These requirements can increase the cost of contaminated dredge material disposal by a factor of 4 or 5 over the cost of uncontaminated material. Beneficial reuse of dredge material, e.g. for beach nourishment, is possible when the material is suitable for use as beach sand (less than 15% mud content). This criterion historically has been met by less than 20% of Northeast dredge material; and beneficial reuse has been limited to a few locations including Chatham and Plum Island (MA) and Saco (ME) (W. Hubbard, p.c. 2013).

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[2] http://www.nae.usace.army.mil/damos/maps.asp

Cost and lack of readily available dredge spoil disposal sites are two major factors holding back the channel improvement project in Boston and maintenance dredging in Portland, ME. In addition to identifying areas for dredge material disposal, ocean planning can identify potential opportunities for beneficial re-use of suitable dredge materials, e.g. for beach nourishment projects, and organize data on potential environmental and ecological concerns that may arise from channel improvement plans.

4.2 Ecological and Environmental Objectives

Maritime commerce generates large economic benefits to the US economy, and to the economy of the Northeast. It can also impose costs, for example as a result of hazardous material spills, air pollution from ships' engine exhaust, and collisions between ships and marine mammals. In the Northeast, the issue of Right Whale ship strikes has been of particular concern because the North Atlantic Right Whale is a highly endangered species, and most of the known animals spend much of the year congregating in waters off New England and Atlantic Canada. Collisions between ships and Right Whales are thought in recent decades to have accounted for several deaths of Right Whales each year (Jensen and Silber 2004). Because these animals are protected under federal law, the risk of ship strikes has led to lawsuits.

To reduce the risk of ship strikes, regulators and the shipping industry narrowed and shifted the shipping lanes leading into Boston across Stellwagen Bank in 2007, and changed the recommended routing of commercial vessels through Cape Cod Bay. (A similar shift of shipping lanes was carried out earlier in Canadian waters in the Bay of Fundy.) Additional protective regulations in the US impose 10 knot speed restrictions on vessels, and encourage them to avoid areas, where aggregations of whales are detected. This kind of speed restriction, and other measures designed to protect Right Whales, affect ports along much of the US east coast, but pose a particular challenge to ports like Boston because the whales are in nearby waters for many months each year, and because cruise ship and (especially) container ship operations are sensitive to potential schedule delays.

Increased attention is being paid to the contribution of ships' engine exhaust to air pollution in the nation's ports. Traditionally, most ships burn heavy (residual) fuel oil to generate power and propulsion. This fuel generally has high sulfur content; and its use results in high levels of particulate emissions unless special exhaust scrubbing equipment is installed. It is possible that stricter regulation of this kind of exhaust gas will restrict how commercial ships can operate in northeast regional waters in the future.

Ocean planning can be useful in the context of these environmental and ecological objectives by delineating areas that are of critical importance to marine mammals, air quality, etc., as well as the maritime commerce industry, thereby supporting systematic analyses of management options that achieve conservation objectives with minimal economic dislocation to the shipping industry.

4.3 Potential Emerging Use Conflicts for Coastal Ocean Space

Some future changes in the use and allocation of coastal marine lands and resources are likely to have significant implications for the maritime commerce sector. In the Northeast, these changes include the allocation of ocean areas to activities such as energy generation (wind power, wave power, tidal current power), aquaculture, and "coastal highways" for "short sea shipping" – a targeted effort to move cargo and people between coastal destinations by sea rather than by land or air. To the extent that they materialize, these developments have the potential to affect maritime commerce both on the water and in ports.

The United States today imports more than 80% of the seafood it consumes. It is likely that economic and food security pressures will lead the US to seek to increase domestic production of seafood. Much of that is likely to come from marine aquaculture; and that will require the allocation of coastal ocean space to fish farms. The development of ocean aquaculture leases in the Northeast is in its infancy, but demand could grow rapidly in the future.

Similarly, as the US works to diversify its energy supply and reduce reliance on fossil fuels, the use of the ocean for renewable power generation (wind farms, tidal current turbines, wave power installations) may become increasingly common. New England has seen first-hand the complications that can arise from siting such projects, in the more than 10-year process of permitting the Cape Wind project in Nantucket Sound. If these and other ocean energy extraction ventures become more common, it will be important to develop streamlined siting procedures that minimize conflicts with other uses of the ocean, including maritime commerce.

Other developments may increase the utilization of northeastern coastal ocean shipping lanes. The United States may be poised to become a major exporter of natural gas, in the form of LNG, in the coming decade. This will require the construction of several LNG export terminals. It is unlikely, but possible, that such a facility could be constructed in the Northeast, bringing with it increased levels of LNG carrier traffic. Perhaps more likely, developers of ocean renewable energy may seek to establish facilities in northeast regional ports to serve as shore bases for the installation and maintenance of offshore energy systems.

The US Maritime Administration has for some time promoted the concept of short-sea shipping or coastal marine highways[3] as a way of relieving congestion on the major land transportation corridors connecting coastal cities (a prominent example is I-95 along the east coast; see Figure 1). In principle, fast and efficient marine transportation options could provide an attractive alternative to trucking for cargo and to vehicle and even air transport for passengers. The concept has been adopted on a large scale in Europe but has not gained traction in the United States, in part because the US Jones Act (section 27 of the US Merchant Marine Act of 1920, P.L. 66-261) requires ships carrying goods or passengers between US ports to be constructed and registered in the US, thereby raising the costs of this option. Other factors holding back expansion of coastal shipping services in the US are summarized in a presentation by Brand (2012), who concludes that policy and regulatory

[3] http://www.marad.dot.gov/ships_shipping_landing_page/mhi_home/mhi_home.htm

changes will be required if such services are to be economically sustainable. These changes might include changes to the Harbor Maintenance Tax and/or the Tonnage Tax for US flag

Figure 1: American Marine Highways concept (source: US Maritime Administration, http://www.marad.dot.gov/ships_shipping_landing_page/mhi_home/mhi_home.htm)

ships, support for US-based ship construction, and tax incentives (carbon or congestion taxes) to ensure that all transport options present the freight market with rates that reflect the full social costs they impose.

In the northeastern region of the US Atlantic Coast north of Boston in particular, limited general cargo (container) freight volumes and competitive rates offered by road transport make coastal shipping services difficult to sustain. However, if adequate policy changes are implemented to improve the economics of the marine highway option relative to road transport, and short-sea shipping becomes more prominent in the future in the Northeast, this will increase utilization of shipping lanes and port facilities in the region.

Recently, reduced wage premiums and energy costs in the United States relative to Asian manufacturing centers have led to the beginnings of a resurgence of manufacturing activity in the US. It is not clear how broad or sustained this resurgence will be, or where manufacturing centers (if any) will emerge in the newly energy-rich United States. If there is a significant return of manufacturing in North America, this would like have major implications for general cargo (container) freight volumes through US ports.

All of these developments have implications for the maritime commerce industry and for ocean planning. In 2010, the US Coast Guard launched the Atlantic Coast Ports Access Route Study[4] on the east coast to determine what new routing measures or changes to existing routing may be necessary to balance the multiple uses of east coast waterways and keep them safe for commercial navigation.

4.4 Climate Change Effects

Sea level rise, increased frequency and/or severity of coastal storms and flooding, and higher rates of coastal erosion are expected to accompany the climate change that will follow from anthropogenic greenhouse gas emissions over the course of century. There are indications that these effects may already be happening at accelerated rates along a section of the US Atlantic coast that includes parts of the northeastern region (Sallenger *et al.* 2012; see Figure 2). Climate change effects may require investment in port facilities and infrastructure to deal with sea level rise in particular; and sea level rise and flooding protection measures should be incorporated into ocean planning, particularly in the vicinity of urban centers.

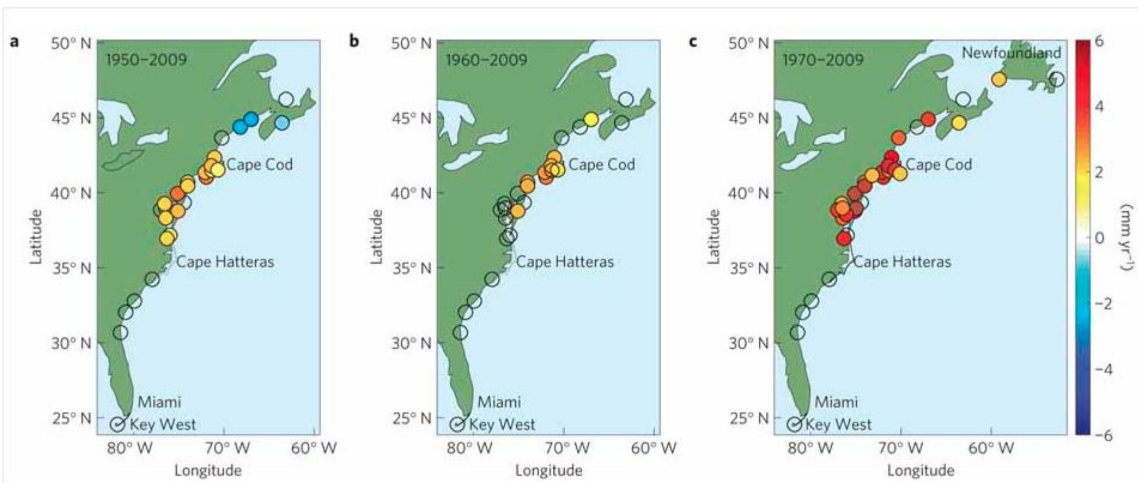

Figure 2: Sea level rise data for US east coast (source: Salenger et al. 2012). Each circle represents a gauge location; circles with no color fill are not statistically different from zero. More gauges were available for plots that show results from shorter time series: **a**, 1950–2009; **b**, 1960–2009; **c**, 1970–2009.

4.5 Economic Implications of Spatial Planning Decisions for Maritime Transport

Broadly, there are two categories of economic implications that flow from ocean planning decisions for the maritime commerce industry. Restrictions on shipping operations that result in shifts of vessel routes generally impose costs on the shipping operation as a result of longer transit distances and times. The economic consequences of such shifts are relatively easy to estimate. More complicated (and significant) consequences may arise from spatial planning decisions (usually in combination with other factors) that cause shipping

[4] http://www.uscg.mil/lantarea/acpars/

operators to modify their use of particular ports of call, perhaps shifting traffic from one port to another altogether.

The economic value of ocean areas as transit lanes for maritime shipping and other vessel traffic can be estimated from the incremental cost to those vessels if they are forced to travel by an alternate (presumably longer) route. Commercial vessels naturally seek the most directly (low cost) transit route between ports of call, subject to safety considerations. If other uses of a section of the ocean preclude vessels from transiting through it, these vessels will incur additional costs that vary with the added distance they have to travel to avoid the "closed" areas.

The cost of closing an area to maritime transits therefore depends on (a) the number and nature of vessels that would use the area if it were not closed, and (b) the incremental distance these vessels must travel given that the area is closed. Each vessel class has a characteristic unit cost per nautical mile of transit. This unit cost depends on the vessel's daily capital and operating cost, and its normal operating speed. Table 3 shows representative unit costs for a range of vessel classes.

Vessel class	Vessel size	Typical speed (knots)	Total cost per day	Cost per nm transit
Dry Bulk Carrier	Handy (27,000 dwt)	13	$17,800	$57
	Handymax (43,000 dwt)	13	$20,900	$67
	Panamax (69,000 dwt)	13	$25,300	$81
	Capesize (150,000 dwt)	13	$34,300	$110
Tanker	Product (45,000 dwt)	13	$24,500	$79
	Aframax (90,000 dwt)	13	$30,600	$98
	Suezmax (140,000 dwt)	13	$38,600	$124
	VLCC (280,000 dwt)	13	$54,400	$174
Container	1,000 TEU	15	$19,500	$54
	1,500 TEU	15	$28,500	$79
	2,000 TEU	20	$32,800	$68
	3,000 TEU	20	$46,600	$97
	4,000 TEU	20	$57,100	$119
LNG Carrier		20	$80,000	$167
Car Carrier		20	$32,000	$67
Tug/Barge	Dry cargo	12	$16,000	$56
	Tanker	12	$16,000	$56
Cruise Ship		20	$80,000	$167
Fishing Vessel		12	$1,500	$5

Table 3: Representative cost per nautical mile (nm) of transit for different vessel classes, based on data from USACE (2002) and Kite-Powell (2001).

For example, traffic entering and leaving the port of Boston in a future year might be forecast to consist of 150 Handymax dry bulk ship movements, 350 product tanker transits, 180 transits of 3,000 TEU container vessels, 75 LNG carrier and 125 car carrier transits, 250 tug/barge movements, and 205 cruise ship transits. A ocean planning decision that increases the transit distance into or out of Boston for this set of vessels by 5 nm would result in increased operating cost of about $620,000. Thus, an estimate of the economic value to the maritime commerce industry of the areas closed to shipping under this zoning decision is about $620,000/year.

If some of this future traffic is diverted to another port as a result of the routing change, the net economic consequences are more difficult to estimate. In that case, there is likely to be a loss of some economic activity in Boston, offset at the regional and national scale by an increase in another port, and a small net increase in cost for the transportation system as a whole.

5. Available Data and Data Gaps

The data required to support ocean planning for maritime commerce include data on the present (historical) use of ocean space for maritime commerce, and data on the local and regional economic implications of potential future changes in this use. Data on the former are, in general, readily available.

5.1 US Army Corps of Engineers Data on Waterborne Commerce

The US Army Corps of Engineers publishes annual reports on the cargo moving through US ports and waterways, and the vessel movements that support this flow of cargo (see US Army Corps of Engineers 2012). Examples of data extracted from this source are shown in Tables 1 and 2 of this paper. These data are useful for developing a historical baseline for the importance of different ports and for the size and nature of vessels that use them. They are best used in conjunction with more specific data obtained from individual port authorities (see below).

5.2 Vessel Track Data

The International Maritime Organization's International Convention for the Safety of Life at Sea requires Automatic Identification System (AIS) equipment to be carried on ships of 300 or more gross tons that are engaged in international trade, and on all passenger vessels. The AIS equipment records and broadcasts information about the vessel's course, along with identifying information. Most of the world's commercial cargo fleet now carries these devices[5]; and it is possible to obtain the track information in real time (see Figure 3) and as an historical track data set (see Figure 4).

[5] http://www.navcen.uscg.gov/?pageName=AISCariageReqmts

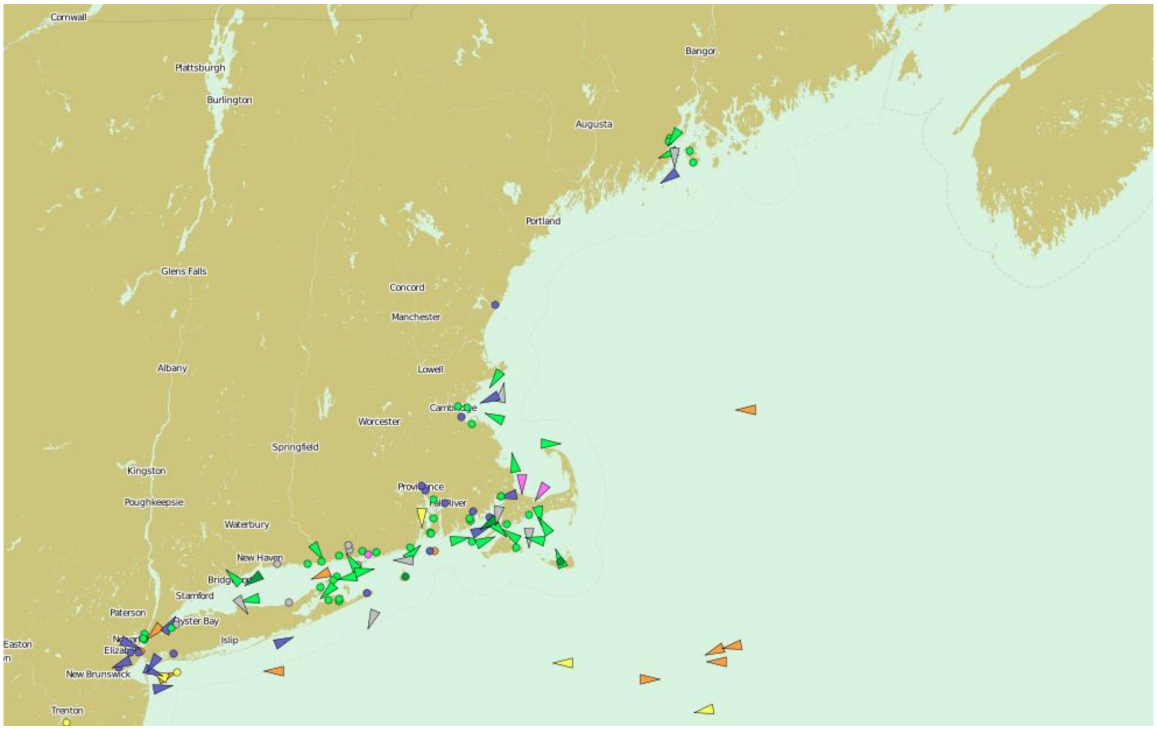

Figure 3: Snapshot of AIS reporting information for the northeast region. (Source: http://www.vesselfinder.com)

In the Northeast, additional vessel track information can be obtained from the Mandatory Ship Reporting[6] System that the National Marine Fisheries Service uses to manage ship strike risk around areas frequented by the North Atlantic Right Whale. Using a combination of these data sources, it is possible to develop comprehensive information on the density and nature of commercial ship traffic in the northeast region's coastal waters – an important baseline component of ocean planning information.

6 http://www.nmfs.noaa.gov/pr/shipstrike/msr.htm

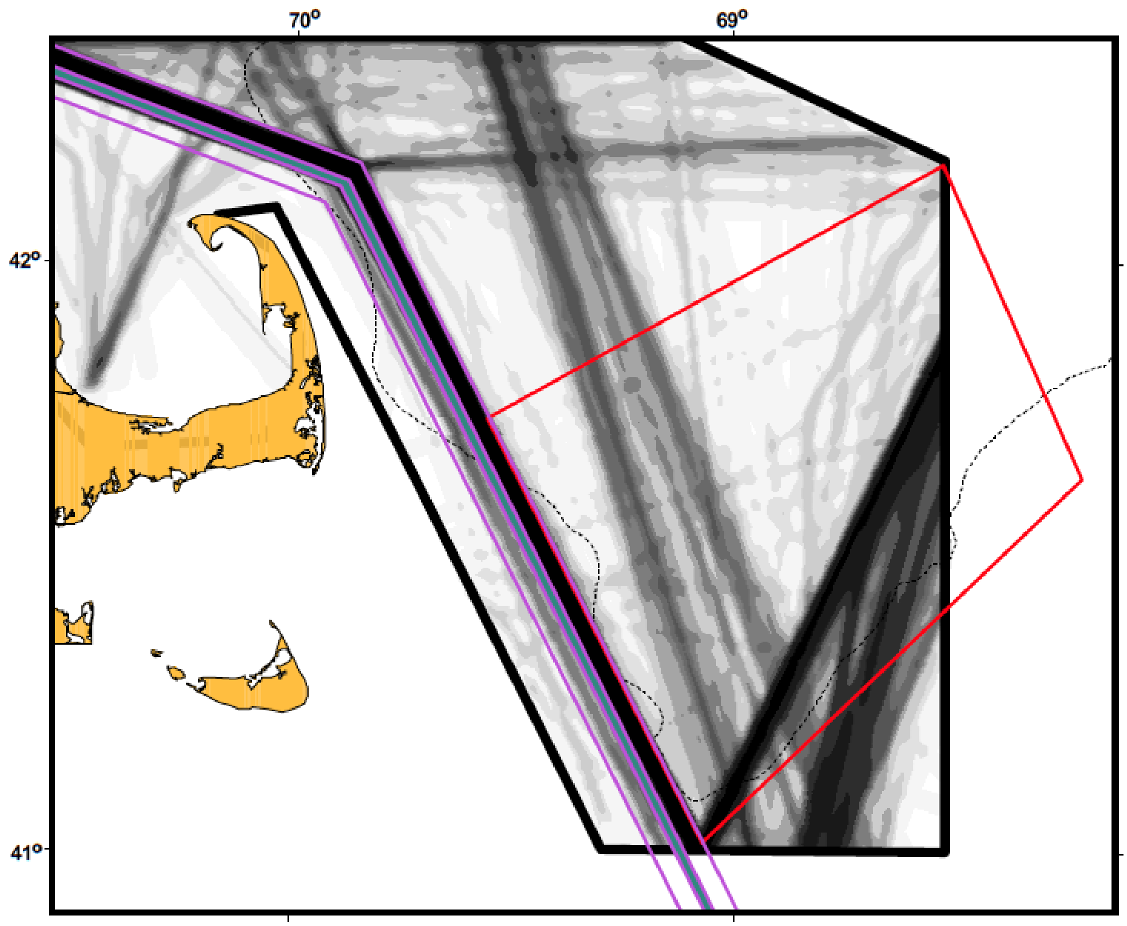

Figure 4: Example of ship track density information derived from reporting sources such as AIS and Mandatory Ship Reporting data, for the Great South Channel and surrounding waters. (Source: Merrick and Cole 2007)

5.3 Port Authority Data

Local port authorities usually maintain more detailed data on vessel calls, vessel movements, and cargo transfers at the terminals under their purview. For example, the Massport Maritime Department provides detailed annual information on maritime commerce throughput for the Port of Boston.[7] These data are sometimes not readily available for extended historical time periods, but they are useful in interpreting and refining the information obtained from the US Army Corps of Engineers and AIS vessel tracking.

5.4 Data Gaps

To understand the implications of alternative future paths for maritime commerce in the Northeast in the context of ocean planning, it is necessary to have data on the economic

[7] http://www.massport.com/port-of-boston/About%20Port%20of%20Boston/PortStatistics.aspx

implications of shifts in commercial vessel traffic and cargo flows. These data are not readily available today. It would be useful to have a sufficiently detailed model/data set representing commercial vessel traffic in northeastern waters and the economic factors that determine ship routing decisions so that shifts in vessel traffic due to allocation of ocean space to wind farms, imposition of emissions restrictions, or changes in future freight patterns, among others, can be analyzed in advance.

Implications of simple shifts in vessel routes can be quantified in economic terms with unit cost data, such as those shown in Table 3 above. More complicated changes, such as shifts in container traffic, passenger ferry service, or cruise ship port calls, require detailed information about the costs of moving cargo and people through different port facilities, including alternatives outside the northeastern region, the onshore implications of these options (trucking of containers, movement of passengers, rail connections), and the direct and indirect economic effects (jobs and revenue generated in cargo handling and storage services, hotel and tourism industry, and others). One way to capture these effects is to link the ocean planning system with a regional input-output economic model.

The tight coupling of maritime transport and land transport of general cargo (containers) and some bulk cargos (e.g. fuel oil) suggests the need for models of regional transportation across the marine/land boundary. Such models could support not only marine spatial planning but also regional transportation planning more broadly by capturing the economics of road/rail/water modes. Marine and road transport are tightly linked in the intermodal container trade, which is dominated by cargos traveling between foreign export centers and US distribution centers for major retail chains. Planners seeking to understand, for example, what policy changes might be needed to make short sea shipping economically viable would benefit directly from a general transportation economics model that projects container flows on different modes as a function of tax structures, fuel costs, subsidies, etc.

6. Conclusions – Implications for Ocean Planning

The waters of the northeastern United States include important maritime commerce routes that presently accommodate some 4,000 transits of commercial ships and 8,000 transits of cargo barges each year. The ports of the northeastern United States handle about 3% of the nation's waterborne cargo. Important factors to consider in ocean planning for the maritime commerce sector in the northeastern region of the United States include (1) projects to deepen navigation channels (Boston) to accommodate post-Panamax container ships and dispose of associated dredge material, (2) regulations to achieve ecological and environmental objectives (prevention of Right Whale ship strikes, reduction of air pollution), and (3) increased use of ocean space for energy development, aquaculture, and marine highways/short sea shipping. Ocean planning can help ensure an efficient and competitive maritime transport industry for the region by providing tools to analyze the operational and economic implications for the shipping industry of ocean use decisions and policies, and by supporting the better integration of regional transportation planning across road, rail, and water modes.

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