4. Coastal and Marine Economy

Data presented in this section on the coastal and marine economy of the Northeast region draws on information assembled for NOAA's ENOW database and on work carried out at the Center for Blue Economy (see below). ENOW (Economics: National Ocean Watch) is a repository of data on the US coastal and marine economy within the Digital Coastal data repository of NOAA's Office for Coastal Management. ENOW data describe six sectors of the United States economy that depend crucially on the oceans and Great Lakes, with annual time series data (from 2005 to 2013, as of 2016) derived from the national accounts of US Bureau of Labor Statistics and Bureau of Economic Analysis, at a resolution of 400 coastal counties, 30 coastal states, and eight regions. ENOW's four economic indicators are the number of business establishments, number of people employed, wages paid to employees, and contribution to gross domestic product (GDP).

Economic value is a human construct, and exists only in the context of human societies that make use of the market goods and services produced by people and the ecosystem services supplied by environmental resources. Because it derives at least in part from people's preferences, which in turn are a function of their circumstances and understanding of the world, economic values are by definition more ephemeral and changeable than, for example, physical or chemical properties of resources. Some economic values can be estimated directly by observing the prices at which goods and services are traded in markets (e.g. the value of a pound of fresh cod fish). Other "non-market" goods and services (e.g. the value derived by a visitor to the Northeast from a day spent at the beach) are not explicitly traded in markets; their economic value must be estimated by techniques such as travel cost and random utility models, hedonic methods, or contingent valuation.

All data used in Section 4 of this document are based on information assembled for NOAA's ENOW database and on work carried out at the Center for Blue Economy, unless otherwise cited. Data on market and non-market ocean economy values and indicators are also available from the National Ocean Economics Program hosted by the Center for the Blue Economy at the Middlebury Institute of International Studies at Monterey, CA.

Section 4.1 provides an overview of the Northeast's ocean economy, as defined by NOAA's ENOW data, in terms of direct employment and value-added (GDP) contribution. Section 4.2 discusses broader impacts or "multiplier effects" of the Region's ocean economy. Sections 4.3 through 4.10 provide additional detail on each major ocean economy sector and the Region's ocean-related national security and research and education activities.

4.1. Direct employment and GDP contribution

The ocean economy (defined as marine construction, living resources (fisheries and aquaculture), ship and boat building, marine transportation and related services, ocean tourism and recreation, and a small minerals sector) directly generated $20.8 billion in GDP and directly supported more than 300,000 jobs in the Northeast in 2013. This represents about 1% of regional GDP and 2% of overall employment for Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut. This proportion is highest for

Maine and Rhode Island, where approximately 4% of GDP and 7-8% of employment are generated by the ocean sector. Tourism and recreation is the largest ocean economy sector in the region, accounting for 50% of ocean economy value added and 75% of employment. Tables 2 and 3 show the breakdown by ocean economy sector and state.

Note that this definition of the ocean economy does not include either national security (US Navy, US Coast Guard) activities associated with the ocean, or marine-related research and education activities, such as oceanography departments of the Region's colleges and universities. As a result, the aggregate ocean economy employment and GDP numbers presented in sections 4.1 and 4.2 do not include contributions from national security or from research and education. Although ENOW-compatible data on employment and GDP contribution for these activities are not available, information on their broader impacts is included in section 4.9 and 4.10 below.

	$ millions (2013)						
	ME	**NH**	**MA**	**RI**	**CT**	**NY**	**Northeast Region**
Living Resources	574.2	67.4	874.9	137.0	69.9	90.6	**1,813.9**
Tourism & Recreation	1,242.3	291.7	3,237.7	1,450.2	1,726.8	2,356.9	**10,305.5**
Transportation	195.7	1,058.4	2,195.3	273.6	817.1	889.2	**5,429.3**
Ship & Boat Building	677.3	--	30.7	309.8	1,679.8	2.1	**2,699.6**
Construction	30.2	6.9	127.9	24.1	49.7	86.8	**325.6**
Minerals	97.3	7.3	25.4	20.6	97.4	17.0	**265.5**
Ocean Economy	**2,817.4**	**1,431.7**	**6,491.7**	**2,215.3**	**4,440.7**	**3,442.6**	**20,839.5**

Table 2 Ocean economy GDP by sector and state, 2013

			jobs	(2013)			
	ME	**NH**	**MA**	**RI**	**CT**	**NY**	**Northeast Region**
Living Resources	7,744	566	7,436	1,385	818	2,473	**20,421**
Tourism & Recreation	30,694	7,328	68,063	34,439	36,875	64,188	**241,586**
Transportation	3,378	6,039	11,261	2,792	4,172	9,956	**37,599**
Ship & Boat Building	11,080	--	463	3,715	9,203	123	**24,584**
Construction	342	85	1,591	173	355	909	**3,455**
Minerals	328	43	151	176	306	328	**1,332**
Ocean Economy	**53,566**	**14,062**	**88,963**	**42,679**	**51,729**	**77,978**	**328,976**

Table 3 Ocean economy direct employment by sector and state, 2013

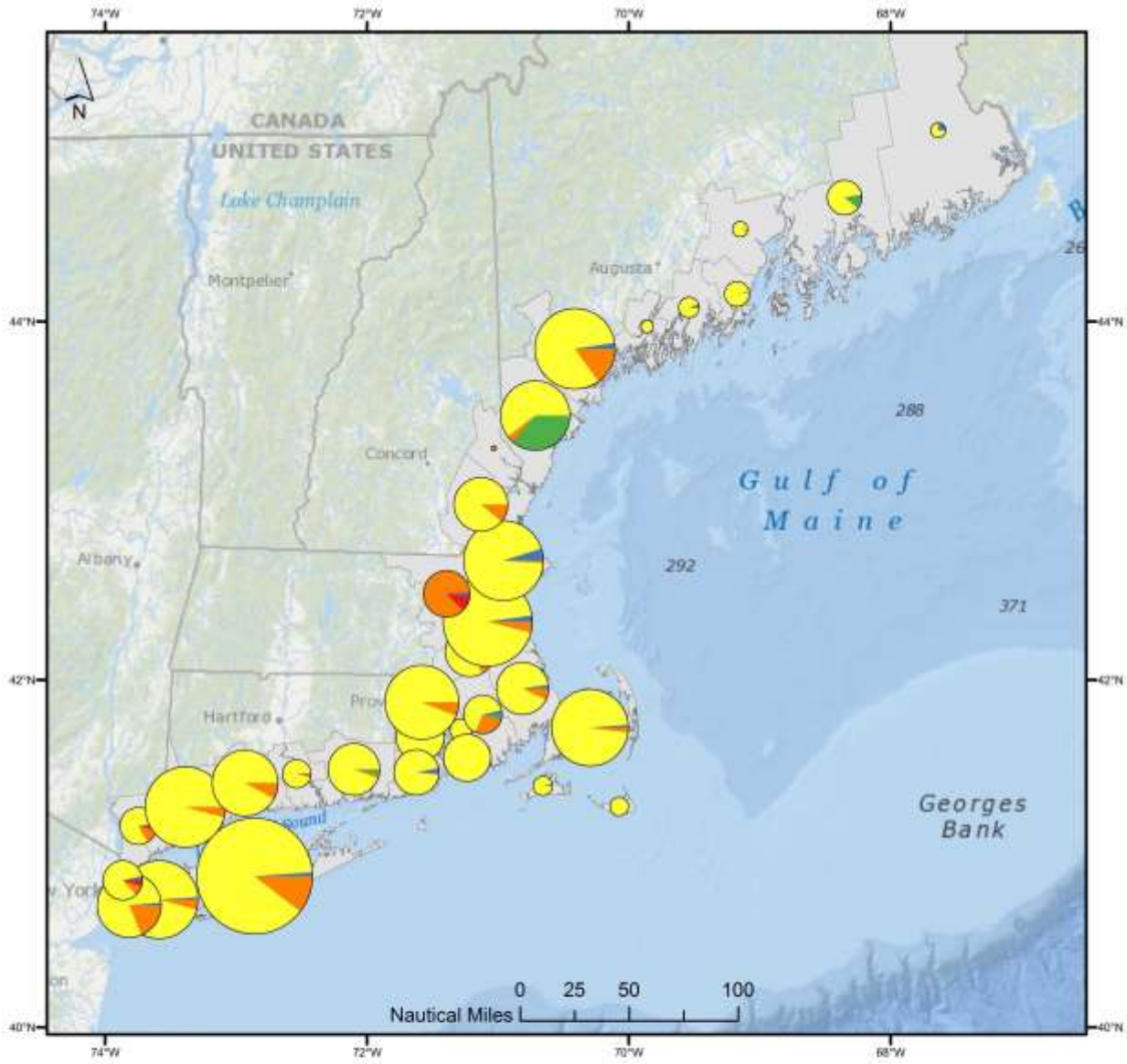
The data in Table 2 and Table 3 capture GDP and employment information from Northeast coastal counties, which comprise the 33 counties from Maine to New York included in the NOAA ENOW data set (Table 4). (Among other things, NOAA uses the population data for these and other coastal counties to calculate funding under section 306 of the Coastal Zone Management Act.) Because of their location in the coastal zone and their proximity to ocean resources and amenities, data from coastal counties result in a better estimate of ocean-related economic activity than data from coastal states.

Geographically, much of the Northeast region's ocean economy is concentrated in urban areas like Suffolk County (Boston, MA) and the New York City region (Figures 23 and 24). But Barnstable County (Cape Cod, MA), Suffolk County in New York, and Cumberland County in Maine have significant ocean economy employment, largely from tourism and recreation.

State	Counties
Maine*	Cumberland
	Hancock
	Knox
	Lincoln
	Sagadahoc
	Waldo
	Washington
	York
New Hampshire	Rockingham
	Strafford
Massachusetts	Barnstable
	Bristol
	Dukes
	Essex
	Middlesex
	Nantucket
	Norfolk
	Plymouth
	Suffolk
Rhode Island	Bristol
	Kent
	Newport
	Providence
	Washington
Connecticut	Fairfield
	Middlesex
	New Haven
	New London
New York	Bronx
	Nassau
	Queens
	Suffolk
	Westchester

Table 4 Northeast region coastal counties

*NOAA includes Kennebec and Penobscot counties in the list of Maine's coastal zone counties for the purpose of calculating coastal population and other statistics, because they contain tidal waters within their boundaries. These counties are not included in the ENOW data because most economic activity in those counties is not closely linked to the ocean.



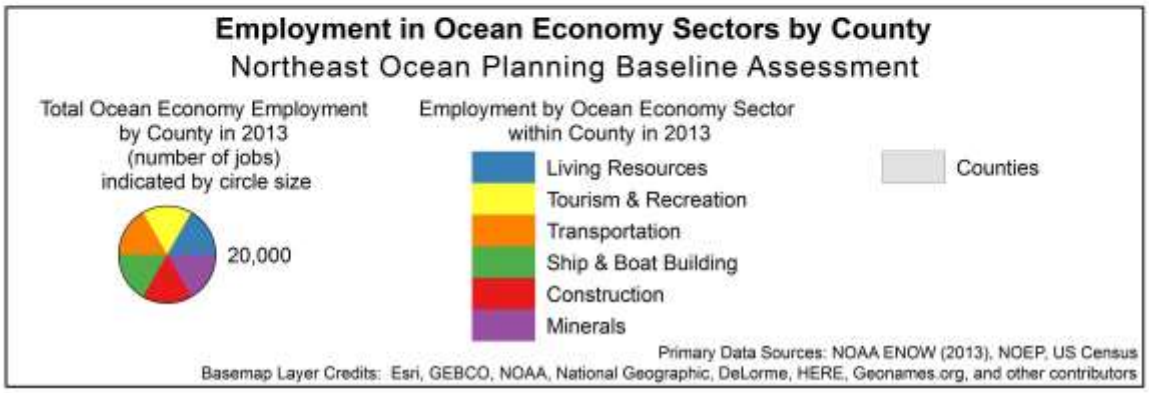


Figure 23 Employment in ocean economy sectors by county, 2013

The contribution of the ocean economy to each county's GDP (Figure 24) shows similar patterns as ocean economy employment. Essex County in Massachusetts and Fairfield County in Connecticut have among the largest ocean economies measured by absolute GDP or value added.

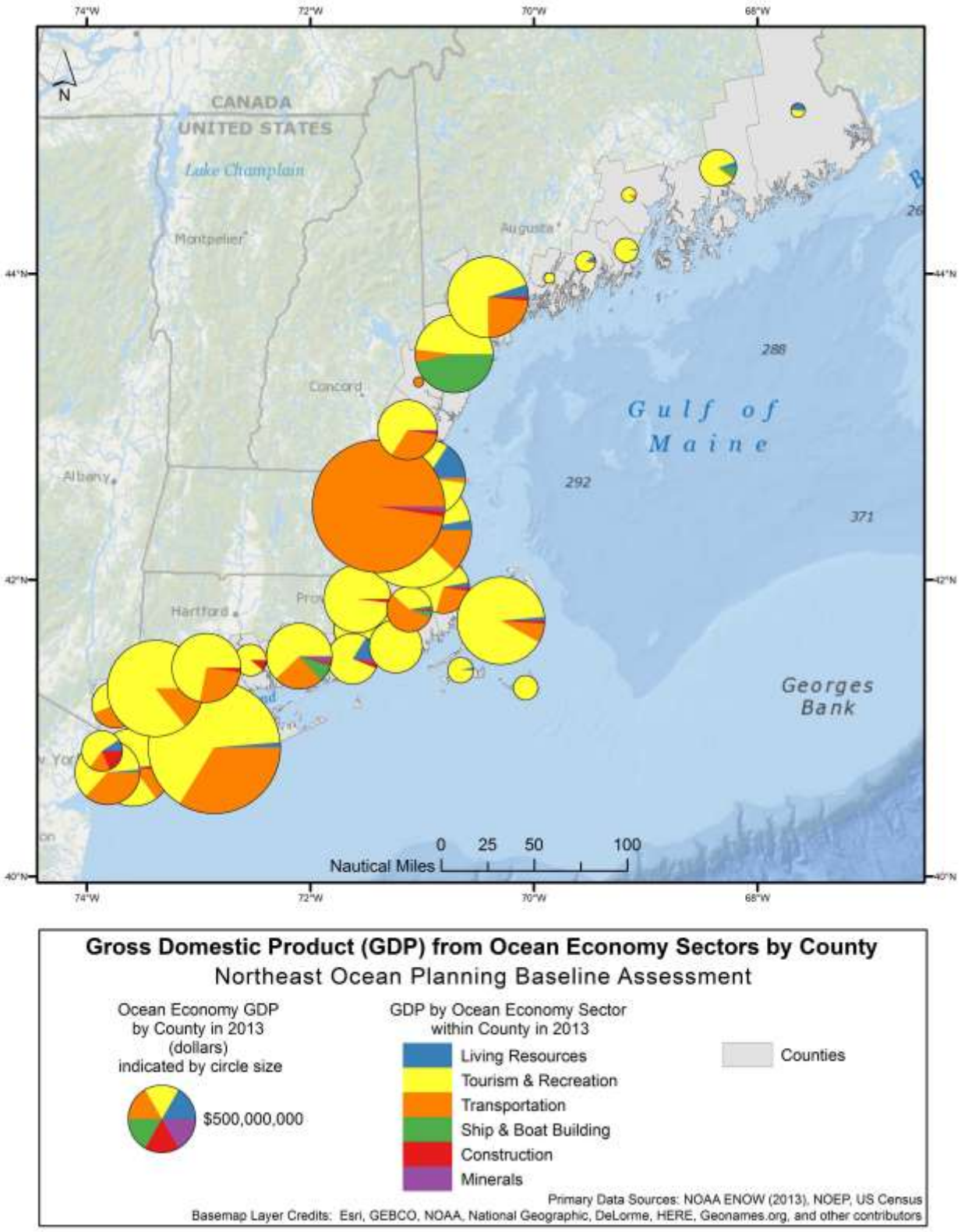


Figure 24 GDP from ocean economy sectors by county, 2013

While the ocean economy is largest, as measured by GDP contribution, in the more urban areas of southern New England, it is most important in relative terms, as a proportion of overall economic activity, in coastal Maine, Cape Cod and the Islands (Massachusetts), and Washington County (Rhode Island). Figure 25 illustrates this stronger relative dependence of some coastal communities on the ocean economy, using employment measures. This highlights the fact that non-urban coastal communities tend to be much more dependent on ocean resources and the ocean economy than larger urban center with significant non-ocean-dependent industries.

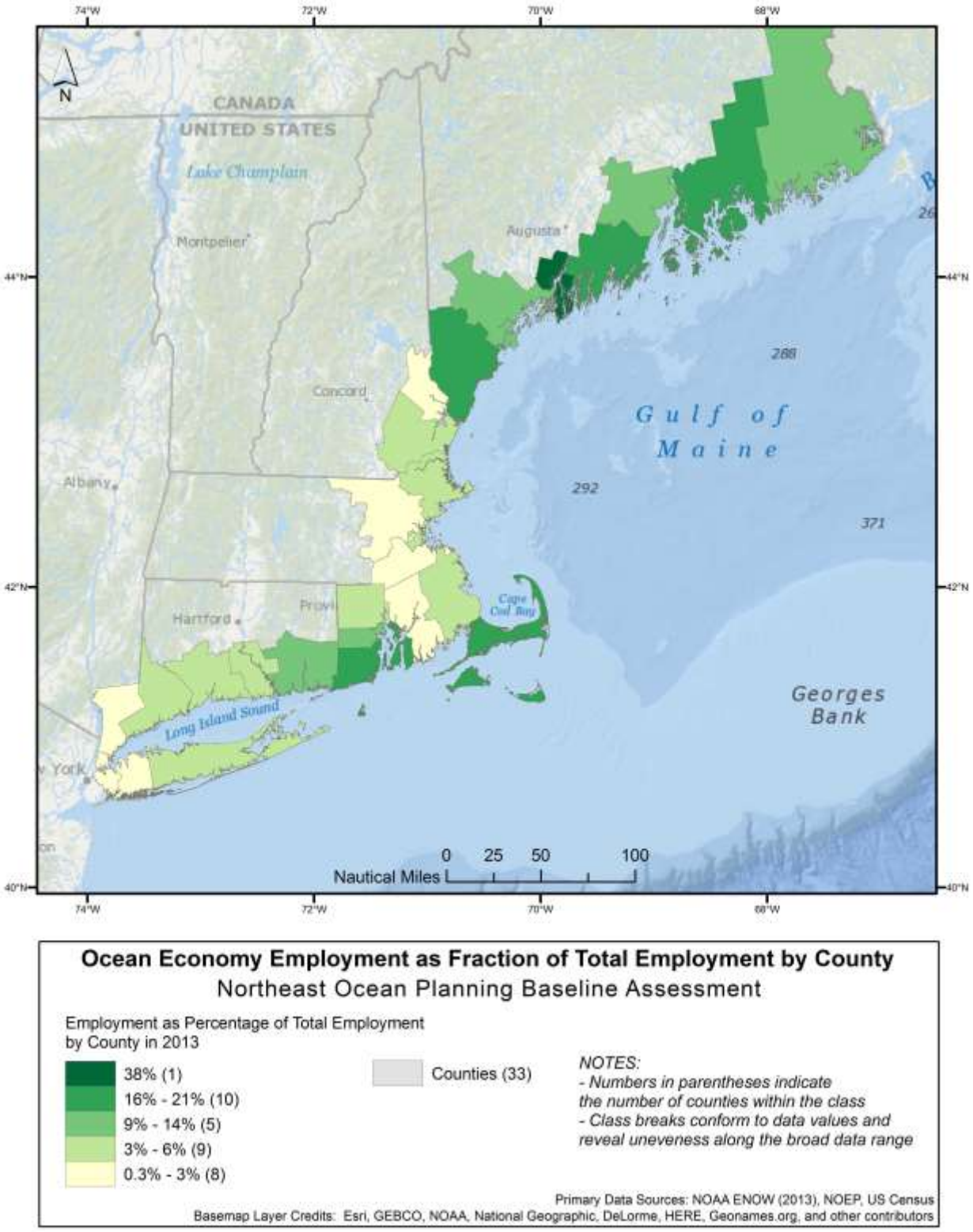


Figure 25 Ocean economy employment as fraction of total employment by county, 2013

4.2. Broader regional impacts of the ocean economy

The Northeast region's ocean economy is a subsector of the overall regional economy. Industries in the ocean sectors are closely connected with industries in non-ocean sectors, and thus exert broader economic impacts on the regional economy. Understanding these broader impacts is important to understanding the total regional economic effects of changes in ocean resource use and activity. This section describes estimates of these linkages and the broader regional economic impacts of the Northeast ocean economy.

The broader impacts of an economic sector are sometimes described as "multiplier effects" or, more specifically, indirect and induced employment and GDP effects. For example, when a new seaside hotel is built in a coastal community, the resulting additional jobs in the hotel and income earned by the hotel's employees are measured as "direct" effects in the ocean economy; these would be reflected in increases in the "tourism and recreation" sector numbers in Tables 2 and 3 above. Changes in related industries, such as additional jobs and income in the industrial laundry and food service supply industries, are considered "indirect" effects of the new hotel. And finally, the increase in household incomes of the hotel, laundry, and food service employees lead to "induced" effects, which include higher regional spending on groceries, housing, automobiles, services, etc. Similarly, using a fisheries example, if a fishing vessel is taken out of service, the resulting lost fishing jobs and income are measured as "direct" effects in the economy. Changes in related industries, such as lost jobs and income in boat repairing, are "indirect" effects; and lower household incomes for employees in the affected industry and in the industries to which it is connected lead to "induced" effects. A standard tool for estimating these multiplier effects is an input-output (IO) model (Miller and Blair 1985; Hoagland *et al.* 2005), which measures the "connectedness" between different sectors of a region's economy.

Tables 5 and 6 show the direct, indirect, and induced GDP and employment effects of the Northeast's ocean economy sectors, based on estimates from a modified IMPLAN input-output model (MIG 2000). The six ocean sectors directly generated $20.8 billion in GDP (see Table 2 above) and employed 329,000 people (Table 3 above) in 2013 in the Northeast. Accounting for the indirect and induced effects of about $19.8 billion, the total GDP impact of the six ocean sectors was $40.6 billion in 2013 (Table 5) – or about 2% of total regional GDP. With about 173,000 indirect and induced jobs attributed to ocean economy sector, total employment impacts for 2013 come to 502,000 jobs (Table 6).

	$ millions (2013)			
	Direct	**Indirect**	**Induced**	**Total**
Living Resources	1,813.9	751.7	868.9	**3,434.5**
Tourism & Recreation	10,305.5	3,595.7	4,727.8	**18,629.0**
Transportation	5,429.3	3,382.1	3,094.7	**11,906.1**
Ship & Boat Building	2,699.6	1,315.4	1,487.7	**5,502.8**
Construction	325.6	127.4	172.0	**625.0**
Minerals	265.5	85.8	142.5	**493.7**
Ocean Economy	**20,839.5**	**9,258.1**	**10,493.6**	**40,591.1**

Table 5 Direct, indirect, and induced ocean economy GDP by sector, 2013

	jobs (2013)			
	Direct	**Indirect**	**Induced**	**Total**
Living Resources	20,421	3,428	4,510	**28,358**
Tourism & Recreation	241,586	33,186	53,723	**328,495**
Transportation	37,599	20,756	21,251	**79,606**
Ship & Boat Building	24,584	13,910	17,934	**56,428**
Construction	3,455	1,279	1,904	**6,637**
Minerals	1,332	435	815	**2,582**
Ocean Economy	**328,976**	**72,994**	**100,136**	**502,105**

Table 6 Direct, indirect, and induced ocean economy employment by sector, 2013

As mentioned above, tourism and recreation is the largest sector within the Northeast's ocean economy, accounting for 73% of its direct employment and 49% of its direct GDP contribution. Transportation, ship and boat building, and living resources are in the second tier set of ocean economy sectors. Overall, indirect and induced employment in the ocean economy is 22% and 30%, respectively, of direct employment; and indirect and induced GDP is 44% and 50%, respectively. This means that, averaging across all ocean economy sectors, an increase in 10 direct ocean economy jobs results in five additional jobs outside the ocean economy; and every additional dollar of ocean economy GDP results in just under one additional dollar of GDP through multiplier effects.

However, the ocean economy sectors differ greatly in the size of their multiplier effects. Tourism and recreation, and living resources, have relatively modest indirect and induced employment effects: indirect and induced employment amounts to 14-17% and 22% of direct employment, respectively, in these sectors. In contrast, the ratios are 55% and 57% for transportation, and 57% and 73% for ship and boat building. That means that for 10 additional jobs in living resources or tourism and recreation, the region should expect about four other new jobs to be supported, whereas ten additional jobs in transportation or ship and boat building might support 13 new jobs in other sectors. These multiplier ratios are important to consider in estimating the total regional economic impact of future changes in the ocean economy sectors. It is also important to consider site specific vs. regional characteristics of categories such as living resources and tourism sectors. For example on the coast of Maine, seafood transportation, packaging, gear shops, and shore side support facilities all rely on the living resource sector in part if not in whole, which the ENOW data may not adequately capture.

4.3. Seafood

Based on NOAA's ENOW data (see introduction to Section 4 above), the living marine resources sector (commercial fishing, aquaculture, and seafood processing) encompassed about 1,200 establishments and supported more than 20,000 direct jobs in the Northeast in 2013, with a contribution to regional GDP of about $1.8 billion.

The economic contribution of fisheries can be measured a variety of ways. For example, ENOW data focus on measures such as GDP, the net value added by an economic sector. Other documents, such as the Fisheries Economics of the United States (NOAA 2014), estimate measures such as "sales impact," the total sales revenue generated by the sector. Each measure has its purpose, but it is important to keep in mind that a measure such as "sales impact" can include sales revenue from a single fish at the dockside, wholesale, and retail level – a form of double counting, if the goal is to estimate the value of the fish. GDP, in contrast, measures the net value added at each stage in the value chain. As a result, "sales impact" and "economic impact" numbers often are significantly larger than "GDP" numbers.

To illustrate, NOAA's *Fisheries Economics of the U.S. 2012* (NOAA 2014) estimates that the total sales impact of the New England Region's seafood industry for 2012 was close to $13 billion – nearly 10 times the contribution to GDP estimated by ENOW. Total sales revenue for fishermen, processors, dealers, wholesalers, distributors, importers, and retailers were $603 million in Connecticut, $1.9 billion in Maine, $8.5 billion in Massachusetts, $609 million in New Hampshire, and $1.2 billion in Rhode Island. Massachusetts generated the largest impacts in the region, with 107,000 jobs, $2.2 billion in income, and $3.4 billion in value added impacts. The smallest income impacts were generated in Connecticut, with 3,900 jobs and $128 million in income.

4.3.1. Commercial fishing

The cultural and economic importance of commercial fishing in New England spans hundreds of years. There is no single commercial fishery in New England; fishing

operations vary from harbor to harbor depending on a myriad of factors, which vary throughout the region and over time: targeted species, vessel sizes, proximity to fishing grounds (current and historic), changes in environmental conditions, economic and market-driven forces, shore-side supporting infrastructure, and many more. Commercial fishing in Maine currently looks quite different than in southern New England. Ports such as New Bedford and Gloucester, Massachusetts (scallops and groundfish) and Stonington, Maine (lobster) have consistently ranked among the top US ports in terms of landings value in recent years (Fisheries Economics of the US 2012).

In 2012, commercial fishermen in New England landed 664 million pounds of finfish and shellfish worth about $1.2 billion in landings revenue (Fisheries Economics of the US 2012). This was a 72% increase (a 24% increase in real terms) from 2003 levels ($691 million) and an 8.1% increase (a 8.5% increase in real terms) relative to 2011 ($1.1 billion). While the 2012 report summarizes economic information related to commercial and recreational fishing activities and fishing related industries in regions of the US, it is important to note that fishing activity is heavily influenced by regulatory factors such as closed areas and that the ability to effectively map fishing activity (Figures 27-33) is limited by the monitoring requirements of a particular fishery and on specific components of that fishery. Figure 26 illustrates the scale and composition of commercial fisheries landings by port. Ports with the largest landings (by weight) are New Bedford MA (mainly scallops and finfish), Gloucester MA (finfish), and Stonington ME (mainly lobster). In general, Massachusetts landings are dominated by finfish and scallops, while Maine landings are dominated by lobster.

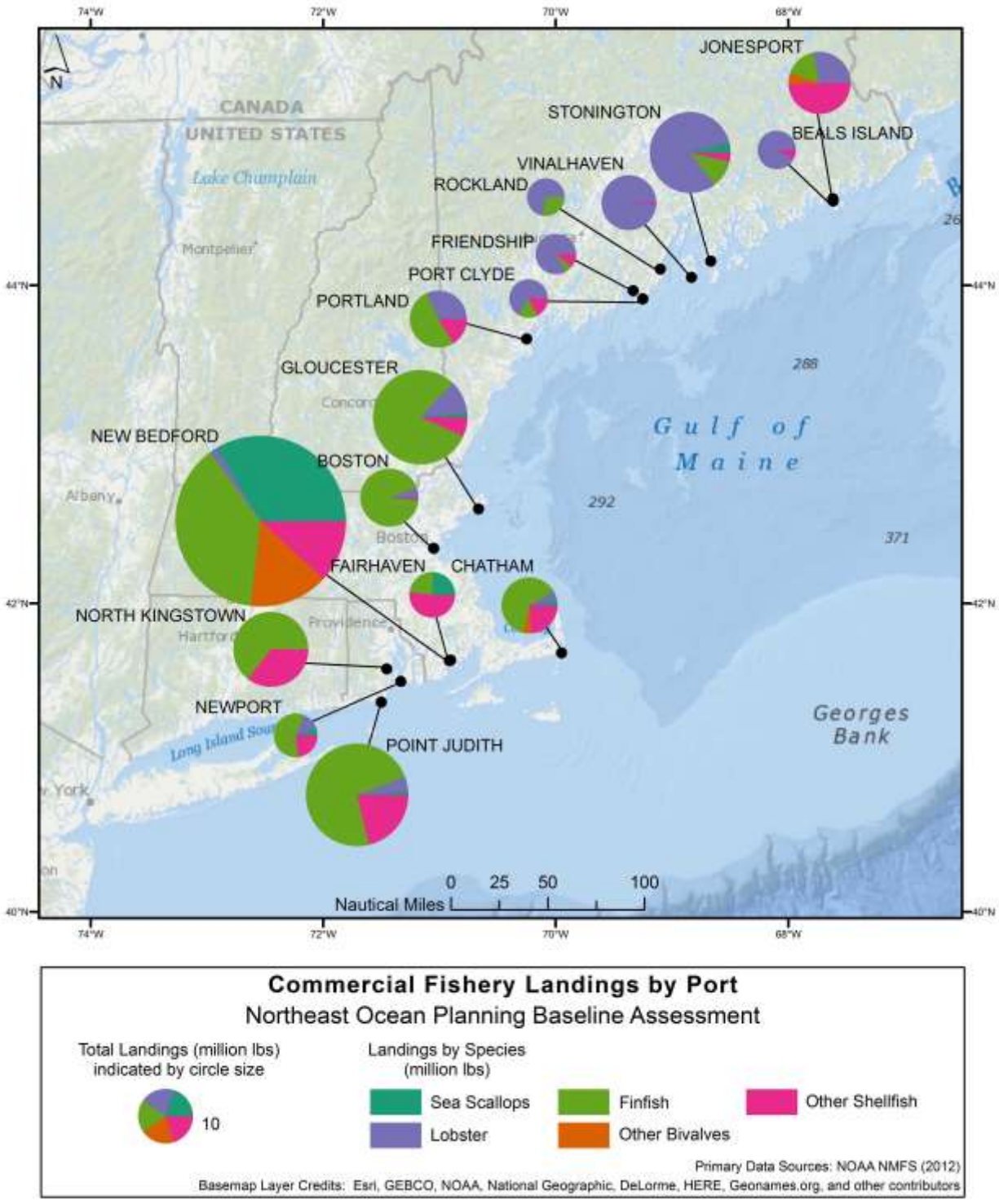


Figure 26 Commercial fishery landings by port, 2012

The NE RPB has supported two phases of work on characterizing the on-water vessel activity associated with the Region's commercial fishing industry:

- Commercial Fishing Phase 1: This project began in 2012 to map federally managed commercial fisheries in the Northeast using data through 2010. Starting with existing data available for certain fisheries, map products were developed and discussed with the fishing industry, scientists, and managers. A 2013 Commercial Fisheries Spatial Characterization Report and a 2014 Fishing Fact Sheet summarize the results of this initial phase.

- Commercial Fishing Phase 2: This project focused on spatial distribution of federally managed species, with additional mapping based on Vessel Monitoring System data through 2013, Vessel Trip Report analysis (using vessel speed to differentiate fishing from other vessel activities, using 2011-2013 data). Results are summarized below and additional detail can be found on the NE Ocean Planning website with a new the Commercial Fishing Spatial Characterization, Phase 2 report.

Results of this work are illustrated in Figures 27 to 33 below. These figures show fishing vessel activity density, based on data collected under NOAA's Vessel Monitoring System (VMS) Program. The figures show an index of vessel activity density over the specified calendar years, for vessels permitted to fish for various species, illustrating both the ports from which the vessels operate, their routes to/from the fishing grounds, and the fishing grounds themselves. Similar data for earlier years (2006-2010) can be found in Appendix D, as can maps illustrating estimated density of fishing activity without the transit routes to/from fishing grounds.

Figure 34 illustrates the geographic extent of the Northeast's lobster fisheries, using data from the Industrial Economics (2014) Vertical Line Model, which was developed to support efforts to protect marine mammals from entanglement in fishing gear. The data in Figure 34 represent the density of vertical or end lines from lobster trap strings, which in turn is representative of the intensity of lobster fishing effort. For the waters off Maine, where most of the region's lobster fishing and landings are concentrated, other data on lobster fishing are available from the Maine Department of Marine Resources and Brehme *et al.* (2015).

Additional information about commercial fisheries is available from the Northeast Ocean Data Portal.

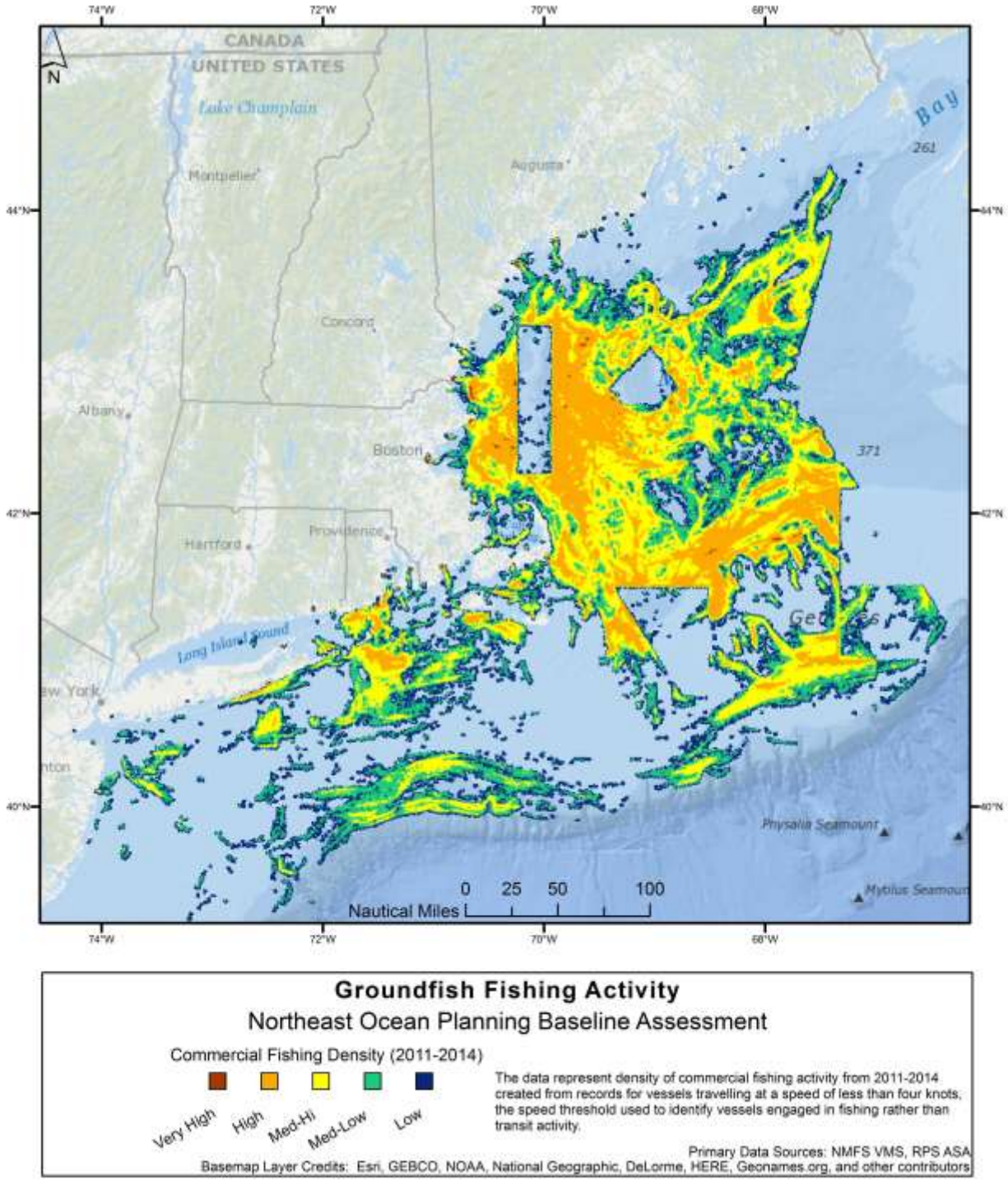


Figure 27 Groundfish fishing activity, 2011-2014

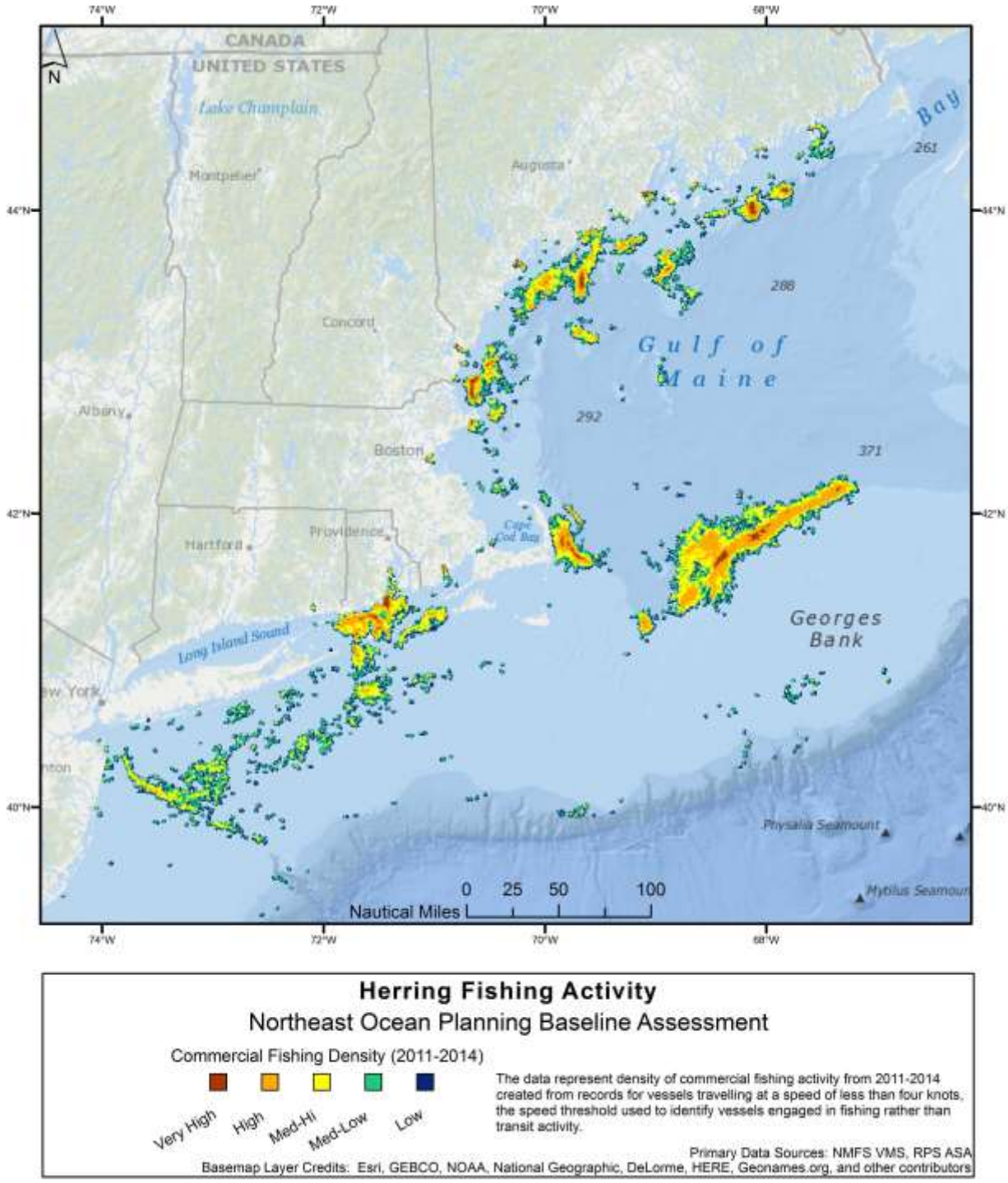


Figure 28 Herring fishing activity, 2011-2014

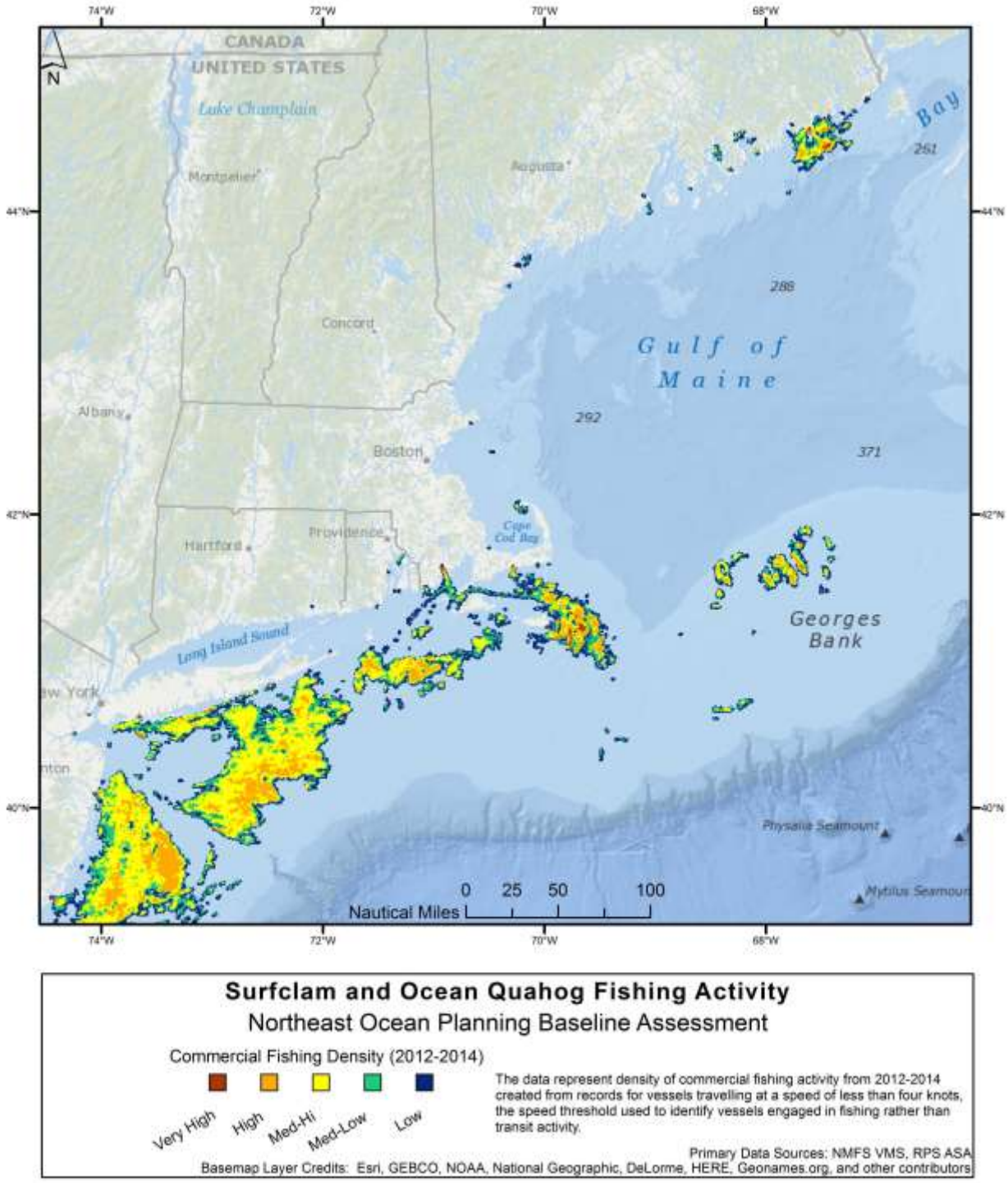


Figure 29 Surf clam and ocean quahog fishing activity, 2012-2014

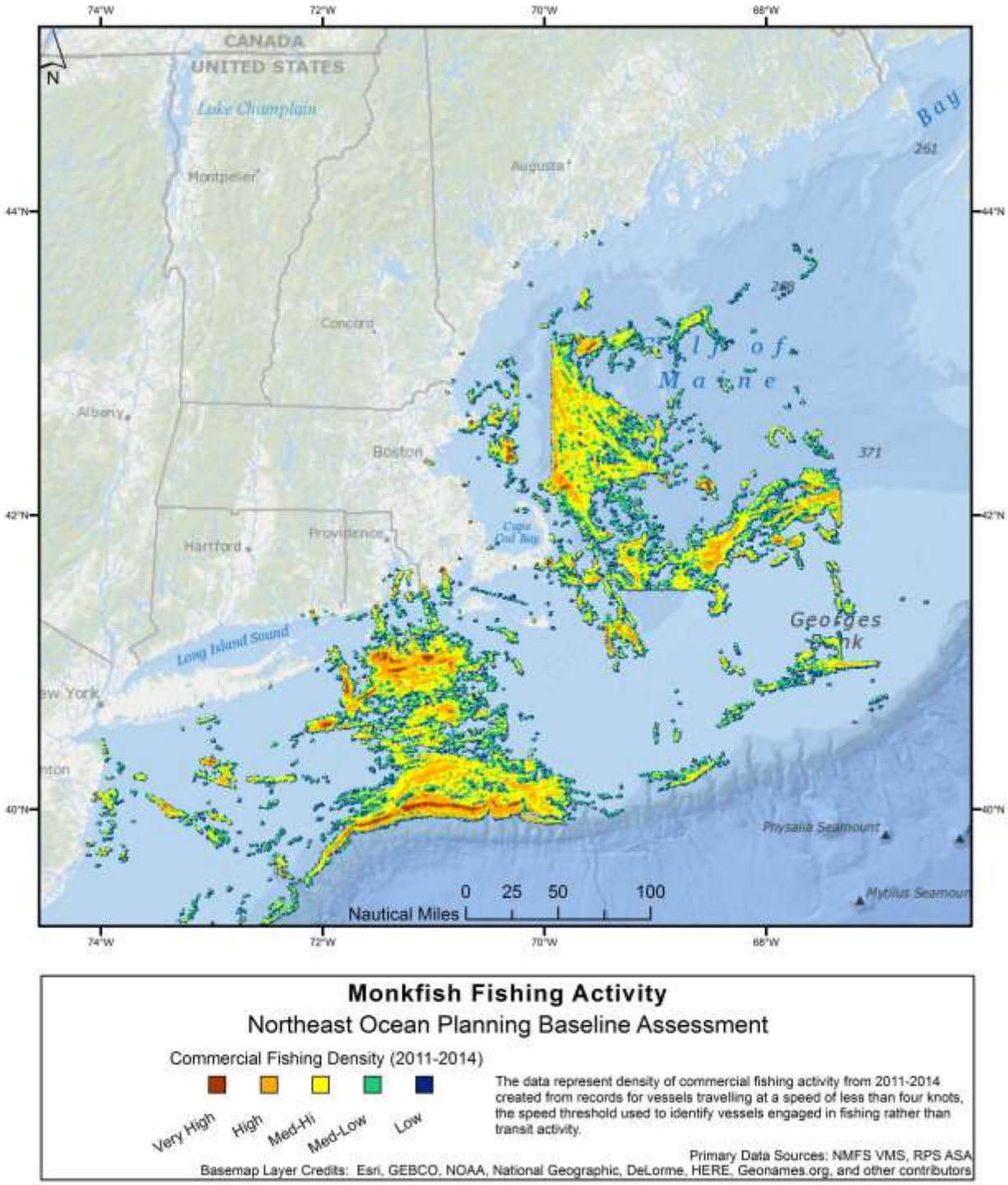


Figure 30 Monkfish fishing activity, 2011-2014

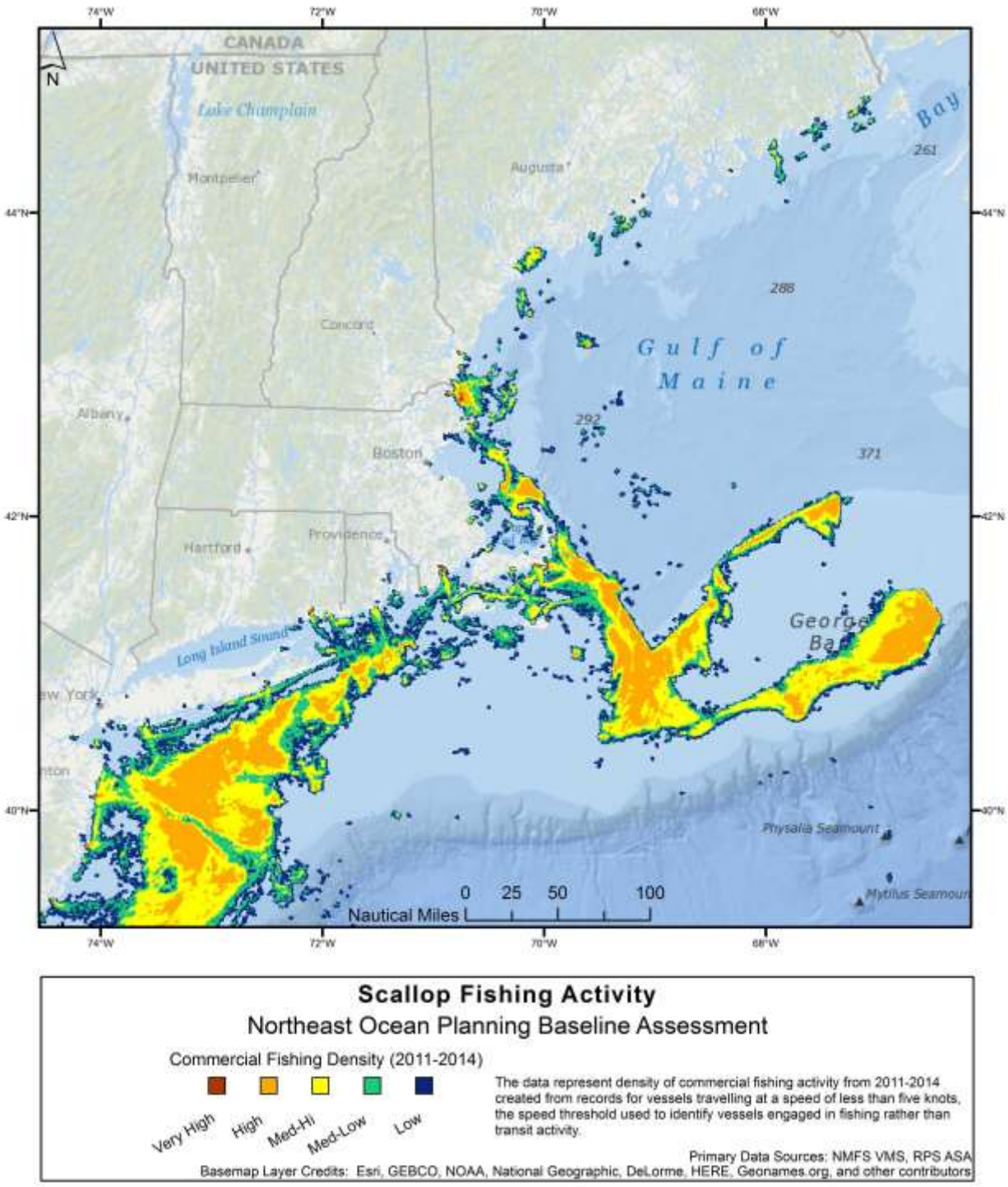


Figure 31 Scallop fishing activity, 2011-2014

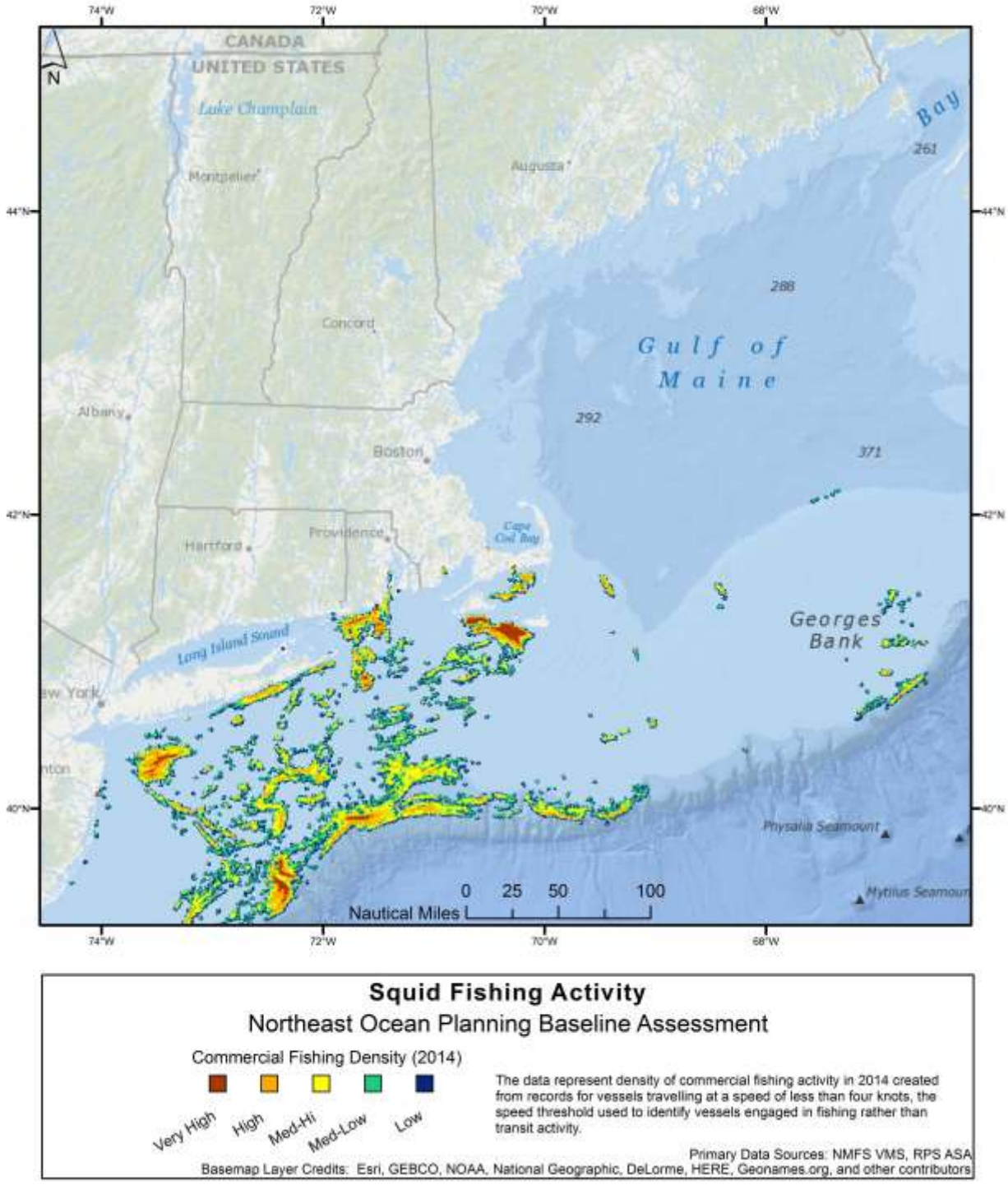


Figure 32 Squid fishing activity, 2014

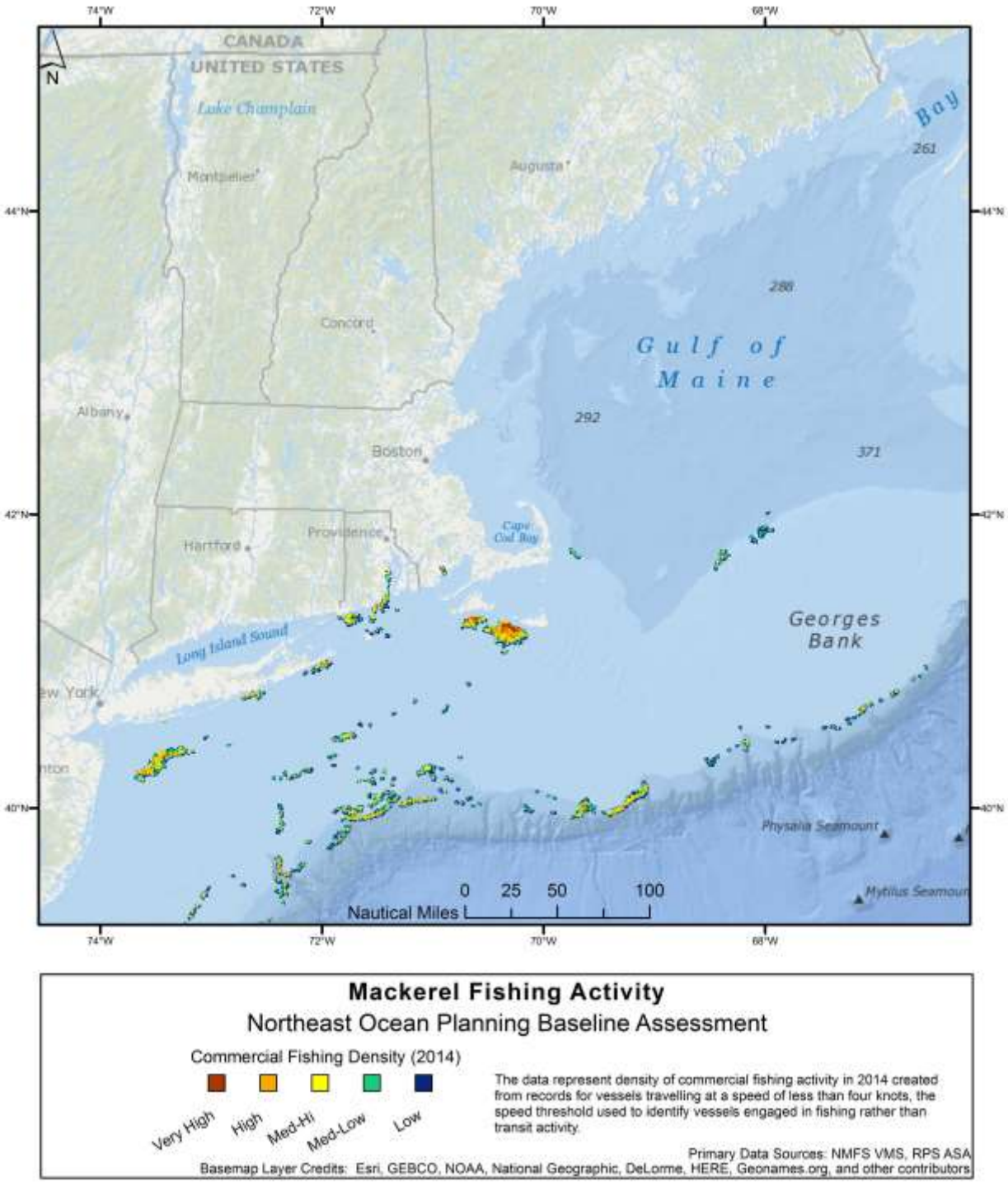


Figure 33 Mackerel fishing activity, 2014

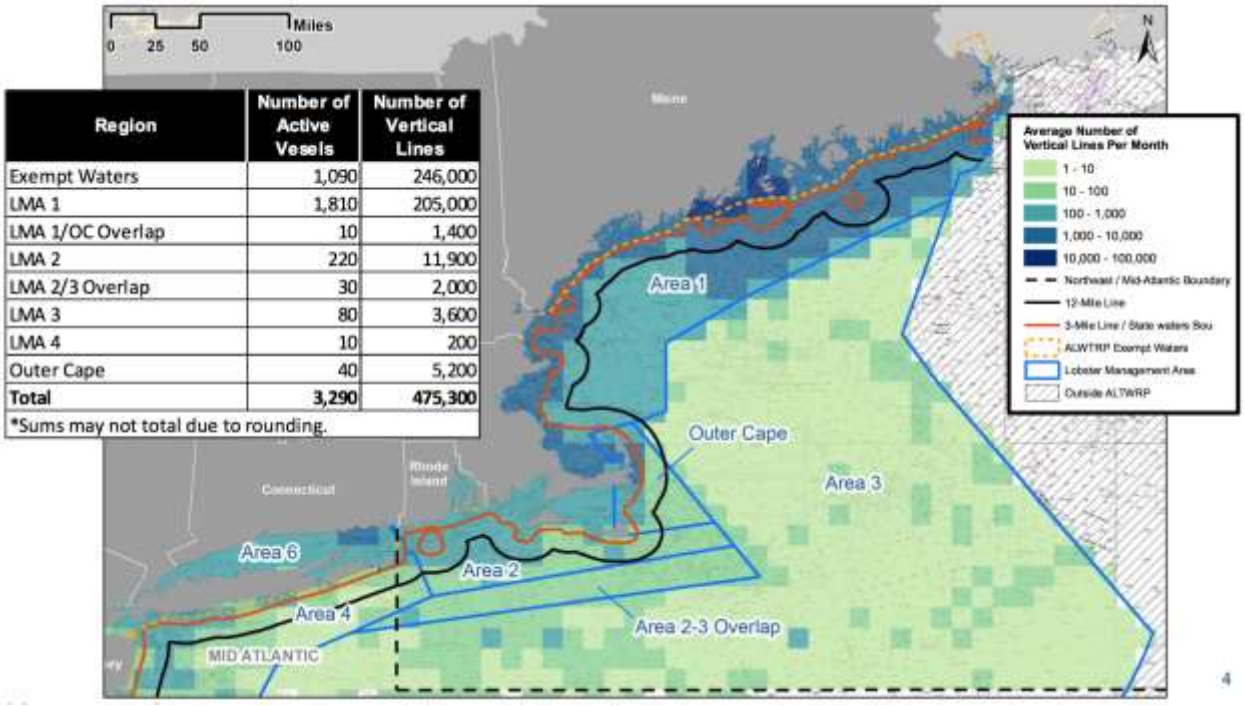


Figure 34 Lobster fishing activity
(source: Industrial Economics 2014)

4.3.2. Aquaculture

Commercial aquaculture production in the Northeast consists primarily of oysters, clams, and salmon. Commercial finfish aquaculture in the region almost entirely consists of Atlantic salmon rearing in Maine, which had a market value of over $73 million in 2010. The majority of this production comes from one New Brunswick based company, with a few other smaller, family owned operations (LaPointe 2013).

Shellfish aquaculture is more widespread than finfish aquaculture in New England, with over 1500 leases from Maine to Connecticut (Figure 35) producing $45-50 million per year of dockside value (point of first sale) with oysters representing the largest portion of that total. The leading producer is Connecticut, where oyster and clam farming generated output of more than $30 million (2010) and supported some 300 jobs. Massachusetts is second with $10.8 million in oysters and $10 million in quahog production in 2013. Maine and Rhode Island each have about $3 million/year in shellfish aquaculture production. Shellfish aquaculture operations in New England include small, family owned companies often with roots in fishing families or from communities looking for economic diversification from wild harvest fisheries as well as large corporations. (LaPointe 2013).

There is future growth potential for aquaculture in New England. NOAA's Marine Aquaculture Strategic Plan (FY 2016-2020) indicates that national production of farm-raised seafood increased 8% per year from 2007-2012, with local shellfish production recently reaching all-time highs in several states. There is also increased interest in the production of new species, such as certain seaweed varieties, and establishing polyculture

facilities that combine multiple species at one site. Combining finfish, shellfish and kelp in a single site can help buffer the effects of changing market and environmental conditions and mitigate waste and nitrogen inputs from finfish culture. In addition, while shellfish aquaculture has traditionally been located in intertidal or nearshore waters, there has been recent interest in locating operations further offshore.

There are many potential advantages to siting aquaculture offshore. Offshore areas often have better water quality and fewer existing activities that may conflict with the development of new facilities. Therefore, offshore areas may be better suited for larger operations. Alternatively, the challenges include a complex permitting process, variable ocean conditions, and increased distance to portside support and infrastructure. In 2014 and early 2015, two long-line blue mussel operations were permitted in federal waters – one 8.5 miles off Cape Ann and the other in Nantucket Sound representing the first two locations permitted for aquaculture in federal waters offshore New England.

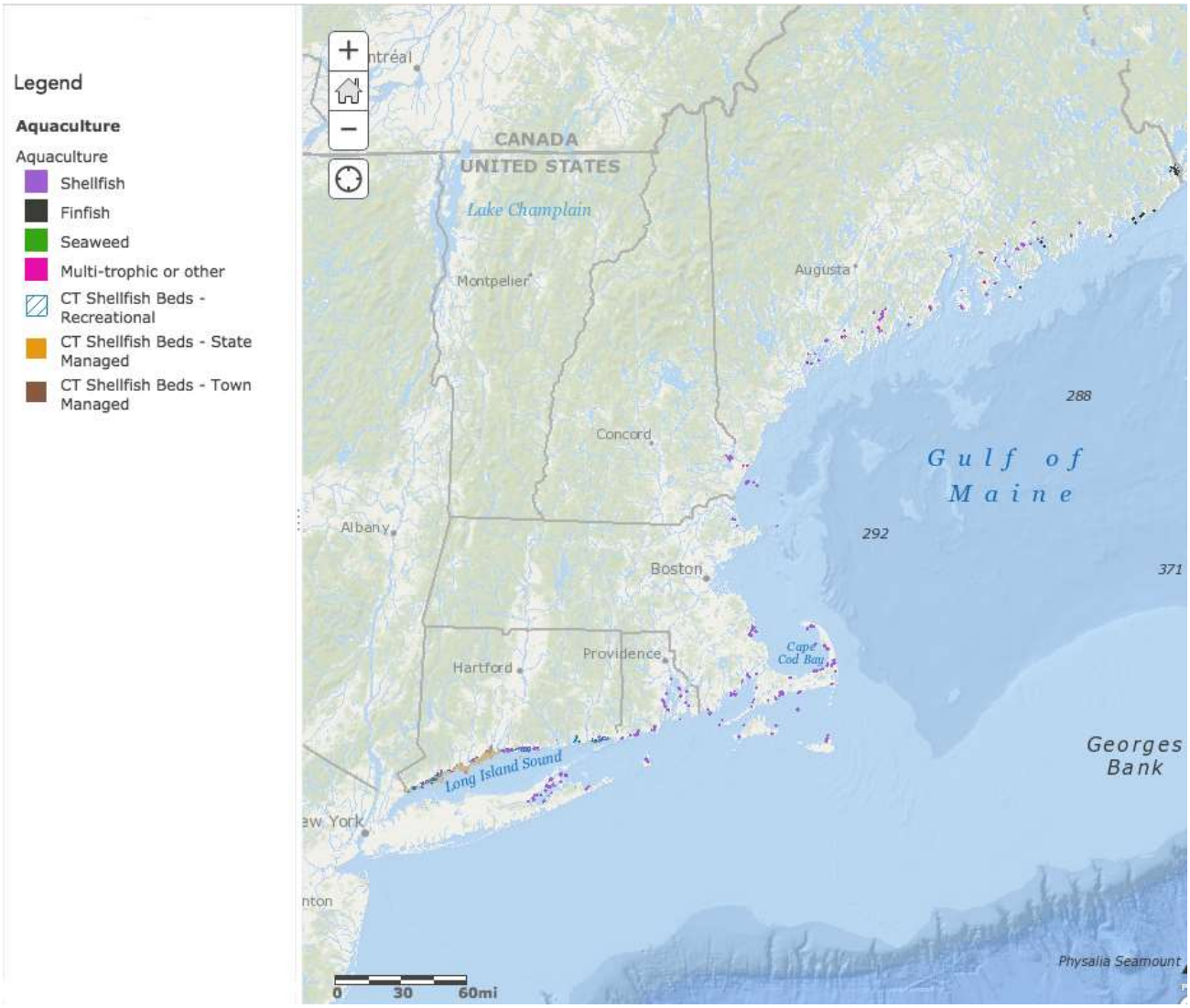


Figure 35 Aquaculture

Three working sessions with aquaculture industry representatives were held in 2012 and focused on topics of: permitting and leasing, current and future space needs, compatibility of aquaculture with other ocean uses, and data about existing aquaculture sites and leases. The Northeast Region Aquaculture White Paper (LaPointe 2013) summarizes these discussions and data on leases and harvest levels by state. Additional information on leases, permits, and harvest levels is available from the relevant state agencies:

Maine Department of Marine Resources
New Hampshire Fish and Game Department
Massachusetts Division of Marine Fisheries
Rhode Island Coastal Resources Management Council
Connecticut Bureau of Aquaculture
New York State Department of Environmental Conservation

4.3.3. Seafood processing

Seafood processing includes activities that convert seafood landed by fishing vessel in Northeast region ports (or imported from elsewhere) into fresh, canned, cured, and frozen seafood products. The Region's seafood processing industry is located primarily in or near the major traditional fishing ports such as New Bedford and Gloucester in Massachusetts, and Portland in Maine. With the declines in regional catch and landings over recent decades, the processing industry has also seen declines; but the US imports some 80% of the seafood consumed in the country, and Northeast processors have maintained output by increasing reliance on imported fish. Essex County in Massachusetts and Knox and Waldo counties in Maine have the largest numbers of seafood processing establishments (Figure 36).

Traditionally, New England's shellfish, particularly lobsters, have received relatively little processing; most of the product is sold in fresh markets. This is beginning to change with the growth of lobster processing, first in Canada, and now in locations like Portland. These changes in the seafood processing industry are not yet reflected in the data presented in this report.

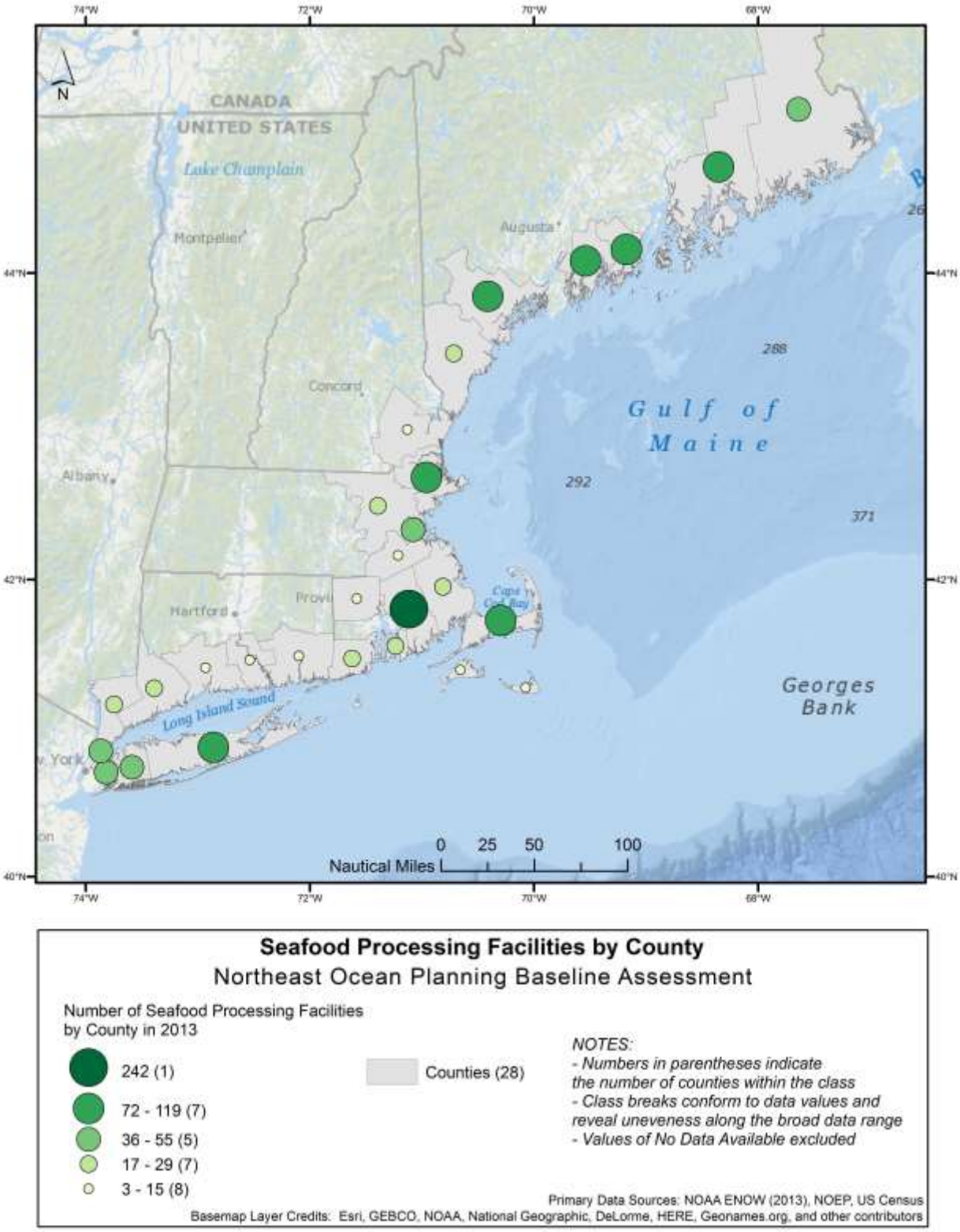
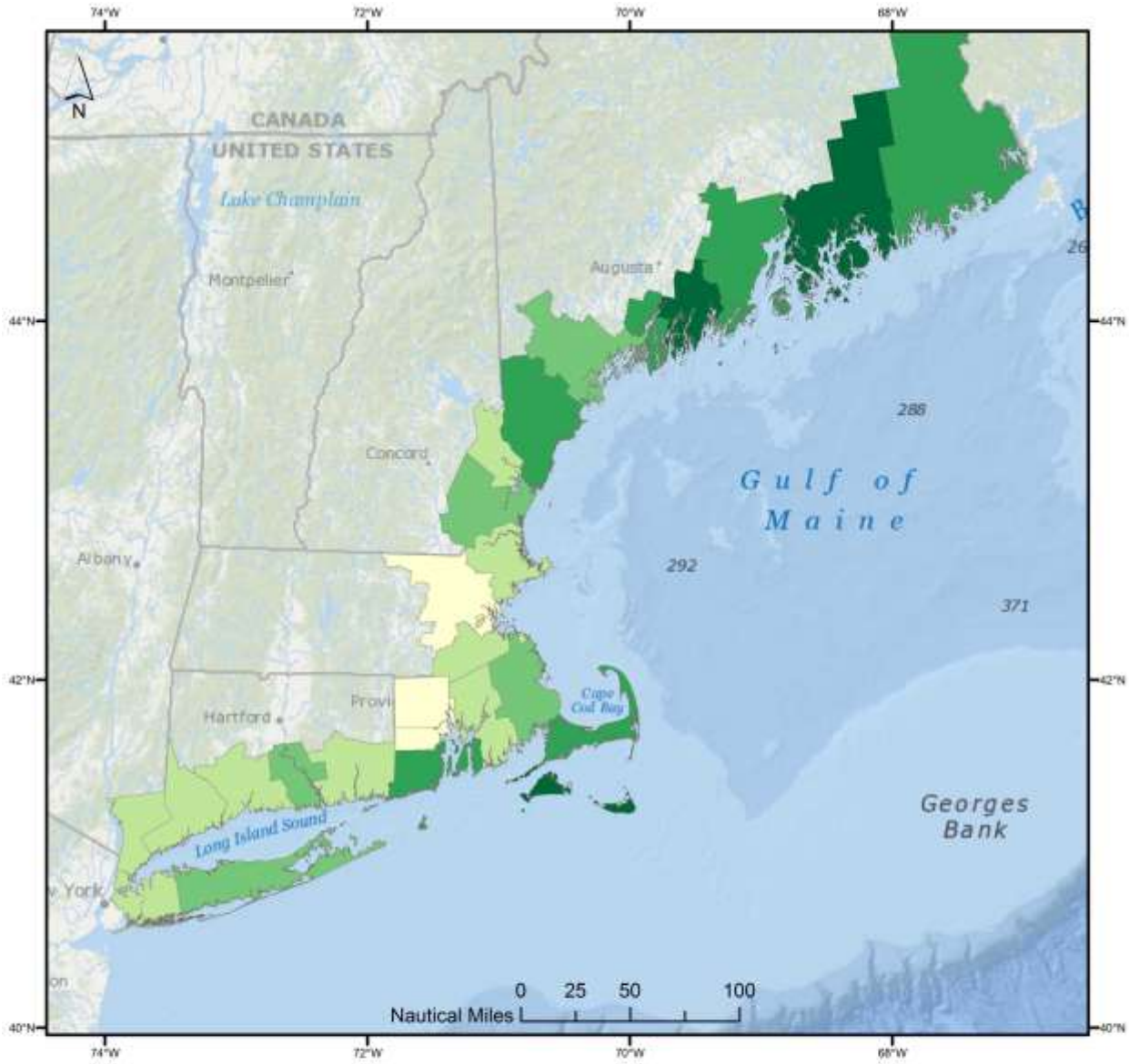


Figure 36 Seafood processing facilities by county, 2013

4.4. Recreation and Tourism

Recreation and tourism account for about half of the economic value generated in the Northeast region's ocean sector. More than the other sectors of the ocean economy, marine recreation and tourism in the Northeast is highly seasonal, concentrated during the summer months, creating seasonal employment patterns. Often, non-urban counties with higher dependency on the ocean economy have, as a consequence of the large role of tourism and recreation employment, much higher employment levels in the summer. Tourists flock to the coast, increasing employment in the tourism and recreation sector by close to 90% in some counties. Nantucket (Dukes County), Martha's Vineyard, and the Maine counties of Lincoln and Hancock show the largest difference between summer and annual average employment (Figure 37).



Seasonal Employment by County

Northeast Ocean Planning Baseline Assessment

Percentage Increase of Summer Employment over Annual Average Employment for Tourism & Recreation by County in 2013

- 62% - 87% (4)
- 25% - 44% (8)
- 11% - 17% (5)
- 5% - 9% (12)
- 1% - 4% (4)
- Counties (33)

NOTES:
- Numbers in parentheses indicate the number of counties within the class
- Class breaks conform to data values and reveal uneveness along the broad data range

Primary Data Sources: NOAA ENOW (2013), NOEP, US Census
Basemap Layer Credits: Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and other contributors

Figure 37 Seasonal employment by county, 2013

Data on economic indicators and values associated with ocean tourism and recreation in the Northeast are available from the Center for the Blue Economy's National Ocean Economics Program, including a summary of published information on non-market values. A 2015 Northeast RPB report on Coastal and Marine Recreational Activity in the Northeast United States (Point 97 *et al*. 2015) describes the results of a study by Point97, the Surfrider Foundation, and SeaPlan to characterize coastal and marine recreational activities in the Northeast. The study focuses on commercial whale watching, SCUBA diving, sailing races and regattas, sportfish tournaments, competitive board and paddle events, and individual activities such as beach going, wildlife viewing, surfing, and non-motorized boating (e.g. kayaking).

4.4.1. Recreational boating and fishing

The 2012 Northeast Recreational Boater Survey (SeaPlan 2013) identified nearly 374,000 marine boaters with boats registered between Maine and New York. Surveys of these boaters suggest that they collectively undertake more than 900,000 boating trips on the ocean each year, and that this activity contributes approximately $3.5 billion/year and the equivalent of nearly 27,000 year-round jobs to the Northeast region's economy. Of these, about 7,700 jobs are in leisure and hospitality; 6,700 in trade, transportation, and utilities; and 5,600 in boat repair and other services. Economic impacts and employment from recreational boating are highest in New York ($1.4 billion/year; 10,800 jobs) and Massachusetts ($840 million/year; 6,500 jobs), followed by Connecticut ($554 million/year; 4,300 jobs), Rhode Island ($227 million/year; 2,000 jobs), Maine ($205 million/year; 1,900 jobs), and New Hampshire ($69 million/year; 500 jobs) (SeaPlan 2013). Note, as with the seafood industry data in section 4.3, that these "economic impact" figures are not compatible with the GDP and employment measures used in the ENOW data.

Recreational boating and fishing activity is particularly intense in the coastal waters south and west of Cape Cod (Figure 38), moderately intense on the coast of Massachusetts from Cape Cod north to New Hampshire, and still significant but moderate along the coast of Maine, with low levels of activity north and east of Acadia National Park. Most recreational boating takes place within 20 nautical miles of the coast, though some fishing trips go further offshore, particularly off the coast of Massachusetts.

Recreational boating includes both power boating and sailing in nearshore and offshore waters, and rowing and paddling in the proximity of the coast. Some 200 sailing clubs organize several hundred races and regattas in the Northeast each year, and about 50 fishing clubs organize on the order of 100 fishing tournaments in the region each year. The 2015 Northeast RPB report on Coastal and Marine Recreational Activity in the Northeast United States (Point 97 *et al*. 2015) documents the coastal areas and routes most frequently used for distance sailing races (Figure 39). It also maps coastal areas used for standup paddle board (SUP) and other paddle events, surf contests, and triathlons. SUP contests are the most common of these, representing 62% of all competitive board and paddle events identified in the report (Figure 40). For additional information, see the Point 97 *et al.* (2015) report on Northeast US coastal and marine recreational activity, and the Rhode Island Ocean Special Area Management Plan (RICRMC 2010).

Angling for recreational purposes is widespread and targets many different species. Striped bass, summer flounder, groundfish, and countless other species are targeted by shoreside anglers, surf-casters, boaters, charter and party boats, and fishing tournaments throughout New England all summer long, drawing residents and visitors by the hundreds of thousands. In 2013, an estimated 5 million trips were taken (Fisheries Economics of the US 2012). The NE RPB is supporting an ongoing pilot project, due to be completed in 2016, to explore methodologies for mapping charter boat activity in New York and Rhode Island waters. Intended to produce better information for fisheries management purposes, the project is deploying apps on the smart phones of approximately 20 charter boat captains to capture spatial data on charter boat location, differentiating between transit and fishing activity.

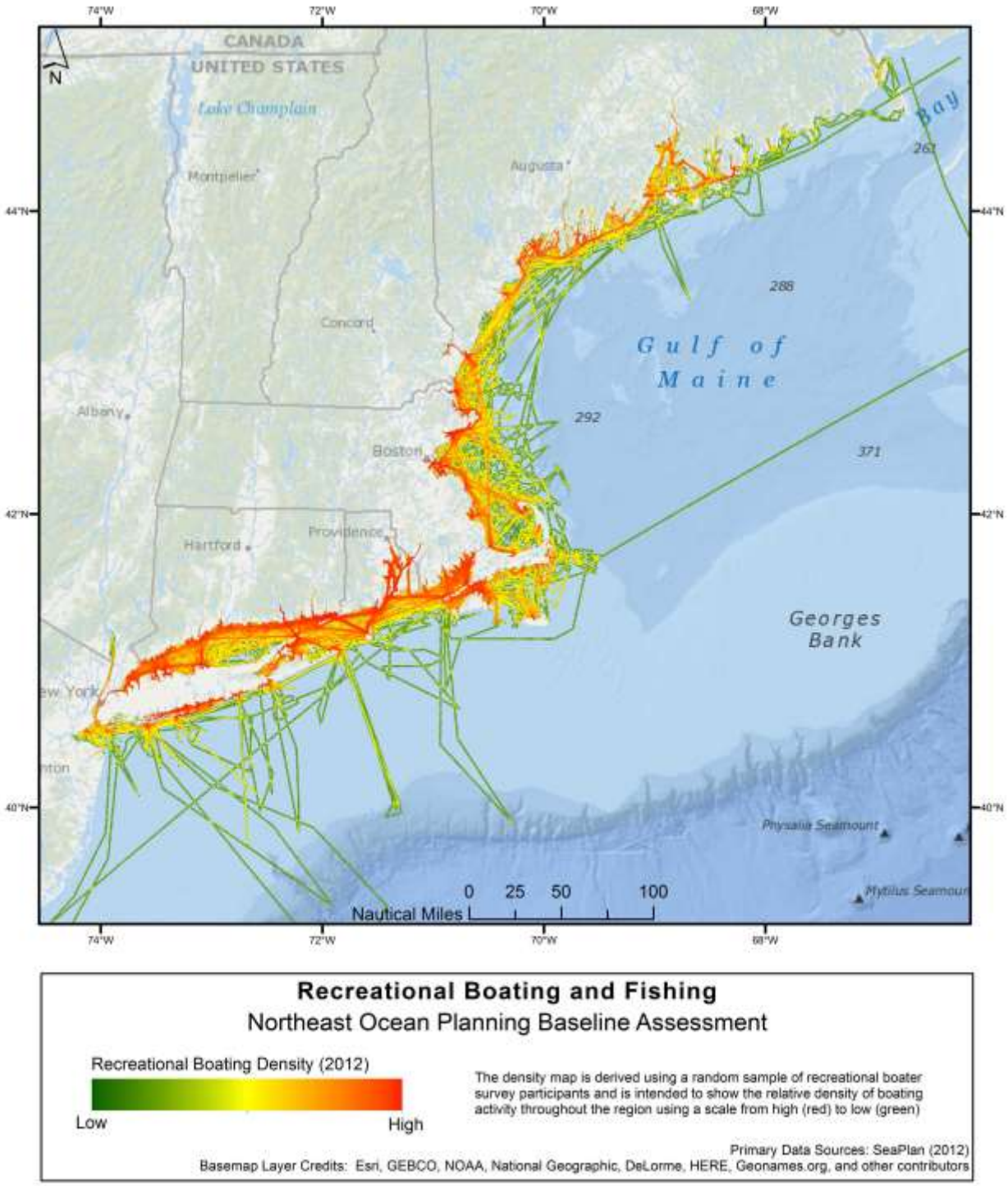


Figure 38 Recreational boating and fishing

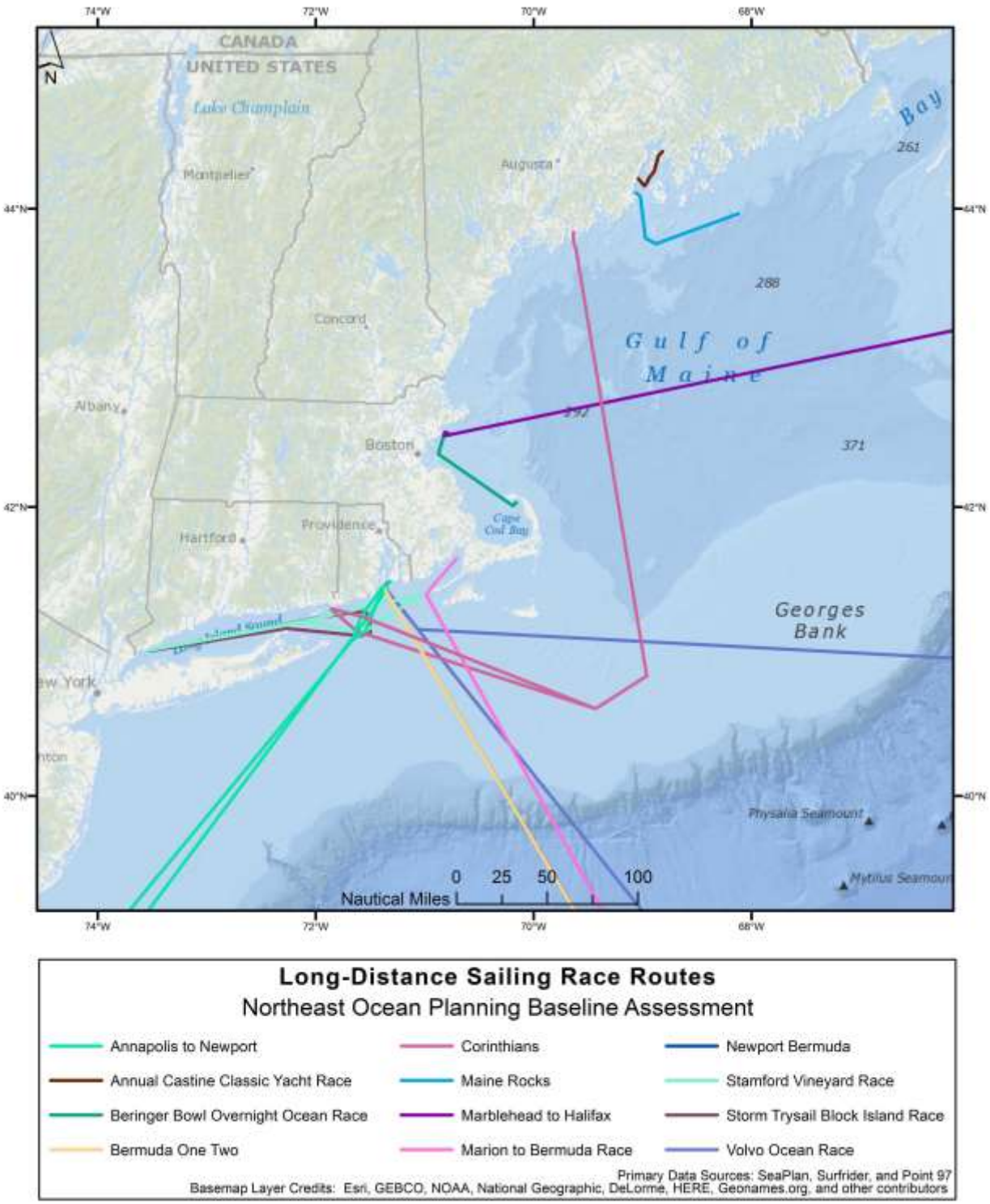


Figure 39 Long-distance sailing race routes

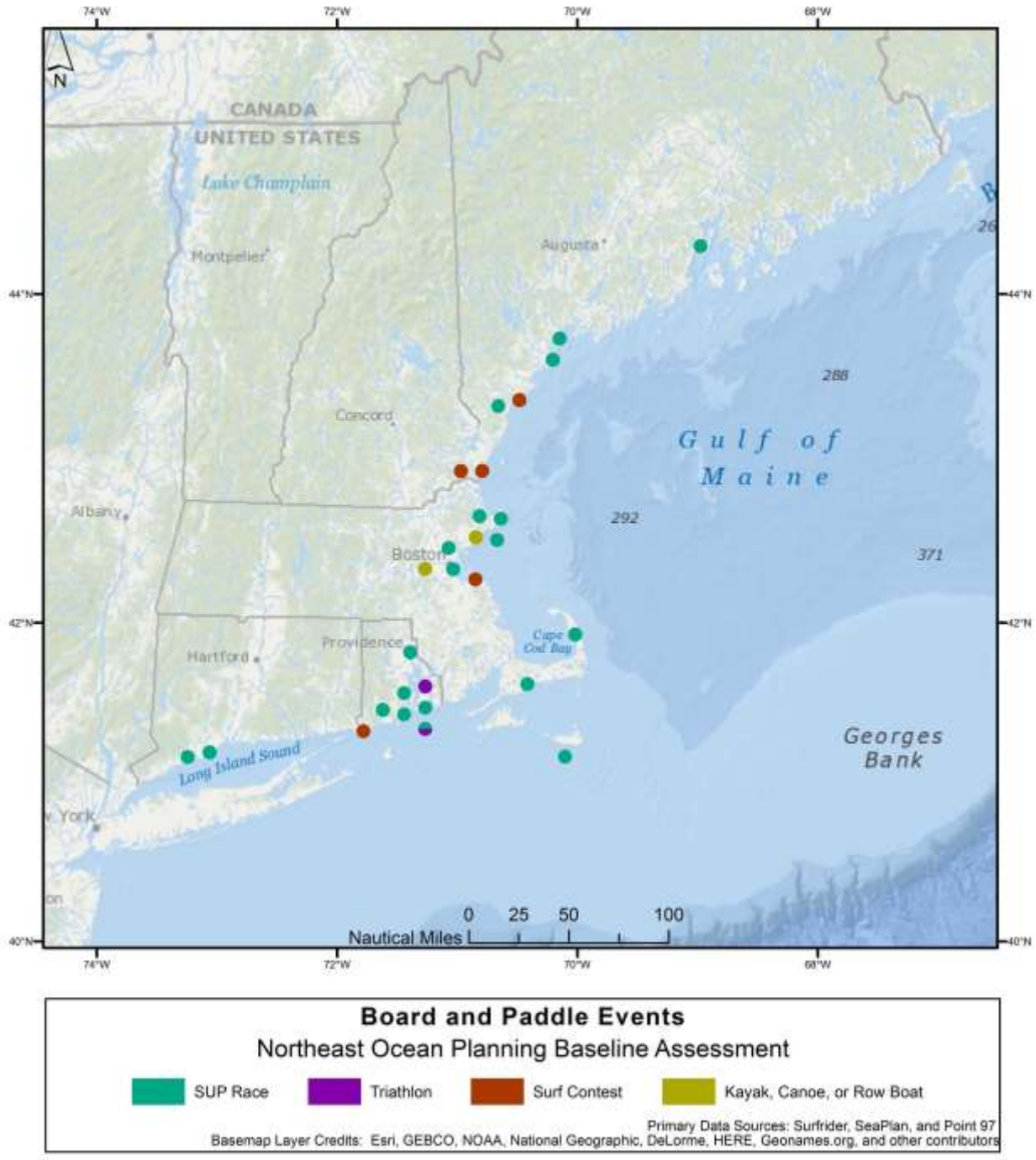


Figure 40 Board and paddle event locations

4.4.2. Marinas

Some 600 marinas in the Northeast region (see Figure 17 above) employ more than 5,000 people and generate about $400 million/year in regional GDP. The highest concentration of marinas is found in New York, Massachusetts, and Connecticut (ENOW data).

Marinas in New England are primarily privately owned and operated and primarily serve recreational boating, including recreational deep-sea fishing. Other activities such as commercial fishing, water taxis, and water tours also operate out of marinas. Marinas are located throughout the coastal area; their dependence on recreational boating makes them one of the most seasonally variable industries in the ocean economy. Suffolk County in New York is the location of the largest number of marinas, followed by Fairfield County in Connecticut and Barnstable and Essex Counties in Massachusetts (see Figure 17 above).

4.4.3. Boat dealers

About 300 boat dealers throughout the Northeast region employ about 2,000 people and generate between $100 and $200 million/year in GDP (ENOW data). Boat dealerships are evenly represented in all Northeast states except New Hampshire, which has relatively few.

4.4.4. Beach recreation

Residents of and visitors to the Northeast region spend approximately 100 million person-days at the regions 1,000+ ocean beaches (see Figure 5 above). This represents about 10% of total beach visits for the United States. Massachusetts and New York provide the largest contribution to the region's total, with an estimated 30 million person-days each. These numbers are estimates based on limited survey work; no detailed visitor numbers are collected for most beaches in the region.

Most of this beach activity (see Figure 41) is concentrated in the summer months, and more than half of beach visits include swimming. Among respondents to a (non-random) survey of waterfront and marine recreation participants conducted by Point 97, the Surfrider Foundation and collaborators, the top five activities individual user participated in were beach going, scenic enjoyment, swimming/body surfing, biking/hiking, and wildlife viewing. On average, respondents to this individual user coastal recreation survey spent $263.29 in trip expenditures during their last trip with approximately 40% of those expenditures spent on food and beverages and approximately 20% spent on lodging (Point 97 et al. 2015). Figure 41 shows the geographic extent of various individual coastal recreational activities (other than boating) in the Northeast.

Using estimates of the non-market value of beach recreation from $5 to $20/day, beach visits in the Northeast generate an estimated $500 million to $2 billion in non-market recreational value each year (see section 5 and Appendix E below for a more detailed discussion of beach recreation opportunity as an ecosystem service).

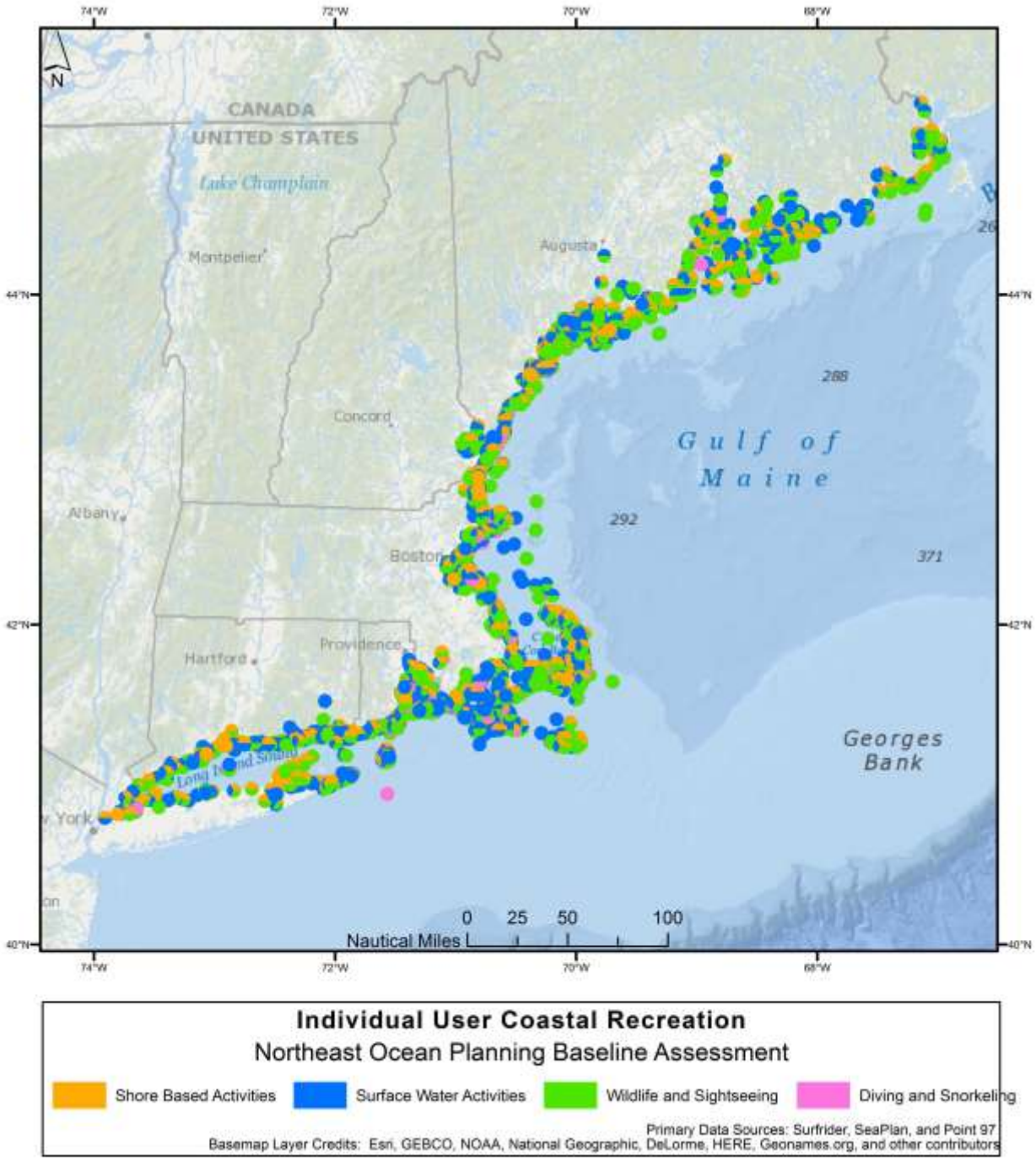


Figure 41 Individual user coastal recreation

4.4.5. SCUBA diving

Shore- and boat-based recreational SCUBA diving is a popular activity occurring at various sites throughout the Northeast, primarily focusing around historical shipwrecks, interesting benthic communities, and popular wildlife viewing areas. Despite the relatively cool water temperatures, diving activity in the Northeast occurs year-round but is concentrated in the months of May through October, and is clustered around regions with

attractive underwater topography such as Cape Ann, MA. Much diving activity occurs from private boats or from the shore, while groups may also charter diving excursions through professional dive boats. Divers engage in a number of activities while diving, including wildlife viewing, photography, and fishing or hunting. The average value per day of SCUBA diving in the Northeast has been valued at $14.93, based on individual diver consumer surplus. Some 100 SCUBA diving clubs are active in the Northeast. In Rhode Island alone, the net economic value of SCUBA diving and snorkeling together was valued at $25.8 million (RICRMC 2010, Kaval and Loomis 2003).

Figure 42 illustrates recreational dive site locations in the Northeast. More information is available in the 2015 report Coastal and Marine Recreational Activity in the Northeast United States (Point 97 *et al.* 2015), which summarizes information about ocean dive sites assembled by state agencies and diving experts around the region, and includes a map of commonly used Northeast ocean diving locations.

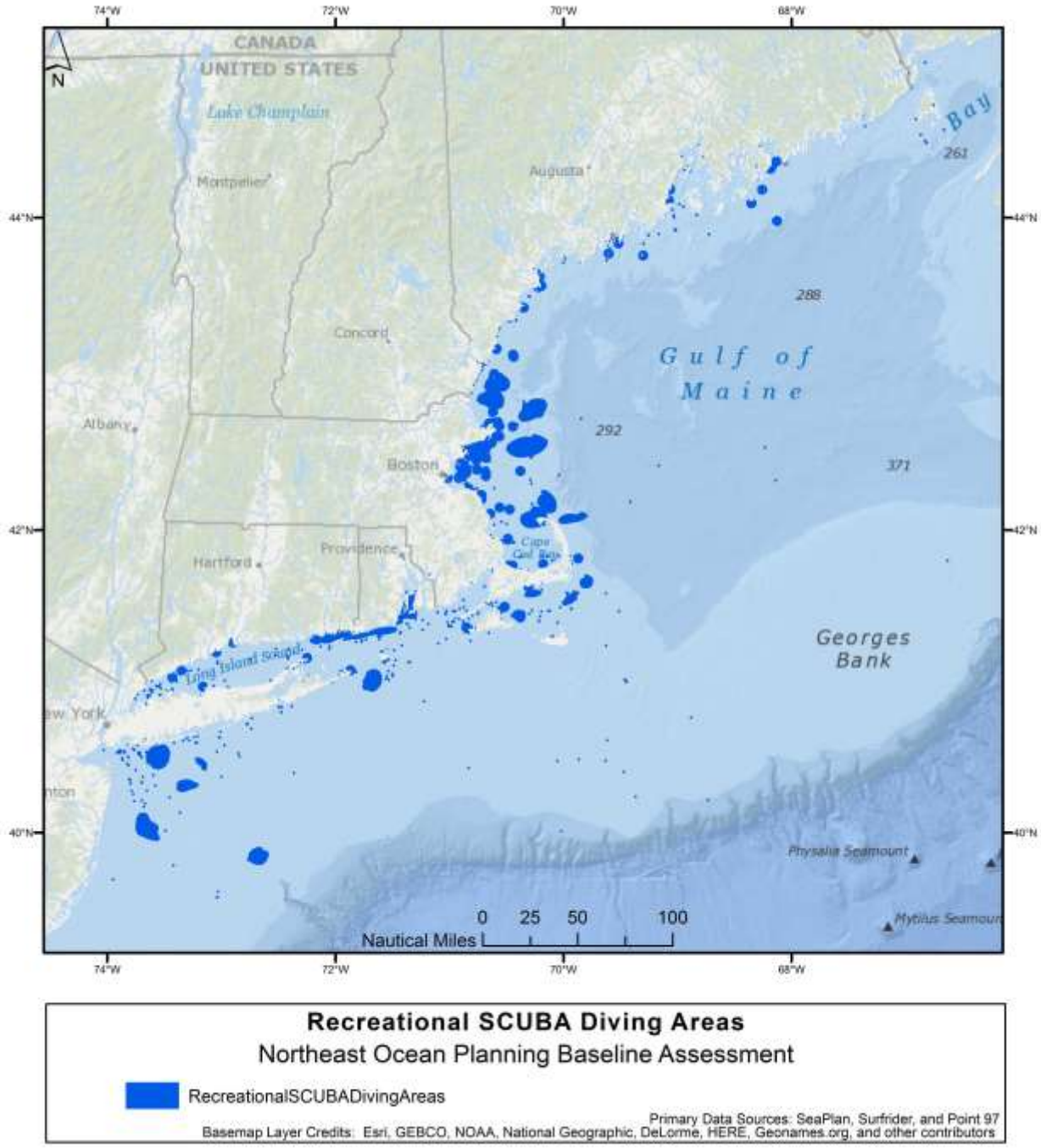


Figure 42 Recreational SCUBA diving areas

4.4.6. Whale watching

Whale watching in the Northeast began in the 1970s and has grown to rank among the region's signature recreational industries, generating total direct and indirect expenditures of $126 million. More than 30 commercial whale watch companies operate from a number of ports from New York to Maine, with Stellwagen Bank National Marine Sanctuary (SBNMS), 25 miles to the east of Boston, the most popular whale watching destination and

accounting for around 80% of whale watching in the region (Figure 43; O'Connor et al. 2009; Hoagland and Meeks 2000; RICRMC 2010). Whale watching occurs primarily during July and August when the demand is highest and the whales are active within the area; however, whale watch operations may extend from the spring through the fall. Companies operate vessels that range from small, semi-private charters that may conduct single daily trips for 6 passengers, to large charters out of hubs like Boston and Bar Harbor (Maine) that may accommodate up to 400 passengers on 3 to 5 trips and serve thousands of patrons daily. The whale species observed most frequently during whale watch trips in the Northeast are humpback (*Megaptera noveangliae*), fin (*Balaenoptera physalus*), and minke whales (*Balaenoptera acutorostrata*). For more information is available in the coastal and marine recreational activity survey report (Point 97 *et al.* 2015).

The commercial whale watching areas shown in Figure 43 are based on information provided by whale watch industry experts in the Northeast Coastal and Marine Recreational Use Characterization Study (Point97 *et al.* 2015). Whale watch vessel owners, operators, naturalists, and data managers attended participatory mapping workshops to map areas where whale watching takes place in the region, and assemble information about seasonality, species, and overall industry trends. The data are classified by the following categories:

- **General use areas** reflect the full footprint of whale watch activity in the last 3 – 5 years (2010 – 2014) regardless of frequency or intensity.
- **Dominant use areas** include all areas routinely used by most users most of the time, according to seasonal patterns.
- **Transit routes** include areas used for transit to and from general or dominant use areas.
- **Supplemental areas** depict areas used for closely related activities and infrequent specialty trips.
- **RI Ocean Special Area Management Plan areas** were mapped as part of the Rhode Island Ocean Special Area Management plan and are symbolized separately to reflect different data collection methodologies.

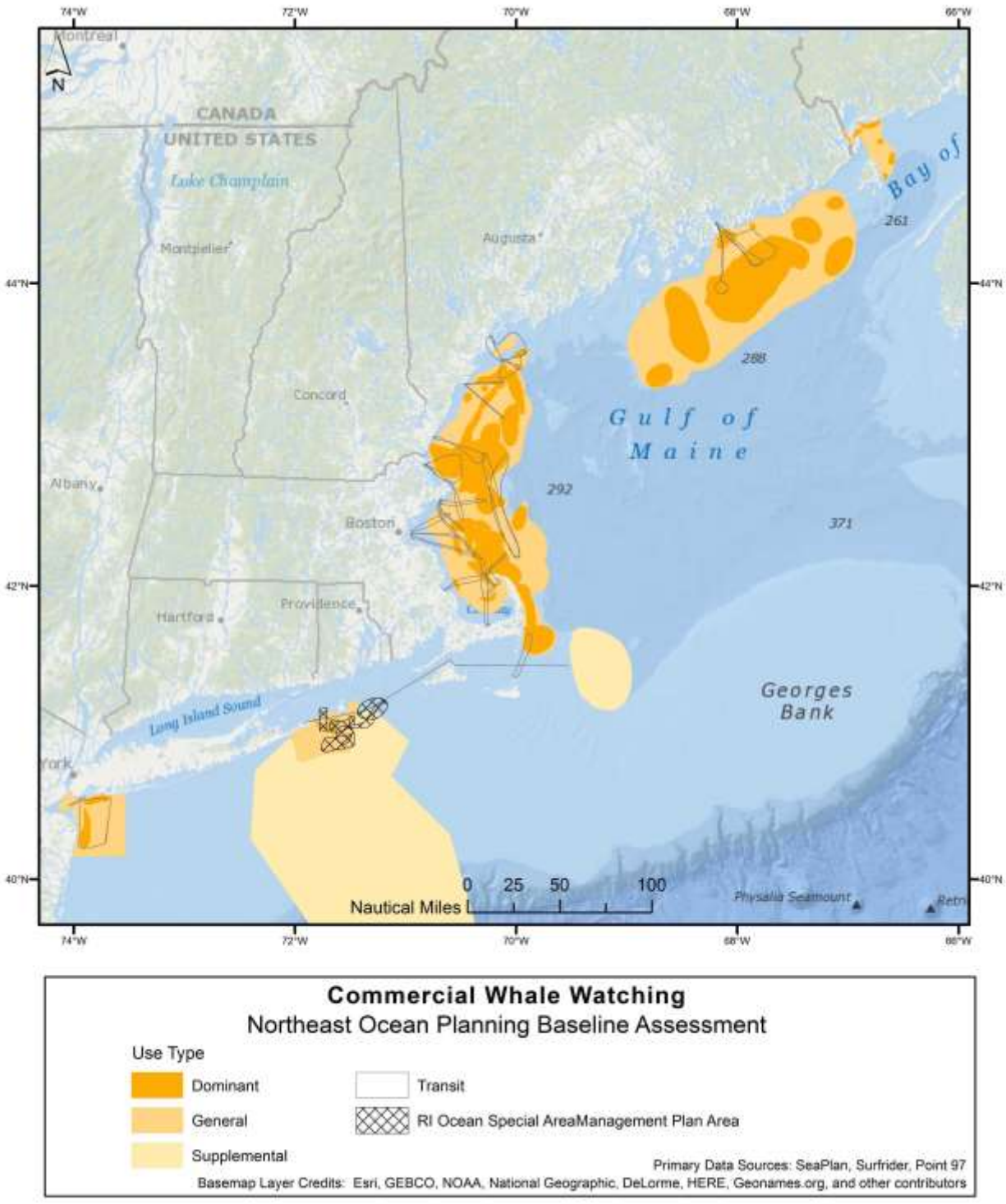


Figure 43 Commercial whale watching

See text above for source information and description of "use types."

4.4.7. Eating and drinking establishments

About 10,000 eating and drinking establishments (restaurants and bars) in the Northeast region's coastal counties employ more than 150,000 people and generate more than $5 billion/year in GDP, making up more than half of the tourism and recreation segment of the region's ocean economy (ENOW data). Higher numbers of eating and drinking establishments are found along the shores of Long Island Sound, Cape Cod, Massachusetts, New Hampshire, and southern Maine (Figure 44).

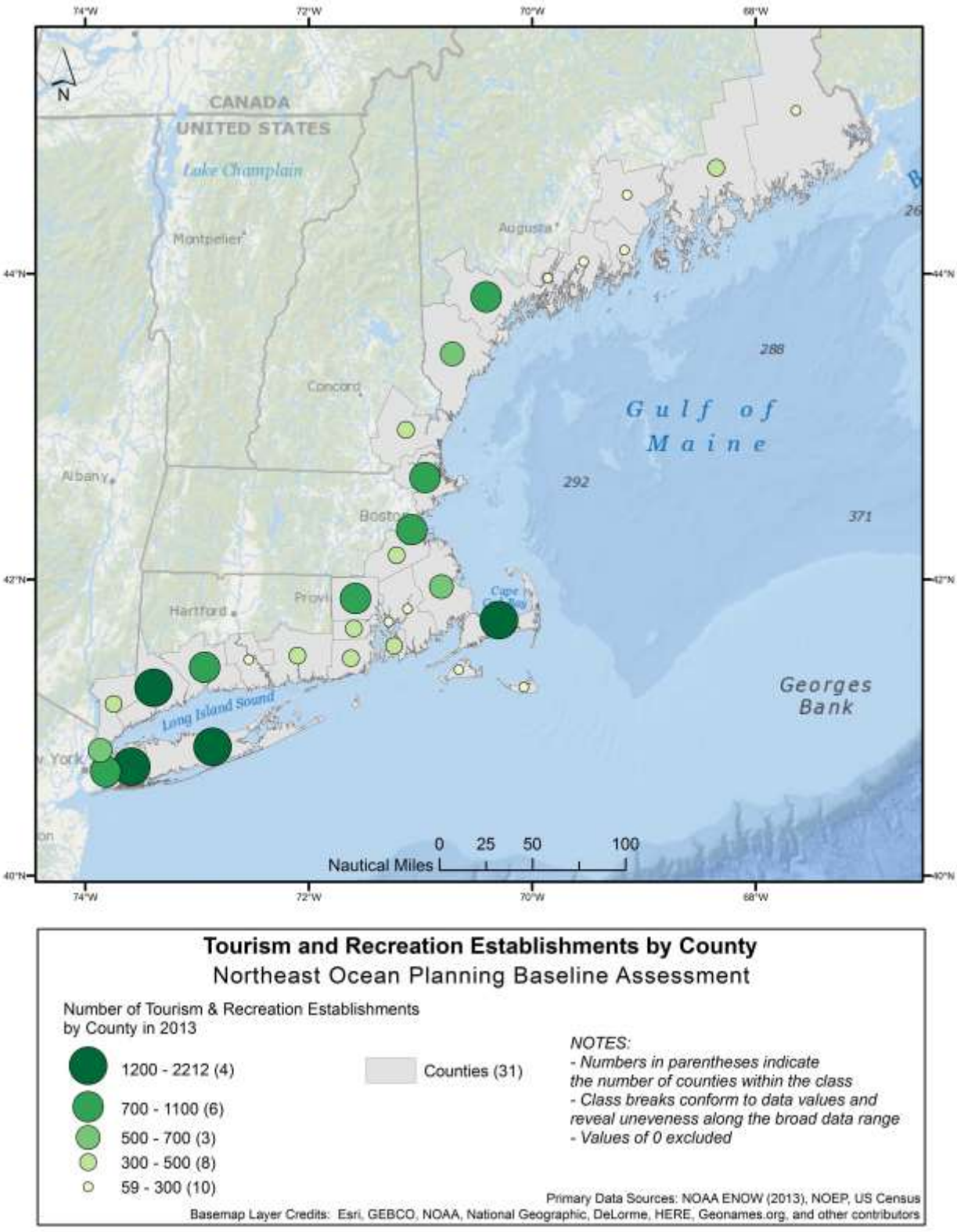


Figure 44 Tourism and recreation establishments by county, 2013

4.4.8. Hotels and lodging places

About 1,500 hotels and lodging places in the coastal counties of the Northeast region employ more than 30,000 workers and generate more than $2 billion/year in GDP (ENOW data). They are included in the tourism establishments shown in Figure 44 above, and are concentrated along the shore of Long Island Sound, Cape Cod, and the coast of Massachusetts. Close to 500 such establishments also exist along the coast of Maine.

4.5. Marine Transportation

The Marine Transportation System is an interconnected system of waterways and ports that moves people (e.g., ferries, cruises, sightseeing) and goods (e.g., agriculture, oil and gas, cars, clothing, appliances). Marine transportation is also crucial to national security by enabling the rapid movement of military resources and logistical support. This system is economically critical to the region as it provides for jobs -- such as pilots, port operators, vessel staff -- as well as taxes to local, state and federal entities. As such, it has broad reaching impacts to the Northeast region, nationally, and internationally.

4.5.1. Deep sea and coastal freight transportation

The commercial ports in the Northeast region of the United States handled about 102 million short tons of cargo in 2013 (Table 7 and Figure 45), or 6% of the nation's waterborne trade (US Army Corps of Engineers 2015). The Port of New York and New Jersey is the busiest port on the United States east coast, and accounts for half of the Northeast's total tonnage. Portland and Boston together account for another 25% (in weight terms). Not including the Port of New York and New Jersey, commercial ports in the Northeast handled about 54 million short tons of cargo in 2013, 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 60% of all cargo moving through the Northeast region's ports; foreign export cargo is minimal in comparison. About two thirds of all cargo (by weight) moved through northeastern ports is inbound crude oil (only to Portland, ME and New York and New Jersey) and refined petroleum products (gasoline, diesel fuel, heating oil) (Figure 45).

Container traffic on the US east coast is dominated by the Port of New York and New Jersey, which handled more than 4.2 million TEU (twenty-foot equivalent unit[1]) movements in 2013 – about 12% of container traffic for all Unites States ports. Container traffic in the Northeast is concentrated almost entirely in Boston, which transshipped about 226,000 TEUs in FY2015. The Port of New York and New Jersey handled imports of more than 394,000 cars and the Port of Boston handled imports of more than 60,000 cars in 2014 (source: Port Authority of NYNJ; MassPort). Boston also processed more than 317,000 cruise passengers (113 cruise ship port calls) in 2014 (source: MassPort). Included in the foreign import trade for Boston is liquefied natural gas (LNG), accounting for about 1

[1] [The most common commercial cargo shipping container today is 40 feet in length; one such container is equivalent to 2 TEUs.]

million tons of imports or 20 port calls in 2014. New York/New Jersey ranks 3rd and Boston ranks approximately 30th among US ports in total tonnage handled per year (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 Halifax (Nova Scotia) and Montreal (Quebec). 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.

	foreign trade, 1,000s short tons		domestic coastal trade, 1,000s short tons	
	imports	**exports**	**inbound**	**outbound**
Eastport, ME	--	--	--	314
Searsport, ME	1,235	--	198	24
Portland, ME	11,040	70	831	1
Portsmouth, NH	2,004	158	499	12
Salem, MA	219	--	19	--
Boston, MA	9,983	1,442	5,365	105
New Bedford & Fairhaven, MA	35	144	21	--
Fall River, MA	260	--	1,105	2
Providence, RI	4,236	681	2,450	285
New London, CT	102	--	136	4
New Haven, CT	2,232	341	5,608	130
Bridgeport, CT	83	--	1,709	10
Stamford, CT	--	--	490	56
New York and New Jersey, NY	27,989	4,670	5,128	10,161

Table 7 *Commercial cargo volumes by port, 2013*
Source: US Army Corps of Engineers (2015)

Table 8 shows the number of vessel transits for each Northeast commercial port. Large commercial ship traffic in the region is concentrated in Portland (tankers) and Boston (tankers, container ships, and cruise ships). Transit numbers for the Port of New York and New Jersey are shown for context. Most of the "dry cargo" transits in the Northeast 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 crude oil carriers in New York/New Jersey and Portland, and about 30 liquefied natural gas (LNG) tankers in Boston. There is significant barge traffic in New York/New Jersey, Portland, Boston, New Bedford/Fairhaven, Providence, New Haven, Bridgeport, and Stamford.

Since each port call involves two transits (one into and one out of the port), the commercial vessel traffic described in Table 8 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 the region. Figure 45 illustrates the major routes used by commercial shipping into and out of the Northeast, and the cargo volume handled by the Region's major ports.

	Dry cargo ships	Tankers	Dry cargo barges	Tank barges
Eastport, ME	77	--	3	--
Searsport, ME	24	60	--	39
Portland, ME	98	198	1	230
Portsmouth, NH	41	60	2	60
Salem, MA	4	--	4	11
Boston, MA	398	251	57	773
New Bedford & Fairhaven, MA	7	--	58	457
Fall River, MA	40	4	9	24
Providence, RI	59	133	20	309
New London, CT	23	--	28	42
New Haven, CT	26	83	56	705
Bridgeport, CT	2	1	332	189
Stamford, CT	--	--	346	22
totals	**797**	**788**	**916**	**2,861**
New York and New Jersey	4,106	1,814	1,184	903

Table 8 *Commercial vessel calls by port, 2013*
Excludes fishing vessels and local and regional ferry traffic.
Source: US Army Corps of Engineers (2015)

New England is the region most heavily dependent on oil for its energy supplies, primarily because of high dependence on heating oil in the winter. Most of New England's petroleum arrives by water, with large volumes of petroleum product (gasoline, diesel, heating oil, etc.) coming to terminals in Boston and Portland. Product brought to New England comes either from the refineries in New Jersey and near Philadelphia (and thus passes through the southern waters of the region) or comes from the Irving Oil refinery in Saint John, New Brunswick, and thus crosses the Gulf of Maine.

Smaller terminals serve regional markets such as New Haven, Providence and Searsport. A number of smaller terminals such as in Salem, MA bring oil to power plants. Long Island Sound oil ports serve Connecticut; the port of New York and New Jersey serves Long Island oil needs. Historically, Portland has been the leading oil port northeast of New York/New Jersey, because of the crude oil brought to South Portland for transport through the 240-mile pipeline to Montreal refinery. Crude oil imported by ship has been declining in the Canadian market because of increasing production from western Canada.

More information is available in the [Northeast Region Maritime Commerce White Paper](#) (Kite-Powell 2013).

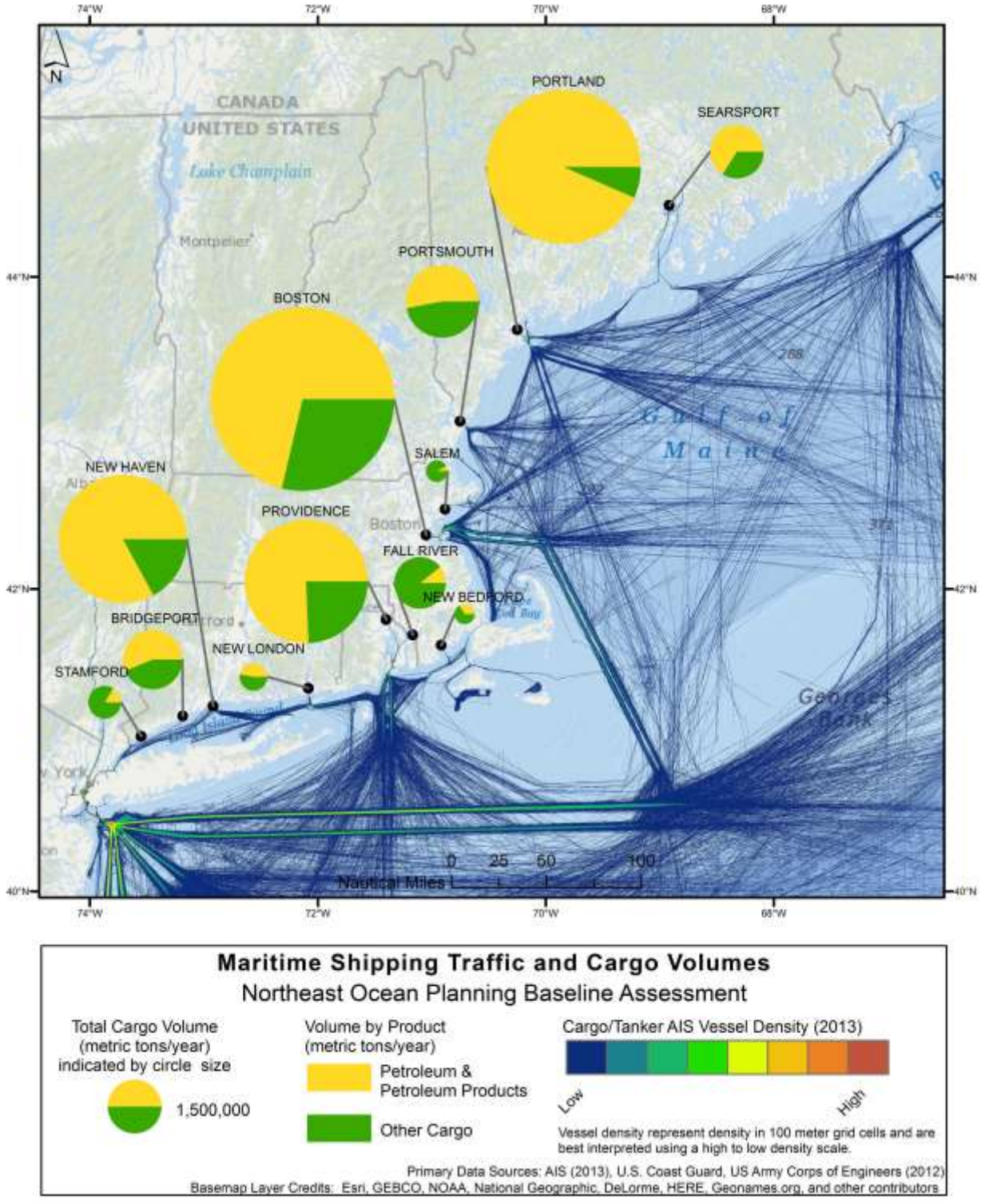


Figure 45 Maritime shipping traffic and cargo volumes

4.5.2. Marine passenger transportation

Marine passenger transportation in the Northeast region is concentrated in Massachusetts and Cape Cod Bay, the coastal waters from Long Island Sound to Buzzards Bay, and the waters between Cape Cod and the islands of Martha's Vineyard and Nantucket (Figure 46). There is seasonal passenger ferry traffic throughout the region. In addition, there are year-round ferry operations to and from Block Island, Martha's Vineyard, Nantucket, and islands along the coast of Maine, as well as cruise ship traffic in and out of the Ports of New York and New Jersey, and Boston. Some of the cruise ship traffic is coastal; other cruise routes connect the Northeast region with Atlantic Canada and Bermuda.

Marine transportation offers an alternative way to commute in some heavily congested areas and may be the only method to get to work in certain Northeast island and coastal communities. Northeast ferries carried 26.6 million passengers and 5.4 million vehicles in 2010, and are expected to carry more in the coming decade. The cruise industry reports a predicted increase in usage with a 16% increase in expenditures over the last four years.

Figure 46 illustrates the combination of all of these types of passenger vessel traffic. The higher concentrations indicated with warmer colors in nearshore/coastal areas are due to ferry service routes. Note that this figure is based only on 2013 data; and while areas that show higher density (such as routes to Long Island and Martha's Vineyard/Nantucket) generally reflect patterns that will persist in future years, passenger traffic routes are subject to change.

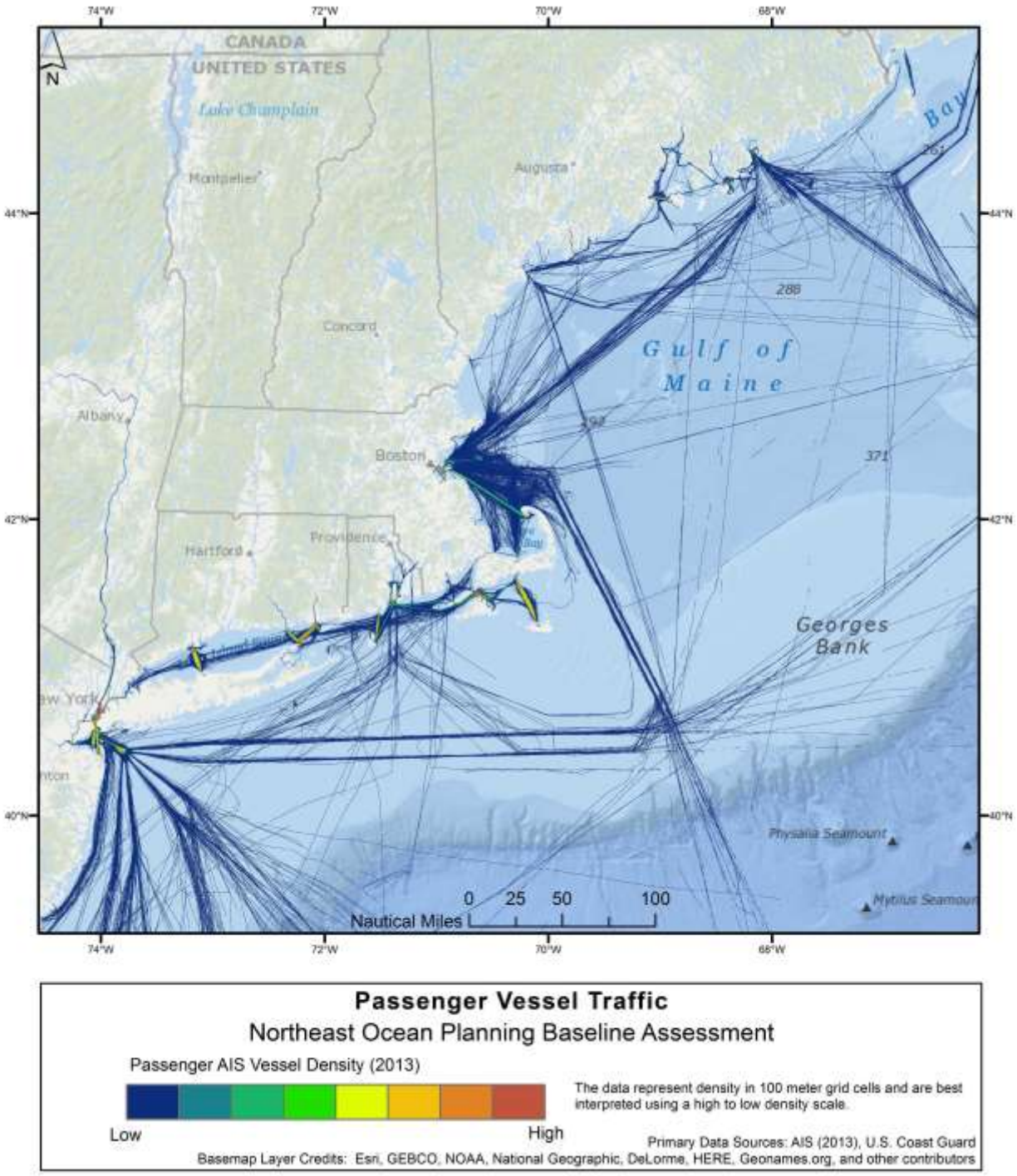


Figure 46 Passenger vessel traffic

4.6. Ship- and boat building and repair

Ship- and boat building and repair is the third largest major segment of the Northeast region's ocean economy, with $2.8 billion in annual GDP and more than 23,000 jobs (NOAA ENOW data). This work is heavily concentrated in Connecticut and Maine, where naval

shipbuilding and repair facilities and ancillary businesses are located (see section 3.3.2). Connecticut accounts for 60% and Maine accounts for 30% of this sector, with minor levels of activity in Massachusetts and Rhode Island.

4.7. Manufacturing and construction

Marine manufacturing and construction is one of the smaller sectors of the Northeast region's ocean economy, accounting for 2,360 jobs and $248 million in GDP in 2012 (just over 1% of the region's ocean economy) (NOAA ENOW data).

4.7.1. Marine technology and instrumentation

A small but vibrant "marine high technology" industrial sector exists in the coastal counties of Massachusetts and other parts of the region, supported and nurtured in part by the marine and oceanographic research laboratories of the region. In 2005, some 481 companies employing 55,000 people and generating $7.7 billion in annual sales were involved in providing marine science and technology products and services in the Northeast (Barrow *et al.* 2005). Some of this is due to small companies that specialize in marine technology. However, most of it is due to large corporations that have marine technology divisions but generate most of their revenue and employment from other lines of business. As a result, the marine technology business is difficult to identify in national economic data and is not well characterized in the NOAA ENOW data.

4.7.2. Marine construction

About 200 marine-related construction companies in the Northeast region employ about 2,000 people and generate roughly $200 million/year in GDP.

4.8. Energy and minerals

In 2012, three working sessions were held for members of the Northeast's offshore wind, marine hydrokinetic, and gas and infrastructure energy sectors. Key issues facing these energy sectors, anticipated changes in coming years, and the potential role of Northeast ocean planning to address issues and opportunities were discussed. The working sessions focused on several key topics: permitting and governmental coordination, data needs, and other sector-specific challenges. A White Paper on the Northeast Region energy sector (ESS Group 2012) summarizes key features of the sector and discussions at these sessions.

4.8.1. Renewable energy

Wind resources offshore New England are abundant and provide an opportunity for offshore renewable energy development in the near term due to available technology. Beginning in November 2010 with the Cape Wind project, nearly one-quarter of a million hectares (222,004 ha) have been leased on the US outer Continental Shelf (OCS) for potential offshore wind power development in the Northeast. More than $4 million in bonus bids were accepted for these leases. Projects have been moving forward slowly, and none is expected to be fully implemented before 2020. Estimated resource rents per hectare range from zero for Cape Wind (which did not involve a lease sale) to $1.73 for the North Lease and South Lease Wind Energy Areas located in the "area of mutual interest" proposed for federal renewable energy leasing by Rhode Island and Massachusetts. Only one small-scale nearshore project (five turbines), known as the Block Island Wind Farm, has begun construction – but not operation – on Rhode Island submerged lands.

Tidal current and, to a lesser extent, wave resources offshore New England have also generated interest as potential energy sources though are still mainly in the research and development stage. In recent years, several small scale tidal projects have either been installed or are at different stages of permitting. These ocean current or tidal power projects are located in river mouths (the ORPC Maine Tidal Energy Project in the Bay of Fundy, Eastport, Maine) or nearshore (the UMass Muskegat Tidal Energy Project, Edgartown, Massachusetts).

Future development of all of these projects will depend upon the negotiation of favorable generation charges though power purchase agreements with regional electricity distributors and the maintenance or expansion of federal subsidies, including tax incentives and production tax credits, and binding state renewable portfolio standards. The current sharp decline in prices for fossil fuels makes it unlikely that projects can be economically justified in the near future. The economic potential of these projects could change with increased regulation of hydraulic fracturing, the removal of subsidies on the production of fossil fuels, the establishment of a carbon price on fossil fuel production, or the ratcheting down of renewable portfolios. Further establishment and growth of offshore wind energy development in particular will be influenced by continued efforts to reduce capital costs (which differ substantially from land-based wind) variations in energy market prices, evolving financing options, and government policy.

Figure 47 illustrates renewable energy leasing areas in the Northeast.

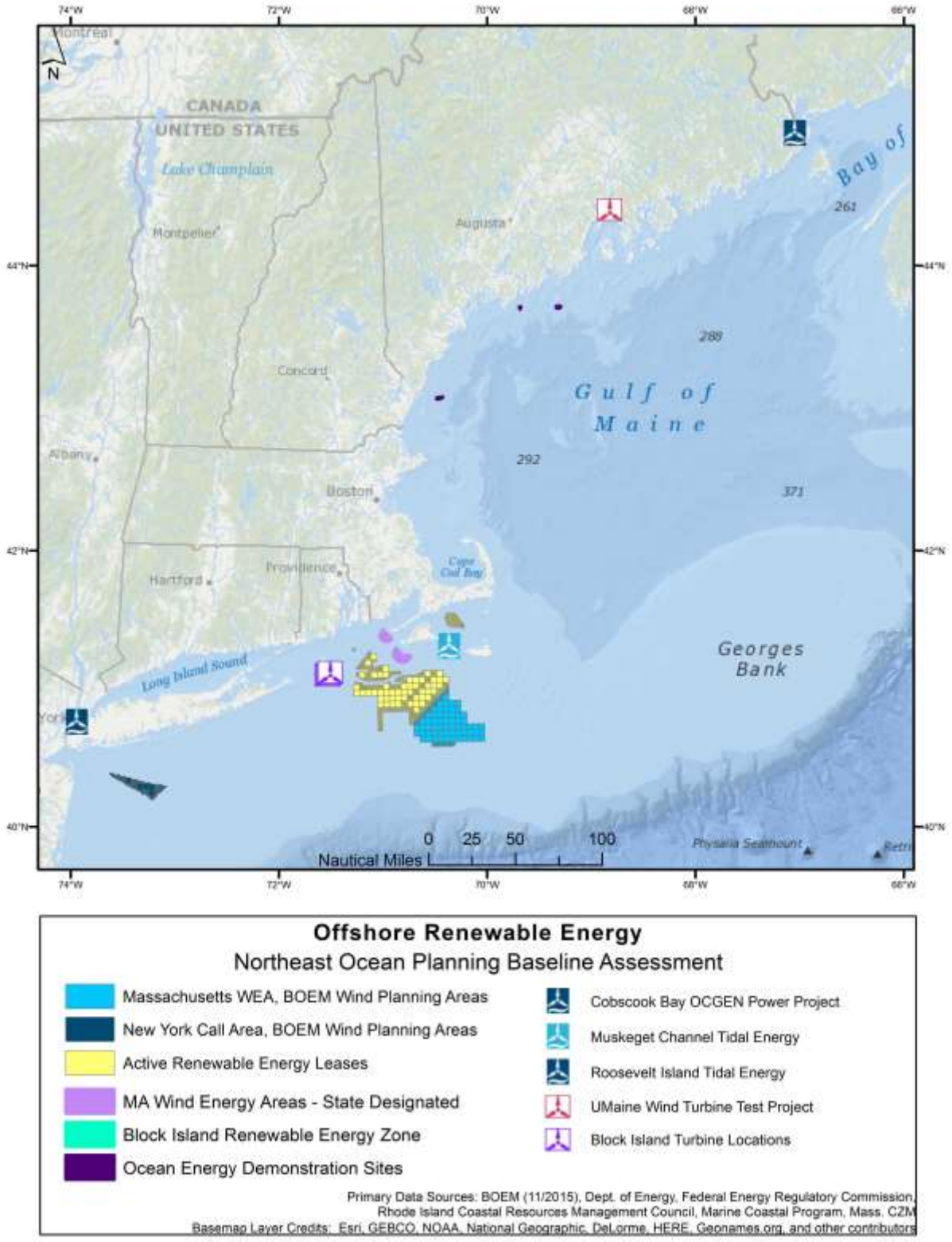


Figure 47 Renewable energy lease areas

More information about ocean-related energy issues in the Northeast is available in the White Paper on the Northeast Region energy sector (ESS Group 2012). The US Bureau of Ocean Energy Management (BOEM) develops and maintains data related to the gross and technical potential for various ocean energy resources, including offshore wind, wave, tidal, ocean current, and ocean thermal. BOEM's Environmental Studies Program gathers and synthesizes environmental, social, and economic science information to support decision-making concerning the offshore renewable energy and oil and gas programs. Relevant BOEM reports include:

- Environmental Risks, Fate and Effects of Chemicals Associated with Wind Turbines on the Atlantic Outer Continental Shelf - final report and technical summary
- Underwater Cultural Heritage Law Study - final report and technical summary
- Inventory and Analysis of Coastal and Submerged Archaeological Site Occurrence - final report and technical summary
- Critical Technical Review and Evaluation of Site-Specific Studies Techniques for the MMS Marine Minerals Program - final report and technical summary
- Compendium of Avian Occurrence Information (Database Section-Seabirds) for the Continental Shelf Waters Along the Atlantic Coast of the United States
- Effects of Electromagnetic Fields from Undersea Power Cables on Elasmobranchs and other Marine Species

4.8.2. Offshore oil and gas

As directed by the Outer Continental Shelf (OCS) Lands Act, the US Bureau of Ocean Energy Management periodically conducts assessments of undiscovered oil and gas resources in the OCS. The 2011 assessment for the Atlantic OCS included the Northeast region and was updated in a 2014 assessment of oil and natural gas resources off the US Atlantic Coast (as a result of additional, geologically analogous new discoveries offshore Africa and accounting for technological advances). The 2014 assessment includes estimates for the North, Mid, and South Atlantic Planning Areas as well as across the entire Atlantic OCS for the amount of "undiscovered, technically recoverable" oil and gas resources. The BOEM assessment does not report resource estimates for subsets of areas within OCS planning areas. Therefore, estimates specific to the New England portion of the Atlantic coastline are not available. Total Atlantic OCS oil resource estimates range from 1 to 9 billion barrels of oil with a mean estimate of nearly 5 billion barrels. Natural gas estimates range from nearly 12 to 68 trillion standard cubic feet of gas with a mean estimate of 38 trillion cubic feet. The 2011 assessment also provides information on "economically recoverable" gas resources, providing price-supply curves which show the relationship of price to economically recoverable resource in various OCS Regions. There are other reports from BOEM and outside of government that attempt to assess national or coast-wide economic benefits of increased oil and gas and fair market value of tracts offered for lease.

There are currently no areas in the North Atlantic Program Area (which includes federal waters off of the New England states) under lease for oil and gas development. In the Draft Proposed Program for the 2017-2022 oil and gas leasing program, there are no locations identified as potential lease sales in the North Atlantic Program Area. In the early 1980s, several exploratory wells drilled on Georges Bank did not encounter "significant

concentrations" of oil or gas. In late 2015, Canadian authorities grant approval for an exploratory lease for an area approximately 225 miles southeast of Bar Harbor, Maine, east of Georges Bank in Canadian waters.

Thus to date, New England has not had oil and gas production off its coast, relying instead on the distribution of oil and natural gas by pipeline, truck, and shipping to local ports such as Portland, Boston, and New York. Notably for ocean planning purposes, this includes the HubLine high pressure gas pipeline and two recently established deepwater LNG ports located in Massachusetts Bay. Each LNG port includes large buoys that receive gas from shipping tankers and distribute the gas to the HubLine through a system of underwater pipelines. The use of these offshore LNG ports and the frequency of associated ship traffic are subject to the dynamics of the natural gas market.

4.8.3. Sand and gravel

The marine minerals industry in the Northeast is focused on sand and gravel resources (Figure 5 above). As shown in Tables 2 and 3 above, the minerals industry generally accounts for $265 million/year in GDP and over 1,300 jobs, with the highest values for both in Maine and Connecticut. A significant portion of these values reported through ENOW minerals sector data can be attributed to sand and gravel resources with a small amount of activity related to oil and gas exploration and production (NOAA 2013 ENOW data).

Many Northeast coastal communities are facing the reality of more frequent flooding and coastal erosion that adversely affect residential and commercial areas, critical infrastructure and important habitat. As a result, several New England states and municipalities are now considering using offshore sand resources to help protect public infrastructure, nourish beaches, and enhance coastal habitat. The Northeast Regional Ocean Council established a Sand and Gravel Work Group that is pursuing pilot projects to study areas in need of sand resources to manage coastal erosion, characterize offshore borrow areas, and consider potential ecological impacts associated with sand extraction, and how sand and gravel mining should be integrated in regional ocean planning.

There are many potential public benefits of nearshore and coastal sand nourishment. Beach and dune systems provide and protect coastal habitat and can be used as an alternative to seawalls and other hardened structures, which can negatively affect habitat and local sediment dynamics. Sand nourishment restores and widens public beaches, improving access and providing safer recreational opportunities. Nourished beaches and stabilized shorelines protect structures, including residential areas, businesses, cultural resources, and critical public infrastructure. However, sediment extraction from offshore sources may also impact benthic and fish habitat and conflict with existing human activities. While offshore shoals and ridges provide good sources of sand, they may also represent valuable habitat for fish and other species.

Additional information related to sand and gravel resources and mining can be found in the following:

- Regional sediment management plans (Rhode Island and Massachusetts, and potentially Connecticut) are considering coastal storm damage risk reduction and associated sand/gravel needs for large sections of New England coastline.
- BOEM's Marine Minerals webpage and related fact sheets:
    - Marine Minerals Program fact sheet
    - BOEM response to Hurricane Sandy, update on recovery assistance and resilience planning fact sheet

4.9. National Security

Multiple branches of the U.S. Department of Defense (DOD) (i.e. U.S. Navy, Army, Marine Corps, and Air Force) and the Department of Homeland Security (USCG) are responsible for our nation's security. Employment and income/wages associated with national security personnel in the Northeast are not captured by the ocean economy data sets described above so are summarized in sections that follow.

4.9.1. US Navy

In terms of national security, the US Navy is the primary branch within the DOD that carries out training and testing activities and therefore is the primary focus for military activities related to ocean and coastal planning programs. The Navy historically uses areas along the eastern coast of the United States and in the Gulf of Mexico for training and testing. These areas were designated by the Navy into geographic regions, and named "range complexes" as illustrated in Figure 48. A range complex is a set of adjacent areas of sea space, undersea space, land ranges, and overlying airspace delineated for military training and testing activities. Range complexes provide controlled and safe environments where military ship, submarine, and aircraft crews can train in realistic conditions. The Boston, Narragansett, Atlantic City, and Virginia Capes range complexes are located along the Mid-Atlantic and Northeastern Seaboard of the United States. Combined, these areas are the principal locations for portions of the United States Navy's major training and testing events and infrastructure, including activities originating out of nearby Navy installations.

Three separate range complexes (the Boston Range Complex, the Narragansett Bay Range Complex, and the Atlantic City Range Complex) are collectively referred to as the Northeast Range Complex. The Northeast Range Complex spans 761 miles along the coast of Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, and New Jersey. The Northeast Range Complex also includes operating areas (OPAREAs) and associated special use airspace for Navy training and testing activities. The Naval Undersea Warfare Center Division Newport Testing Range consists of waters within Narragansett Bay, nearshore waters of Rhode Island Sound and Block Island Sound, and coastal waters of New York, Connecticut, and Massachusetts.

The Northeast Range Complexes also support training and testing by other branches of the military, primarily the USCG and the U.S. Air Force from nearby bases, as well as visiting operators with home bases located farther away. Overall, minimal surface training occurs within the Northeast OPAREAs due to the time and distance from the operators' homeports and home bases. The primary activities in the Northeast OPAREAs consist of submarine and submersible training and testing. Submarine and submersible testing and training is

conducted out of NSB New London and the Naval Undersea Warfare Center Division Newport, while Bath Iron Works builds and tests surface ships in the area. In addition to these users, non-DOD users are likely to use the offshore range complexes for research, including various government agencies such as various branches of the NOAA, research institutions such as Woods Hole Oceanographic Institution, universities such as the University of Rhode Island, the University of Connecticut, and Rutgers University (among others), and various state agencies.

Several military installations including the Portsmouth Naval Shipyard, Naval Station Newport, Naval Submarine Base New London, Naval Weapons Station Earl, and Joint Base McGuire-Dix-Lakehurst, are located on land adjacent to the offshore Northeast Range Complexes. These installations use the waters and airspace of the range complexes for training or testing activities. Work is underway to identify regulated marine areas where the US Navy carries out testing, bombing, and other operations.

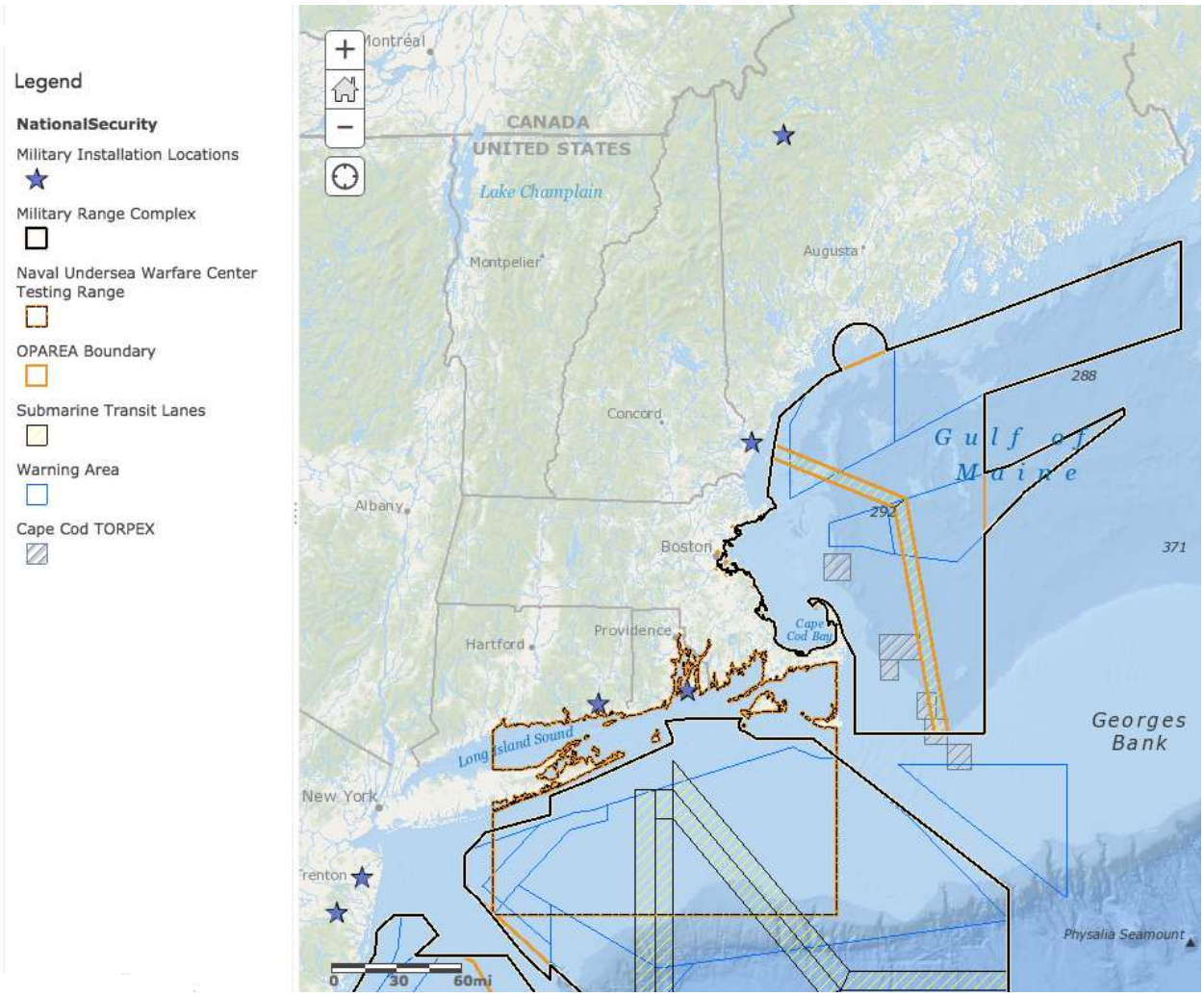


Figure 48 National security range complexes

The Naval Station Newport and the Naval Undersea Warfare Center Division Newport had a total military payroll of about $336 million in FY2013 (about 5,000 military personnel) and a total civilian payroll of about $693 million (9,900 employees). The combined operations also issued some $641 million in contracts and procurements in FY2013 (Naval Undersea Warfare Center Division Newport, RI: Summary of NUWC Division Newport's 2014 Economic Impact on Southern New England).

The Naval Submarine Base, New London, Connecticut, reported a total military payroll of $467 million (about 11,400 military personnel) and a total civilian payroll of $180 million (about 2,900 civilian employees) in FY2014. Procurement of goods and services accounted for about $7 billion (Navy Region Mid-Atlantic FY 2014 Economic Impact Report).

The Portsmouth Naval Shipyard in Kittery, Maine, reported a total military payroll of $42.2 million for 2014. The shipyard purchased goods and services worth about $53.1 million and issued contracts for maintenance, support, and utilities in the amount of $157 million. Civilian employment associated with the shipyard accounted for about 5,900 jobs and $432 million in wages in 2014 (Portsmouth Naval Shipyard Economic Impact Statement – CY2014).

Additional information on US Navy activity and engagement in Northeast ocean resource management can be found in the following:

- Atlantic Fleet Training and Testing (AFTT) Final Environmental Impact Statement (covers Navy activities in the NE for 5 years)
- Wide range of Environmental Assessments (EA) and Environmental Impact Statements (EIS). (e.g. Overseas Environmental Impact Statement (EIS/OEIS))
- The Navy has an overall at-sea Environmental Compliance page that includes the AFTT EIS/OEIS and other comprehensive planning documents.
- Marine Resource Assessment for the Northeast Operating Areas (Prepared for Dept. of Navy, 2005). This MRA documents and describes the marine resources in the vicinity of the Northeast Operating Areas (NE OPAREAs), which include the Atlantic City, Narragansett Bay, and Boston OPAREAs.

4.9.2. US Coast Guard

The U.S. Coast Guard is one of the five armed forces of the United States and the only military organization within the Department of Homeland Security. Since 1790 the Coast Guard has safeguarded our Nation's local, national, and international maritime interests. By law, the US Coast Guard has 11 missions:

- Ports, waterways, and coastal security
- Drug interdiction
- Aids to navigation
- Search and rescue
- Living marine resources

- Marine safety
- Defense readiness
- Migrant interdiction
- Marine environmental protection
- Ice operations
- Other law enforcement

The Coast Guard's First District Headquarters is responsible for Coast Guard activities in Northern New Jersey, New York, Connecticut, Rhode Island, Massachusetts, New Hampshire, Vermont, and Maine. This region includes both ashore and afloat units all described in more detail here: http://www.uscg.mil/d1/units.asp. The US Coast Guard employs about 3,400 active duty military, 800 civilians, and 1,100 reservists in the First District whose headquarters is located in Boston, Massachusetts.

4.10. Research and education

Coastal marine and oceanographic research and education institutions are an important part of the Northeast region's higher education and research sector, and include some of the most prominent marine science institutions in the world. These institutions employ several thousand people and collectively account for more than $500 million/year in research and education work (Barrow *et al.* 2005). They also provide education and training for hundreds of undergraduate and graduate students in marine and geosciences. Technologies developed at these institutions help support the Region's marine technology industry (see section 4.7.1).

Marine research and education institutions in the Northeast include (this list is not exhaustive):

- Mt. Desert Island Biological Lab, Maine
- Bigelow Laboratory for Ocean Sciences, Maine
- Darling Marine Center, University of Maine
- School of Marine Sciences, University of Maine
- University of New England, Maine
- Gulf of Maine Research Institute, Maine
- Bowdoin College, Maine
- Seacoast Science Center, New Hampshire
- University of New Hampshire Center for Coastal and Ocean Mapping
- Northeastern University Marine Science Center, Massachusetts
- University of Massachusetts Boston School for the Environment
- University of Massachusetts Dartmouth School for Marine Science and Technology
- New England Aquarium, Boston, Massachusetts
- Stellwagen Bank National Marine Sanctuary, Massachusetts
- US Geological Survey Woods Hole Coastal and Marine Science Center, Massachusetts
- Center for Coastal Studies, Provincetown, Massachusetts
- Five Colleges Coastal and Marine Science Program, Amherst region, Massachusetts

- Massachusetts Maritime Academy, Buzzards Bay, Massachusetts
- Marine Biological Laboratory, Woods Hole, Massachusetts
- Woods Hole Oceanographic Institution, Woods Hole, Massachusetts
- Sea Education Association, Woods Hole, Massachusetts
- Graduate School of Oceanography, University of Rhode Island
- Roger Williams University, Rhode Island
- Marine Sciences Program at Avery Point, University of Connecticut
- Mystic Aquarium, Mystic, Connecticut
- US Coast Guard Academy, New London, Connecticut