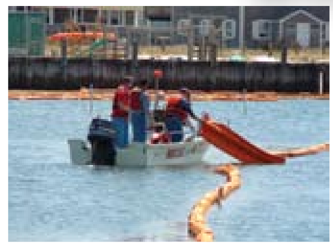
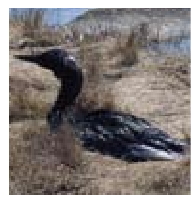
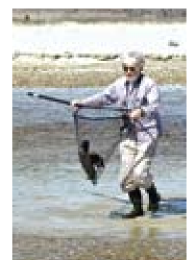
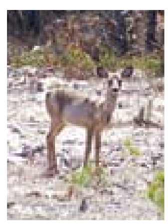
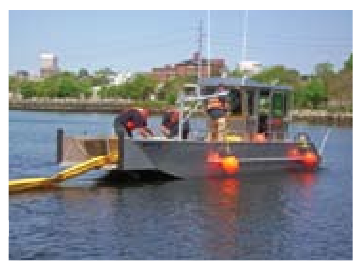
Evaluation of Marine Oil Spill Threat to Massachusetts Coastal Communities

For the COMMONWEALTH of MASSACHUSETTS

Prepared for: Massachusetts Department of Environmental Protection

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Prepared by: Nuka Research & Planning Group, LLC

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Contents

Executive Summary

This report compiles and analyzes information regarding the threat of marine oil spills to coastal communities in Massachusetts. The report was developed by Nuka Research and Planning Group, LLC under contract to the Massachusetts Department of Environmental Protection (MassDEP) under the "Project to Identify Priority Coastal Communities for Distribution of Future Oil Spill Response Equipment, Training and Geographic Response Plans for the Commonwealth of Massachusetts."[1] The content of this report may be used by MassDEP to facilitate oil spill prevention and response resource allocation decisions.

This report represents an assessment of threat levels by threat categories in the harbors, communities, and regions of coastal Massachusetts. To assess overall threat levels and to compare oil spill threats among geographic locations, a methodology was developed to estimate threat exposure at the harbor and community level to three different categories of threat and ten discrete threat factors. Three general categories were used to distinguish threat types – vessel movement, resident vessel fleets, and land-based storage. A measure of gallons of petroleum exposure (GPE) was calculated for ten different threat factors by geographic area. The methodology used to develop the assessment, a description of the data sources used, and an analysis and evaluation of the results are included in this report. This report aggregates and analyzes various measures of oil spill threat exposure, but it is not a quantitative or numeric risk assessment.

The use of GPE to estimate oil spill threat levels is based on the assumption that oil spill risks are directly related to the amount of petroleum storage, transfer, and utilization activity occurring within a designated geographic area. In most cases, the GPE at the local level can be summed to estimate regional threat levels. No effort is made to rank the various threat categories relative to each other; therefore all types of spill threats are considered to have equal priority.

This report finds that the largest oil spill threat for all factors combined occurs in the Boston Harbor Region, due mainly to the level of petroleum imports. The Cape and Islands Region has the second highest threat level largely due to the amount of vessel transits in shipping lanes near their coast. The other regions in order of decreasing threat levels are: South Coastal, North Shore and South Shore. At the harbor level, Boston Harbor, New Bedford Harbor, Sandwich Boat Basin and Great Harbor (Woods Hole) ranked among the highest in terms of total exposure to oil spill threats.

Across all harbors and regions, the oil spill threat from vessel movement was much higher in terms of gallons of petroleum exposure than any other source. This is mostly attributable to the fact that tank vessels moving through shipping channels and in and out of harbors (primarily the Port of Boston) represent the single largest exposure to oil by quantity. Land-based storage in regulated tanks is the second largest total exposure. The third largest threat factor is nontank

[1] Project #101300.

vessel activity. After nontank vessel activity, fishing fleets account for the fourth highest exposure threat. After fishing vessels, recreational and charter vessels seem to pose the fifth largest overall exposure level.

This study is presented as an initial assessment of the magnitude of the threat of an oil spill in coastal Massachusetts and a methodology for continued analysis. One of the goals of this study was to create a basic data set that could be used in future risk assessment or risk management planning. The data supporting the analysis for each threat category can be revised as additional and more detailed sources of information are identified, and additional threat categories can be analyzed and added to the model. Additional factors that may magnify or reduce spill threats could be considered as part of a more comprehensive risk assessment.

Based on the threat evaluation by harbor, region, and threat factor and the conclusions of the companion Response Equipment report, this report recommends specific measures that MassDEP may consider in developing future oil spill prevention and response planning projects, including:

- Tailor prevention activities to the highest-exposure locations and activities by continuing with targeted prevention measures such as escort tugs in high-threat areas, ensuring that GRPs are developed for high threat areas, and ensuring that sufficient equipment is available to support priority GRP deployments.
- Enhance response capacity and spill preparedness in highest-exposure harbors and regions through development of additional tactical plans, supplementing oil spill response inventories, developing harbor and regional spill response plans, and conducting scenario analyses to better assess preparedness in high threat areas.
- Diversify state-owned equipment stockpiles to enhance overall response capability.
- Identify opportunities for outreach and education to encourage awareness of oil spill threats from resident vessel fleets and other smaller magnitude threats that may have cumulative impacts.

Evaluation of Marine Oil Spill Threat to Massachusetts Coastal Communities

Report to Massachusetts Department of Environmental Protection

April 2009

1 Introduction

This report presents the analysis and recommendations developed by Nuka Research and Planning Group, LLC under contract to the Massachusetts Department of Environmental Protection (MassDEP) under the "Project to Identify Priority Coastal Communities for Distribution of Future Oil Spill Response Equipment, Training and Geographic Response Plans for the Commonwealth of Massachusetts."[2] The content of this report is intended to be used by MassDEP to facilitate oil spill prevention and response resource allocation decisions. This report presents an estimate of oil spill threat by geographic area using a measure of gallons of petroleum exposure (GPE).

This report discusses the rationale for estimating oil spill threats in order to develop comparisons of relative spill threats by geographic area. The methodology used to estimate oil spill threat exposure is presented. The report also presents a description of the data sources used, and an analysis and evaluation of the results. While this report discusses how the GPE threat estimate may be analyzed in the context of overall oil spill risk, the report does not present a quantitative or numeric risk assessment and the results, which estimate comparative oil spill threats, should not be confused with a comprehensive risk assessment.

This report is a companion report to the *Inventory and Assessment of Marine Oil Spill Response Resources in Massachusetts and New England States* report (hereafter, Equipment Report). This report discusses the major findings from the Equipment Report in the context of this analysis and makes recommendations to MassDEP regarding the current state of oil spill threats and response readiness. Both reports establish a foundation for further analysis and activity regarding oil spill prevention and response.

1.1 Background

The three-year plan for implementing the Massachusetts Oil Spill Prevention and Response Act and Amendments (June 2009) outlines oil spill prevention and response planning efforts to be led by the Massachusetts Department of Environmental Protection to implement lessons learned from the 2003 Buzzards Bay spill as reflected in the mandates of the 2004 Oil Spill Act and Amendments (2008 and 2009).[3]

[2] Project #101300.
[3] Chapter 251 of the Acts of 2004: An Act Relative to Oil Spill Prevention and Response in Buzzards Bay and Other Harbors and Bays of the Commonwealth. "The Oil Spill Act", including 2008 and 2009 amendments.

A major planning task in the implementation plan is to conduct a coastal oil spill threat evaluation that will serve as the basis for prioritizing future equipment and training deliveries and Geographic Response Plan development. This report presents recommendations regarding relative spill threats, and establishes a foundation that may be used in the future to develop a more robust risk analysis and management program.

Other programs and activities conducted to date in support of the interim plan to improve oil spill preparedness and response capabilities include:

- The delivery of oil spill response trailers to 68 coastal communities.
- The development of geographic response plans (GRP) to protect environmentally sensitive areas in Buzzards Bay, Cape Cod and the Islands, and the North Shore.
- The execution of oil spill response training field exercises to familiarize local first responders with oil spill response equipment, tactics, and GRPs.
- The compilation of an inventory of oil spill response equipment by town, city and region to compare against actual requirements and help determine procurement decisions.

Additional activities in support of the interim Plan will be developed by MassDEP through the Bureau of Waste Site Cleanup with the support of the Massachusetts Oil Spill Act Advisory Committee (OSAAC).

1.2 Purpose and Objectives

An overarching goal of the Oil Spill Act is to develop a statewide oil spill response capability. The purpose of this project was to conduct an informal evaluation of the marine oil spill threats in the Commonwealth of Massachusetts to support future expenditures from the Massachusetts Oil Spill Act Fund for oil spill response equipment trailers, geographic response plans, and other efforts.

The main objective of this report is to develop an assessment of the relative oil spill threat levels in the coastal Massachusetts region and report on the analysis in a manner that can be used in procurement and operational planning decisions.

A secondary objective of this project is to develop the methodology and analysis in such a way that it can be:

- Scaled to provide additional information for specific threat factors as part of future studies;
- Replicated to assess trends in oil spill threats by town, city, and region; and
- Utilized as a first step in a larger risk management program.

1.3 Scope of Work

The comparison of spill threats by region contained in this report may be used to develop or validate intermediate priorities for allocation of spill response planning efforts. This report also presents recommendations for additional planning and response activities that might supplement the overall response capability within Massachusetts.

The Oil Spill Threat Analysis has been conducted to present an initial assessment of the oil spill threats by geographic location and by relative size of each threat. To complete the analysis the following major tasks were undertaken:

- Identification of those towns and cities in Massachusetts that may be considered "coastal" based on the potential threat for an oil spill from any source that would require a coastal (on-water or nearshore) oil spill response;
- Identification of harbors within each coastal town that would likely be exposed to oil spill threats, thus allowing for analysis and evaluation at the harbor level and aggregation of data to the regional level;
- Identification of the major threat factors and activities that contribute to the potential for a marine oil spill to impact a Massachusetts coastal community;
- A compilation of recent, available data regarding the presence or absence of each major threat factor and the size of the threat or activity by geographic location (harbor, town, city, or region);
- Calculation of gallons of petroleum exposure (GPE) for each threat factor at different geographic levels in order to develop a comparative analysis of the relative threats levels;
- Consideration of relative threat levels compared to oil spill response equipment stockpile levels; and
- Publication of the final analysis along with recommendation for future analysis.

1.4 Study Approach

This report identifies potential oil spill threats by geographic region as part of a larger effort to identify and mitigate the risk of an oil spill and the consequent damage the spill would cause. By focusing on the threats, the report presents information that can be used in the initial stages of a comprehensive risk management program.

Risk management can be defined as a logical and systematic method of identifying, evaluating and managing the risks associated with any activity, function or process in a way that will enable an organization to minimize losses and maximize opportunities. Risk management is an iterative process consisting of well-defined steps which, taken in sequence, support better decision-making by contributing a greater insight into risks and their impacts.

Risk assessment, which is a subset of risk management, is the process of identifying the likelihood of a particular event occurring and its potential consequences. Likelihood can be measured in quantitative terms of probability based on the historical frequency of similar events. Or it can be measured in qualitative terms, such as more and less or high and low, and based on an in depth understanding of the system or systems and the possible failure points.

The major components of a risk management program are as follows:[4]

Establish the context - Establish the strategic, organizational and risk management context in which the rest of the process will take place.

Identify risks - Identify what, why and how things can arise as the basis for further analysis.

Analyze risks - Determine the existing controls and analyze risks in terms of consequence and likelihood in the context of those controls.

Evaluate risks - Compare estimated levels of risk against the pre-established criteria.

Treat risks - Accept and monitor low-priority risks. For other risks, develop and implement a specific management plan.

Monitor and review - Monitor and review the performance of the risk management system.

Communicate and consult - Communicate and consult with internal and external stakeholders as appropriate.

This study focuses on the first two components of risk management: 1) Establish the context and 2) Identify risks. The identification of threats is an important step in the overall risk assessment process. The study identifies the types of oil spill threats that exist and compiles relative measures of threat levels by geographic location in order to estimate the comparative level of exposure an area has to the threat of an oil spill.

This study provides MassDEP with a basis from which to conduct further risk analysis and evaluation potentially leading to programs which may reduce the risk of an oil spill or prepare to mitigate the consequences.

The study was designed to include input and review from local, state and federal agencies with harbor management or oil spill oversight authority. Questionnaires and surveys have been sent to stakeholders to determine threat components and draft reports and interim data sets have been reviewed by representatives of MassDEP, the U.S. Coast Guard (USCG), and the National Oceanic and Atmospheric Administration (NOAA) Office of Restoration and Response.

The final report will be made available to OSAAC for their consideration and review.

1.5 Geographic Scope

Geographic designations are important to the final analysis and presentation of the data collected in this study since response planning efforts and projects are to be allocated by community (town or city) and region. In the interest of consistency with other statewide ocean and coastal planning and management initiatives, this study uses the same regional designations used by the Massachusetts Coastal Zone Management (CZM) program.

[4] Standards Association of Australia, *Risk Management AS/NZS 4360 1999*, 12 April 1999

1.5.1 Municipality and Region

As shown in Figure 1.1, the state is divided into five regions for the purpose of coastal oil spill response planning: North Shore, Boston Harbor, South Shore, Cape and Islands, and South Coastal. Three major criteria were applied to Massachusetts communities within the coastal regions to determine whether or not they would be included in the threat evaluation study: [5]

- Does the municipality have a boundary that reaches the marine coast? If **yes**, the community was included. If **no**, then question #2 was considered.
- Does the municipality include a tidal river, estuary, marsh or inlet that flows to marine waters without impediment? If **yes,** then the community was included. If **no**, then question #3 was considered.
- Based on best professional judgment, are there reasonable scenarios where spilled oil from a marine transportation related facility could migrate to the tidal rivers within the community? If **yes**, then the community was included. If **no,** then the community was excluded.

Based on the above criteria, 71 towns and cities were identified as being at risk of being impacted from a marine oil spill and/or being a potential source of a marine oil spill. Municipalities that are included in each region are shown on the map in Figure 1.1.

1.5.2 Harbor and Waterbody

In addition to municipality and region, two other levels of geographic information were identified to assist with the analysis. First, a list of individual harbors within each community was compiled to allow for analysis of oil spill threats by source and quantity. Second, each harbor was listed by the waterbody that it is adjacent to so that information can be aggregated by major waterbody.

A geographic location was considered a harbor if it met at least one of the following criteria:

- The location was called a harbor on the NOAA chart for the area.
- The location provides a refuge from waves and wind and has mooring or docking facilities for more than 25 – 50 vessels.
- The location has a marina or boatyard.
- The location has a significant amount of commercial maritime activity[6].

The analysis identified 95 harbors in the 71 coastal towns and cities with 14 of the 95 harbors shared by more than one municipality. Boston, Everett and Chelsea, for example, each have waterfront commerce, but they each abut Boston Harbor. Seven towns do not have a harbor - Freetown, Dighton,

[5] For a more detailed discussion of how coastal towns were identified, see the report to MassDEP entitled "Rationale for Identifying Massachusetts Communities for Inclusion in Coastal Oil Spill Threat Evaluation," June 2008. http://www.mass.gov/dep/cleanup/ctrec.pdf.

[6] For purposes of this study; A "port" is defined as a location on a waterway that has facilities for loading or unloading cargo from ships or barges.

Acushnet, Berkeley, and Peabody abut rivers above identifiable harbors, and Swampscott and West Tisbury are coastal towns that do not have an identified harbor. Falmouth has fourteen harbors and abuts two waterbodies. The remaining towns have between one and six harbors.

To assist with future analysis of oil spill threats, the waterbody that each harbor is adjacent to was added as an additional geographic identifier. Aggregation of the oil spill threat data by waterbody may be valuable in future studies to assess the effect of very large spills across regions. For example, the Cape and Islands region is adjacent to five different waterbodies (Cape Cod Bay, Atlantic Ocean, Nantucket Sound, Vineyard Sound, and Buzzards Bay) and shares two of the waterbodies with other regions. For a large spill in Cape Cod Bay, the response would likely involve resources from the Cape and Islands and the South Shore regions. For a spill in Buzzards Bay, the response will likely involve resources from the Cape and Islands and the South Coast regions.

Figures 1.2.1 through 1.2.5 contains five maps showing the harbor locations by region. The 95 harbors are numbered in the map and the accompanying index, beginning in the North Shore region and then working south through Boston Harbor and the South Shore, then clockwise around the Cape and Islands and counterclockwise around Buzzards Bay and Mount Hope Bay in the South Coastal Region. Appendix A provides the list of Massachusetts harbors by region, municipality, and waterbody.

Figure 1.1 Map of Coastal Regions and Municipalities Included in this Study

Figure 1.2.1 Harbors located in the North Shore Region

Figure 1.2.2 Harbors Located in the Boston Harbor Region

Figure 1.2.3 Harbors Located in the South Shore Region

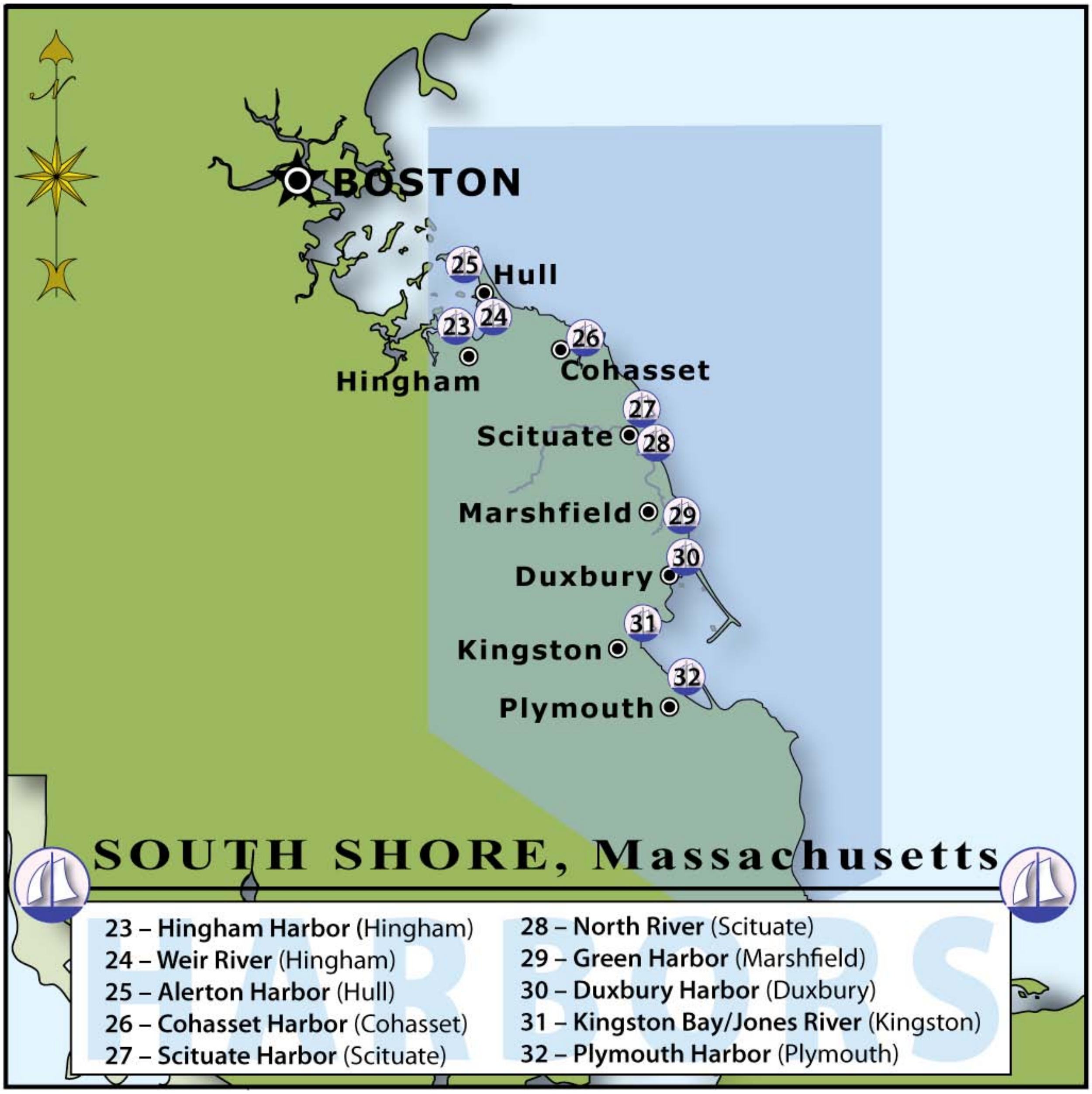


Figure 1.2.4 Harbors Located in the Cape and Islands Region

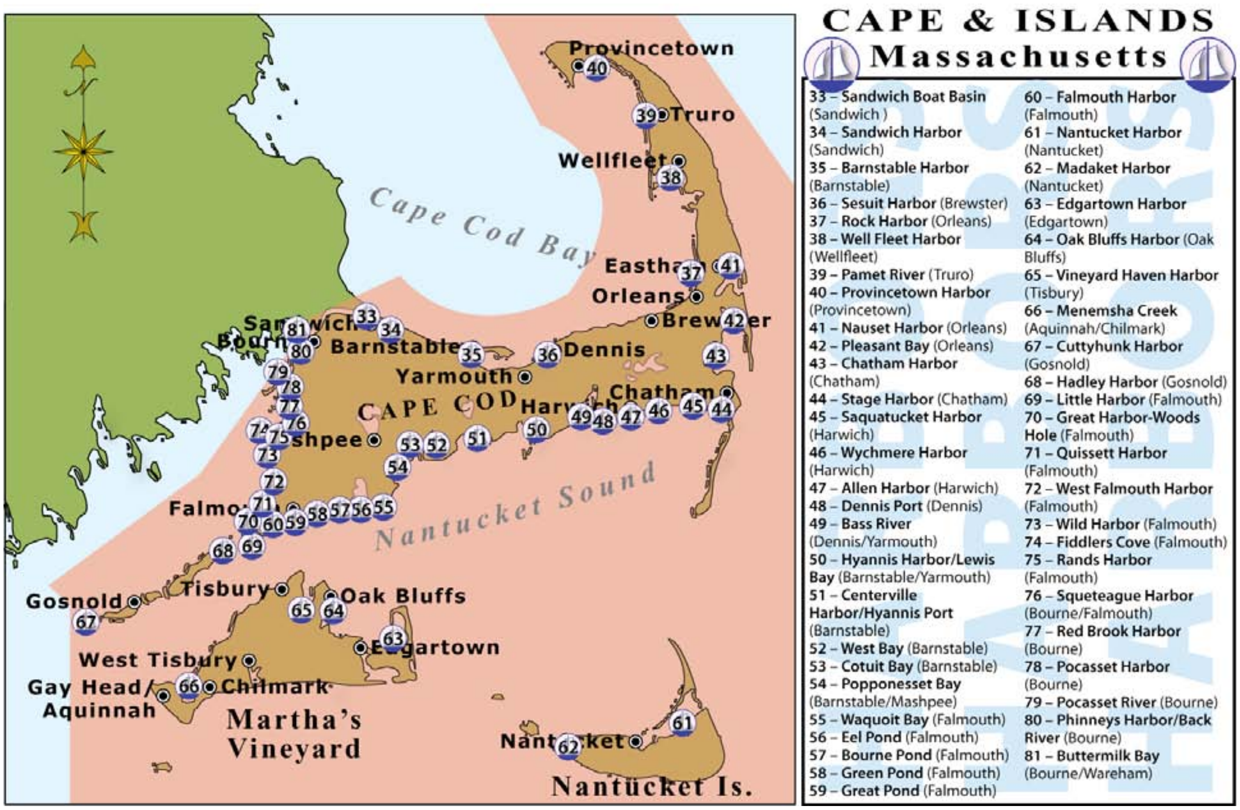
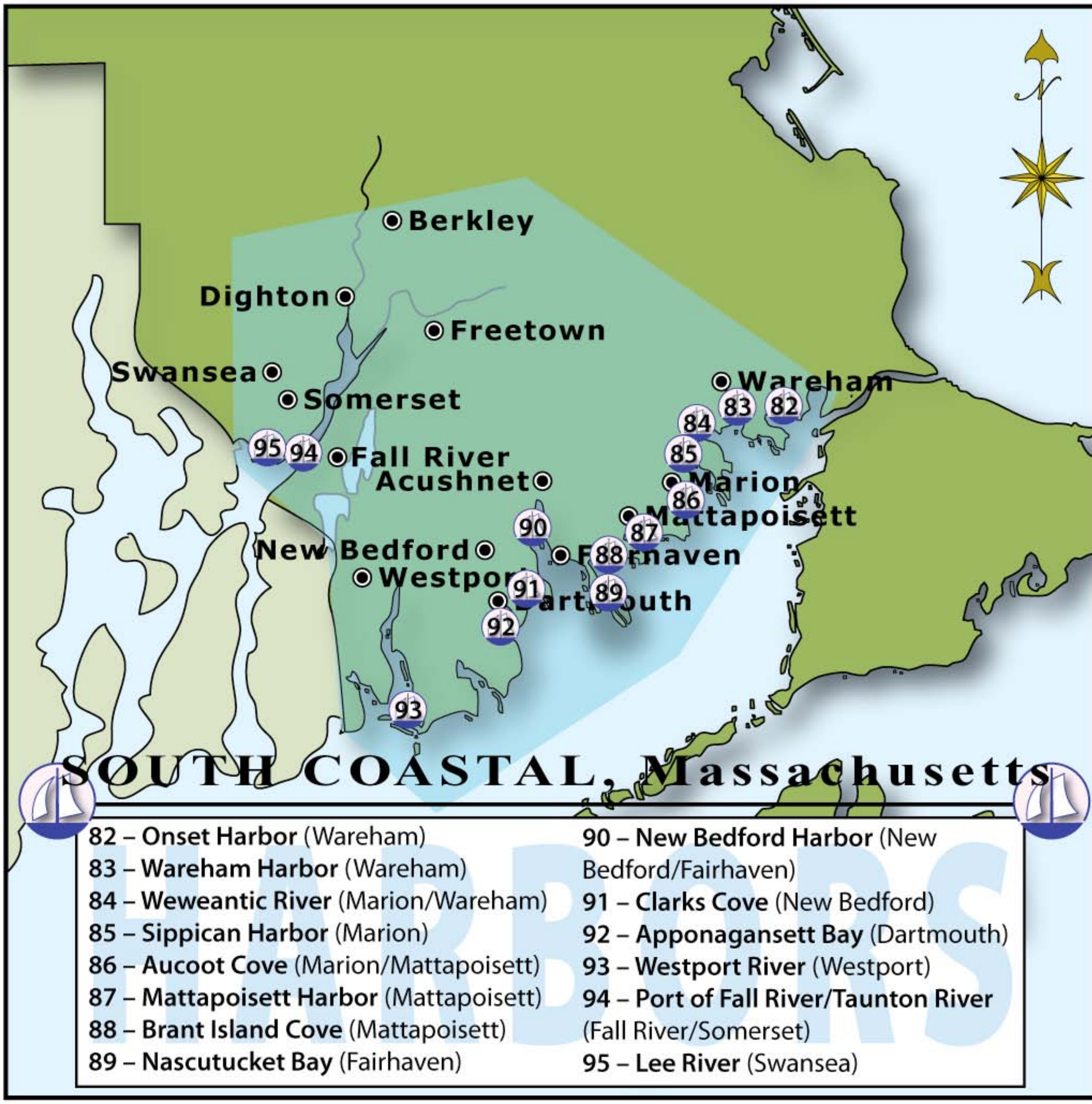


Figure 1.2.5 Harbors Located in the South Coastal Region



2 Threat Categories

This study evaluates relative oil spill threat levels using a measure of total gallons of petroleum product that a harbor, town, city or region could be exposed to on an annual basis. The resulting measurement of Gallons of Petroleum Exposure (GPE) then allows for comparative assessment of marine oil spill threats within and among Massachusetts harbors, towns, cities, and regions.

This study considers the oil spill threats to coastal communities from both marine and land-based sources. Three categories of oil spill threats were analyzed. The first category includes indicators of large vessel movements in the major ports of the state and along shipping routes. The analysis focused on petroleum deliveries in tank vessels and on the movement of large vessels that use petroleum as fuel. The second category of threat factors includes residential vessel fleets that are moored or docked in a harbor. These indicators were analyzed for their total fleet size and average vessel size to determine estimates on the total amount of fuel carried. The third category accounts for land-based bulk fuel storage and non-EPA regulated fuel tanks to provide a total number of gallons of exposure from these sources. The threat factors identified through this study are not exhaustive, but reflect those factors for which sufficient data was available to make a reasonable assessment.

One threat category not considered in this study is the history of oil spills by location. An initial review of local oil spill records indicated that the accuracy of the data was not sufficient to draw meaningful conclusions. Data sets reviewed included MassDEP records, USCG records, and a survey sent to local fire chiefs. Problems with data quality and consistency were noted both within and across databases. A more expansive review of these and possibly other data sets may be useful for future studies of probability and/or frequency of oil spills. Historical studies of oil spills by location and threat type combined with an analysis of oil spill prevention methods and an ongoing accurate tracking of oil spills could become part of a more comprehensive risk management program as discussed in Section 1.4.

Another potential area of study that is not addressed by this report is a location's vulnerability to oil impacts. The NOAA Office of Response and Restoration has classified shoreline types from least vulnerable to most vulnerable and inventoried the natural resources found along the shorelines of Massachusetts. A vulnerability analysis of the NOAA data combined with the threat analysis would provide another layer of information that could be used to better understand overall risks by community and/or region.

Mitigating measures are also not accounted for in this study. Every gallon of oil present in a location is considered to have an equivalent likelihood for being spilled. This is a somewhat artificial assumption, since there are a wide range of spill prevention and mitigation measures in place for vessels and shoreside facilities that can impact the likelihood of a spill from one source as compared to another. A broader risk management program would also factor in such preventative measures and account for the corresponding potential reduction of spill threat or magnitude.

2.1 Vessel Movements

Vessel movements into and out of major ports and along traffic routes can impact the threat of coastal oil spills in a number of ways. A port with a large number of vessel calls may have a higher relative threat of spills than a less active harbor. Vessel traffic patterns in shipping lanes or ship channels may contribute to oil spill threats due to navigational challenges, congestion areas, or other factors. The size and type of vessels that call on a port and the quantity of petroleum they carry as either cargo or fuel (bunker) may also contribute to oil spill threats. An oil spill in Alaska from the vessel *Selendang Ayu* and a spill in San Francisco Bay, CA from the vessel *Cosco Busan* are both examples of fuel oil (bunker) spills.

The individual threat factors for vessel activities that were considered in this study are:

- Oil tank vessel or tank barge activity in ports
- Large nontank vessel activity in ports (freight, passenger, or other vessels – over 300 gross tons)
- Oil tank vessel and large nontank vessel transits in major shipping lanes.

Data on vessel activity in Massachusetts harbors was gathered from several sources, including port entry data, vessel movement information, and surveys with professional mariners and harbor managers in the communities and region.

In aggregating the data from the harbor level up to the regional level, information regarding tank vessel or tank barge activity and large nontank vessel activity within each harbor has been added together to create the regional GPE measure.

However, quantities of GPE calculated as a result of vessel transits are recorded only once per vessel route and then applied without aggregation to each level of analysis. Each gallon of petroleum cargo or fuel in tanks that transits by a harbor adjacent to the vessel routes presents only a single threat of being spilled. Therefore, the same threat level is experienced whether the analysis is by harbor or by region. To aggregate these numbers from the harbor level up to the regional level would overstate the exposure.

2.2 Residential Vessel Fleets

For many harbors in Massachusetts the most likely threat of an oil spill comes from the thousands of recreational and charter vessels, fishing vessels, and commercial vessels that operate within the harbor and utilize it for moorage and dockage. These vessels typically range in size from 18 ft to 65 ft; however a few harbors have recreational and commercial vessels that exceed 100 ft in length. Oil spills from these sources occur during fuel transfer operations, bilge pumping, as a result of a collision or grounding, and as a result of accidental or illegal discharges of fuel, lube oil, or hydraulic oil.

To estimate the magnitude of the threat factors from residential vessel fleets, the following data was collected for this study:

- Recreational and charter vessel range of lengths and average size along with the total number of recreational and charter vessel moorings and slips in the harbor.
- Commercial fishing vessel range of length, average size, and type of vessel.
- Ferryboat lengths and type.
- Information on other large vessels moored and operated in the harbor (i.e. tugboats, whale watching boats, research vessels, and training ships).
- Information on shipyards within a harbor that service large vessels.

For this study, information on moorings and slips was used to estimate the size of the recreational and charter vessel fleet rather than use USCG, state or local registries of vessels. While a detailed analysis of these registries may provide an accurate assessment of the actual vessel fleet size; utilizing mooring and slip counts as an indicator of fleet size allows for an efficient method of information gathering, a high level of accuracy and a consistent measure across different harbors. The assumption made for the study is that all moorings and slips are utilized during the summer season. Thus the total size of the fleet in any given harbor will include vessels that are registered to the harbor as well as transient vessels that utilize the harbor for less than a full season. This assumption then works well for harbors such as Cuttyhunk Harbor in the town of Gosnold, where nearly all moorings are occupied during the summer months by transient vessels, yet there are very few vessels registered with Cuttyhunk as a homeport.

Data collected on these threat factors came from surveys to harbormasters, web-based research on commercial vessel activity and phone conversations with industry personnel, mariners, and harbor managers.

2.3 Land-Based Bulk Fuel Storage

Coastal communities in close proximity to land-based bulk fuel storage have an increased threat of being impacted by a spill. Bulk fuel storage facilities considered for this study include EPA regulated facilities with storage tanks over 10,000 gallons (per the Oil Pollution Act of 1990 requirements for Facility Response Plans) as well as smaller bulk fuel storage tanks at harbors and marinas (typically between1,000 gallons and 4,000 gallons).

The individual threat factors for land-based bulk fuel transportation and storage that were considered in this study are:

- EPA Regulated facility with potential to discharge to tidal waters
- Locally regulated bulk fuel storage at harbor or marina (any product)

Information about spill threats from fuel storage was compiled from several sources. The Environmental Protection Agency (EPA) provided a list of all regulated facilities in Massachusetts (those required to file Facility Response Plans with the EPA, which generally have at least 42,000 gallons of total aboveground storage).[7] Information on smaller bulk fuel storage at harbors and

[7] United States, U.S. Code of Federal Regulations, 40 CFR 112.

marinas (1,000 gallons total or more) was gathered through surveys municipal fire chiefs and harbor masters.

Spills during transfers or vessel refueling are considered the primary oil spill threat from these sources, although it is possible that oil could also be spilled through primary leaks from the tanks themselves or catastrophic tank failures. The GPE from these sources are therefore used as in indicator of the relative level of oil spill threat in any given harbor and can be aggregated together to calculate regional threat indicators.

The evaluation of fuel storage does not distinguish between the types of petroleum product stored; however, it is important to acknowledge that a gasoline spill would pose a much different response scenario than a home heating oil or marine diesel fuel spill. Therefore, as this threat factor is evaluated for the purpose of future planning decisions, it may be salient to consider the type of petroleum storage and tailor prevention and response planning strategies accordingly.

3 Data Sources, Assumptions and Methods

Section 3.1 describes data sets used to estimate the threat factors discussed in Section 2 and identifies limits and constraints encountered in their compilation. One of the objectives of the study was to conduct the analysis using readily available data sources, and the information collected does provide reasonable indications of the type, location and quantity of oil spill threats along coastal Massachusetts. However, to assist future studies, each data set description also discusses some of the constraints encountered while collecting and analyzing the information. These lessons can be applied to future efforts to compile data for analysis of trends, causes, and potential mitigation programs. Section 3.2 discusses several sets of data that were reviewed but not used in this study.

The assumptions used to guide the data collection process are presented in Section 3.3. These assumptions may or may not apply to future studies; however, a review of the criteria presented will be useful to future efforts to either replicate or expand on this study.

To assess the level of oil spill threat in the coastal areas of Massachusetts, this study converts the collected data into a measurement of gallons of petroleum exposure (GPE). The underlying assumption of the method is that the level of threat for an oil spill is directly related to the amount of petroleum in the area. In converting the data to the GPE measure and aggregating the amounts to assess municipal and regional threat levels, it is important to understand that the threat categories have different temporal scales and thus the aggregated numbers provide an indication of the threat level rather than a quantitative measurement of risk.

All GPE estimates are limited by the strength of the data that underlie their calculation, and for this reason data sources are described in this section and their strengths and limitations identified.

The Vessel Movement threat factors capture the quantity of oil that is in transit (both as cargo and as vessel fuel) through the ports and shipping lanes, and the petroleum cargo that is in transition as it is being discharged to shoreside storage tanks. Data gathered for this category are presented as annual numbers and represent the total threat factor for the area over the time span of one year.

For the other two categories, Residential Vessel Fleets and Land-based Bulk Fuel Storage, the GPE measure is a static measure of how much petroleum can be expected to be in a location on any given day based on total storage capacity. This measure then represents the potential of an oil spill based on the number of point sources in the area and the maximum quantity that each source may contain.

To assess the total threat factor to various geographic locations, this study aggregates the quantities from all three categories and presents them as an indication of oil spill threat for the municipality or region. This method allows for a valid comparison across areas and thus meets the objectives of the study. Other approaches that could be used in additional analysis could include calculating an average daily vessel activity GPE and using that as the component of overall threat or identifying the maximum static or transit/transitional GPE and assessing threat on a worst case scenario basis.

3.1 Data Sources

Table 3.1 identifies the sources used to compile information for the study and indicates the threat factors that were associated with each data set. Some of these sources provided necessary background information and others provided specific values directly entered into the GPE calculation.

Table 3.1 Threat Factors and Data Sources

Threat Category	Threat Factor	Data Sources
Vessel Movement		
	Tank Vessel Port Visits	
		Army Corp of Engineers - Waterborne Commerce Reports
		USCG - Port of Entry Reports
	Nontank Vessel Activity	
		Army Corp of Engineers - Waterborne Commerce Reports
		USCG - Port of Entry Reports
	Tank and Nontank Vessel Transits	
		USCG - Port of Entry Reports
		Army Corp of Engineers - Cape Cod Canal traffic data
		NOAA navigational charts
Vessel Resident Fleets		
	Recreational and Charter	
		Harbormaster Surveys
		Massachusetts Harbormaster Association Web-site
		Interviews with Coastal Zone Managers
	Fishing Vessels	
		Harbormaster Surveys
	Ferryboats	
		Harbormaster Surveys
		Follow-up research on websites and with phone calls
	Other Large Vessels	
		Harbormaster Surveys
		Follow-up research on websites and with phone calls
	Shipyards	
		Harbormaster Surveys
		Follow-up research on websites and with phone calls
Land-based Storage		
	EPA Regulated Storage Tanks	
		EPA Schedule of facilities with Facility Response Plans
	Locally (Non-EPA) Regulated Storage Tanks	
		Harbormaster and Fire Chief Surveys

3.1.2 USCG Port Call Data

The USCG port call data was reviewed to identify the type, size, cargo and fuel capacity of vessels arriving at Massachusetts commercial ports. Vessels over 300 gross tons (GT) arriving at U.S. ports are required to submit an arrival notice to the U.S. Coast Guard. In Massachusetts, these arrival notices are collected and compiled by two different units – Sector Boston and Sector Southeastern New England (SENE). Sector Boston compiles port call records for Boston Harbor and the North Shore. Sector SENE compiles port call records for commercial ports in Buzzards Bay, Mt. Hope Bay and the Cape and Islands.

Sector Boston provided data on port calls for 2006 through 2008 for the Port of Boston. Sector SENE provided data on port calls for 2002, 2003, and 2006. Since data sets are for different years and each data set only shows three years worth of information, they should be considered as snapshots of "typical" vessel traffic. They were used to compile data regarding the gross size and type of cargo for vessels calling at major ports in Massachusetts.

For the GPE analysis, the vessel information from 2006 was used since this was the one year that overlapped for both data sets.

3.1.3 Army Corps of Engineers Waterborne Commerce Reports

The Army Corps of Engineers (ACOE) Waterborne Commerce Reports were reviewed to identify the type, size, cargo, and fuel capacity of vessels traveling through Massachusetts waterways monitored by the Army Corps. The ACOE Navigational Data Center publishes annual reports summarizing waterborne commerce traffic through U.S. waterways. The Atlantic Coast report includes data for the following Massachusetts harbors: Port of Boston (including Chelsea, and Everett), Fore River, New Bedford Harbor, and the Port of Fall River. The reports summarize the total short tonnage of vessels transporting various cargoes through these waterways. The reports also contain information comparing current-year data to previous years. Data reports were available from 2002, 2003, 2005, and 2006. The 2006 report was used in this analysis to identify the volume of petroleum delivered to Massachusetts ports.

The ACOE Waterborne Commerce Reports also contains information on vessel trips by draft within each reporting port. This information was found to be unusable do to the lack of detail provided. A vessel trip is recorded for each movement of a commercial vessel within a port including tank vessels, freight vessels, transfers of barges from one dock to another and all ferry transits. However, the report only provides the total number of trips by draft of vessel, not by type of vessel. In analyzing the traffic from each port, the busiest port in Massachusetts would appear to be Edgartown, MA at 143,058 vessel transits in 2006. For comparison, the port of Boston had 88,801 vessel transits. Conversations with the ACOE staff in New Orleans, LA revealed that the high number of trips was due to the Edgartown ferry operation. A follow-up call to the Edgartown Harbormaster indicated that the ferry service between Edgartown and Chappaquiddick Island runs two vessels every 6 minutes during the summer season. Two trips every six minutes for 12 hours a day for 90 days would equal 129,600 trips, or close to the recorded amount for the harbor. If this level of detail could be supplied for all ports in Massachusetts by the ACOE, then the information would prove valuable for future risk studies. At the current level of detail however, the raw data could lead to incorrect conclusions regarding the true level of port activity.

3.1.4 Army Corps of Engineers Cape Cod Canal Transit Data

The ACOE is responsible for operating the Cape Cod Canal and maintains detailed records of all vessel transits. Data was reviewed for the calendar years 2006 and 2007. Data collected by the ACOE includes the vessel name, vessel type, vessel tonnage, date of transit, and cargo carried. This information was then analyzed to estimate the number and size of tank vessels and nontank vessels transiting the canal and Buzzards Bay. Values from the 2006 Cape Cod Canal data set were used in the GPE model for the vessel transit threat indicator.

This data proved to be the most useful for analyzing vessel activity. Detailed information at the individual recorded transit level allowed the data to be categorized to fit the needs of this study much better than the summarized data provided in the ACOE Waterborne Commerce Reports. For a risk management program, this level of detail would be preferable for all commercial traffic.

3.1.5 NOAA Navigational Charts for the Massachusetts Coastlines

NOAA navigational charts for the Massachusetts coastline, numbered 13226 through 13282, were analyzed to determine those towns and cities that were within twelve nautical miles of a major shipping channel. Four shipping channels were identified: the Mount Hope Bay Channel depicted on NOAA chart 13266, the Buzzards Bay Vessel Traffic Lane depicted on NOAA chart 13230, the Cape Cod Traffic Separation Scheme depicted on NOAA chart 13246, and the Boston Harbor Traffic Separation Scheme depicted on NOAA chart 13267. Using estimates of the volume of ship traffic through those traffic lanes and estimates of the amount of product and/or fuel carried on nontank vessels, the GPE quantity was established.

Actual vessel transit movement measurements in these lanes were not available for this study. For future studies, vessel monitoring information such as Automatic Information System (AIS) data could be compiled to get a more accurate assessment of the actual traffic in these lanes.

3.1.6 Survey of Massachusetts Harbormasters and Fire Chiefs

Information was collected through written and oral surveys of fire chiefs and harbormasters for several purposes: (1) to identify smaller, local threat factors; (2) to compile information on vessel fleet size; (3) to query local stakeholders regarding their perception of “high threat” areas and activities; and (4) as an outreach tool to inform local communities that this project was underway.

Appendix B contains a copy of the fire chief survey, which was distributed during summer 2008. The survey was sent to the fire chiefs in all 71 coastal communities and the response rate was approximately 40%.[8] Table 3.2 summarizes the response record for the fire chief surveys.

Appendix C contains a copy of the harbormaster survey. This survey was distributed to 39 of the 71 coastal cities and towns based on an initial review of the number of threat factors that the harbor was likely exposed to. A second criterion for receiving the survey was an identifiable harbormaster to complete the survey. Follow-up phone interviews were conducted to encourage survey completion and explain the purpose of the project. The response rate for the harbormaster surveys was 29 of 39, or approximately 75%. Table 3.3 summarizes the response record for the harbormaster surveys. Additional surveys could be conducted as part of a follow-up study.

Table 3.2 Summary of Fire Chief Survey Responses

Town/ Survey Returned		Town/ Survey Returned		Town/ Survey Returned		Town/ Survey Returned	
Barnstable	Yes	Mashpee	Yes	Gloucester	No	Quincy	No
Beverly	Yes	Mattapoisett	Yes	Gosnold	No	Revere	No
Bourne	Yes	Nahant	Yes	Harwich	No	Rockport	No
Braintree	Yes	Salem	Yes	Hingham	No	Salisbury	No
Brewster	Yes	Sandwich	Yes	Hull	No	Saugus	No
Chatham	Yes	Wellfleet	Yes	Kingston	No	Scituate	No
Chelsea	Yes	Westport	Yes	Lynn	No	Somerset	No
Danvers	Yes	Yarmouth	Yes	Marblehead	No	Swampscott	No
Dartmouth	Yes	Acushnet	No	Marshfield	No	Swansea	No
Duxbury	Yes	Aquinnah	No	Nantucket	No	Tisbury	No
Eastham	Yes	Berkley	No	New Bedford	No	Truro	No
Edgartown	Yes	Boston	No	Newbury	No	Wareham	No
Essex	Yes	Chilmark	No	Newburyport	No	West Tisbury	No
Everett	Yes	Cohasset	No	Oak Bluffs	No	Weymouth	No
Fairhaven	Yes	Dennis	No	Orleans	No	Winthrop	No
Ipswich	Yes	Dighton	No	Peabody	No		
Manchester	Yes	Fall River	No	Plymouth	No		
Marion	Yes	Falmouth	No	Provincetown	No		

[8] Responses were voluntary and were beyond the scope of the fire chiefs' regular responsibilities.

Table 3.3 Summary of Harbormaster Survey Responses

Town/	Survey Returned	Town/	Survey Returned	Town/	Survey Returned	Town/	Survey Returned
Barnstable	Yes	Gosnold	Yes	Provincetown	Yes	Hingham	No
Beverly	Yes	Hull	Yes	Rockport	Yes	Lynn	No
Boston	Yes	Marblehead	Yes	Salem	Yes	Manchester	No
Bourne	Yes	Marion	Yes	Sandwich	Yes	Nahant	No
Chilmark	Yes	Marshfield	Yes	Scituate	Yes	Newburyport	No
Dartmouth	Yes	Mattapoisett	Yes	Tisbury	Yes	Oak Bluffs	No
Edgartown	Yes	Nantucket	Yes	Wareham	Yes	Quincy	No
Fairhaven	Yes	New Bedford	Yes	Wellfleet	Yes	Weymouth	No
Falmouth	Yes	Orleans	Yes	Westport	Yes	Winthrop	No
Gloucester	Yes	Plymouth	Yes	Chatham	No		

3.1.7 Ferry Operator Websites and Route Maps

A list of ferryboat operators was compiled based on the information contained in the harbormaster surveys and follow-up investigations were conducted using the operator's websites and individual phone calls. The Massachusetts Steamship Authority provided copies of their route maps. The quantity of fuel carried by the ferry vessels was estimated based on conversations with industry professionals. These amounts were added to each home port's GPE measurements for vessel fleets.

3.1.8 Boston and Buzzards Bay PAWSA reports

Reports generated through the Ports and Waterways Safety Assessment (PAWSA) workshops were reviewed for information about specific threats associated with vessel traffic in certain high-traffic areas of the state. PAWSAs are held periodically by the U.S. Coast Guard to collect information from waterway users and other experts regarding navigational safety threats in major U.S. waterways. Within Massachusetts, PAWSA workshops have been held for two areas: Boston Harbor and Buzzards Bay. The most recent workshop reports from each PAWSA (June 2000 for Boston and September 2003 for Buzzards Bay) were reviewed for information pertaining to navigational hazards and vessel casualty threats. The results of this review were used to determine the initial assessment of exposure to oil spill threat factors by town or city.

3.1.9 Information from Massachusetts CZM Regional Coordinators

The Regional Coordinators from the Massachusetts Coastal Zone Management (CZM) Program were surveyed informally regarding the activity levels in their local harbors and their perceptions of which coastal communities were at the highest threat of an oil spill. The Regional Coordinators (North Shore, Boston Harbor, South Shore, Cape and Islands, South Coastal) manage and implement a number of local planning projects, including reviewing Harbor Management Plans, overseeing pollution prevention initiatives, and working with local harbormasters to improve harbor safety and environmental protection.

Therefore, they have an "expert" understanding of many of the factors that might contribute to the threat of a spill at each harbor within their jurisdiction.

The Regional Coordinators were asked to answer two questions: (1) identify all "active" harbors within the region (meaning harbors with some level of municipal harbor facilities and services); and (2) indicate which harbors within the region you would consider to be at highest threat for a marine oil spill, and explain as necessary.

This information was considered among other subjective input from local, state, and federal agencies and stakeholders regarding relative threats within regions and statewide and used in the initial assessment of oil spill threat factors by city or town.

3.1.10 EPA Facility Response Plan Database

The EPA Facility Response Plan (FRP) database was queried to show all facilities with FRPs on file in Massachusetts. The resulting data set was used to identify which cities and towns have one or more EPA regulated bulk fuel facilities in operation. While the presence of one of these larger storage facilities increases the threat of a major oil spill, the fact that these facilities are required to have planning and resources in place to respond to such a spill is an example of a mitigating measure that is not considered in this study.

The size of each tank farm was determine or estimated based on one of three methods: 1) information contained in the harbormaster or fire chief surveys, 2) direct communication with tank farm operator, or 3) estimate of fuel tank capacity based on analysis of aerial photos of the tank farms and an average size per tank based on the previous information. The EPA was approached to provide the actual quantities per tank farm, however, the data was not provided. Future risk management programs would benefit from a detailed report of the quantities held at each facility.

3.2 Data Reviewed but Not Included in this Analysis

Three sources of data that were reviewed and initially considered likely contributors to this threat analysis are 1) oil spill history data sets, 2) Massachusetts Department of Revenue data base for petroleum imports to the State, and 3) vessel traffic information from vessel Automatic Identification Systems (AIS). Although these data sets were not used in this study, a quick summary of the analysis that was completed may help future risk management projects.

3.2.1 Historical Oil Spill Records

Historical oil spills were reviewed from three sources: the USCG Sector Boston spills database, the MassDEP Emergency Response historical oil spills database, and as part of the surveys sent to the fire chiefs. Measurement of historical oil spills by location, size, type, cause and impact would allow future risk management and oil spill reduction programs to calculate the probability of an oil spill by threat category and allow for assigning resources by threat type and location to reduce the likelihood of future spills. Over time, trends could be analyzed to determine which programs are effective and which could be improved. However, at present, the information reviewed in the two data sets and from the interviews was not recorded in sufficient detail to develop a reliable estimate of oil spill threat level based on historical occurrences. Future projects conducted by MassDEP could address this gap by establishing new guidelines and requirements for oil spill data compilation that provides the necessary level of information to analyze the data for location, frequency, type, cause, and other factors that could then be used to develop oil spill reduction programs. Other efforts to coordinate state and federal data bases would be useful for tracking oil spills in different jurisdictions.

3.2.2 Massachusetts Department of Revenue Petroleum Import Data

The Massachusetts Department of Revenue (MassDOR) collects a $.02 per barrel fee on all petroleum products imported into the state's ports and harbors in tank vessels. Nuka Research obtained and analyzed copies of MassDOR's 2007 monthly "Uniform Oil Response and Prevention Fee Report" which provided petroleum import information by customer, type of petroleum and quantity. However, because the information was provided by customer and not by port, and some customers have operations in more than one port, the information could not used in this analysis. Additionally, the total gallons reported by the ACOE for 2006 of petroleum commerce was approximately 4.5 billion gallons while the MassDOR quantity for imported petroleum gallons in 2007 was 3.9 billion gallons. This difference in total amounts may be due to the conversion factor used to convert the ACOE data from short tons to gallons, a difference in oil imports during 2007 versus 2006, and/or the fact that ACOE data includes transfers of product between Massachusetts terminals, while the MassDOR data includes only imports. The ACOE data also accounts for vessels that transit through the Cape Cod Canal *en route* from one out-of-state port to another.

For future risk management studies, additional information may be mined from the MassDOR data and should be considered a possible source of detailed information.

3.2.3 Vessel Traffic Monitoring Data

In estimating vessel traffic, Nuka Research relied on vessel arrival information provided by the USCG NOA data and the ACOE Waterborne Transit and Cape Cod Canal data. In total, these data sets provide an overview of vessel traffic for the region. To improve the accuracy of the information by vessel type, size, route and frequency, efforts should be made to procure Automated Information System (AIS) data for detailed analysis. This information is available through private database queries; however the fees associated with accessing the information were prohibitive for this study.

Information that has already been aggregated, such as the port of Boston arrival information, does not answer questions such as days in port by vessel, average size of vessels, seasonality trends, or accurate tracking of vessel routes. Answers to these questions and others would be valuable to any risk management program and can be developed through analysis of AIS data. The data is available through purchase from the private sector. Future MassDEP projects could be designed to include the acquisition of the data and design the tracking programs necessary to support a risk management program.

3.3 Assumptions

A number of assumptions were made during the process of gathering and compiling data for each of the threat categories. Assumptions applied to the data collection, analysis and interpretation are listed in no particular order.

- The threat categories address only those activities that increase the threat of an oil spill that may impact the Massachusetts coastline. Threat mitigation and oil spill prevention measures, as they relate to a specific threat category, are not considered. (e.g. single and double-hulled tank vessels are considered to pose equal threats, despite the fact that most studies show that double-hulled vessels have a lower probability of spilling oil than single-hulled vessels do).
- This study assumes that every gallon of oil present in any given location at any given time has an equal opportunity of being spilled.
- The data does not distinguish between type of petroleum product (gasoline, diesel, heavy fuel oils), although some of the discussion points later in the report do address this issue as it relates to spill response readiness and cleanup equipment.
- This study does not take into consideration vulnerabilities to oil spill impacts. Therefore, the potential for shoreline oiling at any given location is weighted equally, despite the fact that certain stretches of shoreline may be much more vulnerable to oil spill impacts than others.
- This study does not consider spill threats that were determined to be pervasive throughout most or all of the state. Therefore, the study does not attempt to compile the threat of spills from home heating oil tanks (regardless of size), bulk oil storage tanks that hold less than 1,000 gallons, or tank vessel trucks.
- This study does not consider the role of environmental and oceanographic conditions such as wind, tides, currents, and sea state in oil spill threats. It is assumed that all coastal communities and water bodies have an equivalent potential for adverse weather or environmental conditions that could contribute to oil spill threats.
- This study does not consider seasonal variations in threat factors.

Assumptions related to how data was compiled, weighted, and used to determine oil spill planning priorities are discussed in Sections 4, 5, and 6.

4 Oil Spill Threats at Harbor and Municipal Levels

This threat analysis was conducted in two parts. First, all Massachusetts coastal harbors were evaluated for the presence or absence of oil spill threat factors. Harbors that were identified as having two or more threat factors present underwent a second level of analysis, while harbors where less than two threat factors were present were not examined further. For the second part of this analysis, information was gathered on the "high threat" (two or more factors present) harbors to develop a relative measure of the size of each threat based on the estimated amount of petroleum in each category. This section of the report details the analysis conducted in each of these two phases. Section 5 presents regional aggregation of this data.

4.1 Initial Assessment of Threat Factors by Harbor

The initial assessment of exposure to the identified threat factors by harbor used all of the data sources identified in Table 3.1, with the exception of the harbormaster surveys. The initial assessment only assessed whether the threat was present or not, and did not consider the size or quantity of the threat.

Data analysis for the initial assessment did not include data from the harbormaster surveys because it had not been fully compiled at that point. Because of this, the locally (non-EPA) regulated oil storage tank threat factor was not included in the initial assessment. Similarly, for the initial assessment, information on vessel fleet size by harbor was estimated based on a review of the available data and using firsthand knowledge. Fleet size information was updated in the second phase of the study after receipt of the harbormaster surveys. Therefore, the threat factors used in the initial assessment for the presence of an oil spill threat factor were:

Vessel Movements

- Oil tank vessel or tank barge activity in ports
- Large nontank vessel activity in ports (freight, passenger, or other vessels – over 300GT)
- Oil tank vessel and large nontank vessel activity in major shipping lanes.

Resident Vessel Fleets

- Recreational and charter vessel fleet estimated at greater than 500 vessels
- Commercial fishing vessel fleet estimated at greater than 10 vessels
- Initial indication of ferryboat service from the harbor
- Initial indication of large vessels moored and operating in the harbor (i.e. tugboats, small fuel barges, whale watching boats, research vessels, and training ships)
- Initial indication of shipyards within a harbor that service large vessels

Land-Based Storage Facilities

- Regulated facility identified by the EPA with potential to discharge to tidal waters

Based on the initial analysis, 45 of the 71 coastal communities were determined to have harbors that are exposed to two or more threat factors. At the harbor level, of the 95 harbors identified, 60 were found to have exposure to two or more threat categories. Table 4.1 contains the entire list of harbors along with their identified threat factors. The analysis points out that some of the mid-size harbors face nearly the same number of threats as the largest harbors. The town of Tisbury on Martha's Vineyard, for example, has seven identified threat factors, a relatively high number for a small town. Figure 4.1 shows the locations of the municipalities with two or more threat factors present.

4.2 Detailed Assessment and Measurement of Oil Spill Threat Levels

The initial assessment described in Section 4.1 identified 45 municipalities that were likely exposed to two or more of the identified threat factors. To estimate the magnitude of each oil spill threat for the purpose of comparison, a gallons of petroleum exposure measure (GPE) was calculated for each threat within each harbor. Data on two of the oil spill threats, EPA regulated and locally (non-EPA) regulated tanks, was collected in units of gallons. Data on tank vessel transits provided in the ACOE Waterborne Commerce Reports is measured in short tons of cargo and has been converted to gallons using the formula:

Gallons of petroleum = (2000 lbs/ton * tons of petroleum) / (8 gallons/lb).

The other nine measures depend on an estimate of average gallons of petroleum carried on board the identified vessels. Therefore, to calculate the GPE for each vessel fleet, a table of average fuel tank size was created using information from industry representatives and vessel databases.[9] Table 4.2 presents the averages used in this study along with notes supporting the estimates.

The main threat of spills in many harbors and ports is the possibility that a vessel will accidentally discharge petroleum through a vessel sinking, collision, fire, or through accidental or illegal discharges from vessel operations such as bilge pumping, changing engine oil, or refueling. For this study, an assumption has been made that the larger the size of the resident fleets, the larger the threat of an oil spill from any of these possible scenarios. The harbormaster survey was used to estimate the actual size of the fleets in each harbor of interest. Each vessel fleet was then analyzed for their GPE. Surveys were sent to those municipalities that have a harbormaster contact listed with the Massachusetts Harbormaster Association.[10] Of the 45 municipalities of interest, 39 of them have harbormasters and received a copy of the survey.

[9] Chris Bryant, Burr Brothers Boatyard, Marion, MA, personal communications regarding recreational and charter Vessels; Ron Fortier, Fairhaven Shipyard, Fairhaven MA, personal communications regarding large private vessels and fishing vessels; Adam Doherty, Arthur Fournier, Canal Towing, Bourne, MA, personal communications regarding tugboats; Greg Gifford, MA Steamship Authority, Falmouth, MA, personal communications regarding ferry vessels; Mike McGurl, Harbor Express, Quincy, MA, personnel communications regarding ferry vessels, tank vessels, and NTVs.

[10] Mass Harbormaster Association, Website, February 2009, http://mass.harbormasters.org/members.shtml

Approximately 75% of the harbormaster surveys were returned by the harbormasters.

Additional information on the methods used to calculate the GPE for each threat factor along with an analysis of the results is presented in Sections 4.2.1 through 4.2.10.

Table 4.1 Identified Threat Factors by Municipality

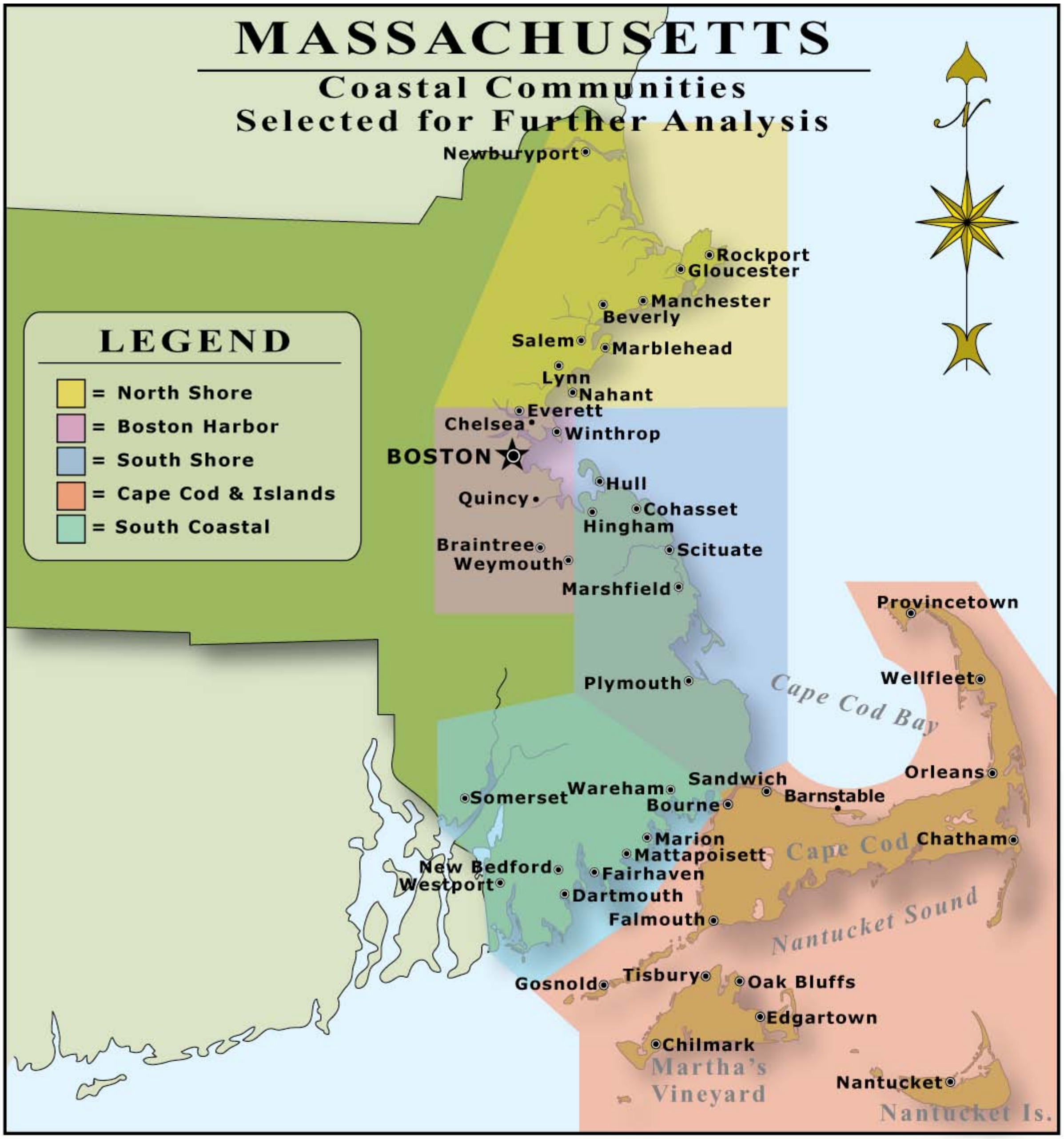
Municipality	Tank Vessel	NTV	Vessel Transit	Rec. and Charter	Fishing Vessels	Ferry	Other Large Vessel	Ship-yard	Reg. Tank
Boston/ Chelsea/ Everett	✓	✓	✓	✓	✓	✓	✓	✓	✓
New Bedford/ Fairhaven	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fall River/ Somerset	✓	✓	✓	✓	✓		✓	✓	✓
Sandwich	✓	✓	✓	✓	✓		✓		✓
Tisbury	✓	✓		✓	✓	✓	✓		✓
Gloucester	✓	✓		✓	✓		✓	✓	
Falmouth		✓	✓	✓	✓	✓	✓		
Nantucket	✓	✓		✓	✓	✓			✓
Salem	✓	✓		✓	✓	✓			
Plymouth	✓	✓		✓	✓	✓			
Barnstable		✓		✓	✓	✓			
Beverly				✓	✓				✓
Bourne			✓	✓			✓		
Braintree/ Weymouth	✓	✓	✓						
Chatham				✓	✓				
Chilmark				✓	✓				
Cohasset			✓	✓	✓				
Dartmouth			✓	✓					
Edgartown				✓	✓	✓			
Gosnold			✓			✓			
Hingham			✓	✓	✓	✓			
Hull			✓	✓					
Lynn			✓	✓					
Manchester				✓	✓				
Marblehead			✓	✓	✓				
Marion			✓	✓					
Marshfield				✓	✓				
Mattapoisett			✓	✓					
Nahant			✓	✓					

Municipality	Tank Vessel	NTV	Vessel Transit	Rec. and Charter	Fishing Vessels	Ferry	Other Large Vessel	Ship-yard	Reg. Tank
Newburyport				✓	✓				
Oak Bluffs				✓		✓			
Orleans			✓	✓	✓				
Provincetown			✓	✓	✓	✓			
Quincy	✓	✓	✓	✓		✓			
Rockport				✓	✓				
Scituate			✓	✓	✓				
Wareham			✓	✓					
Wellfleet			✓	✓	✓				
Westport			✓	✓	✓				
Winthrop			✓	✓					

Table 4.2 Estimated Average Fuel Capacity by Vessel Fleet

Fleet	Vessel Size (length in feet)	Average Fuel Capacity (gal)	Notes
Recreational	15-200 15-135 15-110 15-90 15-70 15-50 15-40 15-35	200 150 125 110 100 80 60 50	A power vessel of 30 ft has a fuel tank capacity of approximately 80 -100 gallons. A sailboat of 30 to 60 ft has a fuel tank capacity of approximately 30 - 50 gallons. Large yachts in the 65 - 100 ft range carry about 10,000 gallons of fuel. Super yachts carry up to 30,000 gallons of fuel (Bryant, C., Fortier, R)
Commercial Fishing	20- 35 25-45 25-65 25-110	300 500 5,000 15,000	Smaller inshore vessels carry between 200 and 1000 gallons. Larger offshore fishing vessels carry approximately 10,000-20,000 gallons of fuel. (Fortier, R)
Commercial Tugs	65-100 100-130	17,500 80,000	Inshore tugs carry between 15,000 and 20,000 gallons of fuel. Offshore tugs carry between 60,000 and 100,000 gallons of fuel. (Doherty, A., Fournier, A.)
Commercial Ferry Boats	Small Displacement Hi-Speed Passenger Passenger/Vehicle	750 2,000 5,000 7,500	Hi-speed ferries carry between 1,000 and 4,000 gallons of fuel. Small displacement ferries carry between 500 and 1000 gallons of fuel. Large displacement ferries carry between 5,000 and 10,000 (Gifford, G., McGurl, M)
Nontank Vessels	Boston, Fall River, Salem (150-1,000) Cape Cod Canal, New Bedford (150 -750*) Nantucket and Martha's Vineyard*	100,000 75,000 50,000	Freight vessels carry between 50,000 and 150,000 gallons of fuel (McGurl, M). * Draft restrictions prevent larger ships from entering these ports.

Figure 4.1 Massachusetts Municipalities with Two or More Threat Factors



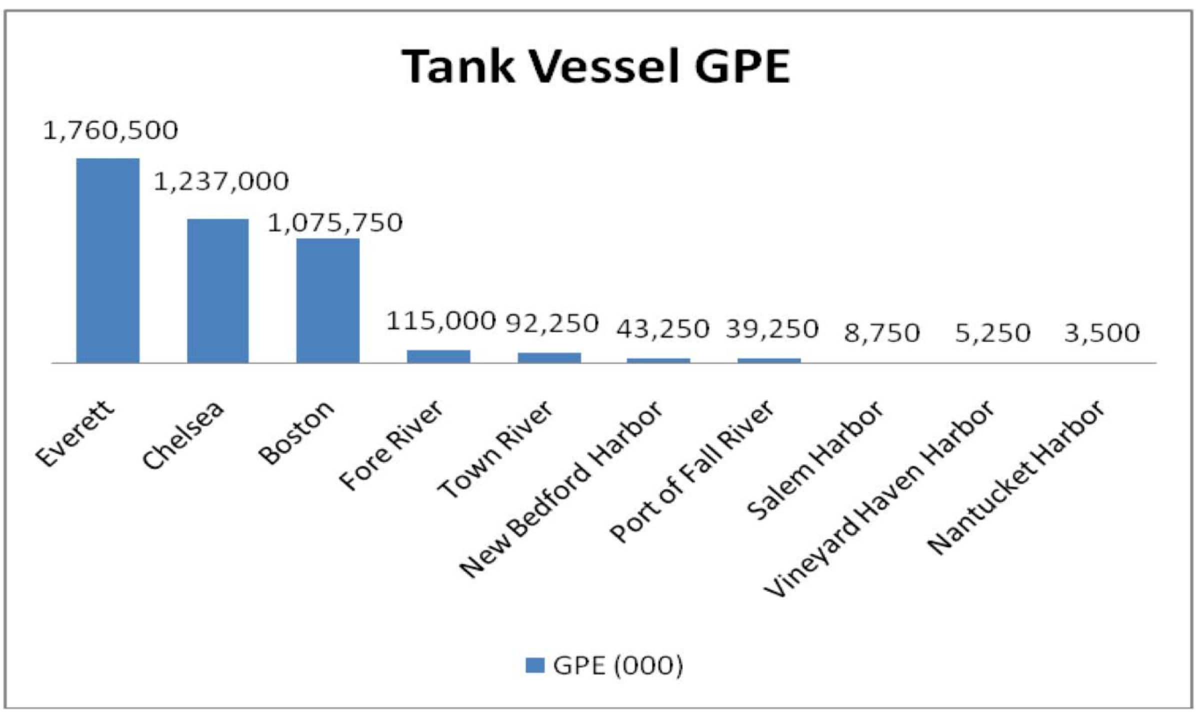
4.2.1 Oil Tanker or Tank Barge Activity in Ports and Harbors

The ports that were listed in the ACOE Waterborne Commerce Report as having received oil deliveries in 2006 along with the quantity received are listed in Table 4.3. Boston Harbor (Boston, Chelsea, and Everett combined) accounts for approximately 93% of the total volume. The ACOE data is recorded in short tons (2000 lbs) of petroleum. An average weight of 8 lbs per gallon of petroleum product was used to convert tons of petroleum into gallons of petroleum. Figure 4.2 shows a graph of the GPE from tank vessel activity for the top ten ports in Massachusetts.

Table 4.3 Tank Vessel Oil Spill Threat in Estimated Gallons of Petroleum Exposure (000)[11] by Port or Harbor (based on data for 2006)

Port/Harbor (City)	GPE	Port/Harbor (City)	GPE	Port/Harbor (City)	GPE
Everett	1,760,500	Town River (Quincy)	92,250	Vineyard Haven (Tisbury)	5,250
Chelsea	1,237,000	New Bedford	43,250	Nantucket	3,500
Boston	1,075,750	Port of Fall River	39,250	Gloucester	2,250
Fore River (Braintree & Weymouth)	115,000	Salem	8,750	Plymouth	1,000

Figure 4.2 Tank Vessel Oil Spill Threat in Estimated Gallons of Petroleum Exposure (000)[12] by Port or Harbor (based on data for 2006)



[11] All values in table should be multiplied by a factor of 1,000.
[12] All values in table should be multiplied by a factor of 1,000.

4.2.2 Large Nontank Vessel Activity in Ports

Information on Large nontank vessels (freight, passenger, or other vessels over 300 gross tons that carry oil as fuel rather than cargo) was determined from vessel arrival data provided by the USCG. Notice of Arrivals are required to be filled out by all foreign vessels entering the U.S. ports and by all U.S. vessels over 300 GT (not including tug/barge combinations) traveling between US Coast Guard Captain of the Port areas. Information on nontank vessel (NTV) traffic from Boston Harbor, Fore River, Town River, and Salem Harbor were received from USCG Sector Boston as one total quantity. USCG Sector Southeastern New England provided the information for the Port of Fall River, Hyannis Harbor, Nantucket Harbor, New Bedford Harbor, Sandwich, and Vineyard Haven.

Because NTV traffic for Salem was included in the USCG Sector Boston NTV report and this volume should be applied to the North Shore Region, the ACOE Waterborne Commerce Report was analyzed to estimate that 22 of the 297 NTV trips into the Sector Boston area were for the port of Salem. The main activity in Salem is the delivery of coal to the Salem power plant.

For this analysis, NTV shipments do not include tank vessel shipments as these are accounted for in the previous indicator (tank vessel activity). However, an argument could be made the fuel carried in tank vessels and tug/barge combinations adds an additional threat to the port and future studies may want to consider this added volume of petroleum.

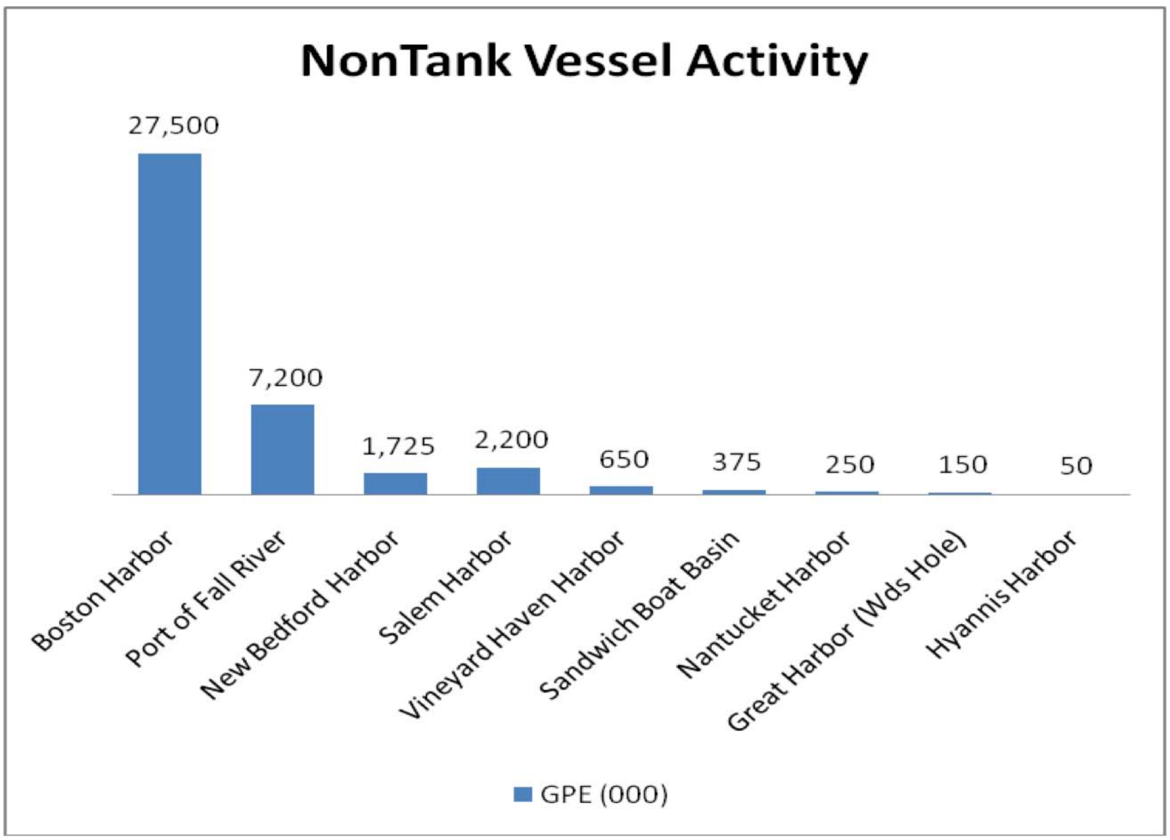
Finally, the data used in this analysis was taken from 2006 activity as presented in the ACOE and USCG reports. This one-year data set provides a snap shot of vessel activity but does not necessarily reflect trends or changes in traffic levels, which might be better captured in a multi-year data set. For example, the port of Boston realized a significant increase in NTV traffic from 297 arrivals in 2006 to 510 arrivals in 2007. The increase was largely due to an increase in container ships.

To calculate the NTV vessel traffic petroleum exposure, the number of NTV trips was multiplied by the GPE quantities presented in table 4.2. The total amount of petroleum exposure by port for 2006 is presented in Table 4.4. As indicated, Boston Harbor accounts for 69% of the NTV activity in Massachusetts ports. Figure 4.3 shows a graph of the gross petroleum exposure volumes from the nine ports reporting NTV traffic in 2006.

Table 4.4 Nontank Vessel Oil Spill Threat in Estimated Gallons of Petroleum Exposure (000)[13] by Port or Harbor (based on data for 2006)

Municipalities	Harbors	Annual NTV Traffic	Average Fuel Tank Size	GPE
Boston, Braintree, Chelsea, Everett, Revere, Quincy, Weymouth	Boston Harbor, Fore River, Town River	275	100,000	27,500,000
Fall River/ Somerset	Port of Fall River	72	100,000	7,200,000
New Bedford/ Fairhaven	New Bedford Harbor	23	75,000	1,725,000
Salem	Salem Harbor	22	100,000	2,200,000
Tisbury	Vineyard Haven Harbor	13	50,000	650,000
Sandwich	Sandwich Boat Basin	5	75,000	375,000
Nantucket	Nantucket Harbor	5	50,000	250,000
Falmouth	Great Harbor (Woods Hole)	3	50,000	150,000
Barnstable	Hyannis Harbor	1	50,000	50,000

Figure 4.3 Nontank Vessel Oil Spill Threat in Estimated Gallons of Petroleum Exposure (000)[14] by Port or Harbor (based on data for 2006)



13 All values in table should be multiplied by a factor of 1,000.
14 All values in table should be multiplied by a factor of 1,000.

4.2.3 Tank Vessel and Nontank Vessel Activity in Major Shipping Lanes

Vessel transits into and out of Massachusetts ports, through the Cape Cod Canal, and traveling near the coast of outer Cape Cod represent the largest oil spill threat for many coastal communities. The municipalities determined to be at risk were selected based on the assumption that harbors within twelve miles of a major shipping lane were most likely to be impacted from an oil spill. NOAA charts for the region were analyzed to determine the location of shipping lanes and the municipalities they abut. The shipping lanes from the NOAA charts and the towns within twelve miles of the lanes are shown in Figure 4.4.

In Table 4.5, the total threat level from vessel activity in shipping lanes is listed by region and by harbor. Although each municipality is affected by the threat, it is assumed that the threat is transient, passing by each municipality within a relatively short period of time. Thus the threat is the same at the regional level as it is at the harbor level. However, for each harbor that has identified tank vessel or NTV traffic, these quantities are removed from the vessel transit quantity so as not to double count the threat from vessels that both visit the port and transit by it.

Therefore, for the towns within the Boston Harbor region, the vessel transit threat was calculated as the net difference between the quantity of petroleum shipped into each port and the quantity that was shipped into the region, to avoid double counting the shipped quantities.

For municipalities to the north and south of Boston, and for municipalities on the outer Cape, vessel transits were estimated using 1/3 of the total vessel traffic volume in the Boston Region. Traffic into Boston converges from the north, east, and south and because specific traffic pattern information was not available, the study divides the traffic evenly by the three possible routes. This method of calculating the threat factor could be greatly enhanced by an analysis of actual AIS data. However, these estimates provide a reasonable quantity to use in this analysis with the understanding that should a study of AIS data become available; the quantities can be updated in the GPE model.

For Mount Hope Bay, the transit quantity is based on petroleum deliveries and NTV traffic into the Port of Fall River/Taunton River. Thus, the municipalities of Fall River and Somerset[15] do not experience any additional threat over the amount that was calculated in the Tank Vessel and NTV threat categories. However, the town of Swansea would be exposed to the entire vessel transit quantity.

For towns close to the Buzzards Bay traffic zone, the ACOE Cape Cod Canal traffic data was analyzed and provided an accurate assessment of vessel transits. The data set has information on each vessel transit and includes the vessel type and size. An assumption was made for the report that all vessels transiting the canal also transit the entire length of Buzzards Bay. This likely

[15] Fall River and Somerset are considered as a single port in this analysis because they are located on opposing banks of the Taunton River. The Army Corps of Engineers uses the same convention in their vessel transit data, considering Fall River and Somerset together as the Port of Fall River.

overstates the threat to some of the towns in the lower part of the Bay because some commercial traffic entering the Canal from the east discharges at the Sandwich power plant and does not transit the entire Bay. A future analysis should attempt to separate out these vessels from the impact to towns further south in the Bay.

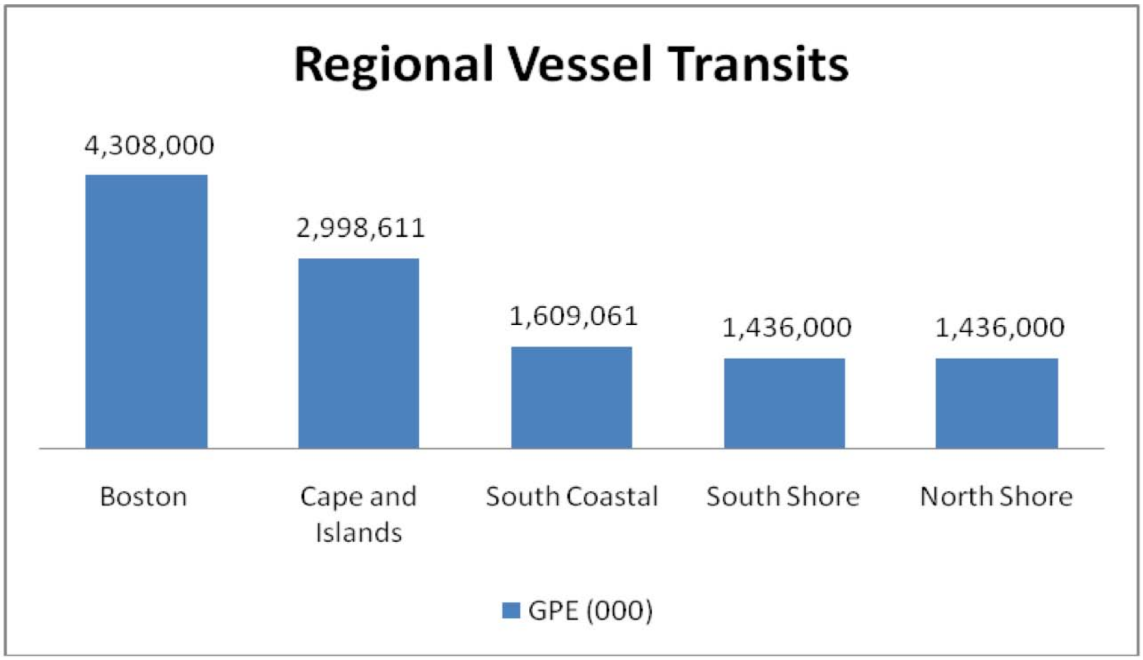
Figure 4.5 shows total estimate gallons of petroleum exposure from vessel activity in shipping lanes for each region.

Figure 4.4. Major Shipping Lanes and Proximity to Massachusetts Coastal Towns.

Table 4.5 Vessel Transit Oil Spill Threat in Estimated Gallons of Petroleum Exposure by Municipality and Region

Region	Municipalities Affected	GPE Quantity	Method of Calculation
North Shore	Lynn	1,436,000,000	Estimated using one third of the vessel traffic into Boston Region.
	Marblehead		
	Nahant		
	Swampscott		
Boston	Winthrop	4,308,000,000	Based on Boston Region vessel traffic of 4,308,000,000 minus individual port traffic.
	Quincy	4,215,750,000	
	Braintree/ Weymouth	4,339,900,000	
	Boston	3,204,750,000	
	Chelsea	3,071,000,000	
	Everett	2,547,500,000	
South Shore	Cohasset	1,436,000,000	Estimated using one third of the vessel traffic into Boston Region.
	Hingham		
	Hull		
	Scituate		
Cape and Islands	Bourne	1,562,611,000	Based on Cape Cod Canal Data
	Gosnold		
	Falmouth		
	Sandwich		
	Eastham	1,436,000,000	Estimated using one third of the vessel traffic into Boston Region.
	Orleans		
	Provincetown		
	Truro		
	Wellfleet		
South Coastal	Dartmouth	1,562,611,000	Based on Cape Cod Canal traffic of 1,562,611,000 minus individual port traffic.
	Fairhaven		
	Marion		
	Mattapoisett		
	Wareham		
	Westport		
	New Bedford	1,517,636,000	
	Fall River/ Somerset	-	Based on Fall River/ Somerset vessel traffic minus individual port traffic.
	Swansea	46,450,000	

Figure 4.5 Vessel Transit Oil Spill Threat in Estimated Gallons of Petroleum Exposure (000)[16] by Region



4.2.4 Recreational and Charter Vessels

Harbors initially identified as having a recreational and charter vessel fleet larger than 500 vessels were flagged as having a threat of oil spills in this category. As described in Section 2.2, the information collected to indicate the actual size of the recreational and charter fleet was the total number of moorings and slips in the harbor. Additional information was collected in the harbormaster survey regarding the range of vessel lengths in each harbor. Most harbors reported a fleet size ranging from 18 to 65 feet, with five harbors reporting vessel sizes in excess of 100 feet.

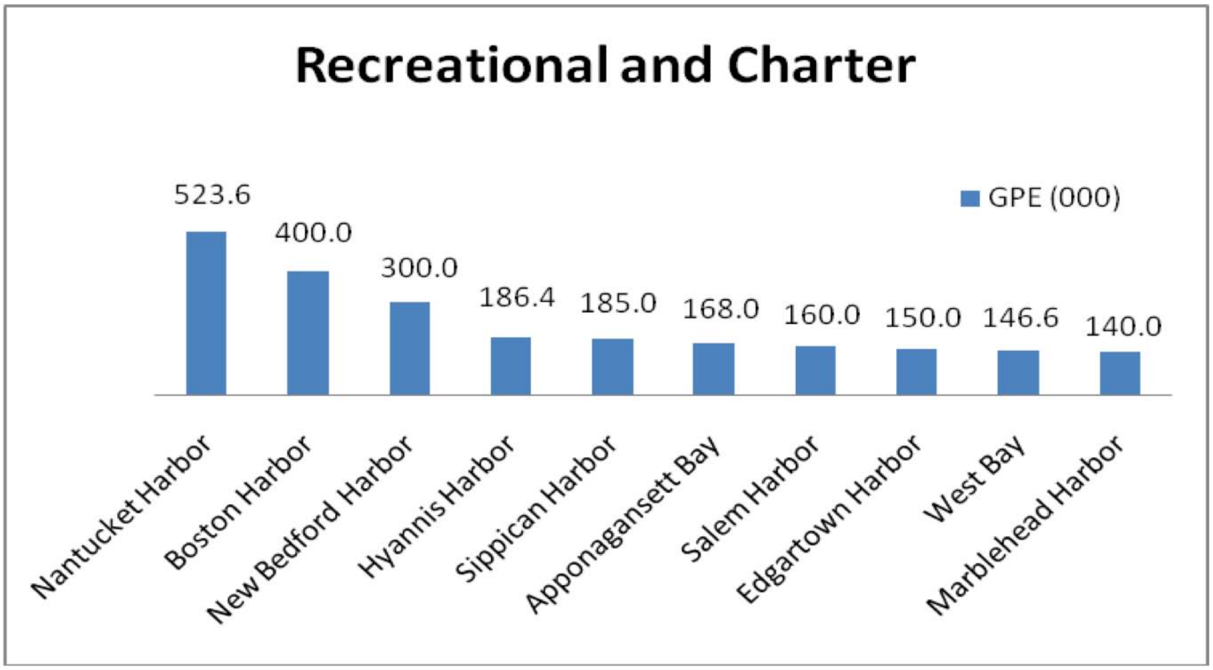
To estimate the petroleum exposure for each harbor, the average fuel capacities identified in Table 4.2 were multiplied by the number of moorings and slips. Boston, Nantucket, New Bedford and Hyannis all reported having recreational vessels up to 200 feet in length. Each also had a high number of moorings and slips. Sippican Harbor, in the town of Marion, appears fifth on this list with the third highest number of moorings and slips reported. The GPE for the recreational and charter fleets by harbor is presented in Table 4.6 and the quantities for the top ten harbors are graphed in Figure 4.6.

[16] All values in table should be multiplied by a factor of 1,000.

Table 4.6 Recreational and Charter Fleet Oil Spill Threat in Estimated Gallons of Petroleum Exposure by Harbor

Harbor	GPE	Harbor	GPE	Harbor	GPE
Nantucket Harbor	523,600	Scituate Harbor	104,000	Wellfleet Harbor	40,000
Boston Harbor	400,000	Onset Harbor	88,800	Green Harbor	38,800
New Bedford Harbor	300,000	Beverly Harbor	85,000	Great Harbor (Woods Hole)	33,800
Hyannis Harbor	186,400	Red Brook Harbor	82,160	Nauset Harbor	29,520
Sippican Harbor	185,000	Pleasant Bay	78,960	Rockport Harbor	21,600
Apponagansett Bay	168,000	Plymouth Harbor	68,000	Sandwich Boat Basin	18,000
Salem Harbor	160,000	Gloucester Harbor	64,600	Buttermilk Bay	12,100
Edgartown Harbor	150,000	Barnstable Harbor	61,000	Cuttyhunk Harbor	11,000
West Bay	146,630	Wareham Harbor	60,720	Weweantic River	8,700
Marblehead Harbor	140,000	Allerton Harbor	52,500	Buttermilk Bay	7,900
Vineyard Haven	125,000	Falmouth Harbor	50,400	Little Harbor	5,800
Westport River	122,000	Mattapoisett Harbor	42,720	Menemsha Creek	4,480

Figure 4.6 Recreational and Charter Fleet Oil Spill Threat in Estimated Gallons of Petroleum Exposure (000)[17] by Harbor

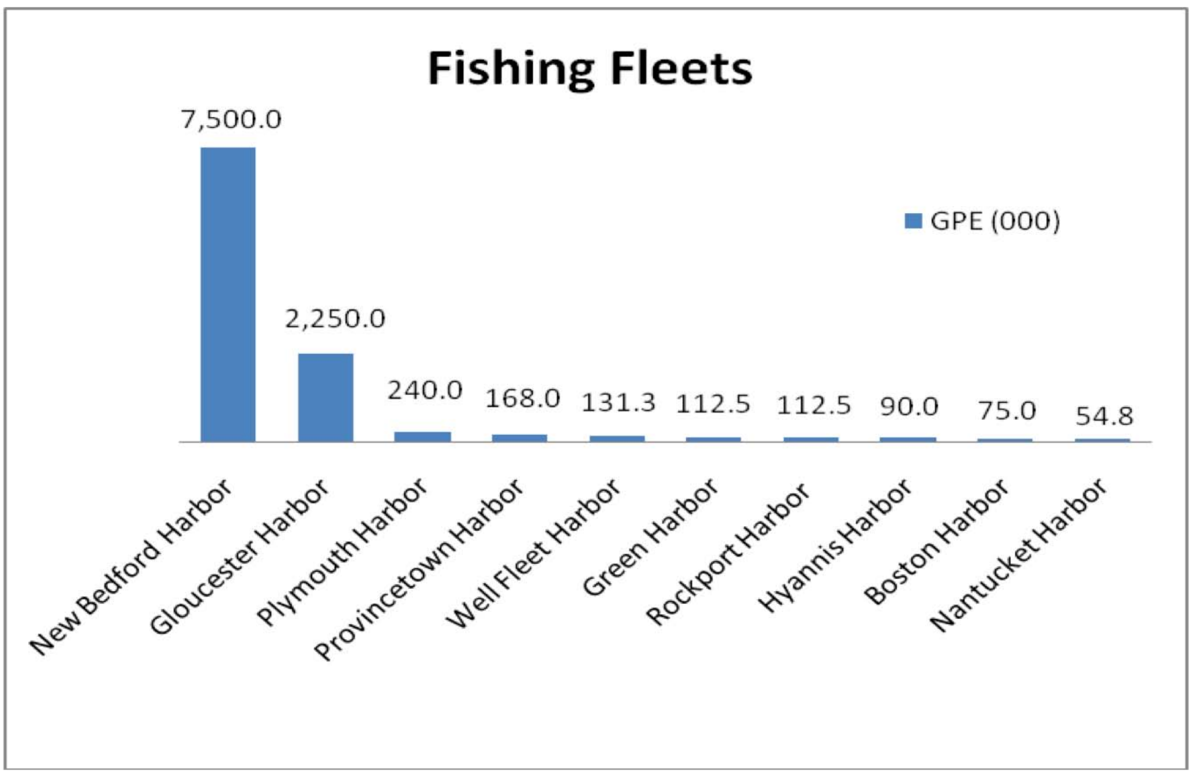


[17] All values in table should be multiplied by a factor of 1,000.

4.2.5 Commercial Fishing Vessel Fleet

Information collected in the harbormaster surveys included the number and type of fishing vessels in the harbor. Lobster and other trap vessels, tuna and shellfish vessels were assumed to be inshore vessels of under 45 feet in length. Draggers, scallopers, and trawlers were assumed to be larger offshore vessels up to 130 feet in length with fuel capacities capable of staying offshore for multiple days or weeks. New Bedford Harbor reported having fishing vessels up to 150 feet in length that are part of the herring fishing fleet. The information provided by the harbormasters along with information gained in the follow-up phone calls was used to determine the average number of vessels in each category. The GPE was then calculated by multiplying the number of vessels by the average fuel tank capacity. The results for the top ten harbors are presented in Figure 4.7 while Table 4.7 contains the GPE for all 30 harbors that reported fishing activity. New Bedford Harbor reported the highest number of vessels with a fleet size of 500, many of which are large offshore scallopers and draggers. The GPE for the New Bedford Harbor fishing fleet is estimated at 7,500,000 gallons, more than three times the next largest amount.

Figure 4.7 Fishing Fleets Oil Spill Threat in Estimated Gallons of Petroleum Exposure (000)[18] by Harbor



[18] All values in table should be multiplied by a factor of 1,000.

Table 4.7 Fishing Fleets Oil Spill Threat in Estimated Gallons of Petroleum Exposure by Harbor

Harbor	GPE	Harbor	GPE	Harbor	GPE
New Bedford Harbor	7,500,000	Beverly Harbor	45,000	Vineyard Haven Harbor	7,500
Gloucester Harbor	2,250,000	Scituate Harbor	41,250	Barnstable Harbor	3,750
Plymouth Harbor	240,000	Sandwich Harbor	30,000	Allerton Harbor	1,800
Provincetown Harbor	168,000	Marblehead Harbor	24,000	Buttermilk Bay	900
Wellfleet Harbor	131,250	Westport River	22,500	Apponagansett Bay	900
Green Harbor	112,500	Edgartown Harbor	18,750	Sippican Harbor	900
Rockport Harbor	112,500	Nauset Harbor	18,750	Mattapoisett Harbor	900
Hyannis Harbor	90,000	Menemsha Creek	15,000	Pocasset River	300
Boston Harbor	75,000	Salem Harbor	9,000	Cuttyhunk Harbor	300
Nantucket Harbor	54,750	Great Harbor (Woods Hole)	7,500	Wareham Harbor	300

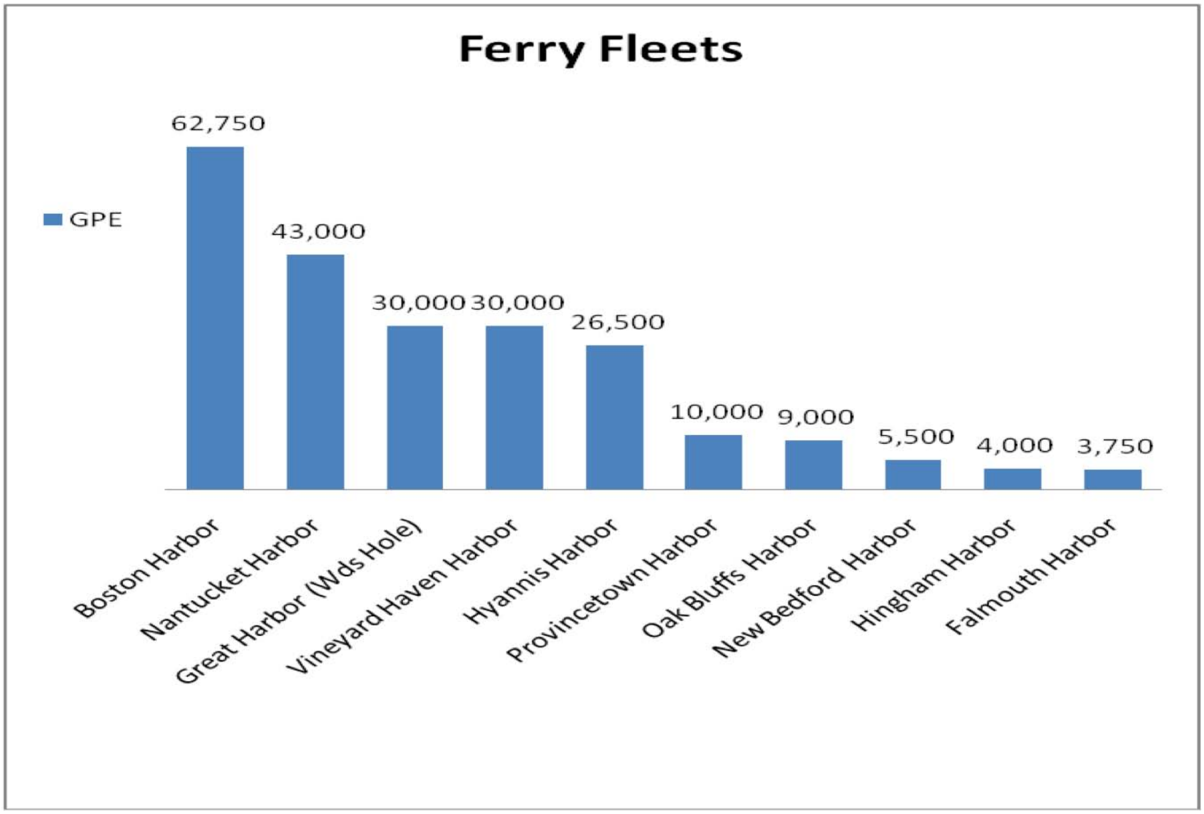
4.2.6 Ferry Terminals

Commercial ferry traffic can represent a significant portion of the daily activity within a harbor. Some ferries operate on a year round basis, while others are operated on a seasonally adjusted basis. Based on the information supplied by the harbormasters regarding which harbors had ferry service, an investigation was then conducted on each operation regarding the type, size, and vessel routes of the ferry service. Much of the information was gathered from ferry company websites while additional information was gathered from personal conversation with company managers. The petroleum exposure for the fourteen harbors that were found to have ferry service is shown in Table 4.8 and Figure 4.8.

Table 4.8 Ferry Fleet Oil Spill Threat in Estimated Gallons of Petroleum Exposure by Harbor

Harbor	GPE	Harbor	GPE	Harbor	GPE
Boston Harbor	62,750	Provincetown Harbor	10,000	Plymouth Harbor	3,000
Nantucket Harbor	43,000	Oak Bluffs Harbor	9,000	Salem Harbor	2,000
Great Harbor (Woods Hole)	30,000	New Bedford Harbor	5,500	Cuttyhunk Harbor	1,500
Vineyard Haven Harbor	30,000	Hingham Harbor	4,000	Edgartown Harbor	750
Hyannis Harbor	26,500	Falmouth Harbor	3,750		

Figure 4.8 Ferry Fleet Oil Spill Threat in Estimated Gallons of Petroleum Exposure by Harbor



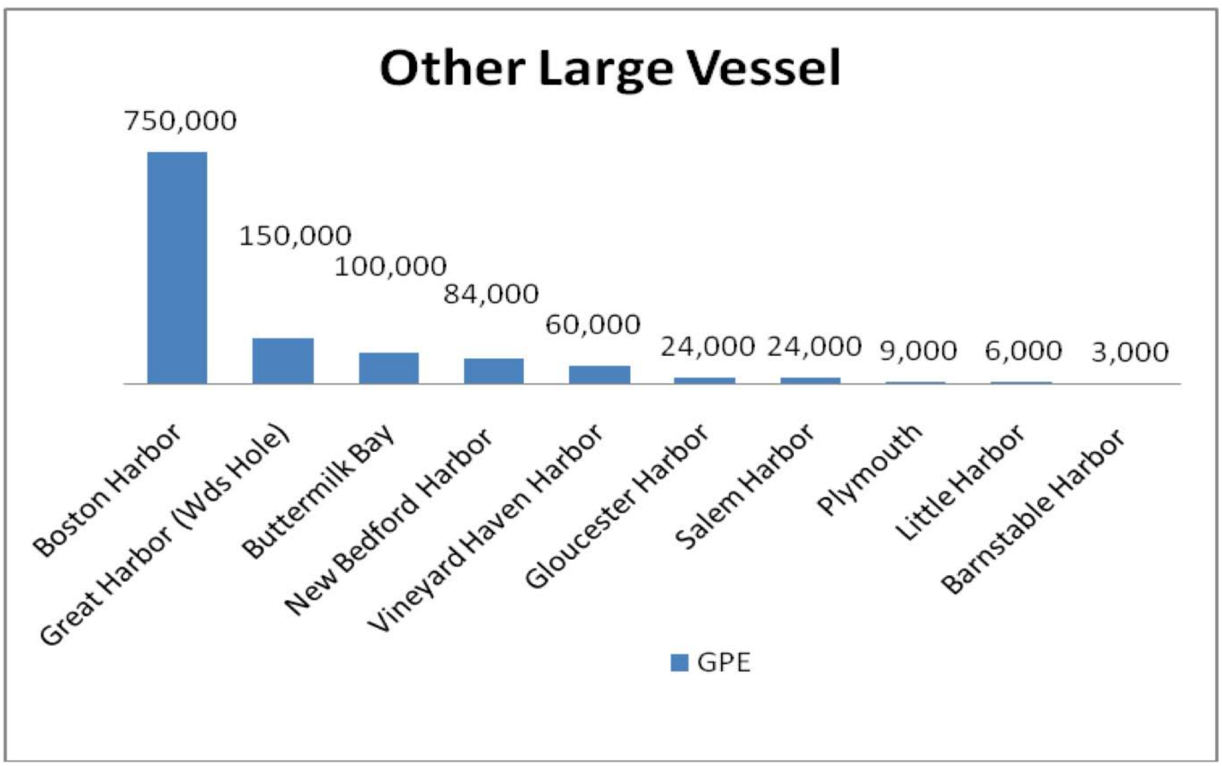
4.2.7 Other Large Vessel Activity

Many other vessels less than 300GT operating or moored within a harbor contain large amounts of fuel. Examples are harbor tugs, training ships, military vessels, and excursion vessels. The harbormaster survey was used to identify these vessels by harbor location. Estimates of fuel capacity for these vessels represent a best professional estimate of these quantities. The vessels by harbor included in the analysis are presented in Table 4.9 along with the calculated GPE estimate. Figure 4.9 presents the GPE estimates for the top ten harbors.

Table 4.9 Other Large Vessel Oil Spill Threat in Estimated Gallons of Petroleum Exposure by Harbor

Harbor	Vessels Types	Est. # of Vessels	Average Fuel Capacity	GPE
Boston Harbor	Coast Guard, Harbor Tugs, Work Boats, USS Constitution	50	15,000	750,000
Great Harbor (Woods Hole)	NOAA Vessels	3	50,000	150,000
Buttermilk Bay	TS Kennedy	1	100,000	100,000
New Bedford Harbor	Tugs, Training Vessels	7	12,000	84,000
Vineyard Haven Harbor	4 Tugs	4	15,000	60,000
Gloucester Harbor	8 Whale Watching Vessels	8	3,000	24,000
Salem Harbor	Whale Watching, Tug	4	6,000	24,000
Plymouth	Whale Watching	3	3,000	9,000
Little Harbor	Coast Guard	3	2,000	6,000
Barnstable Harbor	Whale watching vessels	1	3,000	3,000
Allerton Harbor	Research Vessel	1	600	600
Sandwich Boat Basin	Pilot Boats	3	200	600
Scituate Harbor	NOAA Vessel Auk	1	600	600
Wellfleet Harbor	1 commercial vessel	1	600	600
Westport River	1 commercial vessel	1	600	600
Sippican Harbor	Tabor Boy	1	500	500

Figure 4.9 Other Large Vessel Oil Spill Threat in Estimated Gallons of Petroleum Exposure by Harbor



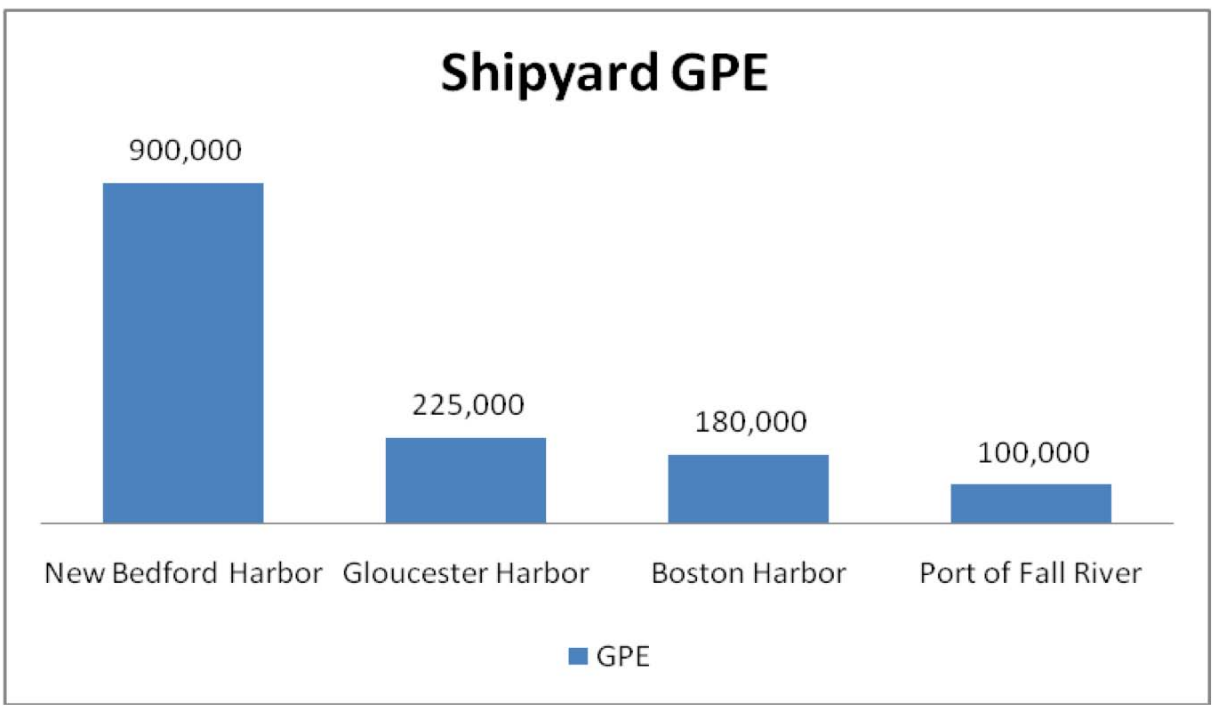
4.2.8 Shipyards

Large shipyards in harbors represent a source of increased activity for vessel movement. While Massachusetts once had a number of shipyards, only four harbors reported having operating shipyards that service vessels larger than 70 feet. These are Gloucester, Boston, New Bedford/Fairhaven, and Fall River/Somerset. The shipyards and their estimated addition to the total threat are listed in Table 4.10. A graph of the GPE quantities is presented in Figure 4.10. The GPE was calculated for these locations based on an estimate of the number of vessels that are being serviced on any given day. For Gloucester, New Bedford and Boston, the estimates were based on follow-up conversations with the harbormasters. The Fall River/Somerset shipyard activity was estimated to be in line with the other three; however this should be updated upon further investigation.

Table 4.10 Shipyard Oil Spill Threat in Estimated Gallons of Petroleum Exposure by Harbor

Harbor	Number of Shipyards	Average Size	Vessels in Repair or Construction	Average Fuel Capacity	GPE Shipyard
New Bedford/Fairhaven	2	45-110	20	45,000	900,000
Gloucester	1	45-110	5	45,000	225,000
Boston	1	45-110	4	45,000	180,000
Somerset	1	25-80	4	25,000	100,000

Figure 4.10 Shipyard Oil Spill Threat in Estimated Gallons of Petroleum Exposure by Harbor



4.2.9 Land-Based Bulk Oil Storage Facilities - EPA Regulated

The EPA requires that all oil storage facilities with a capacity to hold 42,000 gallons or more of petroleum products in aboveground storage tanks must file a Facility Response Plan (FRP) with the Environmental Protection Agency (EPA). The EPA provided a list of all of the FRPs on file for Massachusetts, and this information was used to identify communities with bulk fuel oil storage facilities.

The information provided did not include the total quantity of oil per facility, nor did it identify the size of individual fuel tanks. Quantity information was also not available on the EPA's website listing of facility plans by plan number, status and contact information. Fire chiefs from Braintree, Chelsea, and Sandwich provided information on storage quantities for the facilities in their towns. Additional information on the storage tank sizes for Nantucket was provided by the harbormaster and for Tisbury from the terminal operator.

To estimate the quantities in the remaining facilities, an average amount per tank was calculated based on the information received from Braintree, Chelsea, Sandwich, Tisbury, and Nantucket and the number of tanks in each facility based on a review of aerial photographs of each tank farm. For example, the two facilities in Braintree hold 58,000,000 gallons of petroleum in approximately 18 tanks. The five facilities in Chelsea hold 57,000,000 gallons in approximately 17 tanks. The average quantity for these facilities then is 3.2 million gallons per tank. The amounts for Tisbury and Nantucket were calculated at approximately 100,000 gallons per tank. The amount per tank for Sandwich was calculated at 400,000 per tank. These ranges were then applied to the visual count and approximate size of the tanks for the other municipalities to estimate the tank farm quantity in gallons. The largest concentration of facilities occurs in the Braintree, Boston, Chelsea, Everett, and Revere area with an estimated 92% of the total capacity in coastal Massachusetts.

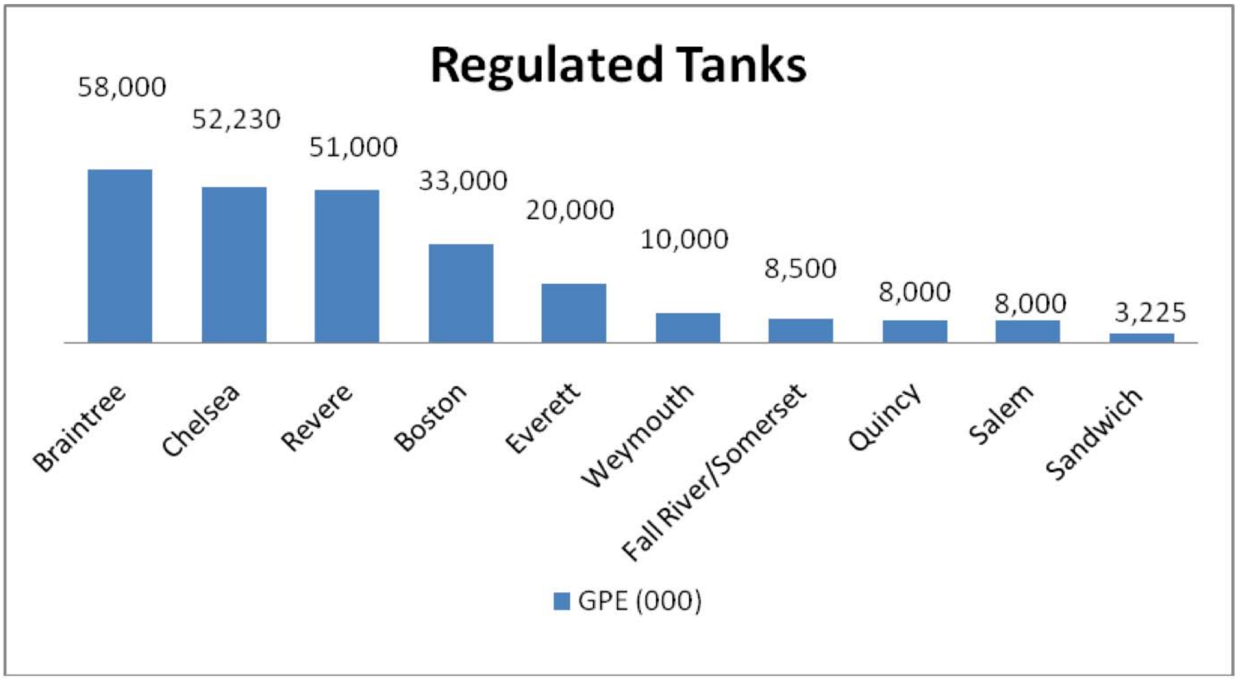
For the facilities with FRPs in Beverly, Lynn, and Peabody, it was not possible to estimate the number or size of storage tanks with available aerial photographs. Therefore, the total storage quantity for each of these three is assumed to be 42,000 gallons, which is the minimum regulated quantity. This is likely an underestimate for these three locations.

The estimated GPE values by municipality and harbor are presented in Table 4.11. Figure 4.11 presents the GPE quantities for the top ten municipalities.

Table 4.11 EPA Regulated Storage Tank Oil Spill Threat in Estimated Gallons of Petroleum Exposure by Municipality

Municipality	Harbor	# of Tank Farms (EPA)	Approx. # Tanks	GPE	GPE Source
Braintree	Fore River	2	18	58,000,000	Fire Chief survey
Chelsea	Boston Harbor	5	17	52,230,000	Fire Chief survey
Revere	Boston Harbor	7	34	51,000,000	Estimated at 1.5 mil per Tank
Boston	Boston Harbor	9	22	33,000,000	Estimated at 1.5 mil per Tank
Everett	Boston Harbor	3	40	20,000,000	Estimated at 1.0 mil per Tank
Weymouth	Fore River	2	10	10,000,000	Estimated at 1.0 mil per Tank
Fall River/ Somerset	Port of Fall River	4	17	8,500,000	Estimated at 500,000 per tank
Quincy	Town River Bay	3	8	8,000,000	Estimated at 1.0 mil per tank
Salem	Salem Harbor	2	8	8,000,000	Estimated at 1.0 mil per tank
Sandwich	Sandwich Harbor	3	8	3,225,000	Fire Chief survey
New Bedford/ Fairhaven	New Bedford Harbor (2)	3	6	2,400,000	Estimated at 400,000 per tank
Nantucket	Nantucket Harbor	2	10	953,000	Harbormaster survey
Tisbury	Vineyard Haven	1	8	780,000	Per Direct Contact
Beverly	Beverly Harbor	1	Plant	42,000	Estimated at the minimum for FRP
Lynn	Lynn Harbor	1	Plant	42,000	Estimated at the minimum for FRP
Peabody	None	1	Plant	42,000	Estimated at the minimum for FRP

Figure 4.11 EPA Regulated Storage Tank Oil Spill Threat in Estimated Gallons of Petroleum Exposure (000)[19] for Ten Municipalities with Highest Threat Levels



[19] All values in table should be multiplied by a factor of 1,000.

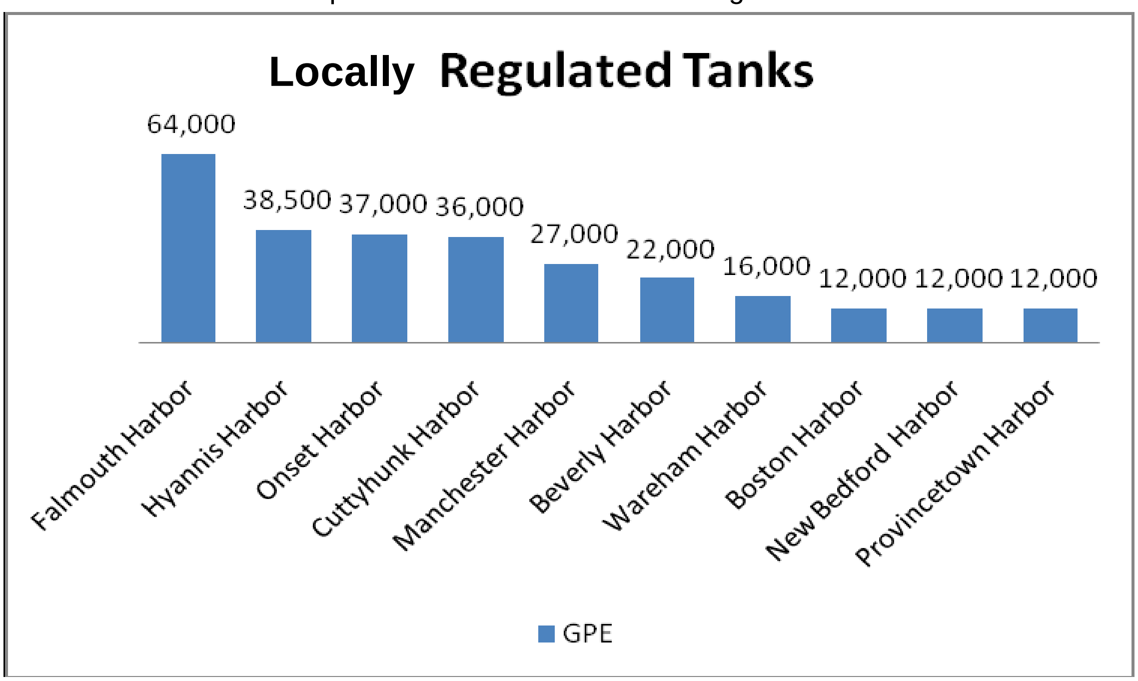
4.2.10 Locally Regulated Bulk Fuel Storage at Harbor or Marina

Information on locally regulated tanks, greater than 1,000 gallons but less than 10,000 gallons that are not regulated by the EPA, was compiled from data contained in the fire chief survey and the harbormaster survey. Additional information was gathered by telephone calls to selected sites to validate information. Most of the fuel storage tanks identified in the surveys are used for providing fuel to marine traffic and are part of marina or boatyard operation. However, at least one (in the town of Gosnold on Cuttyhunk Island) is also used to provide fuel for a small number of vehicles. Table 4.12 presents the data on non-regulated tanks and Figure 4.12 shows the quantities in a graph.

Table 4.2 Non-EPA Regulated Storage Tank Oil Spill Threat in Estimated Gallons of Petroleum Exposure by Harbor

Harbor	GPE	Harbor	GPE	Harbor	GPE
Falmouth Harbor	64,000	Gloucester Harbor	10,000	Sippican Harbor	6,000
Hyannis Harbor	38,500	Little Harbor	10,000	Pleasant Bay	6,000
Onset Harbor	37,000	Plymouth Harbor	10,000	Scituate Harbor	6,000
Cuttyhunk Harbor	36,000	Wellfleet Harbor	10,000	Vineyard Haven Harbor	6,000
Manchester Harbor	27,000	Edgartown Harbor	9,000	Westport River	5,000
Beverly Harbor	22,000	Nantucket Harbor	8,000	Apponagansett Bay	4,000
Wareham Harbor	16,000	Red Brook Harbor	7,500	Allerton Harbor	4,000
Boston Harbor	12,000	Popponesset Bay	6,500	Green Harbor	4,000
New Bedford Harbor	12,000	Barnstable Harbor (1)	6,000	Buttermilk Bay	4,000
Provincetown Harbor	12,000	West Bay	6,000	Menemsha Creek	3,000
Neponset River	12,000	Fore River	6,000	Weweantic River	2,500
Sandwich Boat Basin	12,000	Marblehead Harbor	6,000	Rockport Harbor	1,200

Figure 4.11Locally (Non-EPA) Regulated Storage Tank Oil Spill Threat in Estimated Gallons of Petroleum Exposure for Ten Harbors with Highest Threat Levels



4.3 Analysis of Combined Oil Spill Threats by Harbor

The analysis in the previous section provided estimates of GPE for each threat factor by harbor. In this section, the combined GPE for each harbor is considered.

In considering each threat factor separately, the scale of the threat among the highest-ranking harbors varied considerably. The scale of four of the threat factors – tank vessel activity, NTV activity, vessel transit activity and EPA regulated tanks – was generally in the range of hundreds of millions to billions of gallons. The other six factors – all of those in the residential vessel fleet category as well as locally regulated tanks – were on a scale of tens of thousands to millions of gallons.

Because the magnitude of threats varied so greatly in scale, the threat factors were considered in two sets– as “high magnitude” threats and “low magnitude” threats. In order to allow for a more meaningful analysis of total threat by harbor, the aggregated totals for high and low magnitude threat categories are considered separately.

4.3.1 Analysis by Harbor for High Magnitude Threat Factors

Table 4.13 presents the aggregated GPE for the harbors that registered threat estimates in this study for the four high magnitude threat factors - tank vessel activity, NTV activity, vessel transit volume, and EPA regulated land-based storage tanks. Of the 95 harbors identified in Section 1.5, 60 are represented on this list. Within those 60 harbors, 43 of the harbors are exposed to only the vessel transit threat factor while 17 are exposed to the vessel transit threat factor and at least one of the other three high magnitude threats.

The eight Boston area harbors have the largest high magnitude GPE total, ranging from 4.31 billion gallons to 4.41 billion gallons due to the amount of petroleum delivered to Boston Harbor and the large tank farms located in Boston, Chelsea and Everett. Five of the eight harbors are exposed to only the vessel transit GPE and to no other high magnitude threats.

Outside of the Boston Harbor region, New Bedford Harbor and the other harbors on Buzzards Bay have the next highest GPE. This is mainly attributable to the number of vessel transits through Buzzards Bay, generating a GPE of 1.56 billion. In addition to being exposed to the vessel transit threat, New Bedford has 44.9 million gallons in tank vessel and NTV GPE and 2.4 million gallons in land-based storage GPE. Sandwich has 3.2 million gallons in land-based storage and 500,000 in NTV GPE. The tank vessel traffic into Esco Terminal in Sandwich was not separated from the Cape Cod Canal data in the ACOE database and thus is included in the vessel transit GPE. The only other harbor on Buzzards Bay to have a threat exposure other than the vessel transit quantity is Great Harbor (Woods Hole), which recorded 150,000 GPE for NTV traffic.

Revere is listed with a GPE of 1.48 billion due to two factors: 1.44 billion in vessel transits and 51 million in land-based storage. The land-based storage tanks in Revere are located on the upper portion of the Chelsea Creek and could have been assigned to the Boston Harbor Region. However, because the municipality of Revere is part of the North Shore Region, the tank farm quantity was assigned to the Pines River in Revere.

The next group of harbors by total GPE amount includes those of the North Shore, South Shore and Cape and Islands regions that are exposed to vessel traffic entering and leaving Boston Harbor. The vessel traffic GPE for each of these harbors is 1.44 million. The only harbor of this group with additional GPE is Lynn Harbor, which has a manufacturing site with a facility response plan with an estimated 42,000 GPE for regulated tanks.[20]

Of the Harbors not located near the Port of Boston or Buzzards Bay shipping lanes, the Port of Fall River has the next highest GPE, due to their 54.9 million gallons of tank vessel and NTV activity. Salem, Vineyard Haven, Nantucket, Gloucester, Plymouth, Hyannis, and Beverly all have exposure to tank vessel, NTV, and/or regulated tank threat factors.

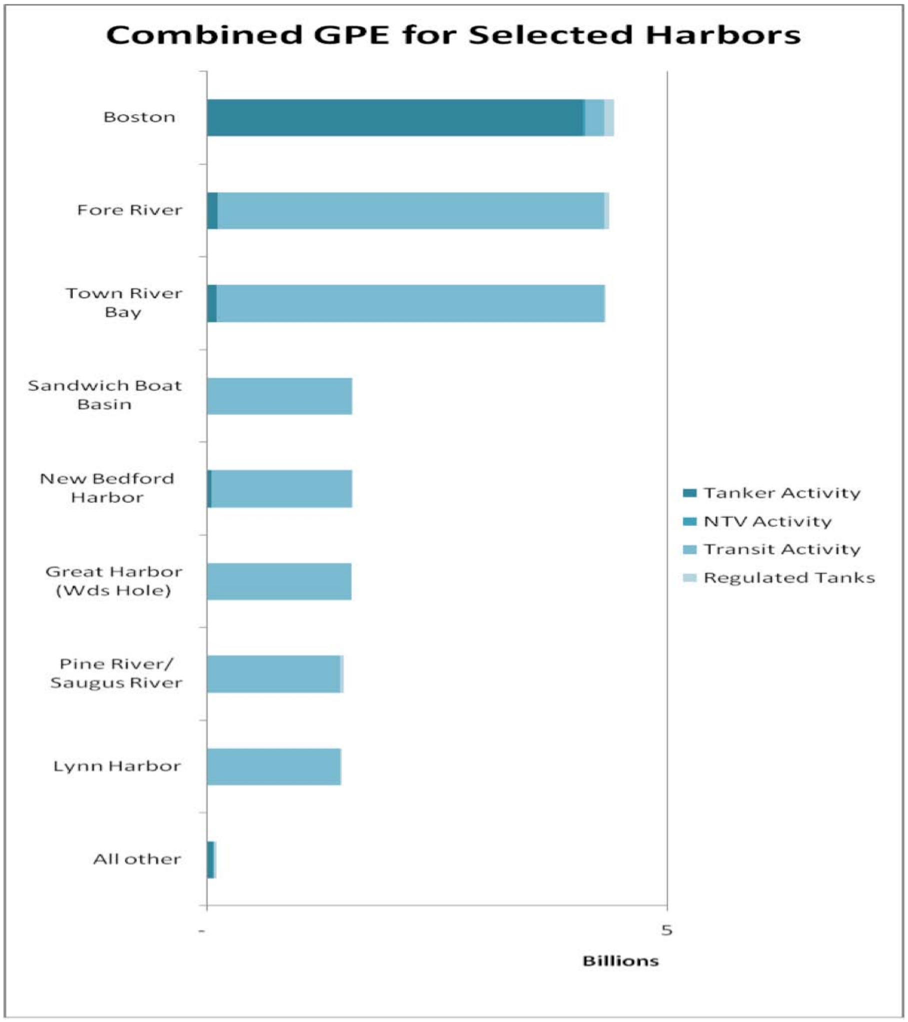
Figure 4.12 shows the GPE estimates for harbors that have exposure to "high magnitude" threat activities. The harbors with less than 100 million GPE are combined in the "all other" column.

Table 4.13 Total GPE by Harbor for Vessel Activity and EPA Regulated Tanks (000)[21]

Harbors	Total GPE	Harbors	Total GPE	Harbors	Total GPE
Boston	4,413,230	Little Harbor	1,562,611	Cohasset Harbor	1,436,000
Fore River	4,366,000	Mattapoisett	1,562,611	Hingham Harbor	1,436,000
Town River Bay	4,316,000	Nasketucket Bay	1,562,611	Marblehead	1,436,000
Back River	4,308,000	Onset Harbor	1,562,611	Nahant Harbor	1,436,000
Dorchester Bay	4,308,000	Phinneys Harbor	1,562,611	Nauset Harbor	1,436,000
Neponset River	4,308,000	Pocasset Harbor	1,562,611	Pleasant Bay	1,436,000
Quincy Bay	4,308,000	Pocasset River	1,562,611	Provincetown	1,436,000
Winthrop	4,308,000	Quissett Harbor	1,562,611	Rock Harbor	1,436,000
Sandwich Basin	1,565,836	Rands Harbor	1,562,611	Scituate Harbor	1,436,000
New Bedford	1,565,011	Red Brook	1,562,611	Weir River	1,436,000
Sandwich Harbor	1,562,611	Sippican Harbor	1,562,611	Wellfleet Harbor	1,436,000
Great Harbor	1,562,611	Squeteague	1,562,611	Port of Fall River	54,950
Apponagansett	1,562,611	Wareham Harbor	1,562,611	Lee River	46,450
Aucoot Cove	1,562,611	Weweantic	1,562,611	Salem Harbor	18,950
Brant Island	1,562,611	West Falmouth	1,562,611	Vineyard Haven	6,680
Buttermilk Bay	1,562,611	Westport River	1,562,611	Nantucket	4,703
Clarks Cove	1,562,611	Wild Harbor	1,562,611	Gloucester	2,250
Cuttyhunk	1,562,611	Pines River	1,487,000	Plymouth Harbor	1,000
Fiddlers Cove	1,562,611	Lynn Harbor	1,436,042	Hyannis	50
Hadley Harbor	1,562,611	Allerton Harbor	1,436,000	Beverly	42

[20] This is a conservative estimate and may in fact be much higher. The EPA did not provide data on total storage amounts at each regulated facility.
[21] All quantities should be multiplied by a factor of 1,000.

Figure 4.12 Total GPE for Selected Harbors (in billions of gallons) for Combination of Four "High Magnitude" Threat Factors



4.3.2 Analysis by Harbor for Low Magnitude Threat Factors

Table 4.13 presents the aggregated GPE for the harbors that registered threat estimates in this study for the six low magnitude threat factors – fishing fleets, recreational/charter vessel fleets, ferry fleets, homeport fleet, shipyards, and locally regulated storage tanks. Of the 95 harbors identified in Section 1.5, 43 are listed as having exposure to the low magnitude threat factors. Harbors that were not included in the Harbormaster survey because they did not have two or more identified threat factors or harbors for which a survey was not returned would account for the other 52 harbors.

New Bedford harbor, with a combined GPE of 8.8 million gallons, has the highest estimated GPE for the measures analyzed in this section. Their resident fishing fleet accounts for 7.5 million gallons, the two shipyards account for 900,000 gallons, and the recreational and charter fleet account for 300,000 gallons.

Gloucester's 2.57 GPE is largely due to the 2.25 million gallons in the resident fishing fleet GPE and the 225,000 gallons in the one Gloucester shipyard.

Boston Harbor has the third highest combined GPE for these low magnitude factors at 1.48 million gallons, mainly due to the 750,000 gallons in the resident homeport fleet and the 400,000 gallons in the recreational and charter fleet. Boston Harbor does not have a large fishing fleet compare to some of the other harbors, placing ninth among the harbors represented.

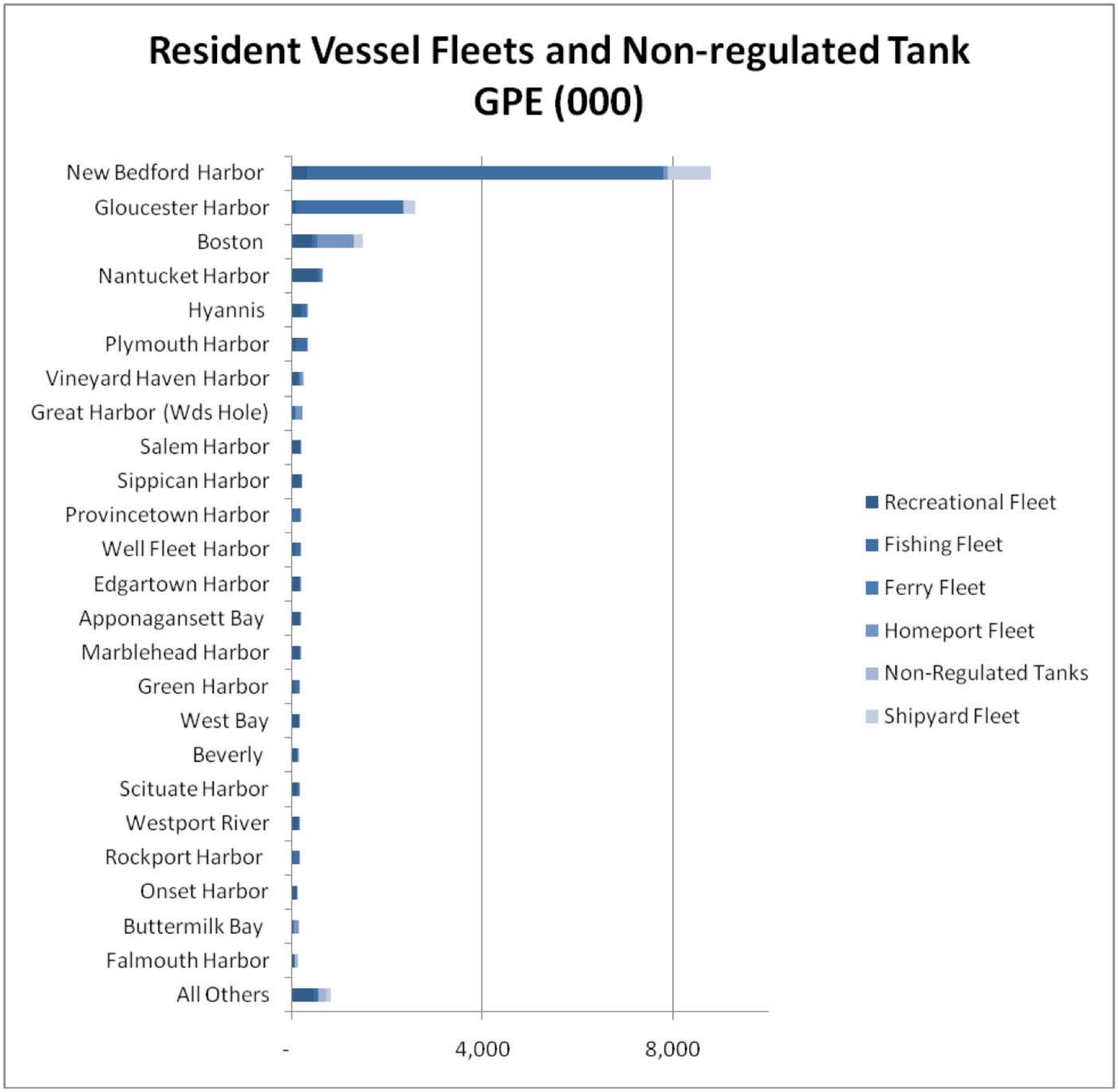
Nantucket follows in fourth place with a combined GPE of 629,350 gallons, mostly due to having the highest estimated recreational and charter fleet GPE of 523,600 gallons. Plymouth and Provincetown harbors have relatively large fishing vessel fleets at 240,000 and 168,000 gallons respectfully. Great Harbor falls in eighth place due to the homeport fleets at the Woods Hole Oceanographic Institute, while Vineyard Haven, Salem and Sippican harbors round out the top ten each with relatively large recreational and charter fleets.

Figure 4.13 shows the GPE estimates for those harbors that have recorded exposure to the resident vessel fleet and locally regulated tank threat factors. The harbors with less than 100,000 GPE are combined in the "all other" column.

Table 4.14 Combined GPE by Harbor in Order of Magnitude

Harbors	Total GPE	Harbors	Total GPE	Harbors	Total GPE
New Bedford	8,801,500	Green Harbor	155,300	Allerton Harbor	58,900
Gloucester	2,573,600	West Bay	152,630	Cuttyhunk	48,800
Boston	1,479,750	Beverly	152,000	Nauset Harbor	48,270
Nantucket	629,350	Scituate Harbor	151,850	Mattapoisett	43,620
Hyannis	341,400	Westport River	150,100	Manchester	27,000
Plymouth	330,000	Rockport Harbor	135,300	Menemsha Creek	22,480
Vineyard Haven	228,500	Onset Harbor	125,800	Little Harbor	21,800
Great Harbor	221,300	Buttermilk Bay	124,900	Neponset River	12,000
Salem Harbor	195,000	Falmouth Harbor	118,150	Weweantic	11,200
Sippican Harbor	192,400	Port of Fall River	100,000	Oak Bluffs	9,000
Provincetown	190,000	Red Brook	89,660	Popponesset Bay	6,500
Wellfleet	181,850	Pleasant Bay	84,960	Fore River	6,000
Edgartown	178,500	Wareham	77,020	Hingham Harbor	4,000
Apponagansett	172,900	Barnstable	73,750	Pocasset River	300
Marblehead	170,000	Sandwich Basin	60,600		

Figure 4.13 Total GPE for Selected Harbors (in billions of gallons) for Combination of Four "Low Magnitude" Threat Factors



4.3.3 Harbors with Highest Concentration of Threat Factors

Of the eight harbors with the highest level of exposure to high magnitude threat factors (Section 4.3.1) and the twenty-four harbors with the highest level of exposure to low magnitude threat factors, the following harbors overlap: Boston, New Bedford, and Great Harbor. The harbors which have a high level of exposure to the high magnitude threats but minimal exposure to the low magnitude threats are the Fore River and Town River in the Boston Harbor region, the Pines River and Lynn in the North Shore Region, and the Sandwich Boat Basin in the Cape and Islands Region. Figure 4.14 shows the highest-ranking harbors for exposure to both low and high magnitude threats. Section 5 discusses regional threat factors based on aggregated data from all harbors in each region.

Figure 4.14 Map Showing Harbors with Highest Exposure to Oil Spill Threat Factors

5 Regional Assessment of Threat Factors

Previous sections of this report estimate the location, source, and relative size of oil spill threats by harbor. The information provided should be useful for local harbor planning and oil spill preparedness activities, and also to MassDEP and other state and federal agencies interested in preventing and responding to coastal oil spills. It provides a useful reference for general oil spill threats at the harbor and municipal level, which is discussed further in Section 6 of this report.

Section 5 of the report considers some of the threat factors discussed in Sections 3 and 4 aggregated to the regional level, in order to compare types and magnitude of threats across geographic region. A major objective of this report is to facilitate the decision making process used by MassDEP to allocate oil spill prevention and response resources. Programs and supplies may be allocated at the harbor or municipal level, but others are likely be allocated by region. This section discusses threat exposure by region and highlights those activities that have the highest comparative contribution to regional oil spill threats.

Like the harbor analysis, the regional assessment uses an estimate of gallons of petroleum exposure (GPE) to compare threat factors within and across regions. All of the GPE estimates are derived from the data described in Section 3, and are limited as noted in that discussion. This section compares threats both by region and by individual threat factor in order to highlight both the geographic areas where spill threats are highest as well as those activities that contribute to these higher oil spill threat levels.

For the regional analysis, the comparative level of individual and aggregated threat, as expressed by estimated gallons of petroleum exposure, is described in order to compare overall oil spill threat among regions. Within each region, the total contribution of each of the ten threat factors is described and the major threats are highlighted. This region-by-region analysis also compares the level of threat from individual factors within the three main threat categories: vessel movement, resident vessel fleet, and land-based storage.

5.1 Comparison of Regional Oil Spill Threats by Category

This study identified three broad categories of oil spill threat for the purpose of data compilation and analysis: vessel movement activity, resident vessel fleets, and land-based bulk fuel storage. Within each of these three categories, individual threat factors were identified.

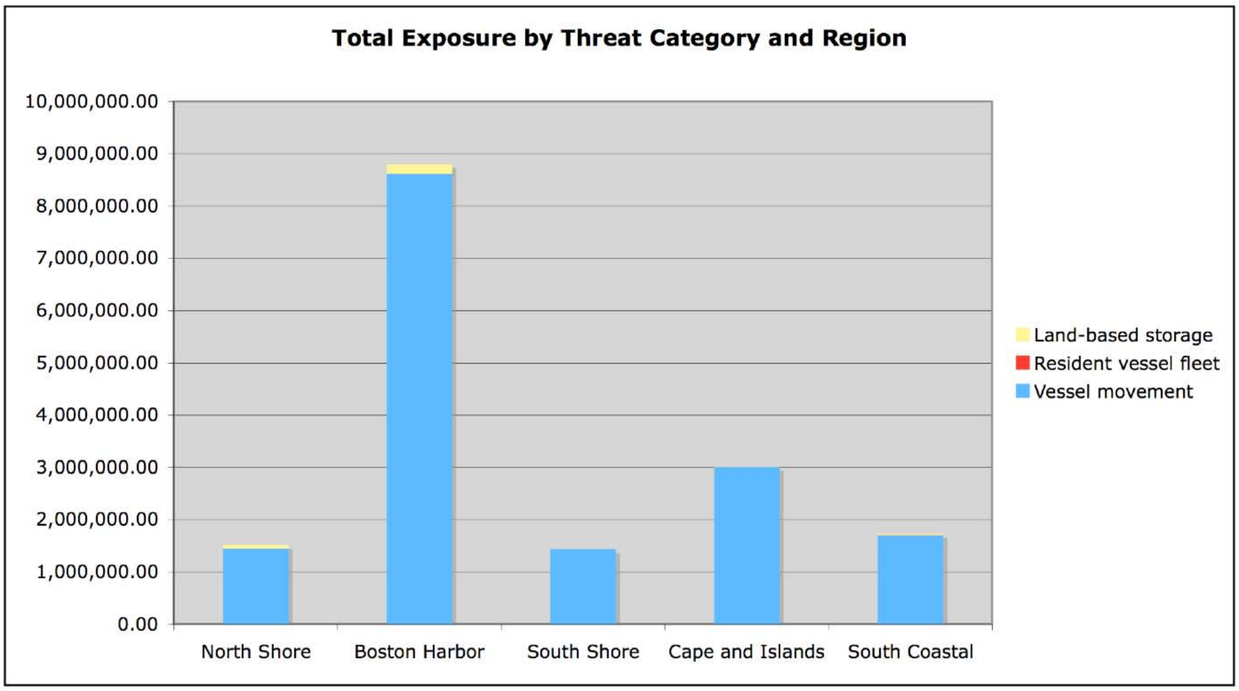
Figure 5.1 shows the total threat exposure for each coastal region of Massachusetts, and also shows the proportional contribution of the three categories of threats – vessel movements, residential vessel fleets, and land-based storage – to the total threat level in each region. Figure 5.2 shows the proportionate contribution of the ten individual threat factors to total threat in all regions.

Figure 5.1 shows that vessel movement activity dominates the total threat for all five regions. Figure 5.2 shows that, within the vessel movement category, two threat factors – tank vessel activity and transit volume – account for nearly 100% of the threat exposure, with a minimal contribution from nontank vessel activity. Transit volume is by far the largest contributor to vessel movement threat and to total threat overall. Transit volume refers to the quantity of oil carried in bulk through shipping channels and in and out of ports and harbors.

Land-based storage provides a minimal contribution to total threat level in two regions (North Shore and Boston Harbor), and accounts for approximately 1% of the total threat for all regions.

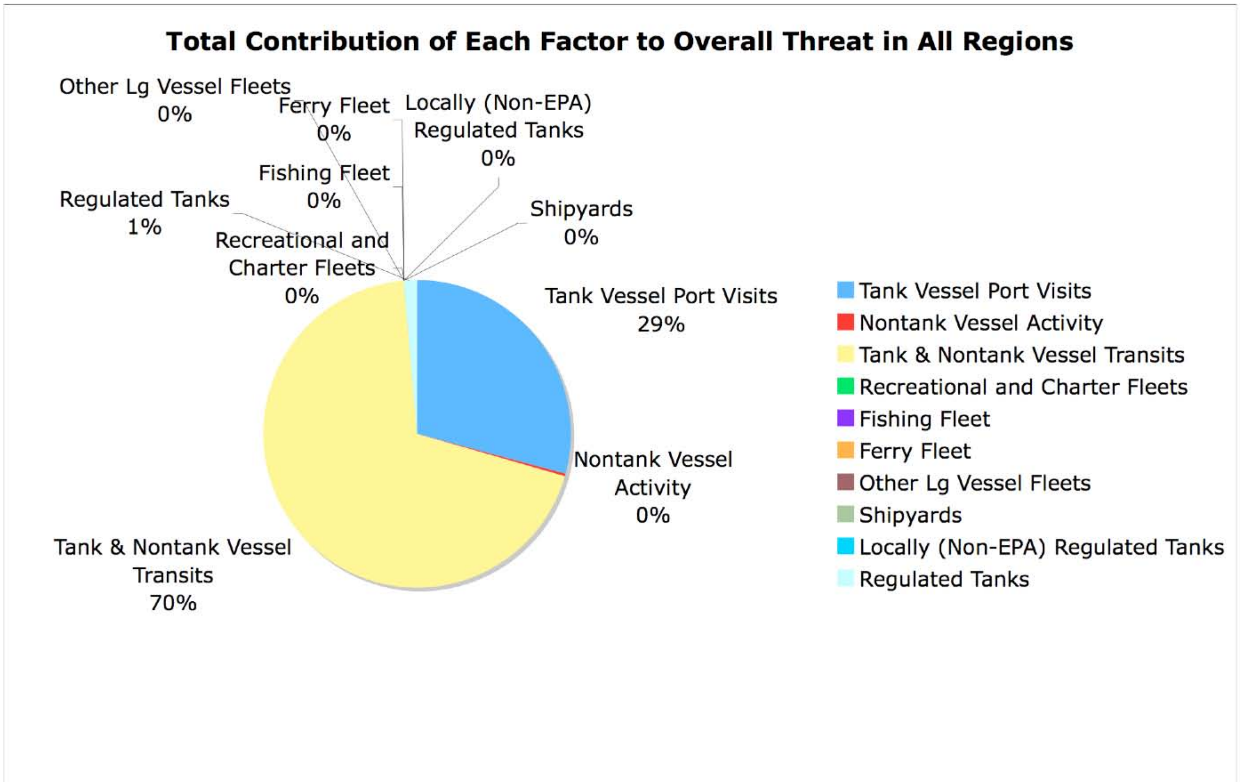
The overall threat from residential vessel fleets does not register for any of the regions, and contributes less than 1% to the total threat for all regions, because the total GPE from residential vessel fleets is an order of magnitude less than the total from vessel movement and land-based storage.

Figure 5.1 Total Threat Exposure for Each Region by Threat Category (000)[22]



[22] All values in table should be multiplied by a factor of 1,000.

Figure 5.2 Proportionate Contribution of all Threat Factors to Total Threat Level for All Regions



5.1.1 Vessel Movement Threat Exposure

Figure 5.3 shows that the total threat exposure from vessel movement activity is highest in the Boston Harbor region, followed by the Cape and Islands and South Coastal regions. The North Shore and South Shore both have similar exposure levels.

Figures 5.4 through 5.7 contain four pie charts. The first chart (Figure 5.4) shows the proportionate contribution of the three threat factors that comprise the vessel movement estimate – tank vessel activity, nontank vessel activity, and vessel transits – to the overall threat for all regions. This chart shows that 70% of the threat exposure from vessel movement is attributable to the volume of petroleum products transported as cargo through shipping channels. The other 30% of the total threat exposure is attributed to tank vessels calling on ports and harbors. Nontank vessels, which are larger vessels that carry oil as fuel rather than cargo, account for less than 1% of the total threat exposure for vessel movement.

When analyzing vessel activity at the region level, the North Shore, South Shore, and Cape and Islands regions do not have any overlap in GPE between the tank vessel and nontank vessel activity with the vessel transit activity. Some overlap does occur in the South Coastal Region where approximately 5% of the transit activity was associated with South Coastal ports. For the Boston Region there is a 100% overlap between the tank vessel and NTV activity with the vessel transit activity. When accounting for the overlaps at the harbor level in

Section 4, the GPE calculation subtracted out the overlap in the estimate of these threat factors. However, at the region level, the tank vessel, NTV, and transit threat factors are considered as independent threat indicators to highlight the magnitude of the activity within ports as well as the magnitude of the activity in the shipping lanes. Nevertheless, it is important to note that the aggregated levels of vessel movement activity is double counting the traffic in Boston Harbor and, to a lesser extent, in the South Coastal Region because the same vessels calling on those ports are also transiting offshore.

Figures 5.5 through 5.7 show the proportionate contribution from each region to the total threat exposure for the three vessel movement threat factors. The Tanker Activity chart (figure 5.5) shows that 98% of the total tank vessel threat exposure occurs in Boston Harbor, with the remaining 2% in the South Coastal region. The Nontank Vessel Activity chart (Figure 5.6) shows that the majority of the exposure to nontank vessel spill threats also occurs in Boston Harbor (69%). The second highest threat exposure to nontank vessel spills is in the South Coastal Region (22%), with the remaining exposure allocated to the North Shore (5%) and Cape and Islands (4%). The South Shore region contributes less than 1% of the total GPE from tank vessel activity.

The Transit Volume chart (Figure 5.7) shows a more even allocation of threat from vessels in transit, with all five regions contributing to the total threat. The highest level is still in Boston Harbor (37%), followed by the Cape and Islands (25%), and with similar levels attributed to the North Shore, South Shore, and South Coastal (12-14% each). Since the transit volume threat is transient, and all regions have some exposure to shipping routes, this more even distribution makes sense. It is important to note that the GPE estimates for the North Shore, South Shore and part of the Cape and Islands (those communities abutting the Atlantic Ocean) were based on an equal distribution of one-third of the volume in and out of Boston Harbor. Further analysis of vessel movement data for specific waterbodies may show that a larger proportion of vessel traffic in and out of Boston Harbor may concentrate in one region or another.

In considering the breakdown of vessel movement threat factors within each region, it becomes obvious that transit volume is the primary contributor to vessel movement threats for all regions except Boston Harbor, where the threat is allocated evenly between tank vessel activity and transit volume. Tanker activity contributes a small amount to the total threat in the South Coastal and North Shore regions.

Overall, the vessel movement activity threat exposure shows that transit volume accounts for more than two-thirds of the total exposure level (measured in gallons of petroleum) to oil spill threats from vessel movements. The Boston Harbor region has the highest threat level for oil spills from vessel movement.

Figure 5.3 Vessel Movement Activity Threat Exposure by Region (000)[23]

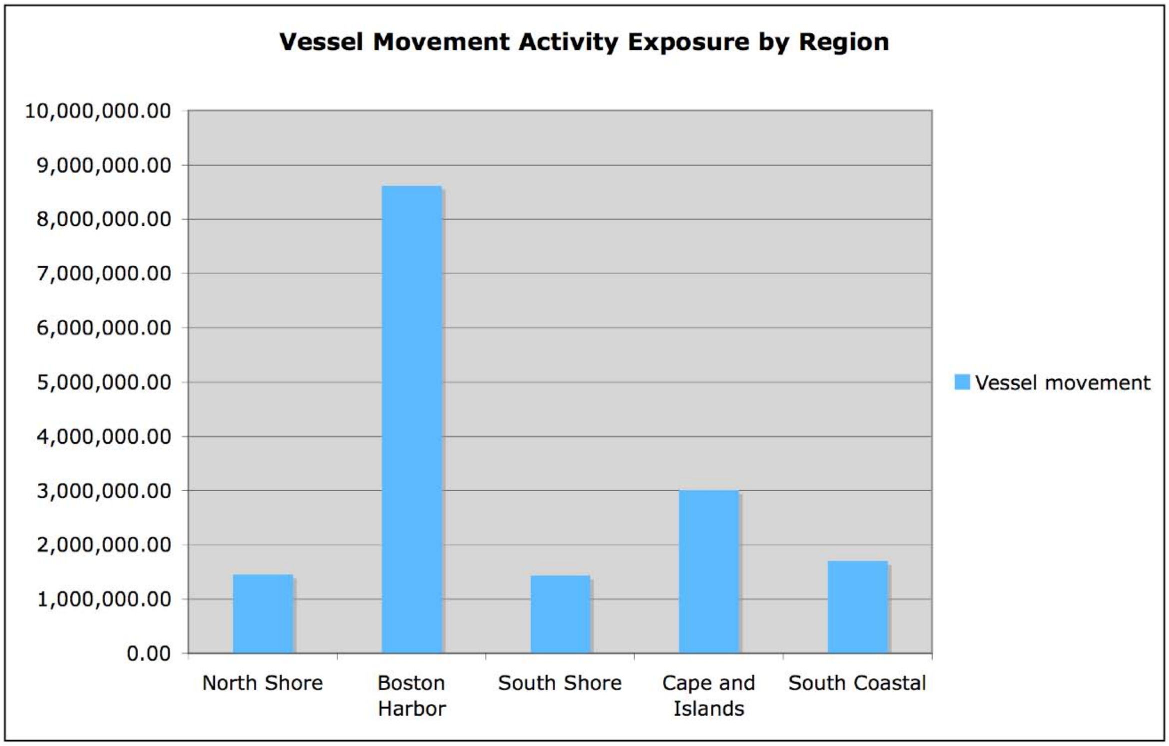
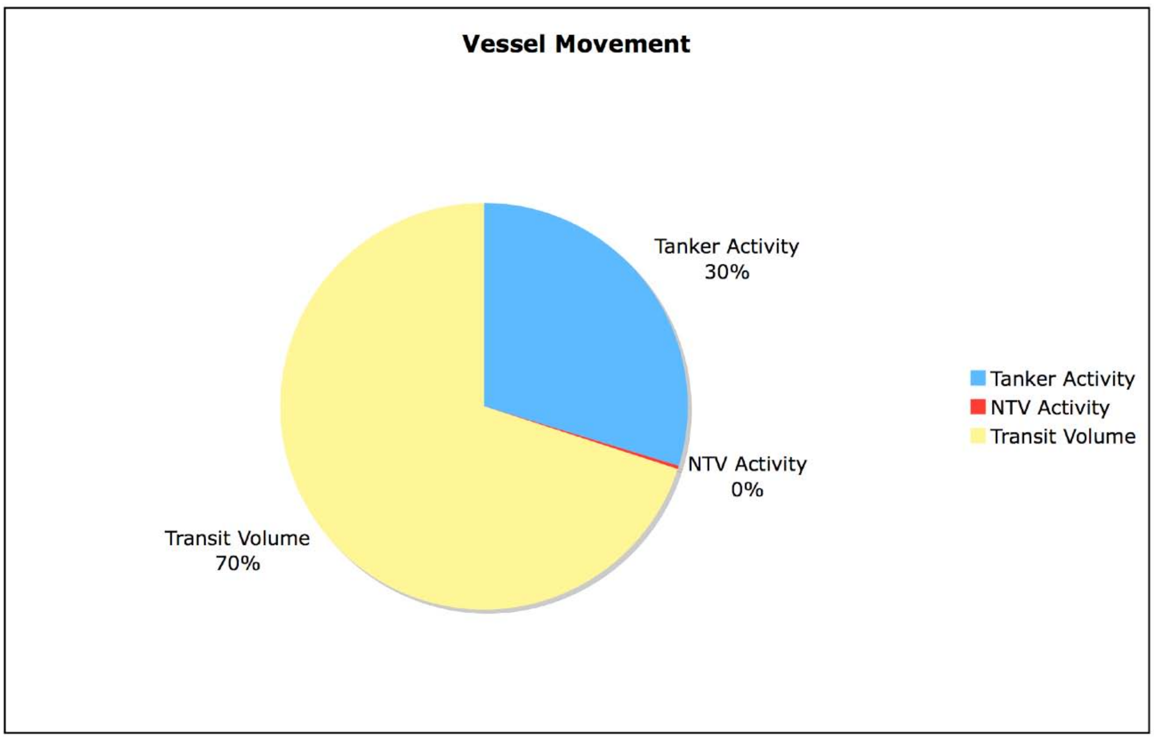


Figure 5.4 Contribution of Threat Factors to total Vessel Movement Threat and Comparison of Threat Factors by Region – Vessel Movement



[23] All values in table should be multiplied by a factor of 1,000.

Figure 5.5 Contribution of Threat Factors to total Vessel Movement Threat and Comparison of Threat Factors by Region – Tanker Activity

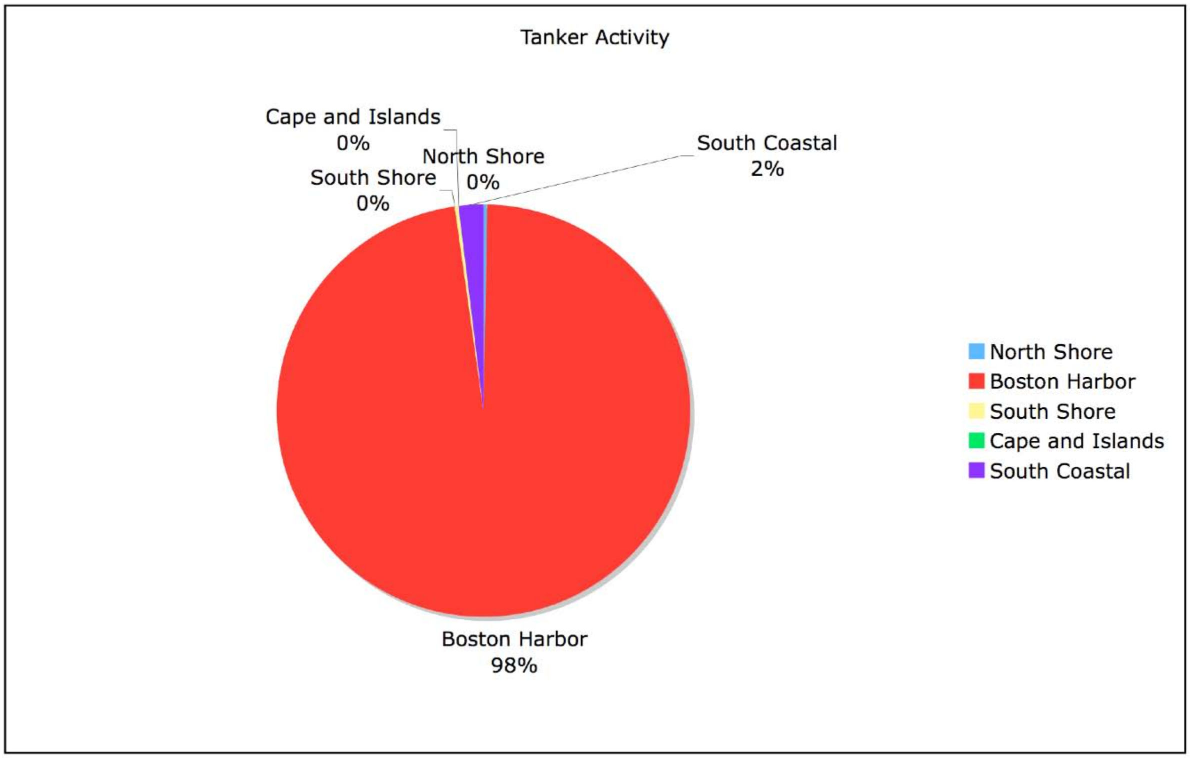


Figure 5.6 Contribution of Threat Factors to total Vessel Movement Threat and Comparison of Threat Factors by Region – Nontank Vessel Activity

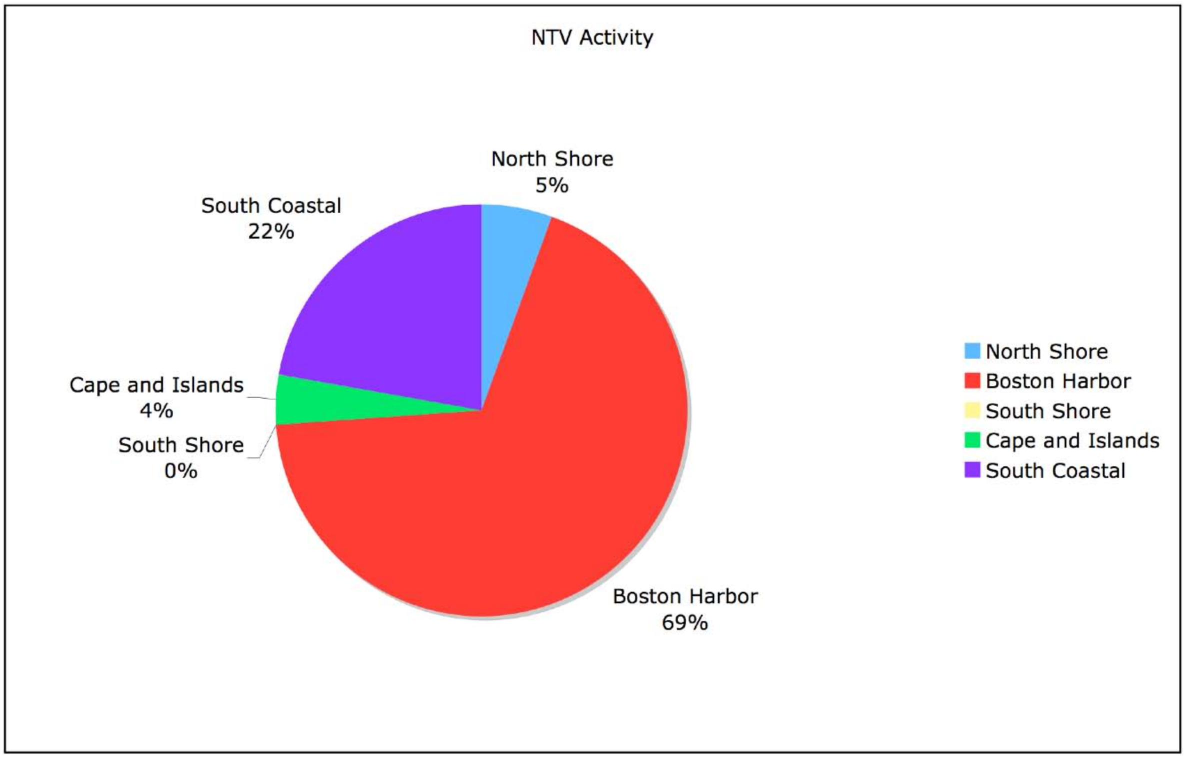
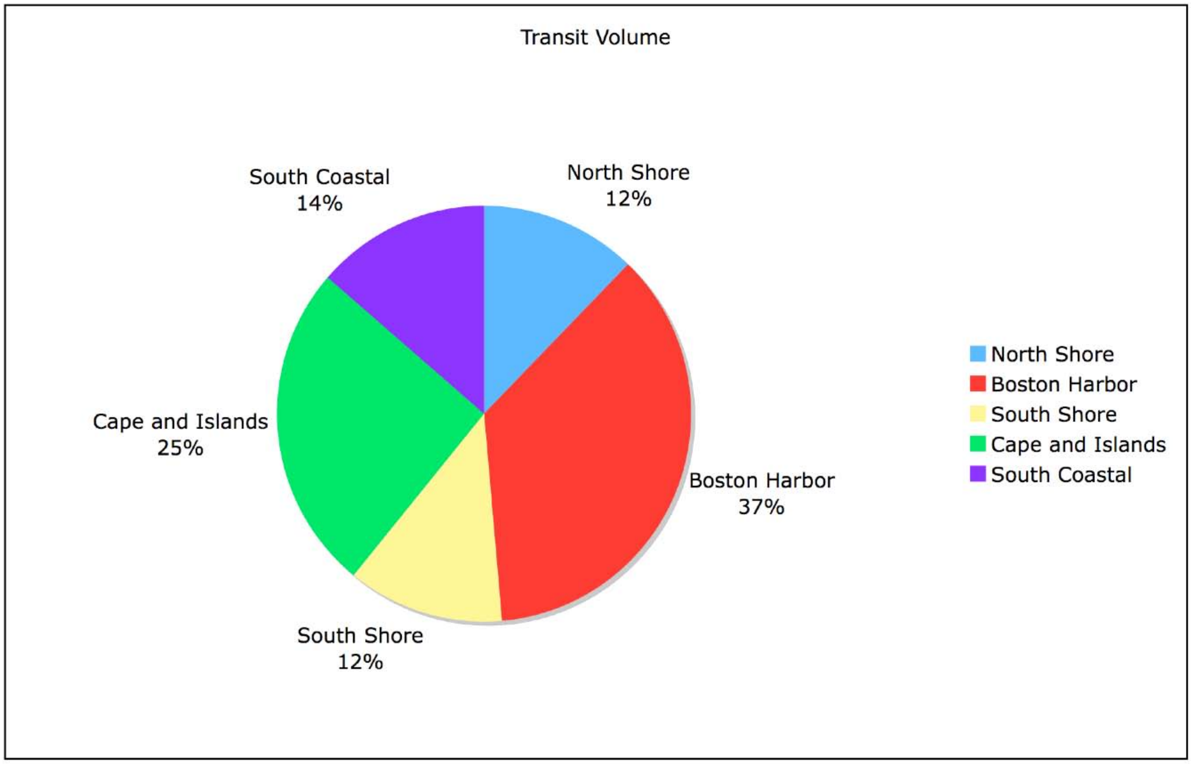


Figure 5.7 Contribution of Threat Factors to total Vessel Movement Threat and Comparison of Threat Factors by Region – Transit Volume



5.1.2 Resident Vessel Fleet Threat Exposure

Figure 5.8 shows that the total threat exposure from resident vessel fleets is highest in the South Coastal region, followed by the North Shore, Cape and Islands, Boston Harbor and the South Shore.

Figure 5.9 shows the proportionate contribution of the five threat factors that comprise the vessel movement estimate – fishing vessels, recreational and charter vessels, ferry boats, homeported vessels, and shipyards – to the overall threat for all regions. This chart shows that 59% of the threat exposure from resident vessel fleets is attributable to the volume of petroleum stored onboard fishing vessels. The next-highest contributor to total threat exposure is recreational and charter vessels. For all regions combined, shipyards and homeported vessels contribute 9% and 8% respectively to the total threat exposure. The smallest contributor to this threat factor is ferry vessels, at 2% of the total.

Figures 5.10 through 5.14 show the proportionate contribution from each region to the total threat exposure for the five resident vessel fleet threat factors. The recreational and charter fleet chart shows that 42% of the total threat exposure from residential and charter vessels occurs in the Cape and Islands, with the next highest level (27%) in the South Coastal region. The North Shore contributes slightly more (13%) to the total threat exposure than Boston Harbor

(11%). The South Shore contributes the smallest amount (7%) to the total GPE for recreational and charter vessel fleets.

The fishing fleet in the South Coastal region has 68% of the total statewide exposure to oil spill threats from fishing vessels, followed by the North Shore (22%). This makes sense, since the two largest fishing ports in Massachusetts are New Bedford (South Coastal) and Gloucester (North Shore). Figure 5.8 shows the relatively high contribution of fishing vessel fleets to total threat exposure in these two regions. The remaining three regions contribute between 1% and 5% to the total threat exposure for fishing vessel fleets.

Of the small amount of oil spill threat exposure attributable to the ferry fleet, 67% of this threat occurs in the Cape and Islands. Boston Harbor has 27% of the total exposure to the ferry fleet spill threat, and the remaining three regions contribute between 1% and 3% to the total threat exposure.

Boston Harbor has the majority (62%) of the exposure to oil spill threats from homeport vessel fleets, with the next highest exposure in the Cape and Islands (26%). The remaining three regions contribute between 1% and 7% to the total threat exposure from homeport vessels.

The threat exposure to petroleum on vessels in shipyards is highest in the South Coastal region (73%). The North Shore contributes 15% to the total threat exposure for this factor, and Boston Harbor contributes 12%. The South Shore and Cape and Islands both account for less than 1% of the total threat exposure statewide for shipyards.

Overall, the resident vessel fleet threat exposure shows that fishing vessels account for more than half of the total exposure level (measured in gallons of petroleum) to oil spill threats from resident vessels in Massachusetts ports and Harbors. The South Coastal region has the highest threat level for oil spills from vessel fleets, and most of this threat is attributable to the large commercial fishing fleet in New Bedford harbor as well as to recreational and charter fleets in several municipalities and harbors. The Cape and Islands region is most exposed to oil spill threats from recreational and charter fleets.

Figure 5.8 Residential Vessel Fleet Threat Exposure by Region (000) [24]

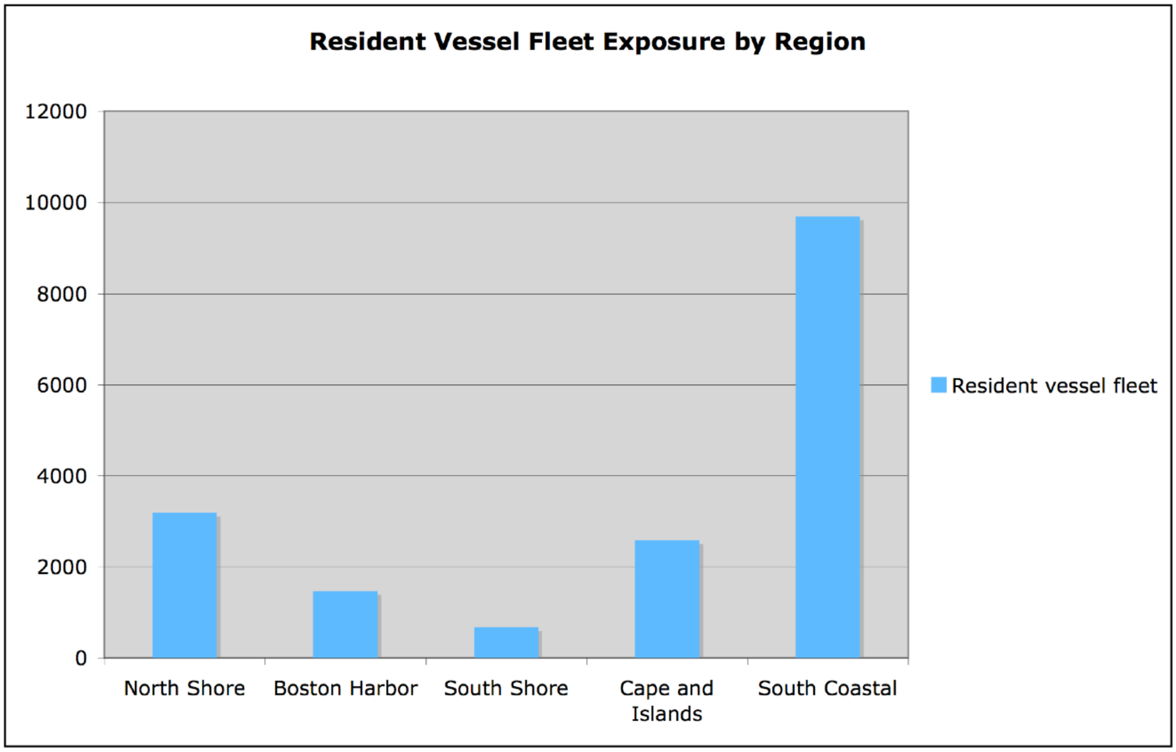
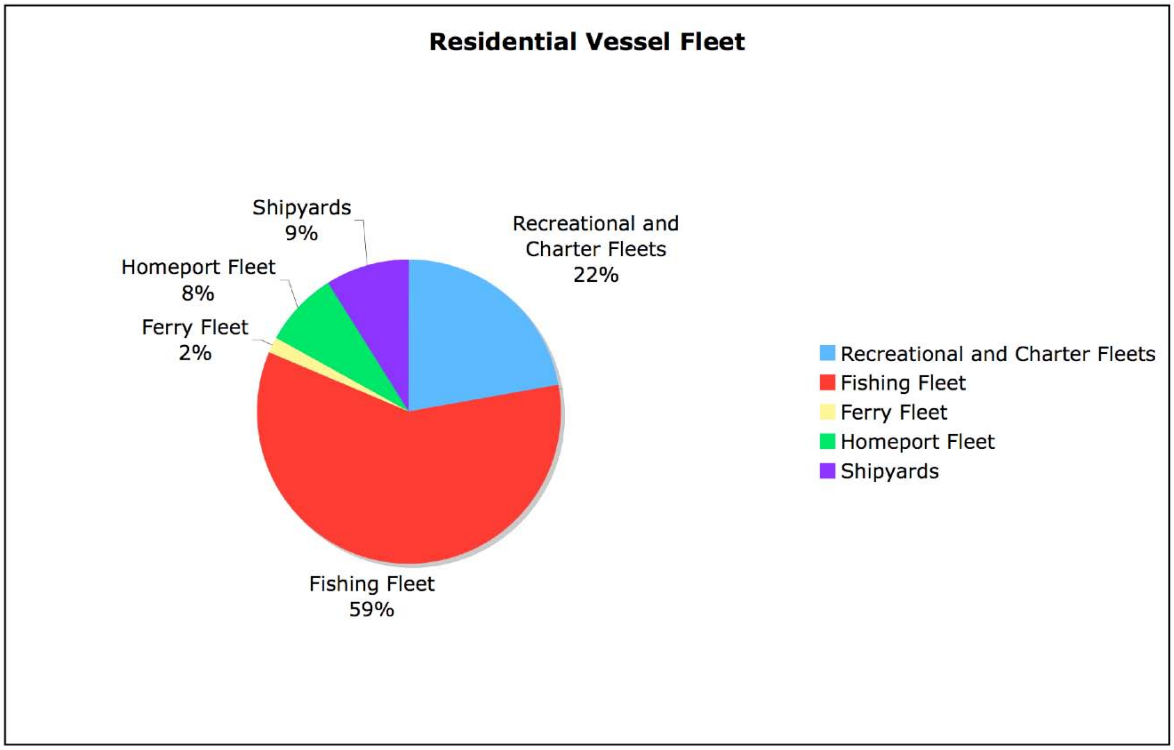


Figure 5.9 Contribution of Threat Factors to total Residential Vessel Fleet Threat



[24] All values in table should be multiplied by a factor of 1,000.

Figure 5.10 Comparison of Threat Factors by Region – Recreational and Charter Fleets

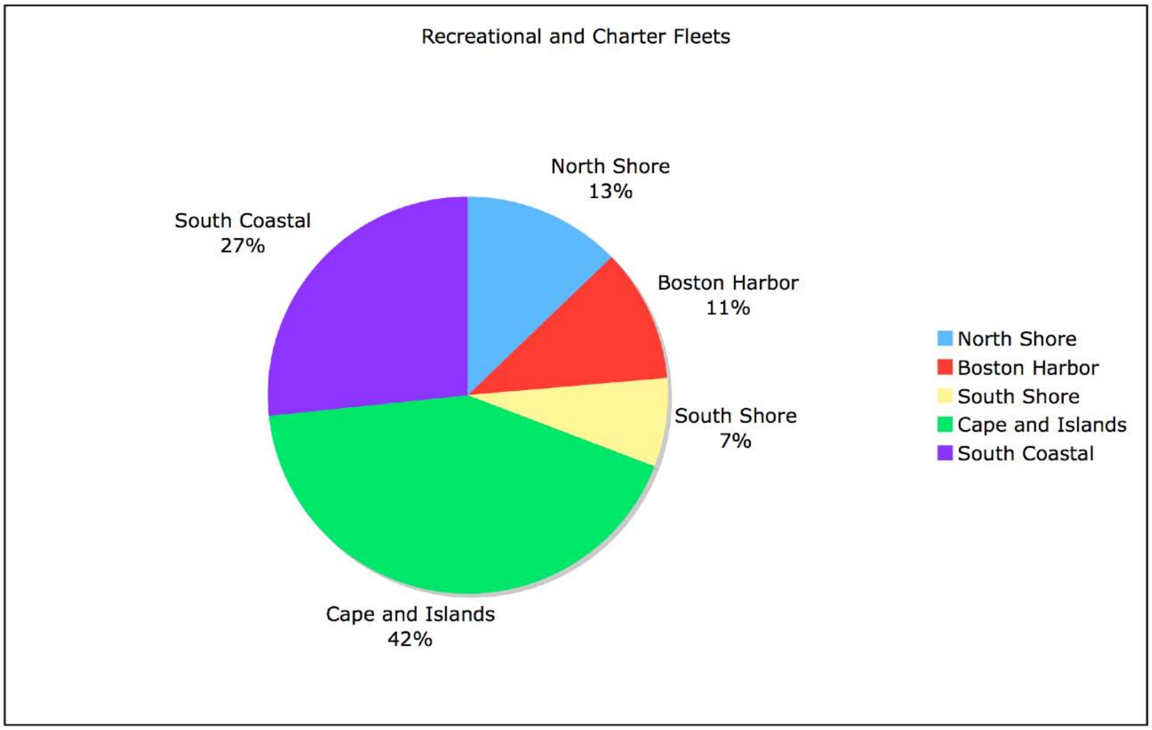


Figure 5.11 Comparison of Threat Factors by Region – Fishing Fleet

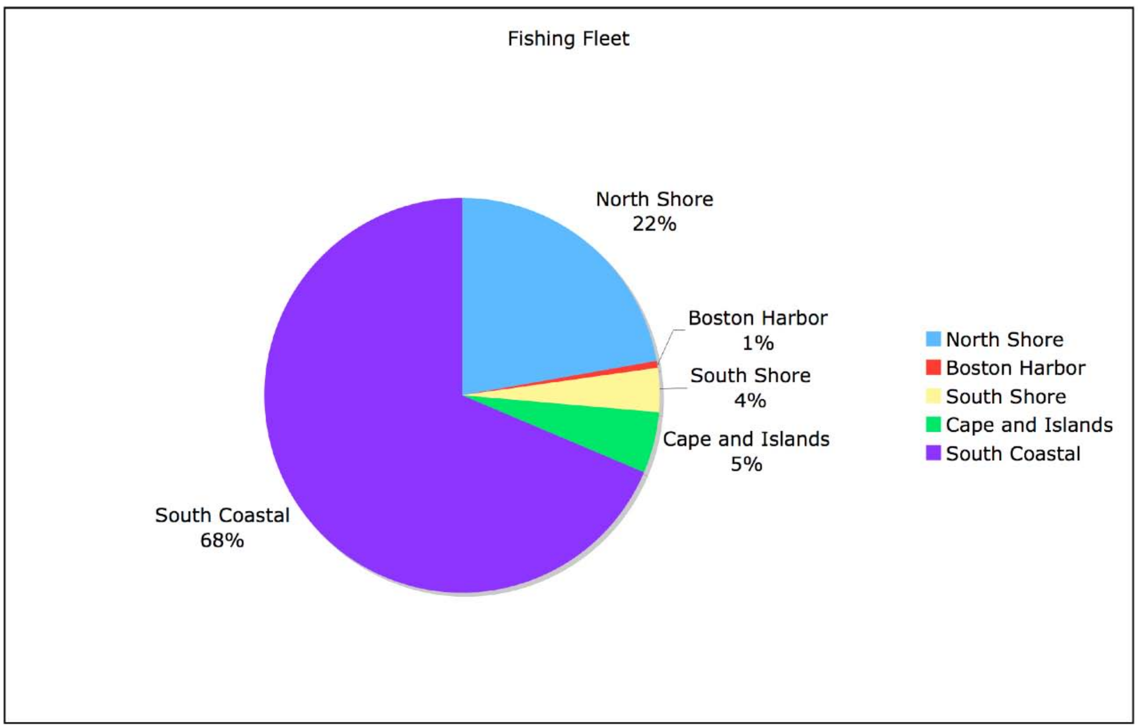


Figure 5.12 Comparison of Threat Factors by Region – Ferry Fleet

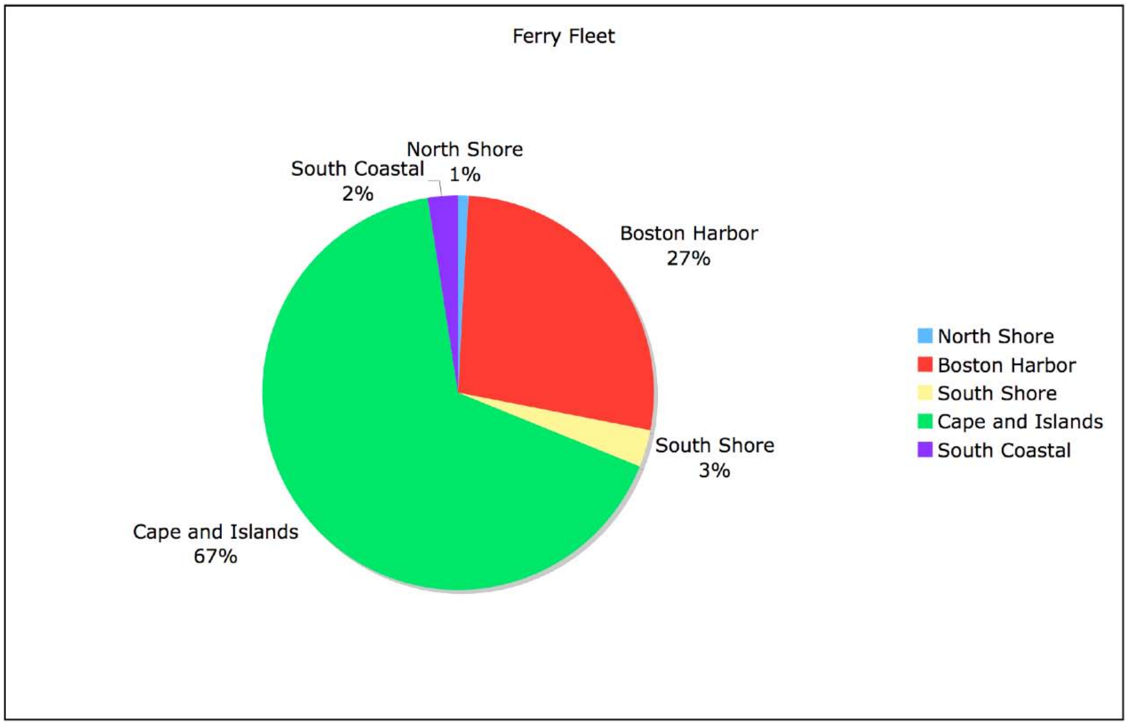


Figure 5.13 Comparison of Threat Factors by Region – Homeport Fleet

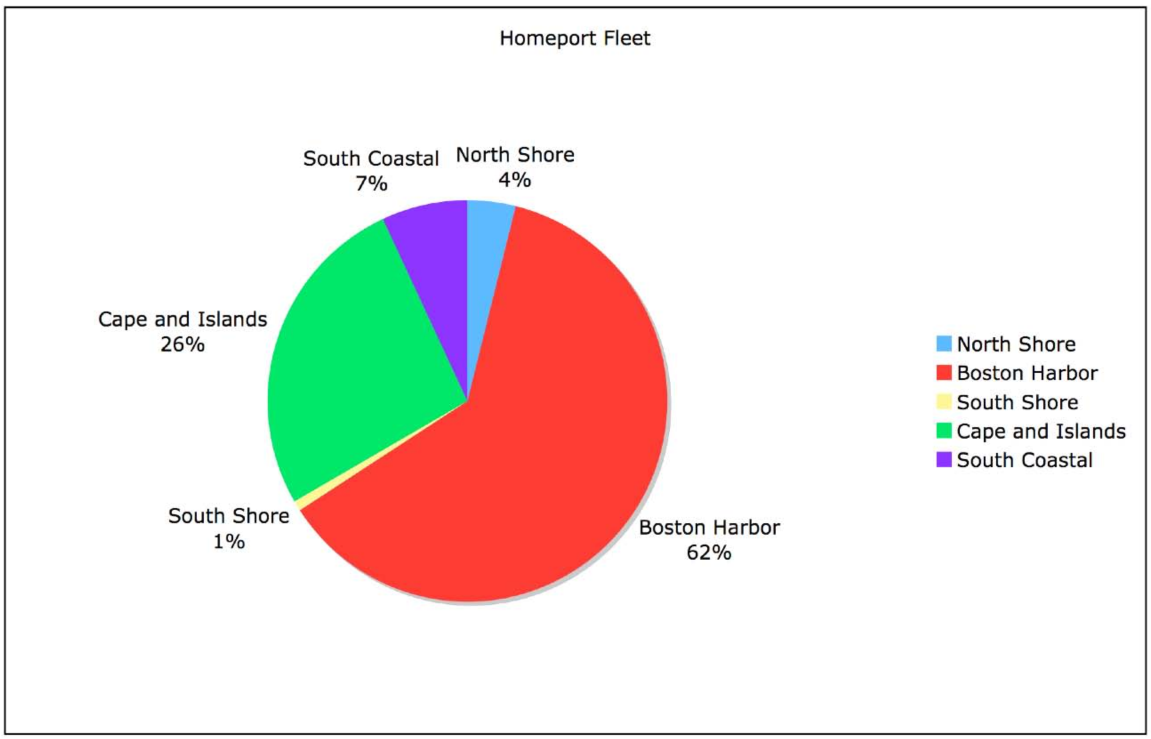
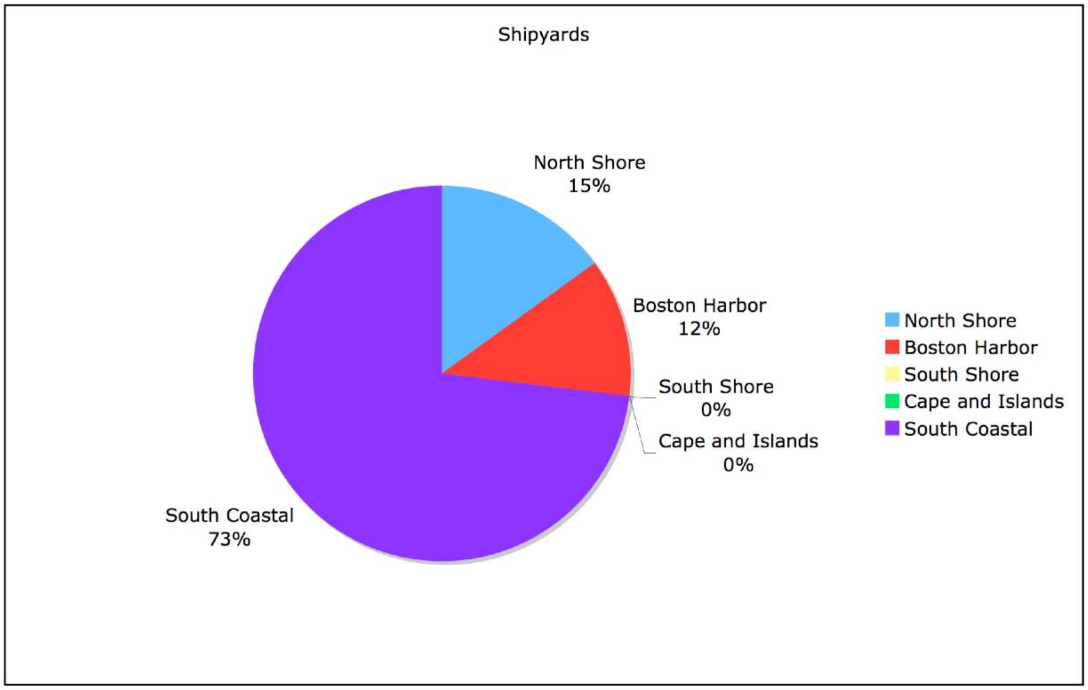


Figure 5.14 Comparison of Threat Factors by Region – Shipyards



5.1.3 Land-Based Petroleum Storage Threat Exposure

Figure 5.15 shows that the total threat exposure from land-based petroleum storage is highest in the Boston Harbor region, followed by the North Shore, South Coastal, and the Cape and Islands. The South Shore has virtually no exposure.

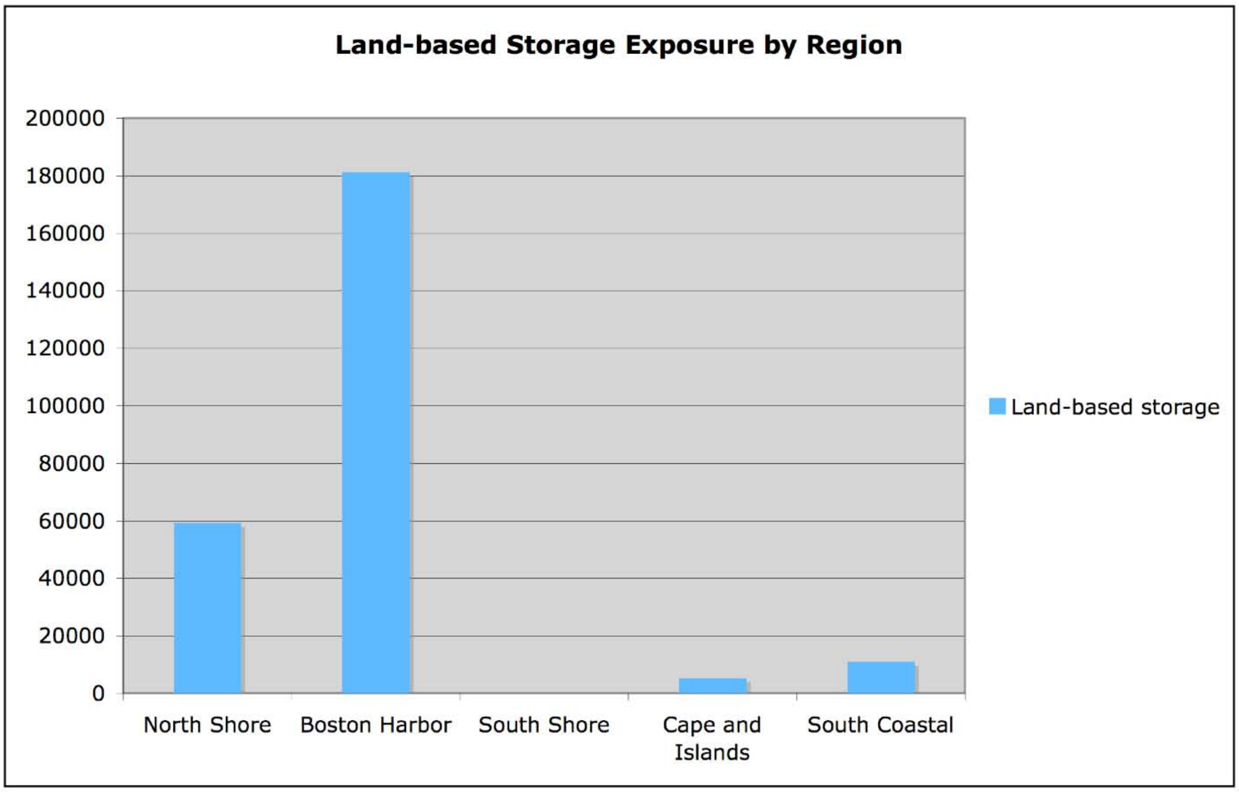
Figure 5.16 shows the proportionate contribution of the two threat factors that comprise the land-based storage estimate – EPA regulated and locally regulated tanks – to the overall threat for all regions. This chart shows that virtually all of the threat exposure from land-based storage is attributable to the volume of petroleum stored in regulated tank farms (those tank farms with over 42,000 gallons total storage capacity that are required to file oil spill response plans with the EPA). Locally (non-EPA) regulated tanks (smaller storage tanks at harbors and marinas, used primarily for vessel fueling) make up less than 1% of the total exposure. This is a reflection of the order of magnitude difference between the size and number of tanks at some of the larger tank farms and the relatively smaller size of locally regulated tanks.

Figure 5.17 and 5.18 show the proportionate contribution from each region to the total threat exposure for the two types of land-based storage threat factors. For regulated tank farms, which make up more than 99% of the total threat exposure from land-based storage, 71% of the exposure is located in Boston Harbor, with 23% in the North Shore. The South Coastal region has 4% of the total exposure to spill threats from regulated tank farms, and the Cape and Islands has 2%. The South Shore does not have any regulated tank farms and therefore contributes less than 1% to the total statewide exposure.

The allocation of threat exposure among regions for locally regulated tanks is much different than for EPA regulated tanks. More than half (54%) of the threat exposure is allocated to the Cape and Islands region. The South Coastal and North Shore regions have similar proportions of the total exposure (19% and 15% respectively). Boston Harbor is the second smallest contributor to statewide exposure from locally regulated tank vessels (7%) followed by the South Shore (5%).

The threat exposure for land-based storage varies by region. Overall, regulated tank farms account for nearly 100% of the total exposure level (measured in gallons of petroleum) to oil spill threats from oil storage tanks in Massachusetts coastal communities. This threat is concentrated in the Boston Harbor region, and to a lesser extent the North Shore. Locally regulated tanks contribute less than 1% of the total exposure from storage tanks. This much lower threat level is concentrated in the Cape and Islands region, where there are a large number of marinas.

Figure 5.15 Land-Based Storage Threat Exposure by Region (000) [25]



[25] All values in table should be multiplied by a factor of 1,000.

Figure 5.16 Contribution of Threat Factors to total Land-based Bulk Storage Threat

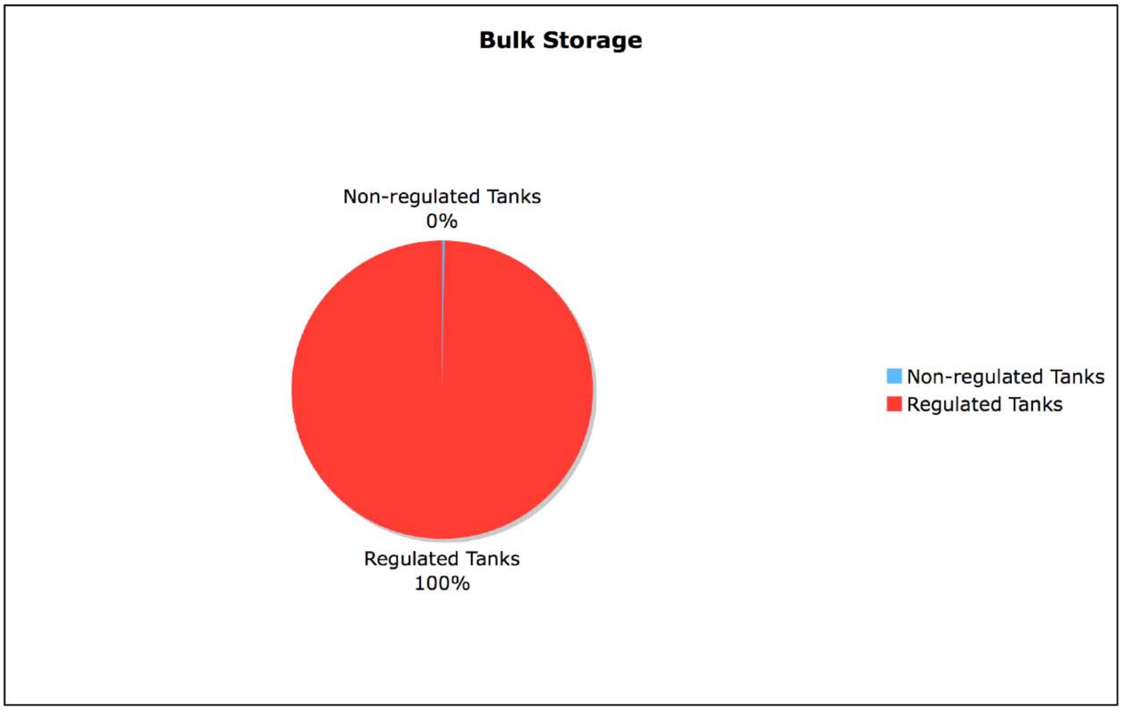


Figure 5.17 Comparison of Threat Factors by Region – Locally Regulated Tanks

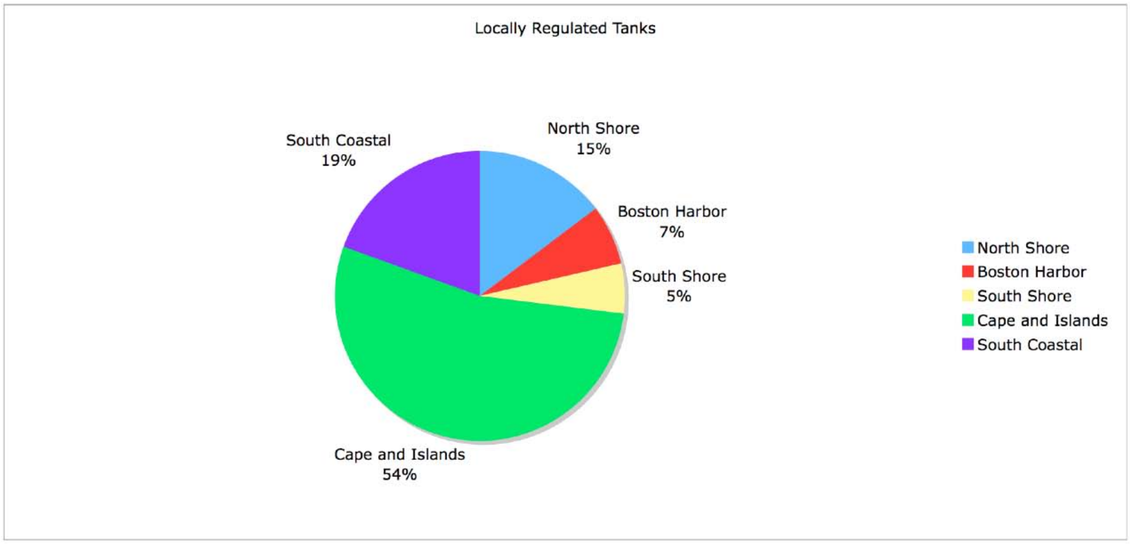
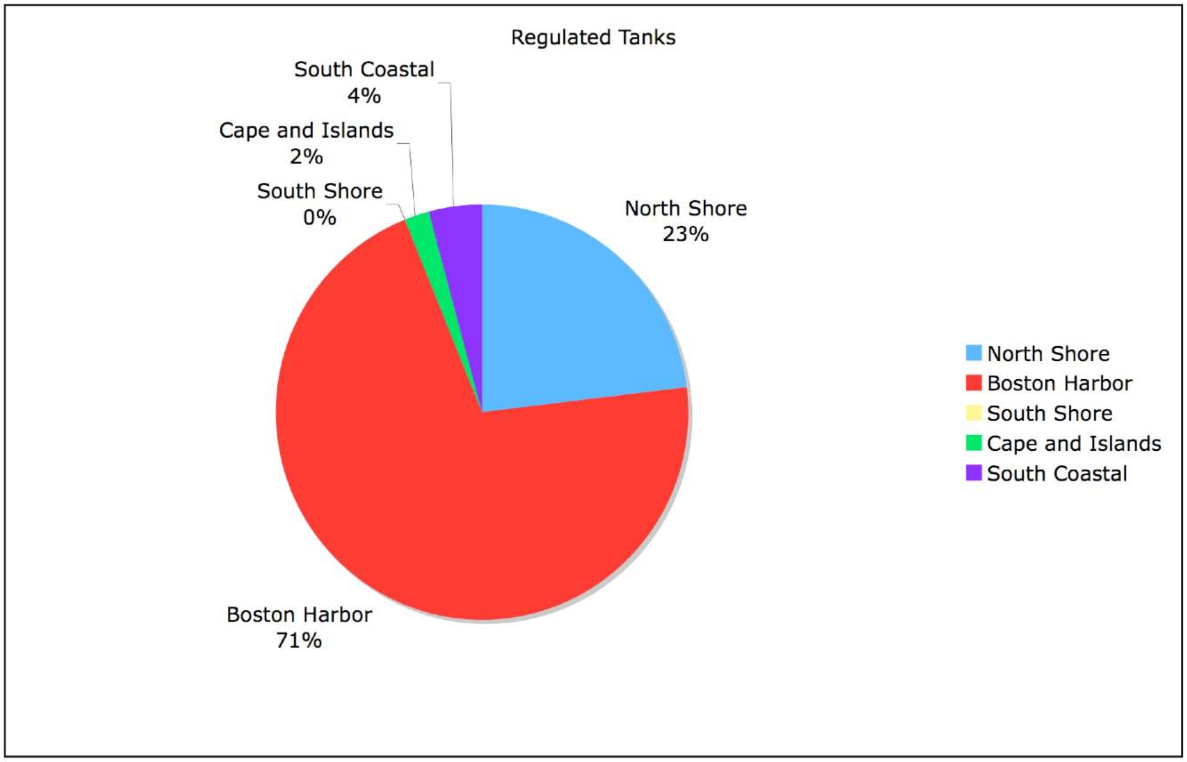


Figure 5.18 Comparison of Threat Factors by Region –EPA Regulated Tanks



5.2 Comparison of Oil Spill Threat Exposure by *Region*

Figure 5.19 shows the aggregated totals by region for estimated gallons of petroleum exposure from all threat factors. Table 5.1 summarizes the estimated gallons of petroleum exposure for of each of the ten threat factors by region. Boston Harbor has the highest threat level of any region, with an estimated 8.8 billion gallons of petroleum exposure. The next highest level is in the Cape and Islands, and just over 3 million estimated gallons of petroleum exposure – nearly one-third the level in Boston Harbor. The South Coastal, North Shore, and South Shore regions all have similar total threat levels – ranging from 1.4 to 1.7 billion gallons of estimated petroleum exposure – less than one-quarter of the level in Boston Harbor.

Figure 5.19 Regional Oil Spill Threat in Estimated Gallons of Petroleum Exposure (000)[26] for all Threat Factors Combined

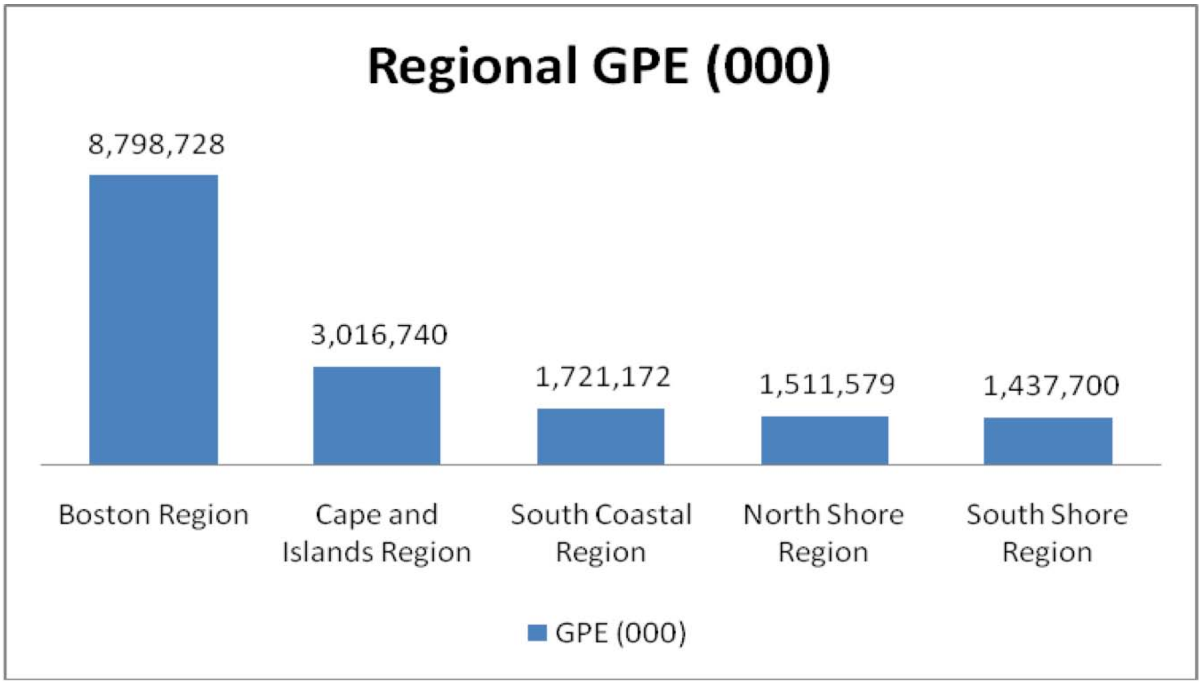


Table 5.1 Regional Summary of Oil Spill Threats in Estimated Gallons of Petroleum Exposure (000)[27]

	North Shore	Boston Harbor	South Shore	Cape and Islands	South Coastal	Total
Tanker Activity	11,000.0	4,280,500.0	1,000.0	8,750.0	82,500.0	4,372,750.0
NTV Activity	2,200.0	27,500.0	-	1,600.0	8,925.0	38,025.0
Transit Volume	1,436,000.0	4,308,000.0	1,436,000.0	2,998,611.0	1,609,061.0	10,351,672.0
Recreational and Charter Fleets	471.2	400.0	263.3	1,558.9	983.8	3,206.0
Fishing Fleet	2,440.5	75.0	395.6	546.8	7,525.5	8,542.8
Ferry Fleet	2.0	62.8	7.0	154.5	5.5	229.8
Homeport Fleet	48.0	750.0	10.2	320.2	85.1	1,165.5
Shipyards	225.0	180.0	-	-	1,100.0	1,280.0
Locally regulated Tanks	66.2	30.0	24.0	240.5	86.5	381.0
Regulated Tanks	59,126.0	181,230.0	-	4,958.0	10,900.0	197,088.0
Total by Region	1,511,578.9	8,798,727.8	1,437,700.1	3,016,739.8	1,721,172.4	

[26] All values in table should be multiplied by a factor of 1,000.
[27] All values in table should be multiplied by a factor of 1,000.

5.2.1 North Shore Region

The North Shore Region has an estimated threat level of approximately 1.5 billion GPE. Figure 5.20 shows the comparative threat levels for all threat factors within the North Shore region. The largest threat within the region is from vessel transit activity, which is attributed primarily to the volume of oil transiting into and out of Boston Harbor as it passes through the region.

As Figure 5.21 shows, the comparative threat from vessel transit activity accounts for 99% of the total threat from vessel movements. While tank vessel activity represents only 1% of the total vessel movement threat, it is actually the third largest threat exposure for the North Shore region.

The second highest threat level is from EPA regulated tank farms, most of which are located in Revere. Regulated tank farms make up nearly 100%[28] of the threat for spills from land-based storage in the North Shore region.

Approximately 76% of the threat exposure for the resident vessel fleet comes from fishing vessels. This is primarily attributable to the large fishing vessel fleet in Gloucester.

Within the North Shore region, Pines River and Lynn Harbor are the two harbors with the highest exposure to the high magnitude threat factors discussed in Section 4.3 (tanker activity, NTV activity, transit activity and regulated tanks). Gloucester has by far the highest level of exposure to low magnitude threats (resident vessel fleet and locally regulated tanks), and has the second highest level of exposure statewide in all regions. Other North Shore harbors with high levels of exposure to oil spill threats from resident vessels and locally (non-EPA) regulated tanks are Salem, Marblehead, Beverly, and Rockport.

Not included in these estimates are current and planned shipments of liquefied natural gas (LNG) to the two new offshore LNG terminals located 10 miles and 13 miles southeast of Gloucester. The first terminal, built and operated by Gateway/Excelerate Energy experienced its first delivery of LNG in May of 2008 and is now operating at less than full capacity.[29] The second terminal, built and operated by Neptune/Suez LNG is scheduled to come on line in September of 2009.[30] The Gateway/Excelerate Energy terminal can discharge one ship at a time while a second ship is moored in standby. The Neptune/Suez project will be able to discharge two ships at the same time. According to a Neptune/Suez project update press release, ships will discharge in four to eight days with some overlap between the two discharge ports. Given this information, an estimate of one ship arriving each 5 days would lead to 73 ships per year under full operation for Neptune/Suez and 35 – 40 ships per year for Gateway/Excelerate Energy.

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[28] As Table 5.1 shows there is a small amount of GPE from non-regulated tank farms in the North Shore region, but it accounts for less than 1% of the total GPE from land-based storage.

[29] Greg Farmer, Boston Harbor Pilots, personal conversation, March 27, 2009

[30] Neptune-Suez, Project Update, March 2009, website, http://www.neptunelngconstruction.com/

The impact on the North Shore threat estimate will be an increase in the Vessel Transit estimate by 10.0 million GPE per year if both terminals operate at full capacity. A small increase to the resident fleet GPE for Boston Harbor will also occur due to the 2 – 4 support vessels that will berth in the port.

5.2.2 Boston Harbor Region

The aggregated estimates of total threat level shown in Figure 5.1 emphasizes the level of threat in Boston Harbor, which has the largest total threat amount for any regional area at approximately 8.8 billion GPE. As shown in Figure 5.22, Boston Harbor's high threat level can be attributed to the fact that the region has the highest total threat level for four factors - tank vessel activity, nontank vessel activity, vessel transits, and bulk petroleum storage.

Boston Harbor has the largest amount of tank vessel deliveries at an estimated 4.3 billion GPE within the municipalities of Boston, Chelsea, Everett, Quincy, Braintree, and Weymouth, accounting for the top six municipalities in the state. Figure 5.23 shows that tank vessel activities account for 50% of the threat from vessel movement, with the other 50% attributable to vessel transit activity. Although nontank vessel activity is the fourth largest component of overall spill threat within the Boston Harbor region and is the highest overall compared to the other four regions in the state, it accounts for less than 1% of the overall oil spill threat exposure for vessel movement activities within Boston Harbor.

As discussed in Section 5.1.1, there is a 100% overlap between the tank vessel and NTV activity and the vessel transit activity. This overlap was discounted at the harbor and municipal levels, but was not removed from the regional aggregation of data. This means that the GPE for vessel movement activity is double counting the traffic in Boston Harbor because the same vessels calling on those ports are also transiting offshore. To avoid counting the same vessels twice, the GPE estimate for vessel transit volume could be cut in half for Boston Harbor, which would reduce the total GPE to approximately 4.4 billion. This would still represent the highest overall threat for any region, due largely to tank vessel traffic.

The homeport fleet comprises just over half of the total petroleum exposure from resident vessels in Boston Harbor. Despite the fact that Boston Harbor has the highest homeport volume of any region in the state, the relative contribution of resident vessel exposure to total GPE in the Boston Harbor region is minimal.

The Boston Harbor region also has the highest amount of petroleum storage at 181 million GPE. This threat is derived from the large number and size of regulated tank farms within the region.

Within the Boston Harbor region, Boston, Fore River, and Town River Bay are the three harbors with the highest exposure to the high magnitude threat factors discussed in Section 4.3 (tanker activity, NTV activity, transit activity and regulated tanks). They also have the three highest exposure levels statewide, due to tanker activity in Boston and vessel transits in Fore and Town Rivers. All can be attributed to tanker traffic in and out of the Port of Boston. Boston also has the highest level of exposure within the region to low magnitude threats (resident vessel fleet and locally regulated tanks), and has the third highest level of exposure statewide in all regions. No other harbors within the Boston Harbor region are exposed to high levels oil spill threats from resident vessels and locally regulated tanks. Again, this fact emphasizes the relative contribution of tanker activity and transits to overall threats in the Boston Harbor region.

5.1.3 South Shore Region

The South Shore Region has an estimated threat level of approximately 1.5 billion GPE. Figures 5.24 and 5.25 show the comparative threat levels for all threat factors within the South Shore region. The largest threat within the region is from vessel transit activity, which is attributed primarily to the volume of oil transiting into and out of Boston Harbor as it passes through the region. The threat from vessel transit activity accounts for 100% of the total threat from vessel movements.

All other threats combined make up less than 1% of the total exposure in the South Shore when compared to vessel transits. The threat factors that contribute most to this much smaller exposure are recreational and charter fleets, fishing fleets, and locally regulated tank farms.

None of the harbors in the South Shore region have a high level of exposure to the high magnitude threat factors discussed in Section 4.3 (tanker activity, NTV activity, transit activity and regulated tanks). Plymouth has the highest level of exposure to low magnitude threats (resident vessel fleet and locally regulated tanks), and has the sixth highest level of exposure statewide in all regions. Other South Shore harbors with high levels of exposure to oil spill threats from resident vessels and locally regulated tanks are Green Harbor and Scituate Harbor.

5.1.4 Cape and Islands Region

The Cape and Islands Region has the second largest total threat quantity of the five regions with a total GPE of 3.02 billion (Figure 5.26). Figures 5.26 and 5.27 show the comparative threat levels for all threat factors within the region. The largest component of the total quantity is from the transit volumes through the Cape Cod Canal and around the outside of Cape Cod at 3.00 billion gallons, presenting the threat of an oil spill to the towns of Bourne, Falmouth, Sandwich, Provincetown, Truro, Eastham, and Wellfleet. The Cape and Islands Region also has the highest recreational and charter fishing fleet largely due to the size of the Nantucket fleet.

Ferry traffic for the Cape and Islands is the highest of the five regions due to the ferry routes between Cape Cod, Martha's Vineyard, and Nantucket. Lastly, Cape Cod has the fourth highest regulated tank farm quantity due to the tank farms located in Tisbury.

Within the Cape and Islands region, Sandwich Boat Basin and Great Harbor (Woods Hole) are the two harbors with the highest exposure to the high magnitude threat factors discussed in Section 4.3 (tanker activity, NTV activity, transit activity and regulated tanks). Nantucket Harbor has the highest level of exposure to low magnitude threats (resident vessel fleet and locally regulated tanks), and has the fourth highest level of exposure statewide in all regions. Of all regions, the Cape and Islands region by far has the largest number of harbors with high levels of exposure to oil spill threats from resident vessels and locally regulated tanks. In decreasing order of magnitude, these harbors are Hyannis, Vineyard Haven (Tisbury), Great Harbor (Woods Hole), Provincetown, Wellfleet, Edgartown, West Bay, Buttermilk Bay, and Falmouth Harbor.

5.1.5 South Coastal Region

The South Coastal Region has the third highest total threat factor at 1.7 billion GPE. Figure 5.28 shows that vessel transit volume comprises most of this threat, which can be attributed to the volume of oil transiting Buzzards Bay and the Cape Cod Canal. The South Coastal Region also has the second highest threat level of tank vessel deliveries at 82.5 million GPE due to the shipping volume into New Bedford/Fairhaven and Fall River/Somerset. As discussed in Section 4, there is approximately a 5% overlap between the tank vessel and NTV activity and the vessel transit activity in Mt. Hope Bay. This overlap was discounted at the harbor and municipal levels, but was not removed from the regional aggregation of data. This means that the GPE for vessel movement activity is double counting the traffic in Mt. Hope Bay because the same vessels calling on those ports are also transiting the region. Even if the transit volume GPE estimate were reduced to reflect this 5% overlap, transit volume would still present the largest threat factor to this region due to the Buzzards Bay/Cape Cod Canal traffic.

The South Coastal region has the highest level of resident fishing fleet threat quantities of all regions, at 7.5 million GPE. New Bedford Harbor has more than three times the number of fishing vessels as the next highest port. Many of these are large offshore trawlers and scallopers. Three of five working shipyards in Massachusetts are also located in the South Coastal Region. Despite the fact that the resident vessel fleet threat level in South Coastal is high compared to other regions, the total quantity of exposure still accounts for less than 1% of the oil spill threat in the South Coastal region, because the comparative volume of oil in tank vessel deliveries and vessel transits is so high.

Land-based storage of petroleum products in regulated tanks is the second highest overall threat in the South Coastal region, after vessel transits, at approximately 59 million GPE. This amount makes up approximately 4% of the total threat exposure in the South Coastal region (Figure 5.29).

Within the South Coastal region, New Bedford Harbor has the highest overall exposure to the high magnitude threat factors discussed in Section 4.3 (tanker activity, NTV activity, transit activity and regulated tanks). New Bedford also has by far the highest level of exposure to low magnitude threats (resident vessel fleet and locally regulated tanks) both in the South Coastal region and statewide. Other South Coastal harbors with high levels of exposure to oil spill threats from resident vessels and locally (non-EPA) regulated tanks are Sippican, Apponagansett Bay, Westport River, and Onset Harbor.

Figure 5.20 Comparative Oil Spill Threat Levels within North Shore Region in Estimated Gallons of Petroleum Exposure (000)[31]

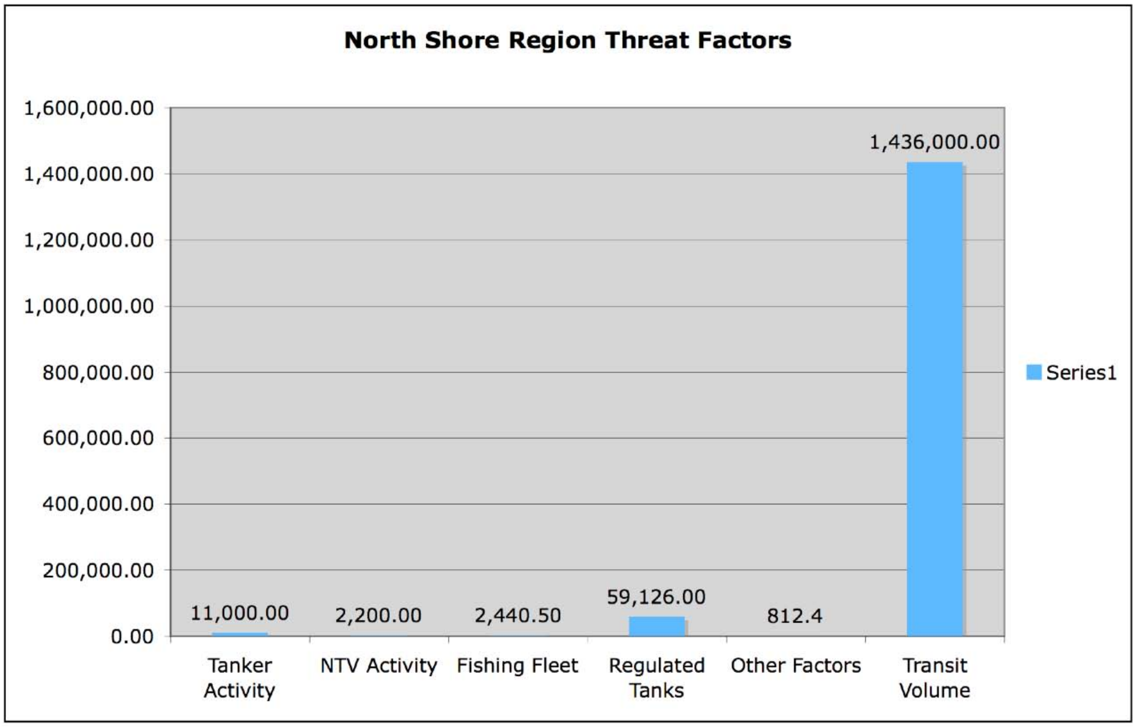
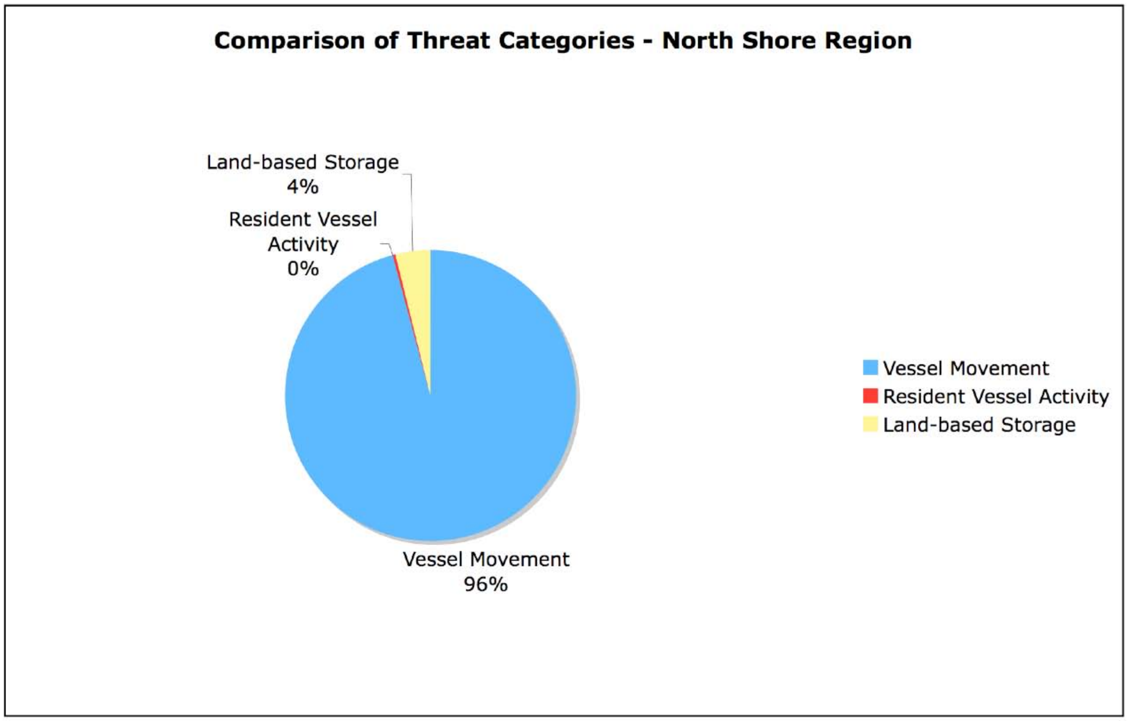


Figure 5.21 Comparative Oil Spill Threat Levels within North Shore Region by Threat Category



[31] All values in table should be multiplied by a factor of 1,000.

Figure 5.22 Comparative Oil Spill Threat Levels within Boston Harbor Region in Estimated Gallons of Petroleum Exposure (000)[32]

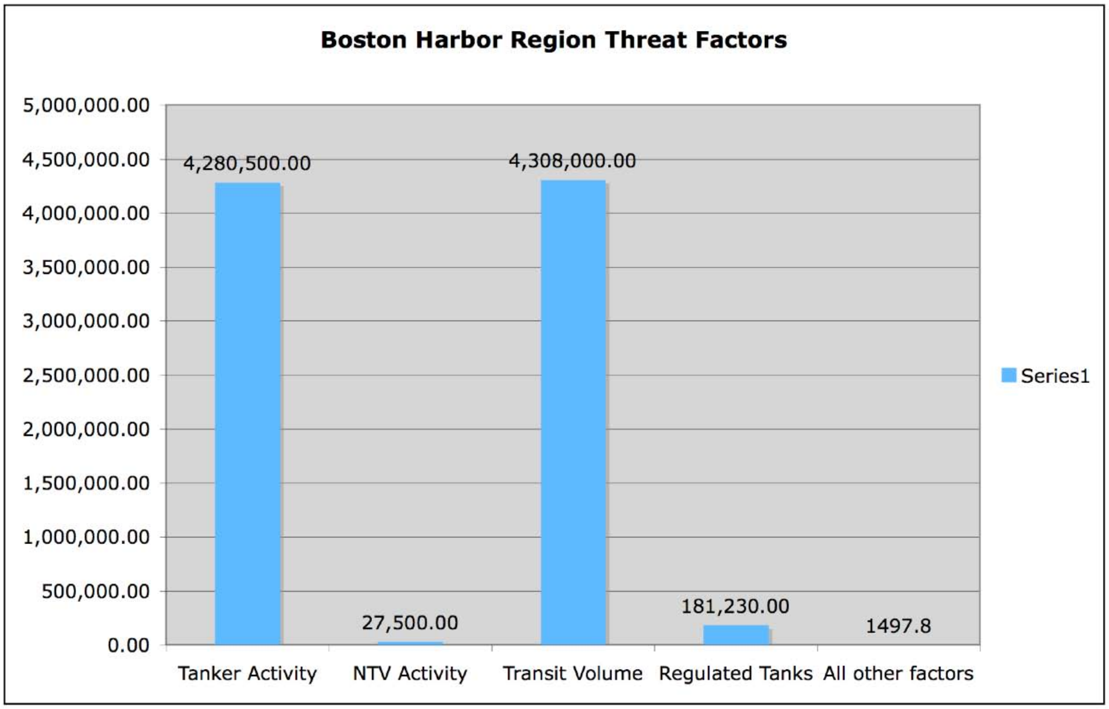
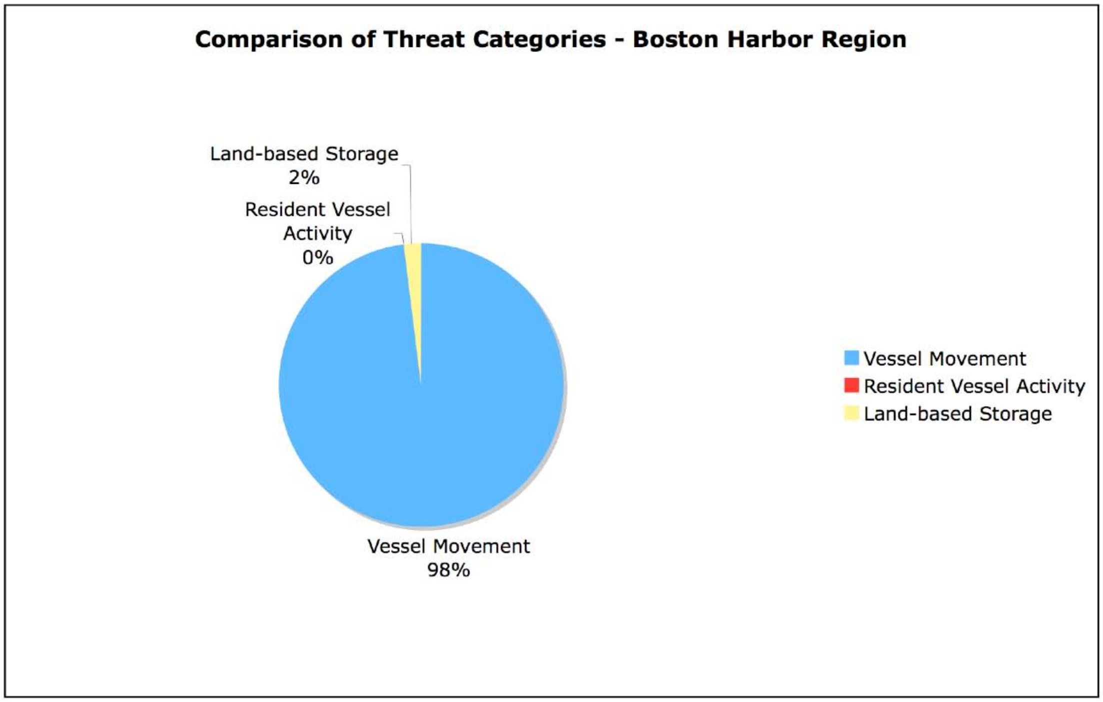


Figure 5.23 Comparative Oil Spill Threat Levels within Boston Harbor Region by Threat Category



[32] All values in table should be multiplied by a factor of 1,000.

Figure 5.24 Comparative Oil Spill Threat Levels within South Shore Region in Estimated Gallons of Petroleum Exposure (000)[33]

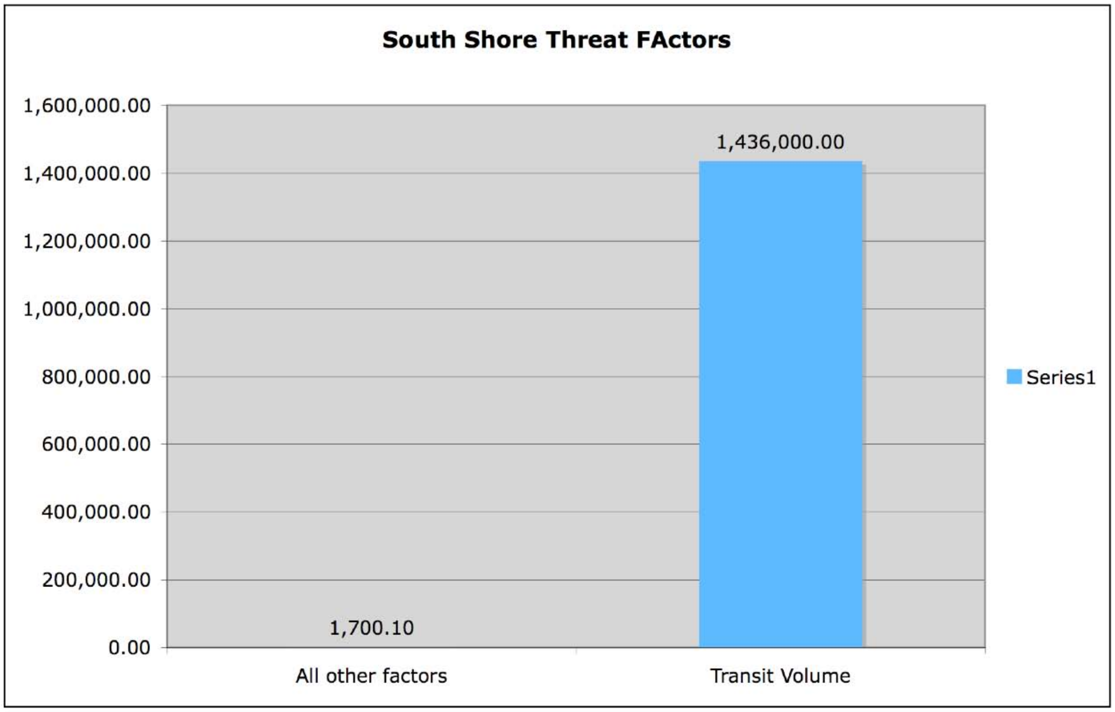
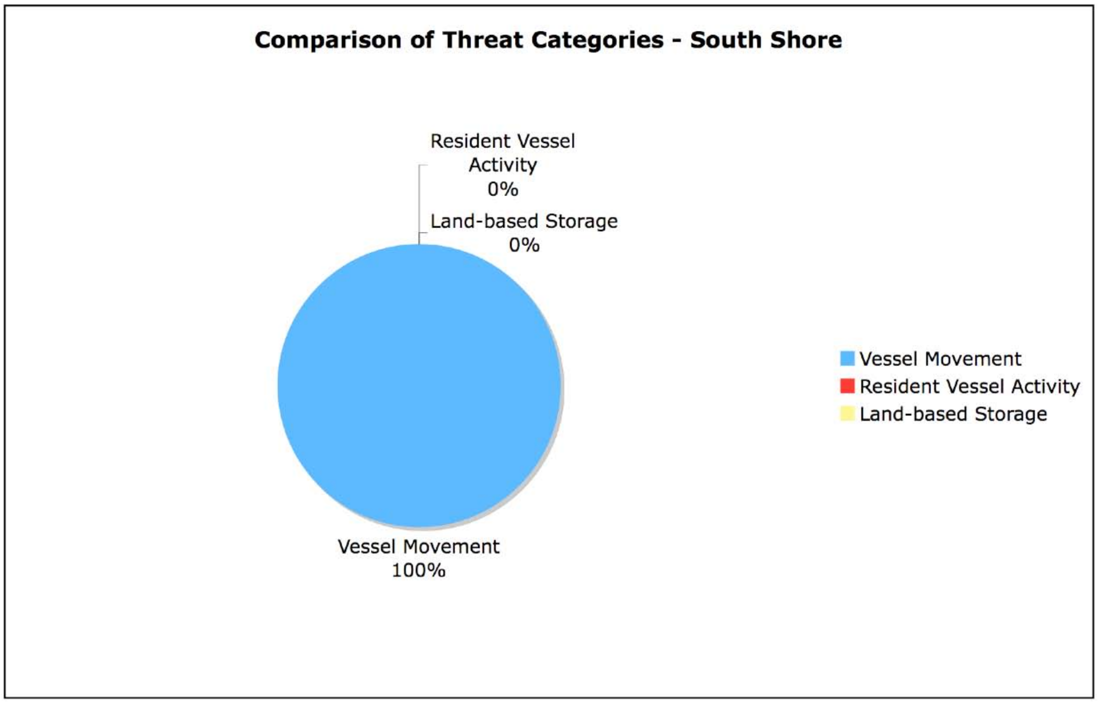


Figure 5.25 Comparative Oil Spill Threat Levels within South Shore Region by Threat Category



[33] All values in table should be multiplied by a factor of 1,000.

Figure 5.26 Comparative Oil Spill Threat Levels within Cape and Islands Region in Estimated Gallons of Petroleum Exposure (000)[34]

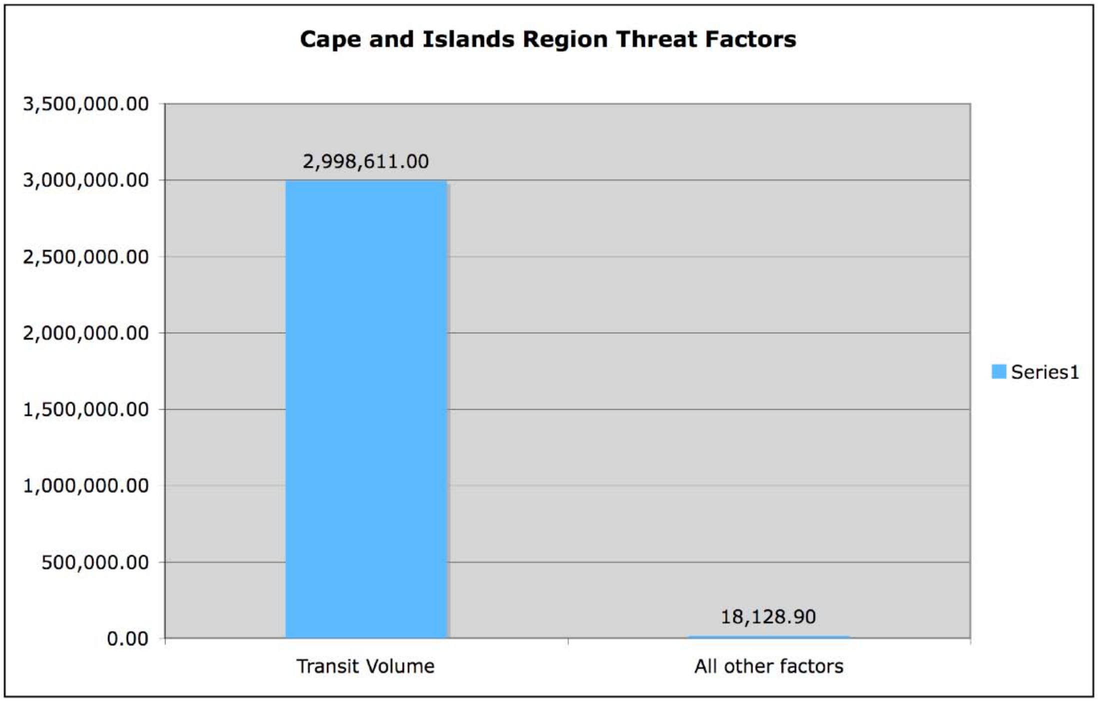
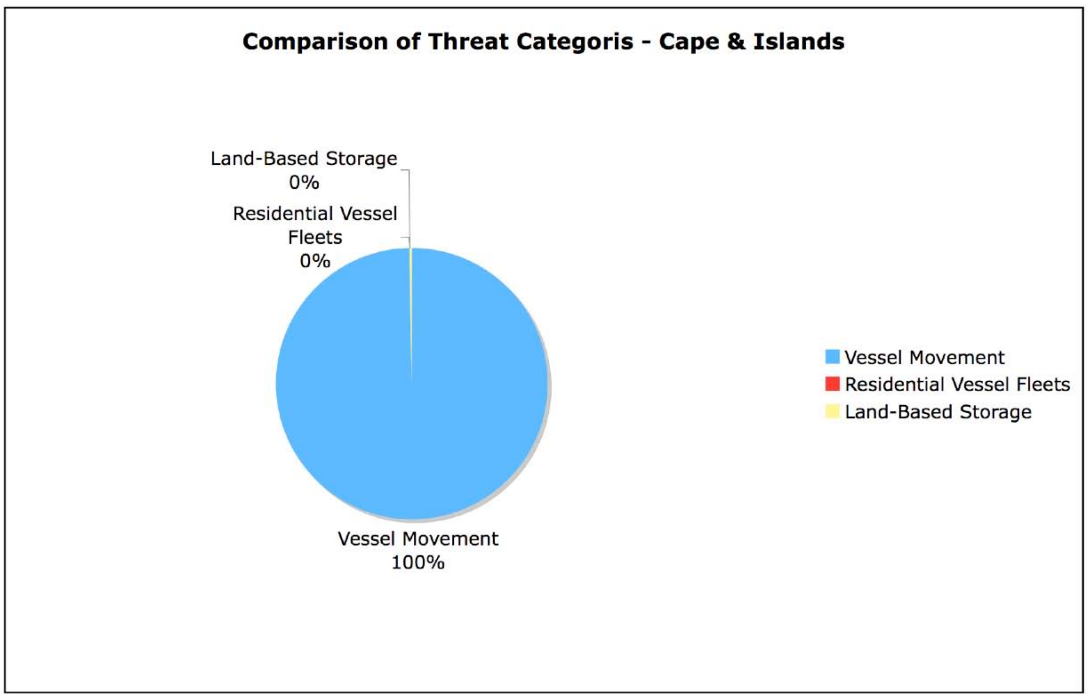


Figure 5.27 Comparative Oil Spill Threat Levels within Cape and Islands Region by Threat Category



[34] All values in table should be multiplied by a factor of 1,000.

Figure 5.28 Comparative Oil Spill Threat Levels within South Coastal Region in Estimated Gallons of Petroleum Exposure (000)[35]

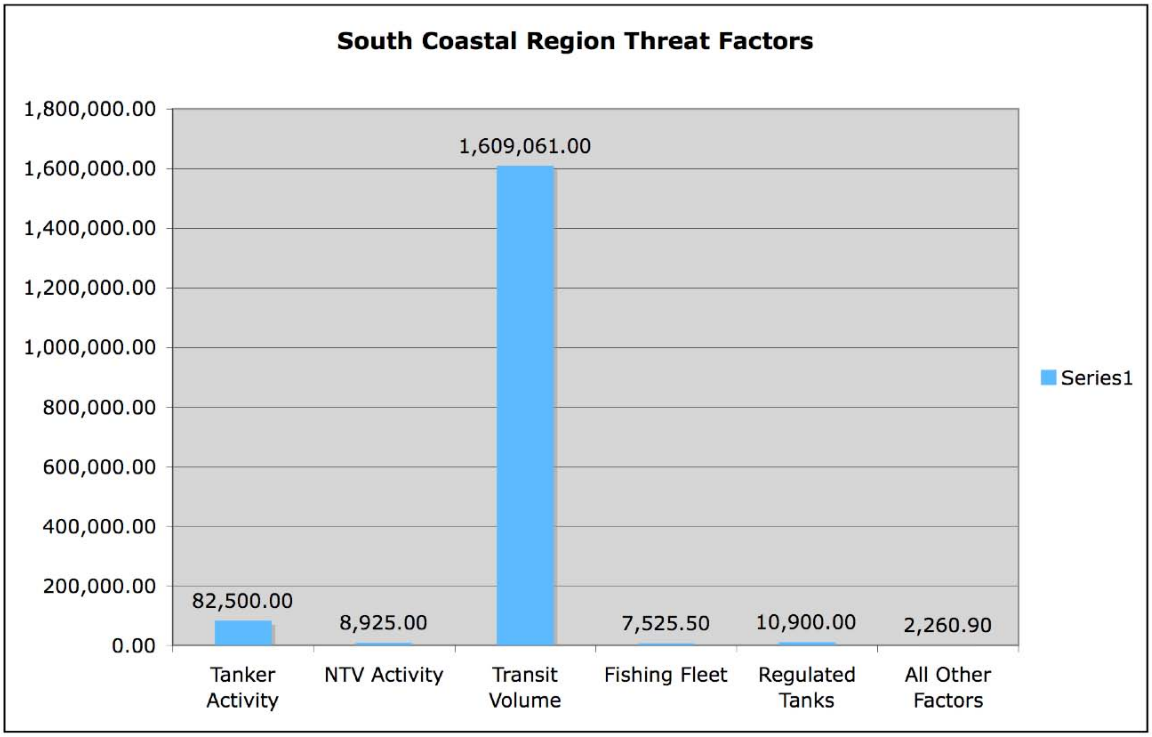
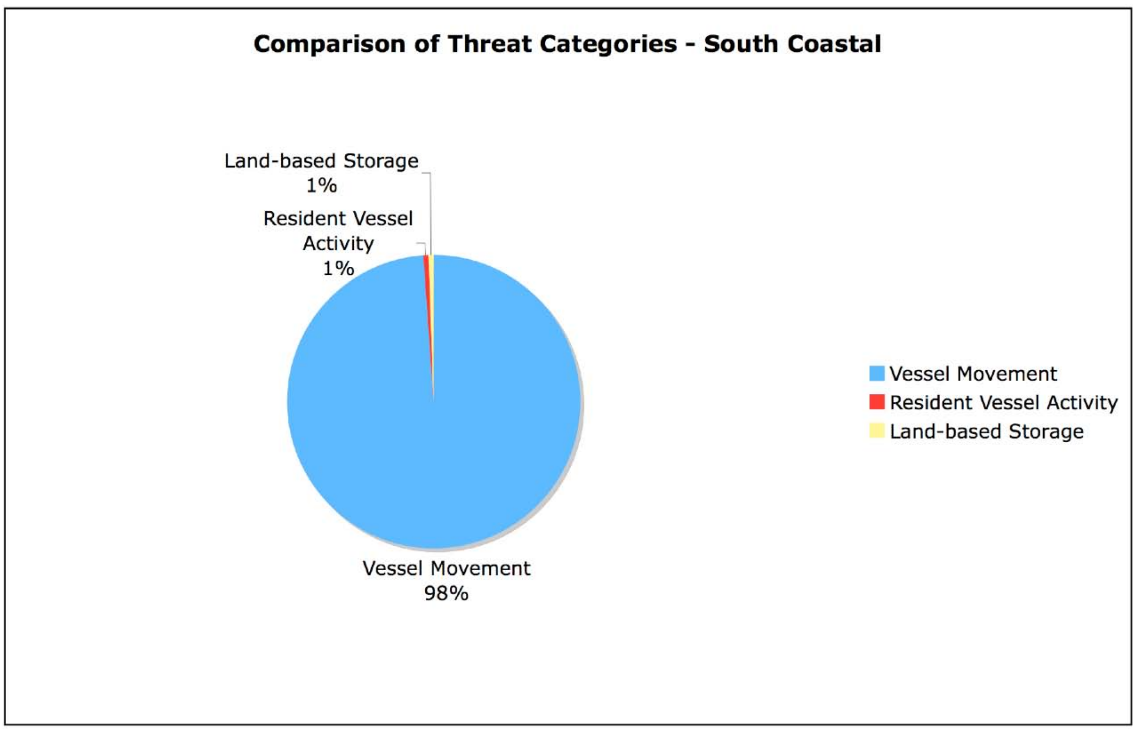


Figure 5.29 Comparative Oil Spill Threat Levels within South Coastal Region by Threat Category



[35] All values in table should be multiplied by a factor of 1,000.

5.3 Summary of Regional Oil Spill Threats by Region

The aggregated data for oil spill threat factors by region provides some insight into how oil spill threats compare across region both overall and by threat factor, and also provide some relative measure of the magnitude of various threats within each region. Figure 5.30 compares the GPE for all threat factors for all five regions. This graph shows that The Boston Harbor region has the two highest GPE levels, for tanker activity and transit volume. Because of the overlap between these two measures at the regional level, this threat can be considered as a single exposure. Still, it shows that tank vessel movements in and out of the Boston Harbor region present the single largest quantity of exposure for any activity in any region of the state. Moreover, vessel transit activity represents the single highest exposure level for the other four regions as well, with the second highest regional level in the Cape and Islands.

The total exposure to petroleum from vessel transits and tanker activity is so much higher than all other threat factors that it is difficult to see much beyond that threat in Figure 5.30. To look further, Figure 5.31 displays the same data with the exception of the tanker and vessel transit estimates. This shows clearly that regulated tanks comprise the second largest regional exposure, with the highest level in the Boston Harbor region, followed by the North Shore.

The third largest threat factor in terms of regional threat is from nontank vessels, with the highest regional exposure again in the Boston Harbor region, followed by the South Coastal, North Shore, and Cape and Islands (see Figure 5.32). After nontank vessel activity, fishing fleets account for the fourth highest exposure threat, particularly in the South Coastal Region and the North Shore (see Figure 5.33). After fishing vessels, recreational and charter vessels seem to pose the fifth largest overall exposure level, most prominently in the Cape and Islands and South Coastal Regions.

Since the Boston Harbor region accounts for the highest threat level of all regions for the four largest threat factors, Boston Harbor data is excluded from Figure 5.34, as is data for the top four threat factors. This shows the relative threat of the remaining six low magnitude threat factors for the other four regions of the state on a more meaningful scale, and shows that the South Coastal region has the highest exposure to these "lower magnitude" threats, followed by the North Shore.

Figure 5.30 Comparison of Estimated Gallons of Petroleum Exposure (000)[36] for all Threat Factors Across Regions

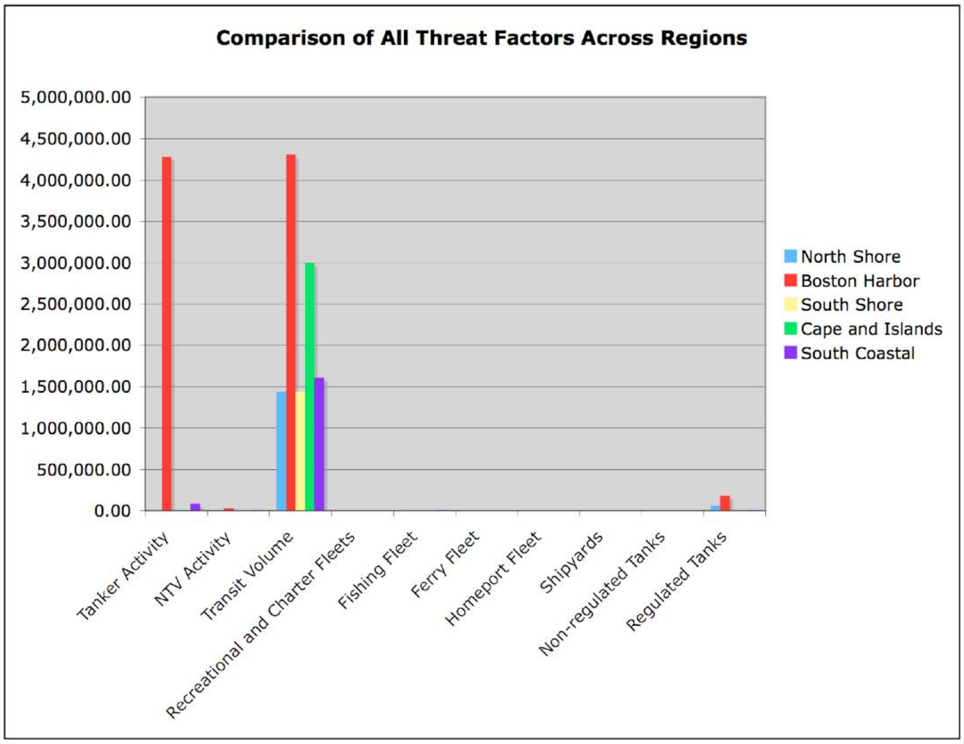
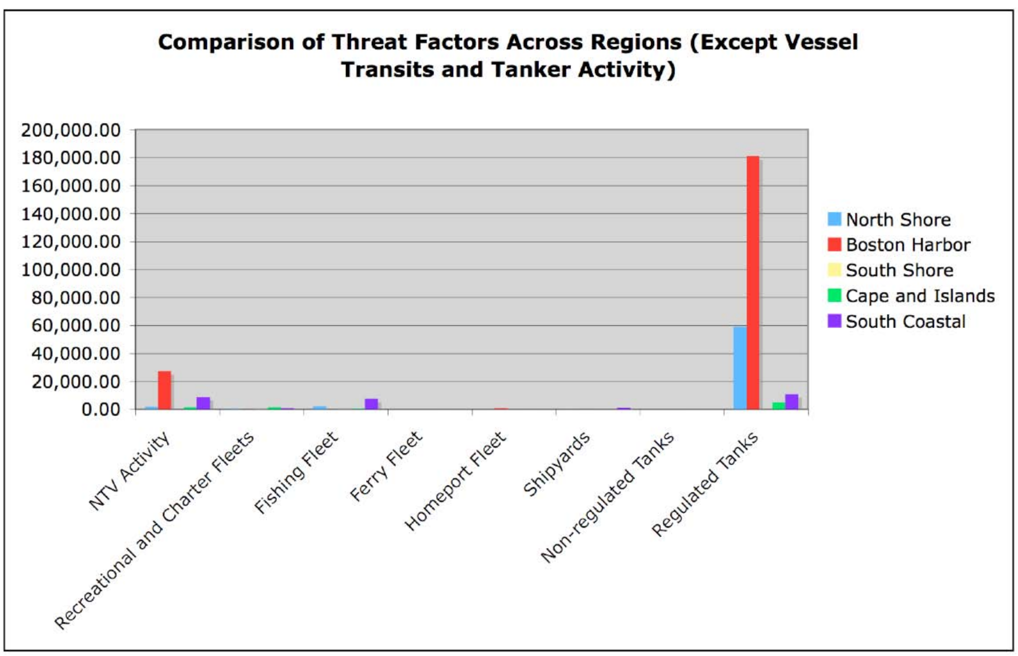


Figure 5.31 Comparison of Estimated Gallons of Petroleum Exposure (000)[37] for all Threat Factors Across Regions, Excluding Transit Volume and Tanker Activity



[36] All values in table should be multiplied by a factor of 1,000.
[37] All values in table should be multiplied by a factor of 1,000.

Figure 5.32 Comparison of Estimated Gallons of Petroleum Exposure (000)[38] for all Threat Factors Across Regions, Excluding Transit Volume, Tanker Activity, and Regulated Tanks

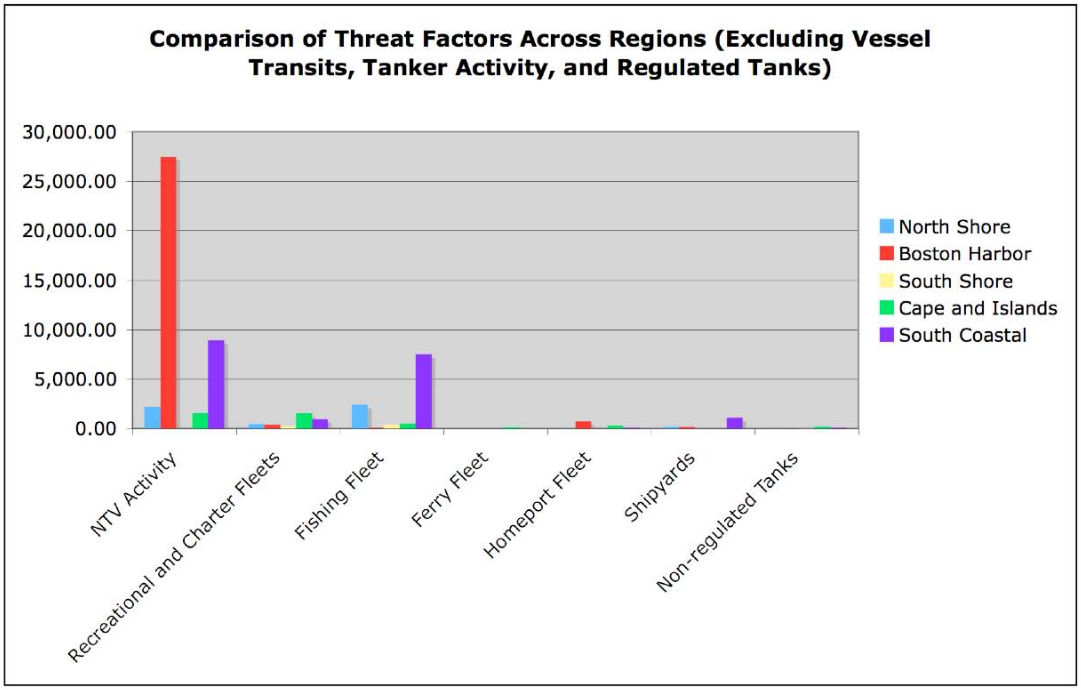
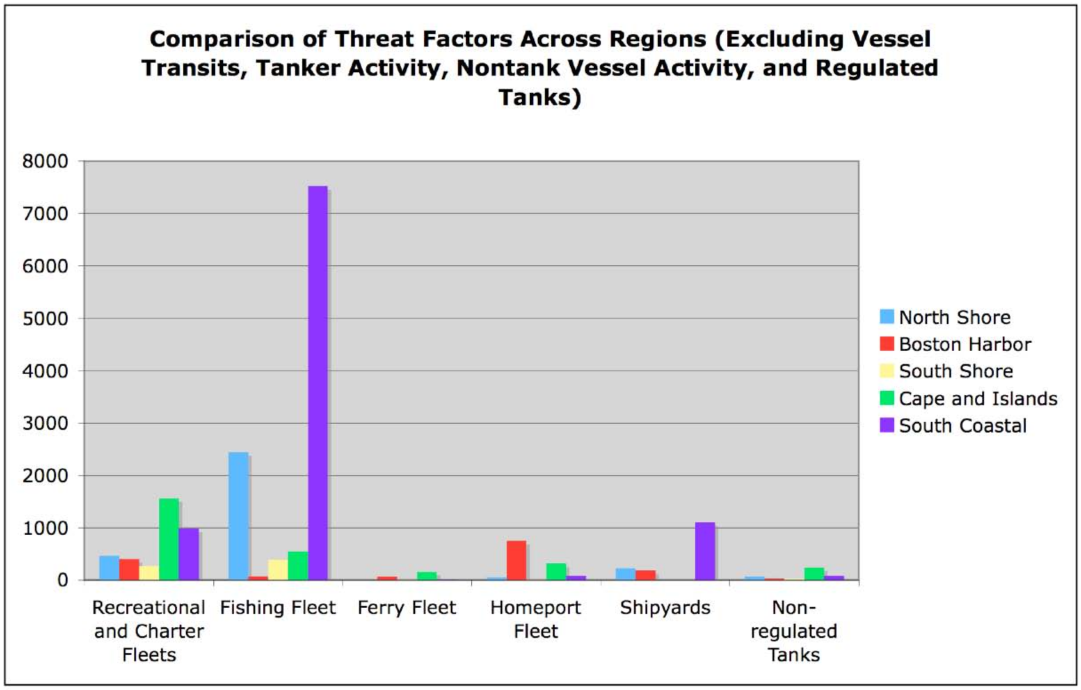
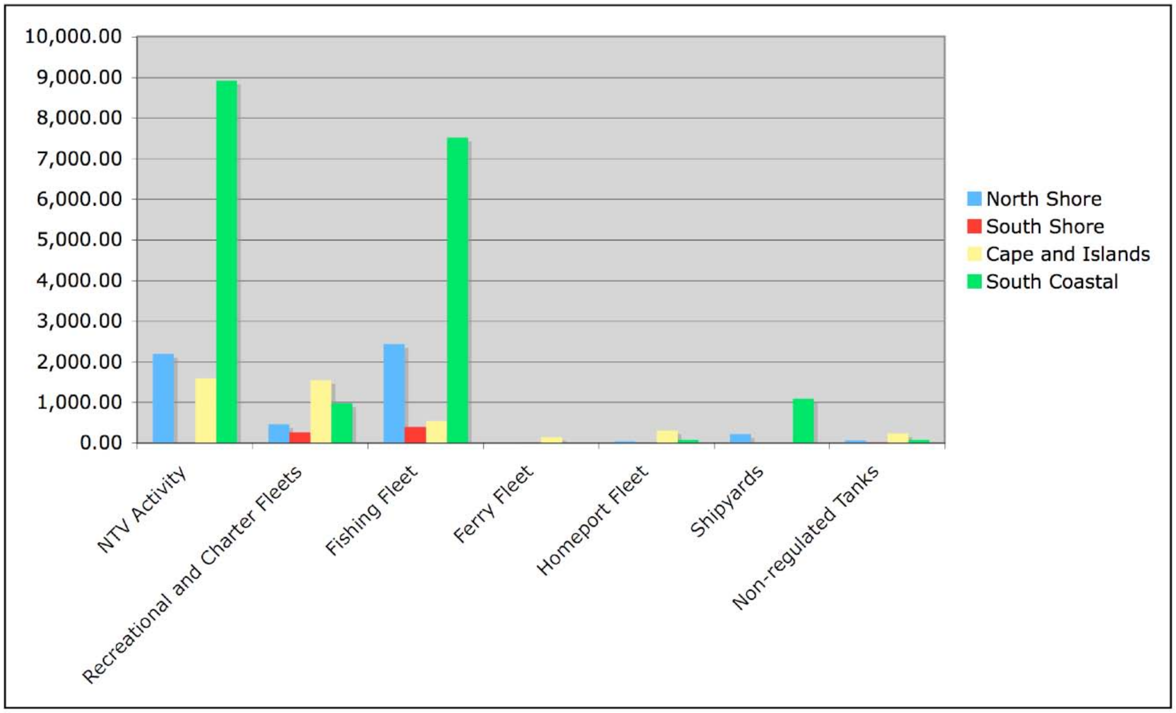


Figure 5.33 Comparison of Estimated Gallons of Petroleum Exposure (000)[39] for all Threat Factors Across Regions, Excluding Transit Volume, Tanker Activity, Nontank Vessel Activity, and Regulated Tanks



[38] All values in table should be multiplied by a factor of 1,000.
[39] All values in table should be multiplied by a factor of 1,000.

Figure 5.34 Comparison of Estimated Gallons of Petroleum Exposure (000)[40] for all Threat Factors Across Regions, Excluding All Data for Boston Harbor Region and Excluding Transit Volume, Tanker Activity, Nontank Vessel Activity, and Regulated Tank Data for Other Regions



[40] All values in table should be multiplied by a factor of 1,000.

6 Discussion

This study was conducted to identify, measure, and compare oil spill threats to coastal Massachusetts. This analysis is more informal and qualitative than a comprehensive risk assessment, and represents a "snapshot" measurement of various factors that may contribute to the overall threat of an oil spill occurring. This report provides specific details about the data sources and data sets developed, in the interest of encouraging future studies to build on this effort.

While none of the observations in this report should be interpreted as absolute measure of oil spill risk, they are still extremely useful in that they provide a methodical approach to identifying and estimating how various types of activities contribute to the overall threat of marine oil spills, and identifying differences and similarities in these threat factors across geographic areas.

Sections 2 and 3 of this report described the types of threat factors considered for this study and Sections 4 and 5 compiled and analyzed data describing each factor by harbor, municipality, and region. Three general categories were used to distinguish threat types – vessel movement, resident vessel fleets, and land-based storage. Across the board, the oil spill threat from vessel movement was much higher in terms of gallons of petroleum exposure than any other source. This is largely attributable to the fact that tank vessels moving through shipping channels and in and out of harbors (primarily the Port of Boston) represents the single largest exposure to oil by quantity. A typical tank vessel can carry millions of gallons of petroleum onboard, compared to hundreds of thousands on a large nontank vessel and thousands to tens of thousands on a large fishing or recreational vessel.

These differences in scale highlight the need to look closely at the data for each threat type, harbor, town, and region. While the total threat exposure from all other factors combined does not approach the vessel transit threat level, there are other reasons to consider these lower magnitude exposures in attempting to interpret overall spill threats and to allocate planning and resources accordingly.

6.1 High Threat Activities

The highest total exposure to oil spill threats comes from tank vessel activity and vessel transits in shipping lanes. Land-based storage in regulated tanks is the second largest regional exposure. The third largest threat factor is nontank vessel activity. After nontank vessel activity, fishing fleets account for the fourth highest exposure threat. After fishing vessels, recreational and charter vessels seem to pose the fifth largest overall exposure level.

6.2 Geographic Areas of Concern

Sections 4 and 5 of this report describe the relative threat levels for coastal oil spills at the harbor and regional levels. These analyses show that by far the highest level of exposure to oil spill threats occurs in the Boston Harbor region, due to the high level of tank vessel activity and the concentration of bulk storage facilities in the Port of Boston. After Boston Harbor, the Cape and Islands region has the second highest total exposure to oil spill threats. The

South Coastal, North Shore, and South Shore regions all have comparable levels of overall exposure, although the composition and relative contributions of threat factors varies in each region.

At the harbor level, Boston Harbor, New Bedford Harbor and Great Harbor (Woods Hole) are the only three harbors that ranked among the highest exposure to both high magnitude threats (tankers, NTV, transits and regulated storage) and low magnitude threats (resident vessel fleets and locally regulated tanks). High magnitude threats were most prevalent in Boston Harbor's harbors, followed by the Cape and Islands, North Shore, and South Coastal regions. None of the South Shore harbors had a significant concentration of high magnitude threat factors.

Ten of the twenty-four harbors with high levels of exposure to low magnitude threat factors are located in the Cape and Islands region, although the harbor with by far the highest level of exposure to lower magnitude threats is New Bedford, in the South Coastal Region. Gloucester Harbor had the second highest level of exposure to low magnitude threats. Other harbors with high levels of exposure for low magnitude threats were Boston, Nantucket, Hyannis, and Plymouth.

6.3 Considerations in Interpreting the Gallons of Petroleum Exposure Estimates

6.3.1 Temporal Considerations

As discussed earlier in this report, the GPE measurement does not account for temporal distribution of oil spill threats. In other words, although the total amount of oil transported by tank vessel is highest compared to all other threat factors, this estimate reflects and annual total and not a daily average. So there is some degree of artificiality in comparing a threat such as vessel transit volume, which can vary considerably over time and is never all present in one area at one time, with a threat such as land-based fuel storage, which is more constant (although storage volumes also fluctuate over time). Neither threat factor attempts to allocate the threat exposure by season, despite the fact that both the volume of vessel transits and the volume of oil stored in land-based tanks may be much higher in winter because of the widespread use of home heating oil in this region.

Similar seasonal variations affect other threat factors. Commercial fishing vessels, which are the single largest contributor to total threat exposure from resident vessel activity, vary their operations based on which fisheries they are targeting. Recreational and homeport vessels are typically only present during the summer boating season, and most are dry-docked through the colder months. Therefore, the total exposure to a spill from resident vessels will vary considerably over the course of a year depending on which fishing vessel are in port, and the level of recreational boating activity.

6.3.2 Oil Type Not Considered

The type of oil transported or stored is not factored into this analysis, yet the type of petroleum product is an important consideration in planning for and responding to oil spills. The data sets for tank vessel activity and land-based storage (both regulated by EPA and locally regulated) contain some information about types of oil stored and transported, but this information was not consistent enough to allow for analysis across data sets. Types of petroleum stored and transported include gasoline, marine diesel, aviation fuel, home heating oil, and intermediate to heavy fuel oils. Future analyses could look more closely at fuel types in order to consider potential response scenarios and planning needs.

6.3.3 Exposure Does Not Equal Risk

In this study, the measurement of gallons of petroleum exposure by region and threat type presumes that every gallon of oil has the same likelihood of spilling. In the real world, this is not the case. Mitigation and prevention measures such as secondary containment at tank farms, double hulls on tank vessels, or transfer procedures at marine terminals may reduce the likelihood of a spill occurring, and/or reduce the total amount spilled in the case that a spill does occur. A quantitative risk assessment would take into considerations these types of factors; this study does not.

This study estimates total exposure by aggregating and comparing the total storage amounts across type of threat and geographic area. While this study uses gallons of petroleum exposure as a unit of measure to estimate and compare spill threats, these gallon measurements should not be confused with a worst case spill size for a single event. It is important to recognize that the aggregation of total volumes within each threat factor means that the GPE estimates far exceed a worst case discharge estimate. For example, the 8.8 billion GPE estimate for the Boston Harbor region does not mean that an 8.8 billion gallon oil spill should be expected or planned for in this region.

6.4 Assessment of Spill Threat Levels Compared to Equipment Stockpiles

A separate study done in parallel to this Threat Evaluation, the *Inventory and Assessment of Marine Oil Spill Response Resources in Massachusetts and New England States* (Equipment Inventory) considered the comparative stockpiles of oil spill response equipment by region, and found that the overwhelming majority of skimmers, skimming systems, and temporary storage capacity in Massachusetts is concentrated in the Boston Harbor region. The inland region has a small stockpile of skimming systems, but otherwise all other regions of the state have virtually no recovery or storage capacity.

The distribution of boom statewide is more even, with the highest percentage of all types of boom combined in the Boston Harbor region, followed closely by the Cape and Islands. Boston Harbor has the highest concentration of larger boom suitable for open water response. Calm water boom is more evenly distributed, with the highest concentration in the Cape and Islands region, followed by Boston Harbor, the North Shore, South Coastal, South Shore, and Inland regions.

Interestingly, the two regions of the state with the highest threat exposure also have the highest overall equipment levels. However, in looking at those specific communities and harbors with the highest threat exposure, outside of Boston Harbor there are limited response resources with the exception of calm water (up to 18 inch) boom. In considering those harbors with the highest total exposure (combined GPE by harbor, see Figure 4.14), all have state spill response trailers within their town, containing 1,000 feet of calm water boom. Some harbors are in close proximity to several state response trailers. However, beyond the hard boom, sorbents, and associated equipment in the trailers, there are no significant stockpiles in several of the highest risk harbors, including Gloucester, Woods Hole, and New Bedford. While the oil boom is useful for initial containment or protection, skimming systems and temporary storage devices are needed to recover spilled oil. Adding such capacity to some of the highest risk harbors might improve the likelihood of successful spill response and reduce overall impacts by cutting down on the time required to transport and deploy these resources.

6.5 Use of Threat Estimates in Other Planning Activities

A common approach to oil spill contingency planning, which is based to some degree on an assessment of overall spill risks, is to consider various categories of oil spill types and to plan accordingly for each type. Two terms are commonly used to differentiate between the types of spills that may occur for a particular operation or region – worst case and average most probable. A worst case event represents the maximum possible spill size based on the total quantity of oil stored in a given location or operation. An average most probably event takes into consideration the source and severity of a spill that is considered most likely to occur, again based on the nature of the operations.

The data collected for this study could be used to estimate the potential magnitude of worst case and/or average most probable oil spills by harbor, municipality, region, and threat factor. For example, a worst case discharge for the South Coastal region from a tank vessel could be estimated as the total capacity of the largest tank vessel transiting through or calling on a local port in that region. The average most probable spill source could be estimated by looking at some of the lower magnitude threats that were most prevalent for a harbor or region. For example, the South Coastal region has the highest exposure to petroleum from the resident fishing fleet; therefore a fishing vessel spill could be used as an average most probably spill scenario in that region. The data collected and analyzed for this study could also be useful to developing scenarios for oil spill drills and exercises.

7 Recommendations

The information and analysis compiled for this study has two broad applications: 1) to facilitate decision-making regarding oil spill prevention and response planning projects in Massachusetts based on relative threat types and concentrations; and 2) provide a foundation for future data collection and analysis. The recommendations in this section address each of these two areas.

7.1 Oil Spill Prevention and Response Planning for Coastal Massachusetts

This study represents the first attempt to measure and assess the types of factors that contribute to oil spill threats for Massachusetts coastal communities and the relative magnitude of these threats statewide, by region, and by harbor. While the presence and size of these threats is only one component of the overall risk picture, it is still useful to directing future planning and prevention efforts.

This study concludes that vessel transits adjacent to coastal communities and tank vessel activity within ports are the two major contributors to the volume of oil present in the state's coastal regions and therefore at risk of spilling. This threat is most significant in the Boston Harbor region, due to the proportionately high level of activity in the Port of Boston compared to the rest of the state. Other harbors with particularly high oil spill threat exposure from all sources, outside of the Port of Boston and surrounding Harbors, are New Bedford, Gloucester, Fall River/Somerset, Sandwich Boat Basin, Great Harbor (Woods Hole), Nantucket, Hyannis, and Plymouth.

Looking beyond the threat from the four high magnitude threat factors (vessel transits, tankers, NTV, and regulated storage), the data showed that every harbor seemed to have its own unique combination of factors. Harbors with large fishing fleets, such as New Bedford and Gloucester, are exposed to relatively high oil spill threats from those resident fleets. Ferry traffic and recreational vessel fleets contribute to oil spill threats in many of the Cape and Islands harbors. This next level of granularity is important to consider because it emphasizes the fact that there is a great deal of local variation by harbor, by waterbody, and by region. Thus, it is important incorporate local considerations and expertise in the oil spill planning process and to tailor prevention programs to address localized risks.

After the Boston Harbor Region, the Cape and Islands has the next highest overall threat exposure, with the other three regions at comparable total levels. While the state has been divided into five regions for the purpose of oil spill planning projects and equipment allocation, it is important to also consider that waterbody distinctions seem to impact oil spill threat levels more so than regional designations. This is particularly evident in the Cape Cod region, where threat levels from vessel transits in particular vary significantly by waterbody.

Specific recommendations for allocation of oil spill prevention and planning projects are:

- Tailor prevention activities to the highest-exposure locations and activities.

  - Continue with efforts such as escort tugs that would provide an immediate response/mitigation asset for vessel transits.
  - Ensure that adequate equipment is available and GRPs are in place for areas adjacent to harbors with the highest exposure to oil spill threats.
  - Ensure that adequate equipment is available and GRPs are in place for areas that could be impacted by a spill from land-based EPA regulated storage facilities. Review Facility Response Plans to assess the level of planning in place.
  - Develop GRPs for Boston Harbor region.
- Enhance response capacity and spill preparedness in highest-exposure locations.
  - Consider developing additional tactical spill response plans for highest exposure harbors, to supplement GRPs.
  - Supplement oil spill response equipment in high-exposure harbor areas (i.e. additional boom, larger boom, skimming equipment).
  - Develop harbor or town-level oil spill response action plans that define responsibilities and initial response priorities. Engage harbormasters and port authorities in oil spill prevention and response planning programs. Encourage oil spill response planning within Harbor Management Plans to address the specific threats associated with each harbor.
  - Develop regional plans that consider how responders and equipment will come together for a spill that impacts multiple harbors and towns in regions with high threat exposure.
  - Develop oil spill response scenario analyses for high-exposure harbors to work through the amount of resources that might be required to respond to a worst case and average most probable discharge and estimate the timeline for mobilization and deployment of the necessary resources.
- Consider diversifying equipment stockpiles to enhance overall response capability (see discussion and conclusions in Equipment Report). Also assess adequacy of equipment stockpiles through scenario analyses.
- Identify opportunities for outreach and education to encourage awareness of oil spill threats from resident vessel fleets.

7.2 Building on this Study

The process of collecting and compiling data for this study highlighted a number of gaps in data quality or availability. Many of these issues are attributable to the fact that the organizations and agencies that compile the data needed for this study do not necessarily do so from a perspective of oil spill planning or analysis. For example, the EPA Facility Response Plan database did not identify total storage by facility, which would have made the analysis of EPA regulated tank farms much easier. Similarly, vessel transit data sets use different measurements and do not cover all waterbodies of the state. AIS data is not publicly available and must be purchased at a considerable cost.

Historical spill data was also problematic, to the degree that it was not included in this study. While information on historical spill occurrences is commonly used to assess future spill risks, this study found that data sets maintained by both the U.S. Coast Guard and MassDEP were incomplete. There were also discrepancies in how data was recorded within MassDEP in different response regions. Standardization of data fields such as spill type, source, location, size, etc. would benefit future analyses. The State of Washington has developed a model for oil spill data keeping that could be adapted in Massachusetts. Efforts are underway to improve historical spill databases at the state and federal level. If efforts to improve and standardize oil spill recordkeeping are successful, then data on historical oil spill occurrences could be factored into future analyses. Once a comprehensive set of historical spill data is established, annual reports could be generated to identify trends in oil spill occurrences and to evaluate the impact of planning and prevention measures.

In addition to the ten threat factors included in this study, several other factors that may contribute to oil spill threats were identified but were not included in this study due to limits on available data and other practical constraints. Future analyses could take into consideration additional threat factors such as vessel refueling from tanker trucks, location of bridges or roadways where tanker truck accidents could impact coastal waters, and vessel refueling from harbor barges.

The data compiled for this study was done so in a manner that would make it relatively easy to revisit and update the study periodically. Continued data compilation would allow for future analyses to look at trends and changes in threat factors, and to assess threats based on a more mature data set. It would also allow for new threats – such as changes to vessel traffic in North Shore ports with new LNG developments or addition of offshore wind farms as proposed by Cape Wind.

Finally, it is important to clarify that the threats measured in this study are only one component of the overall risk equation. Risk is broadly defined as probability times consequence. This study uses a gross measurement of whether or not oil is present in order to estimate the likelihood of a spill occurring. The threat factors identified in this study inform on both components of the risk equation, but they do not provide a definitive estimate of risk. Future studies could consider other components of the risk equation – such as probability of spills from various sources or vulnerability to oil spill impacts.

Specific recommendations for building on this study are:

- Encourage agencies and organizations that compile the data used in this study to update databases and record-keeping to standardize measurements and facilitate future analyses of oil spill threats.
- Improve data recording and management practices for historical oil spill databases by standardizing data fields within and across agencies, with the goal of developing a data set that could be analyzed for trends in oil spill occurrences.
- Continue to populate the data sets developed for this report, and periodically review and analyze.
- Acquire and analyze AIS data.

- Consider additional oil spill threat factors such as:
  - Vessel refueling from tanker trucks
  - Potential for spills from tanker trucks on roads or bridges
  - Vessel refueling from harbor barges
  - Other new or emerging threats (LNG activities, Cape Wind, etc.)
- Investigate other factors related to overall spill risks such as probabilities of spill occurrence and vulnerability to spill impacts.
- Use the information in this report as the foundation for a spill risk management program as described in Section 1.4 of this report.

Appendix A – List of Massachusetts Harbors by Region and Waterbody

Region	Waterbody	Town/City	Harbor	#
North Shore	Gulf of Maine	Newburyport/Salisbury	Newburyport/Merrimack River	1
North Shore	Gulf of Maine	Newbury	Parker River	2
North Shore	Gulf of Maine	Rowley	Rowley River	3
North Shore	Gulf of Maine	Ipswich	Ipswich River	4
North Shore	Gulf of Maine	Essex	Essex Bay	5
North Shore	Gulf of Maine	Rockport	Rockport Harbor	6
North Shore	Massachusetts Bay	Gloucester	Gloucester Harbor	7
North Shore	Massachusetts Bay	Manchester	Manchester Harbor	8
North Shore	Massachusetts Bay	Beverly/Danvers	Beverly Harbor/Danvers River	9
North Shore	Massachusetts Bay	Salem	Salem Harbor	10
North Shore	Massachusetts Bay	Lynn	Lynn Harbor	11
North Shore	Massachusetts Bay	Marblehead	Marblehead Harbor	12
North Shore	Massachusetts Bay	Nahant	Nahant Harbor	13
North Shore	Massachusetts Bay	Revere	Pines River/Saugus River	14
Boston Harbor	Massachusetts Bay	Winthrop	Winthrop Harbor	15
Boston Harbor	Massachusetts Bay	Boston/Chelsea/Everett	Boston Harbor	16
Boston Harbor	Massachusetts Bay	Boston	Dorchester Bay	17
Boston Harbor	Massachusetts Bay	Quincy	Neponset River	18
Boston Harbor	Massachusetts Bay	Quincy	Quincy Bay	19
Boston Harbor	Massachusetts Bay	Quincy	Town River Bay	20
Boston Harbor	Massachusetts Bay	Braintree/Weymouth	Fore River	21
Boston Harbor	Massachusetts Bay	Weymouth	Back River	22
South Shore	Massachusetts Bay	Hingham	Hingham Harbor	23
South Shore	Massachusetts Bay	Hingham	Weir River	24
South Shore	Massachusetts Bay	Hull	Allerton Harbor	25
South Shore	Cape Cod Bay	Cohasset	Cohasset Harbor	26
South Shore	Cape Cod Bay	Scituate	Scituate Harbor	27
South Shore	Cape Cod Bay	Scituate	North River	28
South Shore	Cape Cod Bay	Marshfield	Green Harbor	29
South Shore	Cape Cod Bay	Duxbury	Duxbury Harbor	30
South Shore	Cape Cod Bay	Kingston	Kingston Bay/Jones River	31
South Shore	Cape Cod Bay	Plymouth	Plymouth Harbor	32
Cape and Islands	Cape Cod Bay	Sandwich	Sandwich Boat Basin/Esco	33
Cape and Islands	Cape Cod Bay	Sandwich	Sandwich Harbor	34
Cape and Islands	Cape Cod Bay	Barnstable	Barnstable Harbor	35
Cape and Islands	Cape Cod Bay	Brewster	Sesuit Harbor	36
Cape and Islands	Cape Cod Bay	Orleans	Rock Harbor	37
Cape and Islands	Cape Cod Bay	Wellfleet	Wellfleet Harbor	38

Region	Waterbody	Town/City	Harbor	#
Cape and Islands	Cape Cod Bay	Truro	Pamet River	39
Cape and Islands	Cape Cod Bay	Provincetown	Provincetown Harbor	40
Cape and Islands	Atlantic	Orleans	Nauset Harbor	41
Cape and Islands	Atlantic	Orleans	Pleasant Bay	42
Cape and Islands	Atlantic	Chatham	Chatham Harbor	43
Cape and Islands	Atlantic	Chatham	Stage Harbor	44
Cape and Islands	Nantucket Sound	Harwich	Saquatucket Harbor	45
Cape and Islands	Nantucket Sound	Harwich	Wychmere Harbor	46
Cape and Islands	Nantucket Sound	Harwich	Allen Harbor	47
Cape and Islands	Nantucket Sound	Dennis	Dennis Port/Herring River	48
Cape and Islands	Nantucket Sound	Dennis/Yarmouth	Bass River	49
Cape and Islands	Nantucket Sound	Barnstable	Hyannis Harbor/Lewis Bay	50
Cape and Islands	Nantucket Sound	Barnstable	Centerville /Hyannis Port	51
Cape and Islands	Nantucket Sound	Barnstable	West Bay	52
Cape and Islands	Nantucket Sound	Barnstable	Cotuit Bay	53
Cape and Islands	Nantucket Sound	Mashpee	Popponesset Bay	54
Cape and Islands	Vineyard Sound	Falmouth	Waquoit Bay	55
Cape and Islands	Vineyard Sound	Falmouth	Eel Pond	56
Cape and Islands	Vineyard Sound	Falmouth	Bourne Pond	57
Cape and Islands	Vineyard Sound	Falmouth	Green Pond	58
Cape and Islands	Vineyard Sound	Falmouth	Great Pond	59
Cape and Islands	Vineyard Sound	Falmouth	Falmouth Harbor	60
Cape and Islands	Nantucket Sound	Nantucket	Nantucket Harbor	61
Cape and Islands	Nantucket Sound	Nantucket	Madaket Harbor	62
Cape and Islands	Vineyard Sound	Edgartown	Edgartown Harbor	63
Cape and Islands	Vineyard Sound	Oak Bluffs	Oak Bluffs Harbor	64
Cape and Islands	Vineyard Sound	Tisbury	Vineyard Haven Harbor	65
Cape and Islands	Vineyard Sound	Aquinnah/Chilmark	Menemsha Creek	66
Cape and Islands	Buzzards Bay	Gosnold	Cuttyhunk Harbor	67
Cape and Islands	Buzzards Bay	Gosnold	Hadley Harbor	68
Cape and Islands	Vineyard Sound	Falmouth	Little Harbor	69
Cape and Islands	Buzzards Bay	Falmouth	Great Harbor (Woods Hole)	70
Cape and Islands	Buzzards Bay	Falmouth	Quissett Harbor	71
Cape and Islands	Buzzards Bay	Falmouth	West Falmouth Harbor	72
Cape and Islands	Buzzards Bay	Falmouth	Wild Harbor	73
Cape and Islands	Buzzards Bay	Falmouth	Fiddlers Cove	74
Cape and Islands	Buzzards Bay	Falmouth	Rands Harbor	75
Cape and Islands	Buzzards Bay	Bourne/Falmouth	Squeteague Harbor	76
Cape and Islands	Buzzards Bay	Bourne	Red Brook Harbor	77
Cape and Islands	Buzzards Bay	Bourne	Pocasset Harbor	78

Region	Waterbody	Town/City	Harbor	#
Cape and Islands	Buzzards Bay	Bourne	Pocasset River	79
Cape and Islands	Buzzards Bay	Bourne	Phinneys Harbor/Back River	80
Cape and Islands	Buzzards Bay	Bourne/Wareham	Buttermilk Bay	81
South Coastal	Buzzards Bay	Wareham	Onset Harbor	82
South Coastal	Buzzards Bay	Wareham	Wareham Harbor	83
South Coastal	Buzzards Bay	Marion/Wareham	Weweantic River	84
South Coastal	Buzzards Bay	Marion	Sippican Harbor	85
South Coastal	Buzzards Bay	Mattapoisett/Marion	Aucoot Cove	86
South Coastal	Buzzards Bay	Mattapoisett	Mattapoisett Harbor	87
South Coastal	Buzzards Bay	Mattapoisett	Brant Island Cove	88
South Coastal	Buzzards Bay	Fairhaven	Nasketucket Bay	89
South Coastal	Buzzards Bay	New Bedford/Fairhaven	New Bedford Harbor	90
South Coastal	Buzzards Bay	New Bedford	Clarks Cove	91
South Coastal	Buzzards Bay	Dartmouth	Apponagansett Bay	92
South Coastal	Buzzards Bay	Westport	Westport River	93
South Coastal	Mount Hope Bay	Fall River/Somerset	Port of Fall River/Taunton River	94
South Coastal	Mount Hope Bay	Swansea	Lee River	95

Appendix B Fire Chief Survey

Nuka Research and Planning Group Survey of Fire Departments for MassDEP Project #101300

Survey of Fire Departments for Massachusetts Department of Environmental Protection Coastal Oil Spill Risk Evaluation Project

April, 2008

Please complete and return survey by April 18, 2008.
Please send the completed survey and any additional information you would like to provide to:

E-mail: sierra@nukaresearch.com
Fax: (240) 368 7467
Post: Nuka Research and Planning Group
PO Box 1672, Plymouth, MA 02362

Any questions? Please contact Sierra Fletcher
E-mail: sierra@nukaresearch.com
Phone: (207) 841 0604

The Massachusetts Department of Environmental Protection (MassDEP) has contracted Nuka Research and Planning Group, LLC. to evaluate oil spill risks in all Massachusetts coastal communities (MassDEP Project # 101300).

Project Background
The 2004 Massachusetts Oil Spill Prevention and Response Act mandated the MassDEP to implement "lessons learned" from the oil spill that took place in Buzzards Bay in 2003. In 2007, MassDEP developed an interim implementation plan. One of the major tasks of this plan is to conduct an oil spill risk evaluation that will serve as the basis for prioritizing future equipment and training deliveries and Geographic Response Plan development.

Survey of Fire Chiefs
Nuka Research is surveying fire chiefs in coastal communities to identify fuel storage locations and existing oil spill response equipment. We are also surveying harbormasters and gathering data from state and federal agencies about fuel storage, fuel transfers, and vessel traffic.

This survey has 9 questions. You will be asked for information about the petroleum storage facilities (besides gasoline) located within 150 yards of tidal waters and any oil spill response equipment the Department owns. *Please feel free to send any of this information in a separate document to the contact points above, if this is more convenient for you.*

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Questions

Please write your name and the name of your town.

1. For how many years have you been in service there?

2. Does your town/city have fuel storage facilities within 150 yards of tidal waters? If the answer is "no," please skip to Question 6.

3. Please complete the following table *only for tanks within 150 yards of the coast. Do not include tanks that contain gasoline or LNG.* **If you already have this information in a separate document, please feel free to send it that way.**

You may use as many rows as necessary. See example.

Name & Location of storage site	Type of Product Stored	Total storage (tank sizes, number tanks)	Other information
Jim Bob's marina Street Address	Marine Diesel	30,000 gal (3 x 10k tanks)	Amount of fuel stored is less than half total capacity in winter
Big Guy fuel terminal Street Address	#2 Home heating oil	200,000 (2 x 100k tanks)	Fully lined secondary containment

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4. Have there been any petroleum spills (excluding gasoline) that have reached water in your town?

5. If there have been spills, when and where have they occurred?

6. Does the fire department own any oil spill response equipment (not counting state spill response trailers)?

7. In your town, **what** do you consider to pose the biggest risk for an oil spill to coastal waters? (i.e. spill from a vessel, truck rollover spilling into a stream, fuel storage facility, offshore traffic, etc.)

8. Why do you consider this to be the biggest risk? (i.e., amount of product involved, frequency or congestion of activities, past spills, etc.)

9. Is there any other information you would like to provide to help us to better understand the risk of marine oil spills and the oil spill response capabilities in your city or town? Please use the space here to add additional comments or information relevant to this study.

Appendix C – Harbormaster Survey

Massachusetts Department of Environmental Protection
Massachusetts Coastal Oil Spill Threat Analysis

Town ______________________________

Harbor ______________________________

Harbor Master ______________________________

Vessels – Recreational/Charter	
How many moorings are in this harbor?	
How many boat slips are in this harbor?	
How many marinas/boatyards in this harbor?	
What is the range of vessel lengths?	

Vessels – Commercial Fishing	
How many commercial fishing vessels moor/dock in this harbor?	
What types of fishing vessels moor in this harbor?	

Vessels – Ferries	
What ferry terminals are located in this harbor?	
What are the size and type of ferry vessels?	

Massachusetts Department of Environmental Protection
Massachusetts Coastal Oil Spill Threat Analysis

Vessels - Other	
What large commercial, research, or training vessels moor in this harbor?	
What is their range in size?	

Non-regulated Tanks	
What are the vessel fueling stations in this harbor?	
What is the size of their storage tanks?	

Petroleum Terminals/Regulated Tank Farms	
What petroleum terminals and regulated tank farms are located in this harbor?	
What is the size of these facilities in total gallons?	

Massachusetts Department of Environmental Protection
Massachusetts Coastal Oil Spill Threat Analysis

Cargo Terminals	
What commercial cargo loading/discharging docks are in the harbor?	
How many vessels load/unload at the dock per year?	

Shipyards	
What large vessel shipyards are located in the harbor?	
How many vessels are serviced in these yards per year?	
What is the range in size of vessels serviced?	