State Enhanced Remedy in New Bedford, South Terminal

Expanded Avian Assessment

Massachusetts Department of Environmental Protection

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EXECUTIVE SUMMARY

The South Terminal CDF project (**Figure 1**) has been developed in order to develop a multi-purpose marine terminal, a primary purpose of which will be to provide critical infrastructure to serve offshore renewable energy facilities. The proposed facility will also be capable of supporting other industries within New Bedford, and will beneficially re-use sand from navigational dredging or the construction of confined aquatic disposal facilities to the extent approved by US EPA.

An assessment of the potential locations for supporting offshore renewable energy facilities has resulted in the conclusion that South Terminal in New Bedford, Massachusetts is the only location that is practicable due to a number of constraints, including: horizontal clearance, jack-up barge access, overhead clearance, total wharf and yard upland area, berthing space, site control/availability, and proximity. Due to the lack of other practicable alternatives, and the avoidance and minimization of impacts to resource areas to the maximum extent practicable, the South Terminal CDF is the Least Environmentally Damaging Practicable Alternative that will meet the primary Project Purpose.

The following assessments have been completed to quantify the resource area impacts that are anticipated from completion of the South Terminal CDF project: a shellfish survey, an essential fish habitat assessment, a functions and values assessment, a neighborhood analysis, an analysis of NOx generation from construction activities, a delineation of wetlands onsite, an avian wildlife assessment, an analysis of secondary impacts from construction and operation of the facility, an analysis of the presence of similar habitats within New Bedford Harbor, and an assessment of potential mitigation options.

Historically, much of the land that will be incorporated into the proposed Facility is former heavy industrial property, the site of an extensive former mill complex. The Potomska Mills, which once stretched from the current intertidal to beyond the western proposed site boundary, was present on the site from the late 1800's until about 1936 (when it was demolished), and encompassed an area of approximately 19 acres, more than half of which was within the footprint of the proposed South Terminal CDF Facility.

The resource areas anticipated to be impacted by completion of this project are as follows: 1.43 acres of intertidal area, 4.73 acres of shallow, near-shore sub-tidal area, and 0.18 acres of salt marsh will be filled by construction of the CDF. 6.65 acres of shallow, near-shore, sub-tidal area will be dredged from -1 to -6 MLLW to -20 MLLW. 2.35 acres of shallow, near-shore, sub-tidal area will be dredged from -1 to -6 MLLW to -30 MLLW. 6.39 acres of deeper sub-tidal area will be dredged from -20 to -25 MLLW to -30 MLLW. The impacts anticipated from the South Terminal CDF represent a small portion of the existing larger resource areas nearby that provide similar functions and values.

Impacts to resources have been avoided and minimized to the maximum extent practicable. To mitigate for the unavoidable impacts, the following mitigation is proposed: Creation/Enhancement of 12.3 acres of intertidal area, Creation/Enhancement of 2 acres of a combination of successional marsh areas, Shellfish seeding, a Tern Mitigation Plan, creation of a natural pilot storm-water filtration project, planned enhancement to approximately 26 acres of subtidal areas, planned enhancement to 16.1 acres of near-shore, shallow, subtidal areas, historic enhancement to 49.5 acres of subtidal areas, and historic enhancement to 18.9 acres of near-shore, shallow, subtidal areas.

1. PROJECT PURPOSE

a. Project Purpose

The purpose of the project is *to develop a multi-purpose marine terminal, as a component of the approved State Enhanced Remedy for New Bedford Harbor, a primary purpose of which will be to provide critical infrastructure to serve offshore renewable energy facilities, and which is also capable of beneficially re-using sand from navigational dredging or the construction of confined aquatic disposal facilities to the extent approved by US EPA.*

The Project Purpose has been defined to meet the primary objective of creating port infrastructure with the capacity to support the development, operation and maintenance of offshore renewable energy facilities, place the project in the context of the state enhanced remedy, and acknowledge the on-going Superfund remediation of the Harbor as context for potential future benefits associated with the facility.

b. Multi-purpose Terminal Capable of Supporting Offshore Renewable Energy Projects

Plans for the development of major offshore wind energy generation are under development in most of the Atlantic coastal states. Projects are expected to be under development in Massachusetts and Rhode Island in the near term, and the states have identified areas in federal waters off their coasts for further evaluation for development in the mid-term, and both states (and many of the Atlantic coastal states) are working closely with the Minerals Management Service to initiate the offshore leasing process. A key component of developing offshore wind energy generation is the shore-side infrastructure necessary to support construction, assembly and transshipment of foundation and turbine components. Without a well-positioned, marine-industrial terminal to receive store, stage, assemble, and maintain wind turbine components and their supporting infrastructure, the development of off-shore wind facilities cannot be accomplished. As described in detail below, such facilities have specific operational requirements associated primarily with the scale of the turbine and foundation components: factors such as proximity to the offshore facilities, horizontal and vertical clearances, laydown area, and access to deep water navigation constitute 'hard criteria' site requirements. This would also be case for tidal or wave energy projects should those technologies become viable in the long term.

The City also proposes to use the terminal for other cargoes, which may include container, break bulk, and bulk cargo shipping. Additionally, the terminal would facilitate implementation of America's Marine Highway (Short-Sea Shipping) and would also serve as a location to temporarily store sand generated during CAD Cell construction, so as to facilitate reuse of the material.

The anticipated future uses (container shipping, break-bulk cargo shipping, bulk cargo shipping, short-seas shipping and CAD Cell sand storage) each require approximately the same type of facilities: deep water berthing, quae-side loading and unloading area, and upland storage and staging area. Major demands for berthing and upland storage and staging space will be temporary, and will fluctuate based upon the size of the shipments anticipated to arrive or leave. Break-bulk cargo, containers, trucks, or bulk cargo may require temporary storage prior to loading and transport of vessels; however, only a small portion of the site (1-2 acres) would be required for any one method of transportation with any regularity. Reserving a portion of the site for the storage of CAD Cell sand will therefore not be difficult.

The intent is to use the terminal for the purpose of offshore renewable energy development until late 2012 or early 2013 (the anticipated completion date of the first offshore renewable energy construction project) and, subsequent to that date, utilizing the facility for, other cargoes (until such time as another alternative energy support project requires the use of the site). Thus, the terminal would be constructed to the specifications required for wind energy development but would be designed so as to accommodate a range of future uses described above.

Additionally, the proposed terminal represents an opportunity to beneficially reuse and/or manage material dredged from the harbor as part of the State Enhanced Remedy and ongoing EPA Superfund harbor cleanup activities as described below:

2. WHY SOUTH TERMINAL CDF IS THE LEAST ENVIRONMENTALLY DAMAGING PRACTICABLE ALTERNATIVE THAT MEETS THE PROJECT PURPOSE

a. Proposed Project Description

The proposed South Terminal CDF is a filled structure adjacent to the shoreline, bounded by sheet piling, currently planned to be capped by crushed stone. **Figures 2 and 3** note the anticipated orientation of construction for the facility as well as the plots of land anticipated to be incorporated into the facility. The total estimated size of the facility, including the ancillary southern properties, is currently anticipated to be approximately 28.25 acres.

b. Anticipated Future Uses of South Terminal CDF

Use of the South Terminal CDF for off-shore wind energy support terminal is anticipated to start as early as November 2011 (immediately subsequent to construction of the terminal). Operation of the facility for off-shore wind energy support for the first major off-shore wind energy project is anticipated to last until February of 2013.

Although off-shore wind energy support operations will utilize the entire facility until February of 2013, subsequent to that date, the facility is anticipated to be utilized in a number of non-off-shore wind energy related means, including: as a terminal for container shipping, a terminal for break-bulk cargo shipping, a terminal bulk cargo shipping, and as a location to store sand generated via CAD Cell construction, so as to facilitate reuse of the material.

Existing break-bulk cargo and refrigerated cargo is currently accommodated at State Pier, Maritime Terminal and Bridge Terminal; however, the Route 6 Bridge restriction (limiting vessel width to no greater that approximately 90 feet) and the depth restrictions (current maximum depth is approximately -23 feet MLLW) at the two terminals prevents vessels of a certain size from accessing Marine Terminal and Bridge Terminal, and keeps vessels that can access the terminals from being fully loaded at these locations. Maritime International estimates a significant annualized loss of income from less than fully loaded vessel, and that any availability at the South Terminal CDF would be quickly utilized to expand its break-bulk operations. The increased capacity would allow a significant increase in international cargo vessels with break-bulk cargo to utilize the Port.

South Terminal would also be ideal for shipment of bulk cargo, such as sand, gravel, or other bulk material. Multiple terminals within New Bedford already service bulk cargo. The R.M. Packer facility ships sand, gravel, fuel, modular homes, and “heavy lift” items. Island Barge transports construction materials and scrap to and from Nantucket. D.W. White recently suspended bulk shipment operations from its location at Pope’s Island, from which it transported salt, gypsum, cement, and scrap lumber, due to inefficiencies caused by lack of minimum storage space as well as lack of an appropriate bulkhead with sufficient draft for loading and unloading of bulk cargoes. Access to an available South Terminal CDF would allow larger barges, and potential increased shipments for these organizations.

The Port of New Bedford is also in negotiations to set up South Terminal as a major shipping location within America’s Marine Highway (Short-Sea Shipping). Short-sea shipping operations are the diversion of wheeled cargo (truck traffic) from congested highways to the open sea – as well as on inland waterways to absorb a significant part of the future projected growth in highway freight traffic, reduce air pollution, traffic congestion, and shipping costs.

Refrigerated cargo does require refrigerated storage areas; however, refrigerated storage areas are available in other areas of the harbor, and cargo would be transported to refrigerated storage locations after offloading at the facility. Break-bulk cargo will need shelter from the elements; but will be shipped to a warehouse after unloading at the facility. Bulk cargo will need space onsite for temporary storage prior to loading, but will be staged and delivered to limit its footprint at the site. Truck staging will be required for short-seas shipping; but the trucks will only be onsite immediately before and after a short-seas vessel arrives or leaves.

c. Least Environmentally Damaging Practicable Alternative

South Terminal in New Bedford has been determined to be the only practicable alternative for siting of an offshore renewable energy support facility. All other alternatives have been reviewed within the August 25, 2010 document entitled "State Enhanced Remedy in New Bedford, South Terminal" and have been found to not be practicable.

3. IMPACT ASSESSMENT OF PROPOSED PROJECT

a. Summary of Existing Resource Area Assessment and Anticipated Direct and Secondary Impacts

The project as planned will result in the following *Direct Impacts* to existing resource areas as outlined below:

- **Areas of Proposed Filling:**
  - 1.43 acres of intertidal area,
  - 4.73 acres of shallow, near-shore sub-tidal area; and
  - 0.18 acres of salt marsh will be filled during the construction of the facility.

  These areas currently serve as:
  - Essential Fish Habitat for winter flounder, windowpane flounder, scup, and black sea bass,
  - Shellfish habitat,
  - Potential foraging habitat for avian wildlife, and
  - The intertidal area serves as horseshoe crab habitat.
- **Temporary Impacts Associated with Bridge:** 10 Pilings temporarily in place to support the bridge, totaling approximately 50-125 square feet of alteration (assuming 30-48 inch diameter pilings)
- **Areas of Dredging (Existing Depth Between -1 and -6 MLLW):**

    - 9.0 acres of near-shore, subtidal area will be dredged to between -20 and -30 MLLW (6.65 acres to -20 MLLW and 2.35 acres to -30 MLLW).

  These areas currently serve as:

    - Essential Fish Habitat for winter flounder, windowpane flounder, scup, and black sea bass,
    - Shellfish habitat, and
    - Potential foraging habitat for avian wildlife.

- **Areas of Dredging (Existing Depth between -20 and -25 MLLW):**
    - 6.39 acres of subtidal area will be dredged to -30 MLLW.

  These areas currently serve as:

    - Essential Fish Habitat for winter flounder, windowpane flounder, scup, and black sea bass, and
    - Shellfish habitat.

- **Shellfish Impacts**:
    - It is estimated that approximately 1,019,986 shellfish will be lost during construction of the facility and associated dredging.

The project as planned will also result in the following ***Secondary Impacts*** to existing resource areas as outlined in previous sections:

- Dredging and Other Construction Related Turbidity;
- Operational Prop Wash Post-Construction;
- Stormwater Runoff;
- Traffic;

- Noise;
- Lighting;
- Bilge Water Management Issues; and
- Sloughing Slopes.

As noted above, these existing resources that will be impacted via construction and dredging are not unique to New Bedford Harbor; many areas within New Bedford Harbor, including some areas very nearby the proposed construction location (for example, Palmer's Island), provide similar functions and values that will remain in place.

The existing resources at the proposed construction site have a severely limited value due to the existence of PCB laden sediment; thus, the capping of this area will help eliminate the exposure pathways from the PCBs to the surrounding environment. The flood storage loss created by the completion of the South Terminal CDF would have a minimal overall impact on New Bedford harbor, as noted within the document entitled Hydrology of Floods, New Bedford Massachusetts, produced by the Hydrologic Engineering Section of the U.S. Army Corps of Engineers in September 1987, due to the enormous flux of harbor water that is able to flush in and out of New Bedford Harbor as it is adjacent to Buzzard's Bay.

As sections of New Bedford Harbor are designated as a Designated Port Area, the area of the project has historically been utilized for industrial purposes. Much of the land consists of fill material that has been transported to this location. Use of the site for water-dependent industrial activity would be in compliance with Commonwealth of Massachusetts Waterways Regulations. Additionally, a CDF would create positive economic benefits to the area by facilitating new water-dependent industrial activity. Although CDF creation represents a change of portions of the shoreline of New Bedford Harbor, CDF creation has already been vetted through a public process within the New Bedford/Fairhaven Harbor Plan process during 2009.

b. Expanded Avian Wildlife Assessment

An assessment with regard to the potential for usage of the site by avian wildlife for nesting and foraging activities was conducted as a part of this study. The avian wildlife assessment consists of review, analysis, and evaluation of existing data. An independent review of the data evaluation was performed by an independent part, and the resume of the individual is attached Existing data for Southern New England, Bristol County, New Bedford and its Surroundings, and New Bedford Harbor include:

- **New Bedford Harbor** - A bird survey conducted within New Bedford Harbor by USEPA in 1987.
- **Bristol County Data** - Raw bird observations within Bristol County made via the Massachusetts Audubon Society's online "eBird" system,
- **Southern New England Data** - The species prioritization list associated with Bird Conservation Region 30,
- **New Bedford and Its Surrounding Communities** - Information from the Paskamansett Bird Club's 2007 Christmas Bird Count.
- **New Bedford and Its Surrounding Communities** - Specific identifications made by an individual within New Bedford from 2005-2008.
- **New Bedford Harbor** - Observations made for Mass Audubon Society's Breeding Bird Atlas 2.

These data provide a reasonable estimate of the avian wildlife that utilizes the site at any point in time for habitat. Although other avian wildlife could utilize the site as well, it is anticipated that that use would be infrequent, due to the absence of that avian wildlife in the surveys that focus closely on New Bedford Harbor. The following is a description of the evaluation undertaken in order to produce a list of avian wildlife that are anticipated to be present within New Bedford Harbor and utilize the site:

A bird survey for the New Bedford Superfund Site was conducted in the Summer of 1987. This survey was completed in support of a wetland analysis promulgated by the US Army Corps of Engineers. Of particular interest in this document was the comparison of avian wildlife populations present within the survey area (Upper New Bedford Harbor) as compared to the avian wildlife present at a location in Fairhaven in the Outer New Bedford Harbor (immediately to the east and south of the New Bedford Hurricane Barrier). The comparison indicates distinctly different avian wildlife populations within and outside of the Hurricane Barrier. The information associated with this bird survey is included within **Appendix 7**.

Data from the Massachusetts Audubon Society were accumulated between the years 2000 and 2010. This data were collected via an online data collection system utilized by bird watchers associated with the Mass Audubon called “eBird”. “eBird” is an easy to use, interactive, computerized database that provides a simple way for bird watchers to keep track of the birds they see, and share that information with Mass Audubon (as well as researchers and other bird watchers). The data from the “eBird” site wwere easy to download into an excel spreadsheet and to sort by species and sighting frequency; however, the “eBird” data could only be collected on a county-wide basis, and are not immediately representative of New Bedford Harbor. In fact, it may be an inaccurate representation of the actual species located at the project site. Due to restrictions in property access, bird watching is mainly conducted from public areas and not in locations specific to the project area. Therefore, the raw “eBird” data were also combined with a few other sources of more site-specific information. Information on “eBird” is included within **Appendix 2**.

Information regarding “Priority Species” within Bird Conservation Region 30 (New England/Mid-Atlantic Coast) was collected and analyzed. Bird Conservation Regions are ecologically distinct regions in North America with similar bird communities, habitats, and resource management issues. Bird Conservation Regions were developed through a mapping team comprised of members from the United States, Mexico, and Canada assembled at the first international North American Bird Conservation Initiative (a forum of governmental agencies, private organizations, and bird initiatives helping partners across the continent to meet their common bird conservation objectives). “Priority Species” within Bird Conservation Region 30 were noted by the Atlantic Coast Joint Venture, a partnership focused on the conservation habitat for native birds in the Atlantic Flyway of the United States from Maine south to Puerto Rico (representing 18 states and commonwealths and key federal and regional habitat conservation agencies and organizations in the joint venture area). The management board of the Atlantic Coast Joint Venture includes the Regional Refuge Chief from Region 4 and the Regional Director of Region 5, of the U.S. Fish and Wildlife Service as well as the Director of the Massachusetts Division of Fisheries & Wildlife. In addition six of the eight staff members listed on the Atlantic Coast Joint Venture website are noted to be U.S. Fish and Wildlife Service employees. Information on the North American Bird Conservation Initiative and the Atlantic Coast Joint Venture are included within **Appendix 3**.

Each Christmas, the National Audubon Society promulgates a nation-wide bird count. In 2007, the Paskamansett Bird Club 2007 completed its Christmas Bird Count within the greater New Bedford, Acushnet, Fairhaven, Dartmouth and Mattapoisett cities. This information was collected in the winter, and therefore would miss migrating birds; however, it provides some additional information regarding avian wildlife presence in New Bedford and its surrounding communities. More detailed information regarding the 2007 Christmas Bird Count is included within **Appendix 6**.

Information from the postings of an amateur bird watcher were collected from an online web log or "Blog" posted by Mr. Daniel Harper. From August, 2005- September, 2008 Mr. Harper was the minister for the First Unitarian Church of New Bedford. During that time period, Mr. Harper conducted amateur bird watching events, during which he identified a range of birds inhabiting New Bedford Harbor (although not necessarily at the site). Mr. Harper posted the results of his observations, and posted a list at http://www.danielharper.org/blog/?page_id=454. Mr. Harper did not keep detailed records of his observations, and therefore only posted a summary of the birds he viewed, and did not have information on specific dates, times, or weather conditions at which he viewed the birds. Mr. Harper visited locations both within New Bedford and Fairhaven; therefore, the information that he collected is not specifically representative of the

South Terminal area, but is helpful in presenting a range of avian wildlife present in the vicinity of the project area. Information on Mr. Harper's blog are attached as **Appendix 4.**

The Massachusetts Audubon Society is nearing the end of its second effort to collect data on distribution of birds statewide in order to promulgate its Breeding Bird Atlas. The first Atlas was undertaken in the 1970s. Surveyors visit specific quadrants (approximately 10 square miles each) within Massachusetts and record all of the avian species observed. Due to the intense investigation requirements, no more than four quadrants are investigated by any surveyor in any one year. Surveyors conduct their investigations only during breeding periods (typically May 15 – August 1), and spend a minimum of 20 hours surveying for birds in each quadrant. This survey would have been conducted during time periods within which migrating birds would have been present within New Bedford Harbor. The quadrant for New Bedford North 06 encompasses most of the area north of the New Bedford Hurricane Barrier, and is primarily water, and therefore presents an ideal opportunity to record the presence or absence of shore birds within New Bedford Harbor. Information on the Breeding Bird Atlas is included within **Appendix 5**.

Data from the sources listed above, are presented and sorted within **Table 1A** through **Table 1D** contained within **Appendix 1**. The data are presented in raw form (unsorted) within **Table 1A**, and are gradually sorted in steps until a final list is presented within **Table 1D** as follows:

- Table 1A: Unsorted Raw Data

- Table 1B: Only birds observed by one of three field observers (Mr. Dan Harper, 1987 New Bedford Superfund Site Survey, and Mass. Audubon Breeding Bird Atlas Survey).
- Table 1C: Includes only birds observed by surveyors located (at all times) within New Bedford Harbor (1987 New Bedford Superfund Site Survey and Mass. Audubon Breeding Bird Atlas Survey).
- Table 1D: Includes only Bird Conservation Region 30 Priority Species observed by surveyors located (at all times) within New Bedford Harbor (1987 New Bedford Superfund Site Survey and Mass. Audubon Breeding Bird Atlas Survey).

Although Table 1D does not necessarily represent all birds that could utilize the site for habitat, it does represent the "Priority Species" most likely to utilize the site. It is likely that if other species utilize the site, they do so infrequently. The species of concern, therefore, are:

- American Black Duck
- American Oystercatcher
- Baltimore Oriole
- Black-crowned Night-Heron
- Blue-winged Warbler
- Canada Goose
- Chimney Swift
- Eastern Kingbird
- Eastern Towhee
- Gadwall

- Gray Catbird
- Great Crested Flycatcher
- Killdeer
- Least Tern
- Mallard
- Nelson's Sparrow
- Northern Flicker
- Saltmarsh Sparrow
- Snowy Egret
- Spotted Sandpiper
- Willet
- Willow Flycatcher
- Wood Duck

c. Endangered Species Analysis

The site is not located within an area identified as federal critical habitat or state priority habitat for rare or endangered species; however, due to the wide range of avian wildlife habitat use, it is unavoidable that some impacts to shallow-water feeding areas for some rare avian species may occur, but are anticipated to be minimal.

The Roseate Tern and Common Tern are noted to be state-listed as “Endangered” and “Special Concern” species, respectively, within the Commonwealth of Massachusetts. The Roseate Tern is listed as a Federally “Endangered” species. Common Tern presence is often indicative of the presence of the Roseate Tern, as the Roseate Tern nests within Common Tern colonies and also often forages with Common Terns. Fact sheets regarding these two birds are included within **Appendix 8**.

Common Terns nest generally on sandy or gravelly offshore islands and barrier beaches. Roseate Terns typically nest among Common Tern colonies, but typically choose areas with denser vegetation to use as cover for chicks. Both species prefer to nest on islands to avoid predators and intruders. A variety of predators, including birds, mammals, snakes, ants, and land crabs eat tern eggs, young, and adults. Neither species has ever been known to nest at the project site or elsewhere in New Bedford Harbor.

Common Terns feed mainly on a wide variety of small fish and crustaceans; however, their primary prey in most Atlantic coast breeding areas is the American sand lance. Similarly, the Roseate Tern feeds almost exclusively on small fish. About 70% of its diet consists of sand lance. Both the Roseate Tern and the Common Tern forage by plunge-diving (diving from heights of between 1-12 meters and oven submerging to greater than 50 centimeters. Sand lance occur throughout the water column over sandy substrates into which they burrow. The sand lance burrows for rest and escape from predators; hence much time may be spent within the substrate, isolated from the water column. Due to this specific defense behavior, the sand lance is particularly vulnerable to become contaminated by adjacent contaminated sediment, such as the high levels of PCBs within the contaminated sediment of New Bedford Harbor. It is likely the Common Tern and Roseate Tern’s preference for American sand lance is the source of high levels of PCBs found in chicks found dead at Bird Island in 1970, and increased levels of PCBs within existing Roseate and Common Tern colonies. Additional details with regard to the American sand lance are included within **Appendix 9**.

The information gathered within bird surveys outlined within **Section 3b** above, indicates that Common Terns and Roseate Terns forage within Buzzard's Bay and the outer portions of New Bedford Harbor. Bird surveys that included areas outside of New Bedford Harbor (eBird information and observations completed by Mr. Dan Harper's surveys) noted the Common Tern and/or the Roseate Tern as being identified, while bird surveys conducted solely within the Hurricane Barrier (1987 New Bedford Superfund Site Bird Survey and Mass Audubon Breeding Bird Atlas surveys) did not note the presence of the Common Tern or the Roseate Tern. It should also be noted that the 1987 New Bedford Superfund Site Bird Survey in fact noted the presence of the Common Tern at a control site located outside of the New Bedford Hurricane Barrier. (The Paskamansett Bird Club 2007 Christmas Bird Count was conducted in the winter, when Common Terns and Roseate Terns would have already migrated south for the winter.)

These surveys indicate that the Common and Roseate Terns likely do not travel inside of the New Bedford Hurricane Barrier, and if they do, they do so infrequently and have not been noted within the surveys in question.

It is likely that Common and Roseate Terns do not utilize the area within the New Bedford Hurricane Barrier for the following reasons:

- **Food –** As stated above, the primary food source for the Common or Roseate Tern is the American sand lance, whose protective behavior appears to create a significant vulnerability to contaminated sediment. Therefore, foraging within New Bedford Harbor presents a particular risk to the Common and Roseate Tern, who both selectively forage for this fish. It is likely that, if Common and Roseate Terns ever foraged within New Bedford Harbor historically, that their preference for sand lance resulted in bioaccumulation of PCBs within the birds, perhaps resulting in higher chick mortality rates, such as those found dead at Bird Island in 1970. As a result of this preference, it appears that, at least until PCB contamination is removed from New Bedford Harbor, that areas north of the New Bedford Hurricane barrier represent poor foraging habitat for Common or Roseate Terns.
- **Noise –** New Bedford Harbor is a highly industrialized area, and produces regular noise of human industrial and commercial activity. This includes the operation and repair of over 500 commercial fishing vessels, operation of dozens of fish processing plants, multiple cargo ship receiving facilities, multiple ship-yards, ferry boats, cruise ships, and repair yards. This activity produces a significant quantity of noise, particularly in the spring, summer, and early fall, during which the activity within the harbor is at its peak, and when foraging for the Common or Roseate Tern would be at its peak.
- **Human Activity -** Most areas of New Bedford Harbor contain some level of human activity, be it industrial (ship-building, commercial fishing, cargo transport), commercial (recreational sailing or fishing vessels), or recreational (recreational fishing along the shoreline, recreational boating, mooring, canoeing or rowing). It is likely that this level of activity would be discouraging to the Common or Roseate Tern.

As a result of this analysis, it appears that neither the Common Tern, nor the Roseate Tern are likely to utilize the site for regular foraging. In fact, regular foraging would likely be detrimental to either species within the areas north of the New Bedford Hurricane Barrier, as the tern's foraging patterns make them extremely vulnerable to PCBs in sediment. Therefore, it does not appear that the project as proposed will have a significant impact upon either the Common Tern or the Roseate Tern. In fact, mitigation measures proposed as part of the project, specifically those proposed south of the New Bedford Hurricane Barrier, may be very beneficial to the Common and Roseate Terns, due to enhancement of foraging habitat (see **Section 4** for a discussion of proposed mitigation).

A request for a consultation on the potential impact of the proposed project on the Roseate Tern was filed with the Natural Heritage & Endangered Species Program, resulting in a letter prepared by Dr. Thomas French (Assistant Director), which stated the Roseate Tern and Common Tern (species that could utilize the site as foraging habitat) are state-listed as "Endangered" and "Special Concern" species within the Commonwealth of Massachusetts. The Roseate Tern is also listed as a Federally "Endangered" species. The nearest breeding colony for the Roseate Tern is located at (Bird Island), which is approximately 17 kilometers away from the site (the daily flight radius of the Roseate Tern is approximately 25 km).

The letter from Dr. French states that "It appears that the proposed dredging and terminal extension would only impact a small acreage of shallow-water feeding habitat for terns. Given the relatively small project footprint within mapped tern habitat, it does not appear that the project will result in measurable harm to state-listed species" (see **Appendix 9**). Please note that since Mr. French's review was completed, that the project has been modified slightly; however, the overall area of impact to avian wildlife habitat has not significantly changed.

d. Oil Spill Analysis

Another potential vulnerability to Avian Wildlife is the potential for increased vessel traffic to result in releases of oil that could then impact foraging birds or their nesting areas (particularly shorebirds). In order to conduct this analysis, existing research into the vessel traffic and the risk of associated oil spills was reviewed. The most up-to-date analysis of the risk posed to coastal communities in Massachusetts by oil spills was prepared by Nuka Research & Planning Group, LLC for the Massachusetts Department of Environmental Protection, titled "Evaluation of Marine Oil Spill Threat to Massachusetts Coastal Communities", dated December 2009 (included as **Appendix 10**).

As stipulated within this report, the main risk of spills in many harbors and ports (not to mention navigable waterways) is the possibility that a vessel will accidentally discharge petroleum through a vessel sinking, grounding, collision, fire or through accidental or illegal discharges from vessel operations, such as bilge pumping, changing engine oil, or refueling. For the purposes of this section, the assumption is made that the larger the size of the fleet of vessels servicing a harbor, the larger the threat of an oil spill from any of these possible sources. To estimate the magnitude of each oil spill threat for the purpose of comparison, a gallons of petroleum exposure measure (GPE) is calculated for each threat within each harbor in Massachusetts. For vessels permanently stationed within a harbor, the total GPE is the volume of petroleum product that could be released at any one point in time (usually the volume of the fuel tank of the vessel); for vessels in transit, the total GPE is the volume of petroleum product times the number of visits that the vessel makes to that port.

There are two categories of potential risk from vessels that are evaluated below: oil spill risk from vessels within and/or transiting to and from New Bedford Harbor, oil spill risk from increases in bulk oil storage within New Bedford Harbor, and the potential increased risk for oil spills from regional vessel transits. The following outlines the existing Oil Spill Threat in these three categories:

Existing Oil Spill Threat For New Bedford Harbor

The following is a summary of the existing oil spill threat based upon existing traffic (based upon data gathered from 2006) in Gallons of Petroleum Exposure (GPE) for the City of New Bedford, based upon the category of vessel:

- Oil Tanker or Tank Barge Activity – 43,250,000 GPE
- Large Nontank Vessels – 1,725,000,000 GPE
- Recreational and Charter Vessels – 300,000 GPE
- Commercial Fishing Vessel Fleet – 7,500,000 GPE
- Ferry Terminals – 5,500 GPE
- Other Large Vessels (Tugs, Training Vessels) – 84,000 GPE
- Vessels Associated with Shipyard Activity – 900,000 GPE

Total Existing Oil Spill Threat in GPE for Vessels, New Bedford Harbor: **1,777,039,500 GPE**

Existing Oil Spill Threat for Vessel Activity Within Shipping Lanes

The following is a summary of the existing oil spill threat for existing shipping lanes based upon existing traffic (based upon data gathered from 2006) in Gallons of Petroleum Exposure (GPE) for the following areas:

- Regional Transit Vessels (South Coastal/New Bedford) – 1,517,636,000 GPE
- Regional Transit Vessels (Dartmouth/Fairhaven/Marion/Mattapoisett/Wareham/ Westport) – 1,562,611,000 GPE
- Cape and Islands – 1,562,611,000 GPE

Increased Vessel Traffic Due to South Terminal CDF Construction

Increased traffic at the South Terminal CDF site is anticipated to include the following vessels during the first year:

- An international vessel (similar to a traditional non-tank vessel), between 140 - 150 meters (460 – 490 feet) in length. The international vessel can only carry components for 6 turbines at one time. Therefore, for constructing an offshore wind energy facility for 130 turbines, 22 separate shipments from international vessels would need to be received at the support facility. These shipments would be anticipated to be receive within the first year of operation of the facility.
- Two installation vessels would be also required at the facility. Offshore renewable energy facility installation ships would consist of jack-up barges that would be

approximately 91 meters (300 feet) in length and 30 meters (100 feet) in width. The vessels would not be powered on their own, and would require a tug to maneuver them out of dock and out to the construction site. It is currently anticipated that each barge would require one tug (each tug is estimated to be approximately 30 meters, or 100 feet in length) to maneuver the vessel out to sea; however, the facility would employ two tugs (one for each installation vessel). Each installation vessel would be capable of delivering components for installation of 2 wind turbines for each trip, resulting in a total of 65 total trips for the vessels during the first year.

In accordance with the categorization system created by Nuka Research & Planning Group, LLC within their report, the anticipated increased oil spill threat for the additional vessels is as follows:

- International Vessels: Nontank Vessels within New Bedford area anticipated to have an average fuel capacity of 75,000 gallons. 22 annual non-tank vessels X 75,000 gallons per vessel equates to 1,650,000 GPE for the international vessels.
- Installation Vessels (and tugs) Within the Port of New Bedford: For commercial tugs between 65 and 100 feet in length, the average fuel capacity is 17,500 gallons. There are anticipated to be two tugs in port at any one time in order to assist in tendering the installation vessels in and out of port. Therefore, the increased oil spill threat due to the additional tugs is: 2 tugs X 17,500 gallons per tug, which equates to an increase of 35,000 GPE.

- Installation Vessels (and tugs) In Transit to the Construction Site: There are anticipated to be one tug that accompanies each installation vessel to the construction site. There are anticipated to be approximately 65 trips to the construction site. Therefore, the increased oil spill threat in transit to the construction site due to the installation vessels is: 65 tugs X 17,500 gallons per tug, which equates to an increase of 1,137,500 GPE.

The total increase in oil spill threat for New Bedford Harbor is: 1,650,000 GPE + 35,000 GPE = **1,685,000 GPE.** As stated earlier, the total existing oil spill risk for the Port of New Bedford is: 1,777,039,500 GPE. Therefore, the construction of the South Terminal CDF will result in a 1,685,000/1,777,039,500 = **0.095%** increase in oil spill risk for the Port of New Bedford, an extremely small increase over current existing conditions.

The total increase in oil spill threat for areas within which the international vessels and installation vessels/tugs will transit is: 1,650,000 GPE + 1,137,500 GPE = **2,787,500 GPE** over the course of a year of installation. As stated earlier, the total existing oil spill risk for areas surrounding the south coast as well as Cape Cod and the Island is:

- Regional Transit Vessels (South Coastal/New Bedford) – 1,517,636,000 GPE
- Regional Transit Vessels (Dartmouth/Fairhaven/Marion/Mattapoisett/Wareham/Westport) – 1,562,611,000 GPE
- Cape and Islands – 1,562,611,000 GPE

Therefore, the relative increase in oil spill risk due to the addition of international vessels and the transit of installation vessels is:

- Regional Transit Vessels (South Coastal/New Bedford) – 2,787,500/1,517,636,000 = **0.18%**
- Regional Transit Vessels (Dartmouth/Fairhaven/Marion/Mattapoisett/Wareham/Westport) – 2,787,500/1,562,611,000 = **0.18%**
- Cape and Islands – 2,787,500/1,562,611,000 = **0.18%**

All of which represent an extremely small increase in oil spill risk over current existing conditions.

Maritime Terminal Operation

After the initial use of the facility as an offshore renewable energy support facility, the facility will serve as a maritime terminal. Increased traffic at the South Terminal CDF site (subsequent to the first year) is anticipated to include the following vessels:

- An average of one cargo vessel per week is currently anticipated at the facility subsequent to the first year. This vessel would likely be similar in size to the above-mentioned international vessel (similar to a traditional non-tank vessel), between 140 - 150 meters (460 – 490 feet) in length. Alternately, several smaller, short-seas shipping barges may service the site, (transmitting a similar quantity of cargo) which could result in an average of approximately four smaller barges (similar in size to the installation vessels) per week. Therefore, the total anticipated traffic increase is an average of 3 vessels per week (approximately 156 vessels per year).

In accordance with the categorization system created by Nuka Research & Planning Group, LLC within their report, the anticipated increased oil spill threat for the additional vessels is as follows:

- Non-Tank Cargo Vessels within New Bedford area anticipated to have an average fuel capacity of 75,000 gallons. 156 annual non-tank vessels X 75,000 gallons per vessel equates to **11,700,000 GPE** for the oil spill threat (after the first year) for cargo vessels. This value would be the same for both vessels within New Bedford Harbor and Vessels in transit to the site.

The total increase in oil spill threat for New Bedford Harbor is: **11,700,000 GPE.** As stated earlier, the total existing oil spill threat for the Port of New Bedford is: 1,777,039,500 GPE. Therefore, the oil spill threat (after the first year) will result in a 11,700,000/1,777,039,500 = **0.65%** increase in oil spill threat for the Port of New Bedford, an extremely small increase over current existing conditions.

The total increase in oil spill threat for areas within which the cargo vessels will transit is: **11,700,000 GPE** over the course of a year. As stated earlier, the total existing oil spill risk for areas surrounding the south coast as well as Cape Cod and the Island is:

- Regional Transit Vessels (South Coastal/New Bedford) – 1,517,636,000 GPE
- Regional Transit Vessels (Dartmouth/Fairhaven/Marion/Mattapoisett/Wareham/ Westport) – 1,562,611,000 GPE
- Cape and Islands – 1,562,611,000 GPE

Therefore, the relative increase in oil spill threat after the first year of operation of the new terminal is:

- Regional Transit Vessels (South Coastal/New Bedford) – 11,700,000/1,517,636,000 = **0.77%**
- Regional Transit Vessels (Dartmouth/Fairhaven/Marion/Mattapoisett/Wareham/Westport) **–** 11,700,000/1,562,611,000 = **0.75%**
- Cape and Islands **–** 11,700,000/1,562,611,000 = **0.75%**

All of which represent an extremely small increase in oil spill risk over current existing conditions.

4. PROPOSED MITIGATION FOR PROJECT IMPACTS

i. Proposed Compensatory Mitigation For Unavoidable Direct Impacts

In order to compensate for direct impacts resource areas due to construction of the Proposed South Terminal Extension CDF, a number of potential mitigation options have been evaluated. The results of this evaluation were that the following mitigation package is proposed:

- Creation/Enhancement of 11.8 acres of intertidal area via a combination of sites either immediately outside of New Bedford Harbor to enhance spawning and foraging areas for winter flounder, scup, black sea bass and windowpane flounder, and enhance foraging area for avian wildlife identified within the resource delineation, including the Common Tern and the Roseate Tern, enhancement of shellfish habitat, and enhancement of horseshoe crab habitat (Alternative 3).

- 0.5 acres of intertidal area via a combination of sites either within New Bedford Harbor to enhance spawning and foraging areas for winter flounder, scup, black sea bass and windowpane flounder, and enhance foraging area for avian wildlife identified within the resource delineation, including the Common Tern and the Roseate Tern, enhancement of shellfish habitat, and enhancement of horseshoe crab habitat (Alternative 5).
- Creation/Enhancement of 2 acres of a combination of successional marsh areas (mudflat, low marsh, high marsh, and transitional area) to enhance spawning and foraging areas for winter flounder, scup, black sea bass and windowpane flounder, and enhance foraging area for avian wildlife identified within the resource delineation, including the Common Tern and the Roseate Tern, enhancement of shellfish habitat, and enhancement of horseshoe crab habitat (Alternative 8).
- Shellfish seeding to compensate for shellfish lost during filling and/or dredging operations.
- Creation of a natural pilot storm-water filtration project within New Bedford to compensate for upland wetlands impacted by the upland portion of the project.
- Planned enhancement to approximately 26 acres of subtidal areas via the dredging, removal, and sequestration of PCBs within marine sediments from various locations within New Bedford Harbor during Phase IV of Navigational Dredging to enhance winter flounder, scup, black sea bass and windowpane flounder habitat.

- Planned enhancement to 16.1 acres of near-shore, shallow, subtidal areas via the sequestration of PCBs in sediment outside of the Hurricane Barrier at the OU3 New Bedford Superfund Site location during Phase IV of Navigational Dredging to enhance spawning and foraging areas for winter flounder, scup, black sea bass and windowpane flounder, and enhance foraging area for avian wildlife identified within the resource delineation, including the Common Tern and the Roseate Tern.
- Historic enhancement to 49.5 acres of subtidal areas between 2002 and 2010 via the dredging, removal, and sequestration of PCBs within marine sediments from various locations within New Bedford Harbor during Phase I, Phase II, and Phase III of Navigational Dredging to enhance winter flounder, scup, black sea bass and windowpane flounder habitat.
- Historic enhancement to 18.9 acres of near-shore, shallow, subtidal areas in 2005 via the sequestration of PCBs in sediment outside of the Hurricane Barrier at the OU3 New Bedford Superfund Site location to enhance spawning and foraging areas for winter flounder, scup, black sea bass and windowpane flounder, and enhance foraging area for avian wildlife identified within the resource delineation, including the Common Tern and the Roseate Tern.

A. Intertidal Habitat Creation (Immediately Outside and Within New Bedford Harbor)

In order to provide compensatory mitigation for impact to intertidal area and shallow, near-shore subtidal habitat, 12.3 (11.5 acres at the Hurricane Barrier and 0.5 acres north of Pease Park in Fairhaven) acres of intertidal area is proposed. The following provides a summary of the proposed program:

- Intertidal area would be created in two areas: inside the Hurricane Barrier on the Fairhaven side of the Harbor, and outside the Hurricane Barrier on the New Bedford side of the Bay (see **Figure 8** for the location of the proposed intertidal creation areas). These areas were selected because they were previously intertidal areas that were formerly affected by anthropogenic structures (the Hurricane Barrier and parking lots), and would significantly benefit from created intertidal;
    - 11.8 acres of intertidal area creation at the OU3 Pilot Cap location in the outer Harbor in New Bedford. This proposal is based upon Alternative 3, Capping of OU-3 Between the Hurricane Barrier and Existing OU-3 Cap. The mitigation project would have the dual purpose of creating intertidal area while simultaneously capping and isolating from the environment sediments with a high level (but likely lower than 10 mg/kg) of PCB contamination within them while also utilizing clean sand from CAD Cell construction. This location is not accessible from the shore and is rarely travelled by recreational vessels. As a result, the area that would be created would be relatively isolated from human impacts, and would provide a prime location to enhance spawning and foraging areas for winter flounder, scup, black sea bass and windowpane flounder, and enhance foraging area for avian wildlife identified within the resource delineation, including the Common Tern and the Roseate Tern, enhance shellfish habitat, and create horseshoe crab spawning habitat;
    - 0.5 acres of intertidal area creation north of Pease Park in Fairhaven, MA. The proposal is based upon Alternative 5, Construction of Beach North of Pease Park,

Fairhaven. The mitigation project will create intertidal area in front of an existing rip-rap wall, similar to that created outside of the hurricane barrier and with similar benefits, while utilizing clean sand from CAD Cell construction. The majority of the new area will be below the high tide line; however, some sand may be placed above the high tide line;

- o See **Figure 8** for a Locus Map of the proposed intertidal area creation sites;

- The form of the intertidal area created would be designed to emphasize re-creation of a specific ecological system – namely that of shore bird foraging, Essential Fish Habitat spawning and foraging, shellfish habitat and Horseshoe Crab habitat. The profile created will include a large proportion of intertidal sandy (silt/sand/gravel mixture) area, representing creation of preferential habitat. A cross-sectional diagram of an example beach profile for the proposed created intertidal area is included in **Figure 9**.

B. Successional Marsh Area Restoration/Enhancement

In addition to the intertidal area creation, restoration/enhancement of a 2 acre Salt Marsh and successionary sequence in the drainage swale that exists to the west of the Hurricane Barrier, just to the south of the Gifford Street Boat-ramp parking area is proposed. This proposal is based upon Alternative 8 – Hurricane Barrier Vegetated Swale Rehabilitation and Restoration. The area currently serves as a stormwater runoff channel that runs behind the Hurricane Barrier. The benthic substrate is currently filled with PCB impacted sediment. The western side of the channel is currently a rip-rap slope that has little ecological value. By removing the PCB contaminated sediment and capping the residual impacted sediment, creating drainage channels, removing the rip-rap slope, and grading into the upland behind the rip-rap slope, approximately 2 acres of mudflat, low marsh, high marsh, and transitional salt marsh area can be created or enhanced. This area is owned by the City of New Bedford. The project will enhance the hydraulic capacity of the drainage ditch to transport stormwater from behind the Hurricane Barrier, and will enhance spawning and foraging areas for winter flounder, scup, black sea bass and windowpane flounder, and enhance foraging area for avian wildlife identified within the resource delineation, including the Common Tern and the Roseate Tern,.

Currently, the drainage swale in this location is tidally influenced (it is subtidal), however the quality of the resource is degraded mudflat/drainage ditch. The area of the proposed mitigation is currently characterized by the growth of invasive species and has a large amount of trash evident. The sediments in the drainage swale are contaminated (with PCBs).

The goal of the restoration project at this location would be to create a functioning marsh area in a publically visible area, so as to have both an ecological benefit and an educational benefit. The mitigation project at this location would include four primary elements:

- Removal of PCB and metals contaminated sediments;
- Re-grading of the swale profile to allow for the creation of a successionary sequence of marsh vegetation;
- Planting of high, low, and transitional marsh species within the regarded swale; and
- Installation of a public access walkway/bike path adjacent to the created marsh area with appropriate signage identifying the type and importance of the biota in the restored/created resource area.

The proposed marsh restoration/creation includes the following characteristics:

- Sampling to determine the extent and depth of PCB and metals contaminated sediments;
- Excavation and removal of those sediments and placement of those sediments in the CAD Cell;
- Installation of a layer of clean material across the bottom of swale graded into a topographic succession that will include a deeper flow channel meandering through the middle of the swale and benched sides that will promote high and low marsh vegetation growth as well as transitional vegetation growth.
- Planting of Low Marsh vegetation (such as sp. *spartina alternaflora*) on the lower created benched steps;
- Planting of High Marsh vegetation (such as sp. s*partina patens* and sp. *distichlis spicata*, and possibly some sp. *spartina alternaflora* mixed in to the High Marsh sequence; and
- Planting of Transition Zone vegetation (such as sp. *panicum virgatum*, sp. *iva frutescens*, and some sp. *distichlis spicata and* s*partina patens*, as well as sp. *myrica pensylvanica*, sp. *rosa virginiana*, and sp. *arctostophylos uva-ursi* shrubs);
- Installation of an adjacent public access walkway/bike path and bordering ornamental fence with appropriate signage to inform the public of the restoration/creation project conducted as well as pointing out both the types and importance of the marsh sequences installed.
- A conceptual diagram of the proposed successionary salt marsh creation/restoration project is attached as **Figure 10**.

C. Shellfish Seeding

In order to provide compensatory mitigation for impact to shellfish organisms in the footprint of the proposed South Terminal expansion, a shellfish seeding program is proposed. The Massachusetts Department of Marine Fisheries has indicated in the past that the dollar value recommended for seed purchases to mitigate for shellfish loss during construction projects is often five times the value of the shellfish. A Shellfish Survey (completed in May 2010) identified an approximate shellfish organism count in the to-be-affected area of 1,019,986 shellfish organisms. Mitigation seeding is proposed at a ratio of 5:1 (seed provided to organisms effected), in keeping with generally accepted practice. The following provides a summary of the proposed program:

- A total of 5,099,930 seed stock is proposed, with relative percentage of animal type provided at a ratio that is consistent with the current projected ratio found to be existing in the potential footprint of the proposed Terminal expansion (based upon the 2010 crop survey of the currently proposed affected area):
    - 72 % of the seed = Quahogs;
    - 22% of the seed = Common Oyster;
    - 6 % of the seed = Soft Shell Clam;

- The seed stock will be provided over a period of time (over a five year period):
    - 1,019,986 seed stock (at the organism percentage noted above) will be provided the first year of significant construction at the Site (expected to be 2011);
    - 1,019,986 seed stock (at the organism percentage noted above) will be provided each successive year for a period of 4 years;

- Seed stock will be provided to the New Bedford Shellfish Constable for distribution in accordance with the City shellfish program.

- As a condition of providing seed stock, the project will review the Shellfish Office seeding plan to encourage use of the seed stock in appropriate locations (i.e., not in contaminated areas), and at the appropriate time(s) of the year.

D. Tern Survey Plan

Although it is not currently anticipated that substantial impacts to Common Tern and Roseate Tern habitat will occur due to completion of the South Terminal CDF project, elements of the proposed project mitigation related to creation of intertidal and shallow water subtidal habitat, in conjunction with the removal of PCB-contaminated sediment, is intended to compensate for the impacts to tern foraging habitat that may occur. In addition, a tern survey plan will be implemented in Spring/Summer 2011 to determine the extent of the foraging habitat for the Terns as well as Tern use of the area. Based on consultation with the NHESP (Mostello, pers. comm.), the survey will entail weekly surveys from May through mid-July, peak tern nesting season, to acquire data on the density and abundance of terns using the area on both an east/west and north/south gradient to determine tern abundance and density as a function of proximity to shoreline and distance up the estuary. Outside the hurricane barrier, transects would be roughly east/west (shoreline to shoreline); inside the hurricane barrier one north/south transect would extend from the hurricane barrier as far north as navigability allows. At the recommendation of the NHESP, the surveys will be conducted using methodology consistent with guidance provided in the document titled <u>Towards standardised seabirds at sea census techniques in connection</u>

with environmental impact assessments for offshore wind farms in the U.K. (http://www.offshorewindfarms.co.uk/Assets/1352_bird_survey_phase1_final_04_05_06.pdf), and in consultation with the NHESP and the U.S. Fish and Wildlife Service.

E. Pilot Stormwater Filtration Project

Although not subject to federal jurisdiction, there exists within the proposed footprint of the South Terminal CDF some amount of degraded upland wetland. As noted in the referenced studies, these wetlands have developed on top of urban fill (which includes piles of asphalt, brick, block, and stone debris, cement and other demolition rubble). An Environmental Site Assessment Report (21E Report) for a large proportion of the property indicates that the filled land that the wetlands have developed upon also contains soils contaminated with common industrial contaminants. Non-invasive wetlands plants are noticeably absent from the site, and invasive species (particularly sp. *phragmites austalis*) are dominant. As such, these upland wetlands at the site are in poor condition and do not represent functioning wetland resources. However, it is recognized that as topographic features on the site, these areas play a role in storm-water retention and filtration. In recognition of that, the project proposes to conduct certain activities related to storm-water management and retention, including:

- Conducting a thorough review of storm-water flow and infiltration for the proposed CDF Facility as part of the design activities that will be undertaken. Should the study results indicate that significant storm-water retention and/or discharge issues may be anticipated, the project will incorporate into the Facility design best management practice solutions to the storm-water issues;

- The project will conduct a natural Pilot Storm-water Filtration project within New Bedford in order to assess and demonstrate the effectiveness and importance of designed natural storm-water filtration systems. Such a system (sometimes referred to as a "rain garden") would be constructed on City property or on easement property in an area where storm-water runoff issues are either present or suspected. While the ideal location for such a feature is currently unknown, a study would be undertaken as part of the project that would identify a useful location for such feature (likely to be adjacent to one of the major roadways that cross the Harbor or parts of the Harbor – such as the I-195 crossing of the Acushnet at Washburn Street). It is anticipated the size of the Pilot system that may be installed would be on the order of approximately 0.1 to 0.2 acres. Detailed design of this system would be conducted in concert with appropriate agency and non-governmental organization input.

F. Planned Removal of PCBs from Benthic Habitat Within New Bedford Harbor

The New Bedford Harbor Development Commission plans to dredged, remove, and sequester PCB contaminated sediment from approximately 26 acres of New Bedford Harbor while conducting Phase IV Navigational Dredging. Dredging, removal and sequestration of PCB and heavy metals impacted sediment will remove the sediment from contact with Essential Fish Habitat, shellfish and benthic organisms. It will result in a reduction in the bioavailability of PCBs within Essential Fish, horseshoe crabs and shellfish within New Bedford Harbor, which will subsequently reduce the quantity of PCBs available to avian wildlife when foraging within New Bedford Harbor. Phase IV Navigational Dredging is dependent upon funding.

G. Planned Near-Shore, Shallow Subtidal Enhancement

The New Bedford Harbor Development Commission, working with USEPA, plans to utilized material generated during CAD Cell construction to sequester PCB contamination within an area located immediately outside of the New Bedford Hurricane Barrier. The area, designated by USEPA as OU3, contained sediment with PCB concentrations ranging 94 to 10 mg/kg. It is currently planned to cap a 16.1 acre area. The pre-capping bathymetry within the OU3 area ranges from -7 to -14 MLLW. Post capping bathymetry within the OU3 area will likely range from -4 to -9 MLLW. As a result of this work, not only will PCB contaminated sediments be isolated from the benthic environment, improving Essential Fish Habitat, but relatively deep subtidal areas will be shallowed slightly, creating an area that will be relatively more productive as a shallow near-shore subtidal environment for spawning and foraging areas for Winter Flounder, Scup, Black Sea Bass and Windowpane Flounder, and foraging area for avian wildlife identified within the resource delineation, including the Common Tern and the Roseate Tern. This action will serve as a significant enhancement of 16.1 acres of near-shore, shallow subtidal habitat area. Either remediation or capping of the OU-3 area is part of the New Bedford Superfund Record of Decision. Capping this area not only will have significant environmental benefits, but will complete a significant task associated with Superfund Cleanup, and will save significant costs and logistical difficulties for USEPA. Capping of OU-3 will be completed in conjunction with creation of CAD Cell #3, which is dependent upon funding.

H. Historic Removal of PCBs from Benthic Habitat Within New Bedford Harbor

In addition to the above-listed proposed mitigation, the New Bedford Harbor Development Commission has dredged, removed, and sequestered PCB contaminated sediment from 49.5

acres of New Bedford Harbor while conducting Navigational Dredging from 2001 to 2010. The work has been completed in three Phases. Phase I, which began in 2001 and was completed by the end of 2002, removed approximately 75,000 yards of PCB-impacted sediment. Phase II, which began in January 2005 and was completed in January 2006, removed more than 156,000 cubic yards (cy) of PCB-impacted sediment. Phase III, which began in September 2006 and was completed in September 2009, removed more than 189,000 cubic yards (cy) of PCB-impacted sediment.

Dredging, removal and sequestration of PCB and heavy metals impacted sediment has removed the sediment from contact with Essential Fish Habitat, shellfish and benthic organisms. It has resulted in a reduction in the bioavailability of PCBs within Essential Fish, horseshoe crabs and shellfish within New Bedford Harbor, which has subsequently reduced the quantity of PCBs available to avian wildlife when foraging within New Bedford Harbor.

I. Historic (2005) Near-Shore, Shallow Subtidal Enhancement

When constructing CAD Cell #1 during Phase II of Navigational Dredging in 2005, a significant quantity of clean sand (approximately 85,000 cubic yards of material) was generated. Rather than dispose of the material at the Cape Cod Bay Disposal Site, the New Bedford Harbor Development Commission, working with USEPA, utilized the material to sequester PCB contamination within an area located immediately outside of the New Bedford Hurricane Barrier. The area, designated by USEPA as OU3, contained sediment with PCB concentrations ranging 94 to 10 mg/kg. During CAD Cell #1 construction approximately 18.9 acres were sequestered utilizing clean sand. The pre-capping bathymetry within the OU3 area ranged from -7 to -14

MLLW. Post capping bathymetry within the OU3 area ranged from -4 to -9 MLLW. As a result of this work, not only were PCB contaminated sediments isolated from the benthic environment, improving Essential Fish Habitat, but relatively deep subtidal areas were shallowed slightly, creating an area that was relatively more productive spawning and foraging areas for Winter Flounder, Scup, Black Sea Bass and Windowpane Flounder, and foraging area for avian wildlife identified within the resource delineation, including the Common Tern and the Roseate Tern. This action served as a significant enhancement of 18.9 acres of near-shore, shallow subtidal habitat area that was conducted in order to further navigational dredging within New Bedford Harbor and has not been used as mitigation for any project. Either remediation or capping of the OU-3 area is part of the New Bedford Superfund Record of Decision. Capping this area not only had significant environmental benefits, but had complete a significant task associated with Superfund Cleanup, and saved significant costs and logistical difficulties for USEPA.

ii. Proposed Avoidance, Minimization, and Mitigation For Secondary Impacts

A. Traffic

Increases in vessel traffic with in New Bedford Harbor are not anticipated to greatly impact the current operations of the Port. During the construction of the CAD Cell, material being shipped to the South Terminal CDF will likely be incorporated into the normal Port traffic pattern without a major disturbance. During previous dredging project barges would move through the Route 6 swing bridge during its normal openings; additional openings were not required and a similar pattern is anticipated for the construction of the South Terminal CDF. There should be very little commercial vessel traffic through the CAD Cell area or through the South Terminal CDF area. Recreational boat traffic will need to be redirected around the work area, however this has been normal practice during previous navigational dredging projects completed within the port.

B. Construction Turbidity

The increase in turbidity during the construction of the CDF and CAD Cell will be monitored utilizing existing Performance Standards which are attached as **Appendix 11**. The Performance Standards within **Appendix 11** have been developed through the State Enhanced Remedy process at the New Bedford Superfund Site. The Performance Standards have been developed over two phases of navigational dredging (Phase II, which began in January 2005 and was completed in January 2006 and Phase III, which began in September 2006 and was completed in September 2009). The Performance Standards were developed with the coordination with a number of Federal, State and Local authorities who are represented at the State Enhanced Remedy meetings, including MassDEP, USACE, USEPA, the National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Division of Marine Fisheries (DMF), Massachusetts Coastal Zone Management (MACZM), EOEA, and the Coalition for Buzzards Bay.

In addition to conformance with the Performance Standards, certain Time of Year Restrictions will be observed. Work will be minimized from January 15 to June 15; if unavoidable, work will be completed with the use of silt curtains areas with water depths greater than -5 MLLW. If additional Time of Year restrictions are identified, work will be minimized at those times of year, or silt curtains will be utilized during those times of year, as outlined above.

Environmental dredge buckets will be utilized, as applicable, to contain impacted sediment completely, and reduce turbidity during dredging activities. There will be turbidity monitoring during the deployment of silt curtains. Written contingency plans will be required from the marine contractors working at the facility. Should turbidity monitoring indicate exceedances of Performance Standards, the contractor will be required to implement its contingency plans to reduce the turbidity levels. Possible contingency options include: decrease in the speed of work, the halt of work, fixes to equipment, use of an environmental bucket, use of silt curtains or other potential measures.

C. Noise

Noise from construction of the expansion at South Terminal will be minimized to the extent practical. Work will be completed during permitted work hours. However, the area around the site is within the Designated Port Area of New Bedford Harbor, and fishing vessels enter, offload, and exit New Bedford Harbor at all hours of the day. Navigational dredging (which can be a noisy process) has taken place within the Harbor for multiple events. There have been very few noise complaints during the navigational dredging process, which indicates that noise will likely not be a major problem during construction of the South Terminal CDF. Although noise may frighten wildlife, this may be for the best, as it will keep wildlife from being injured from construction operations at the site.

As stated earlier within the Neighborhood Analysis (**Section 5b**), Map Number 21, Lot Number 45 is adjacent to the residential neighborhood at Cove Street; however, this area would be utilized with much less frequency than other portions of the terminal. This property (as well as the other, southern ancillary properties) will be utilized primarily for wind blade lay-down. Although 24/7 access is required for the facility, this is anticipated to be required mainly due to issues associated with loading and unloading of vessels and assembly of wind turbines, activities that will not be occurring at the Map Number 21, Lot Number 45; therefore, although some access to the southern portion of that property may occur within a 24/7 timeframe, it will likely be very infrequent. Additionally, due to the anticipated use of the property (lay down of wind blades is anticipated to take place at the far southern end first, and subsequent wind blades are anticipated to be subsequently laid down in a south-to-north fashion as they arrive onsite, and then utilized in a north-to-south fashion), it is currently anticipated that noise caused by operations (when utilized) at this property will be relatively minimal.

D. Stormwater Management

Stormwater management as a part of the construction will be in accordance with standard construction means and methods. Best management practices (use of vegetated swales, stormwater detention basins (where possible), storm-ceptors (where possible), or other methods will be utilized to reduce sediment within stormwater prior to discharge to New Bedford Harbor. The site will be designed to manage stormwater in compliance with the Massachusetts Stormwater Handbook.

Erosion and sedimentation controls will be present at the site during the construction process. A Licensed Site Professional will review the presence of impacts to soil and/or groundwater located within the parcels that are anticipated to be incorporated within the proposed project, evaluate the health and environmental risk posed by the impacted soil and/or groundwater, and will determine how the project can be designed to prevent and/or minimize erosion of impacted sediment that could be transported into New Bedford Harbor during the design process.

E. Bilge Water Management

Vessels docked at the facility must comply with Section 311 of the Clean Water Act as Amended by the Oil Prevention Act of 1990. Bilge water requiring off load at the facility will be treated prior to discharge to the local POTW or shipped to a certified treatment facility.

F. Sloughing Slopes

To limit slope failures associated with propeller wash in the newly constructed channels a full geotechnical evaluation of the in-situ soils will be completed. Generally speaking native soils in New Bedford Harbor have an angle of repose of approximately 3 feet horizontal per 1foot vertical. The 3:1 slope has been utilized for conceptual design; a full geotechnical evaluation of the site must be completed prior to the establishment of side slopes as it relates to dredging.

G. Lighting

The newly constructed marine terminal in New Bedford will have security lighting as the rest of the City has street lights. When international vessels are at the facility and work is to be completed 24-hours a day temporary lighting will be utilized. Other than prudent management to ensure unnecessary use of lighting, it is unlikely that lighting can be controlled at the site due to the anticipated demand for 24-hour site usage.

H. Operational Prop Wash Post-Construction

In order to manage turbidity that may be generated from prop wash during operation of the facility, low speeds will be utilized by international vessels and installation vessels when approaching, maneuvering at the facility, or leaving the facility. This will also be necessary as there will be a limited amount of available room for the vessels to maneuver. Tugs with relatively shallow drafts will likely be utilized to transport installation vessels in and out of the harbor, which should minimize prop-wash turbidity. Additionally, tugs with shallower drafts than the larger vessels will likely be needed to maneuver the larger, international vessels into berthing at the facility.

iii. General Construction Sequence

The following section highlights the construction sequence and timing of construction activities.

A. Mitigation Construction

Construction of the mitigation will involve the placement of material within the intertidal restoration areas. Particular care will be utilized to ensure that the final grades are correct. It is likely that the material will be placed hydraulically to ensure that the surface is created relatively uniformly.

Creation of the marsh mitigation area will involve re-grading, and may involve the placement of erosion control mat (likely of a biodegradable material, such as coir or jute) and the re-graded slope may utilize one or more erosion control rolls (also made of coir or jute) to help to stabilize the slope temporarily while vegetation is replanted. Planting of wetlands plants will foster the permanent stabilization of the area. Invasive species removal will also be completed while re-planting occurs.

B. Oversight and Timing

A wetland scientist shall be on-site to monitor construction of the wetland mitigation area(s) to ensure compliance with the mitigation plan and to make adjustments when appropriate to meet mitigation goals.

To reduce the immediate threat and minimize the long-term potential of degradation, the species included on the "Invasive and Other Unacceptable Plant Species" list in Table 4 of the US Army Corps of Engineers New England District Mitigation Plan Guidance shall not be included as planting stock in the overall project. Only plant materials native and indigenous to the region shall be used.

C. Monitoring and Maintenance Plan

The following section provides guidance regarding monitoring and maintenance that will be conducted to ensure success of planned mitigation efforts.

Intertidal Areas and Marsh Area

The intertidal areas and marsh area as depicted on **Figure 8** will be inspected on a monthly basis during the period from April through October for the first 3 years after construction. Subsequent to the first 3 years, the mitigation areas will be inspected in May and September of each year for an additional 2 years. Inspections shall be completed by a wetland scientist. The general health of the plants within the marsh area shall be determined during each inspection. Invasive species found within the areas will be removed. The entire area will also be inspected for excessive erosion or siltation.

If plants are found to be dead or stressed, they will be replaced. If the erosion control blankets (which may be used with discretion to stabilize planting areas within the marsh restoration area) are found to have been torn or show evidence of tears, eroded material will be replaced and tears in the blanket will be sewn shut. If the coir rolls (which may be utilized to stabilize slopes within the salt mash restoration area) become dislodged, additional tie-downs will be added to secure the coir rolls. If excessive erosion or siltation is noted, grades within the area will be restored to match the final elevations. The coir rolls will be replaced or repaired if plant growth has not been well established before the coir roll has decayed.

Monitoring Reports

The results of the mitigation activities and subsequent inspections will be documented in annual reports that will be submitted to USEPA by December 15th of each year following the completion of the first growing season subsequent to planting.

FIGURE 1

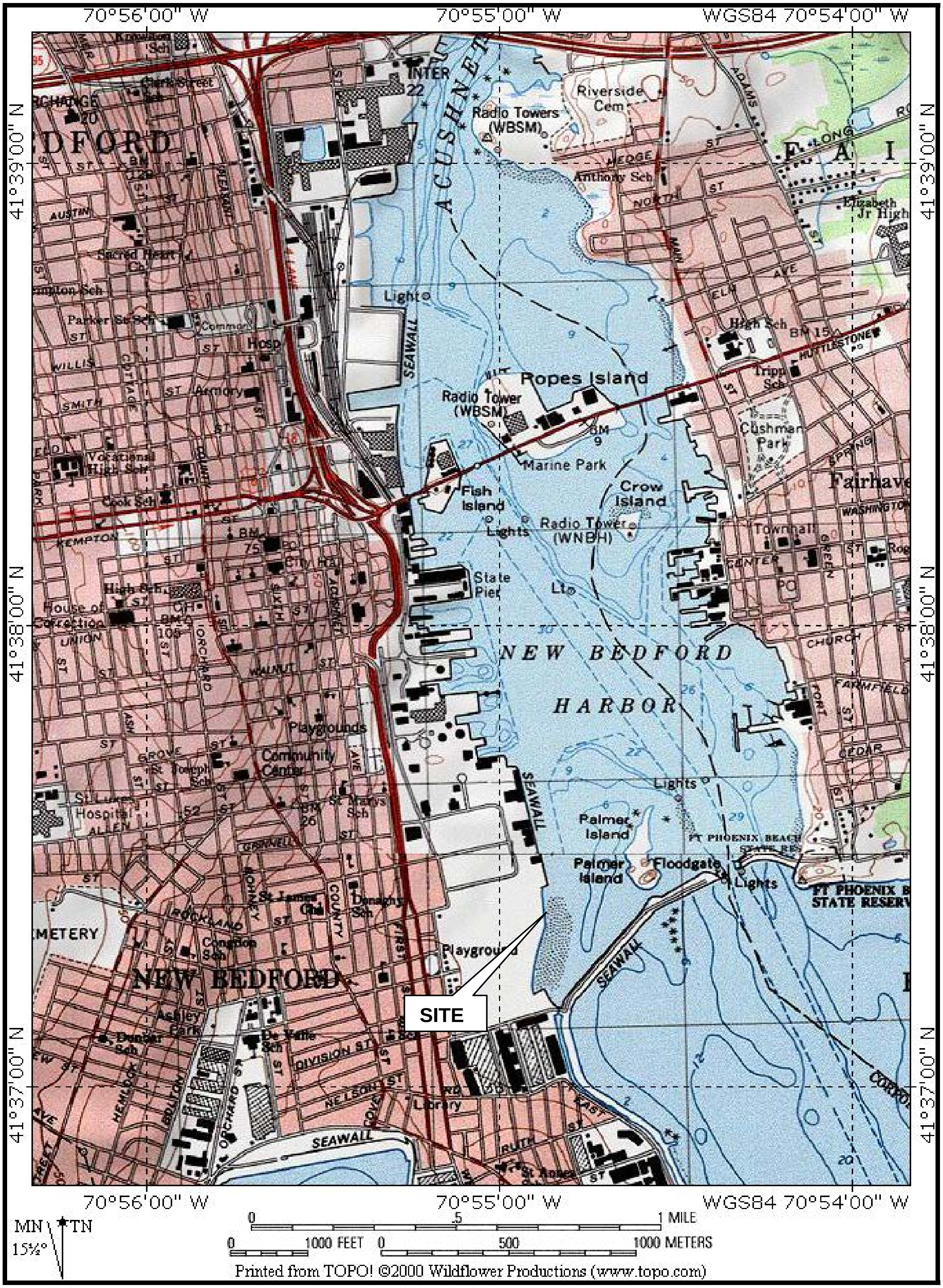


Figure 1: Site Location Map

South Terminal CDF Proposed Location

City of New Bedford, New Bedford, Massachusetts

FIGURE 2

Apex Companies, LLC

1 WAMSUTTA STREET
SUITE 6
NEW BEDFORD, MA 02740

184 HIGH STREET
BOSTON MA 02110

REVISIONS

NO.	DATE	DESCRIPTION

PREPARED FOR:

THE NEW BEDFORD
HARBOR DEVELOPMENT
COMMISSION
NEW BEDFORD,
MASSACHUSETTS

DRAWING TITLE:

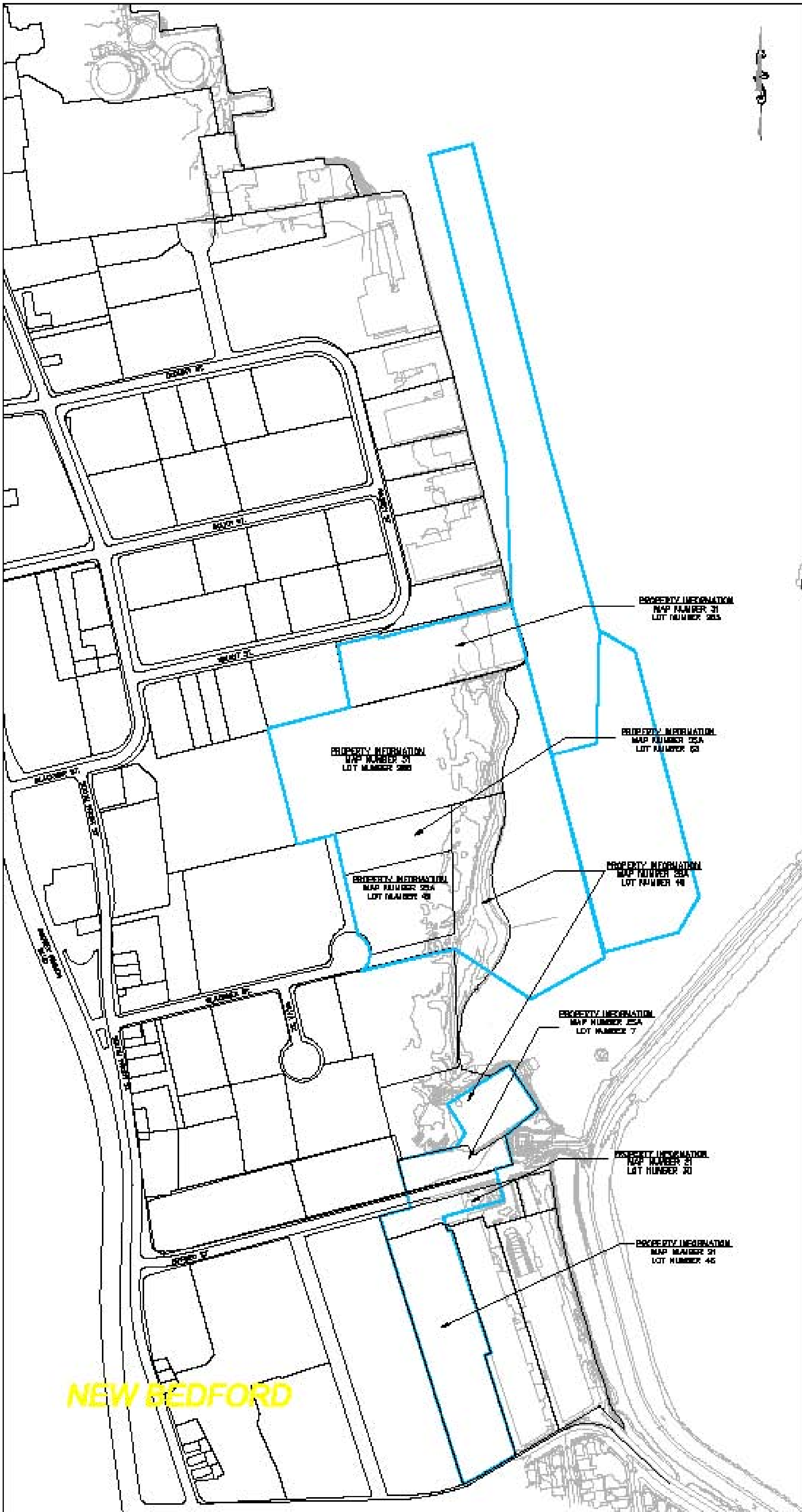
SOUTH TERMINAL
MARINE
INFRASTRUCTURE PARK
PROPOSED BULKHEAD

Scale: 1"=150'

0 75 150 300 400 FEET

Date	3/24/10	Drawing No.
Proj. Mgr.	JAB	
Design	CMM	P-4
Check	DHM	
Drawn	DDD	
Job. No.	[illegible]	
Last Rev.	[illegible]	

FIGURE 3



Apex

164 HIGH STREET
BOSTON MA 02110

REVISIONS

NO.	DATE	DESCRIPTION

PREPARED FOR:

THE NEW BEDFORD HARBOR DEVELOPMENT COMMISSION
NEW BEDFORD, MASSACHUSETTS

DRAWING TITLE:

SOUTH TERMINAL MARINE INFRASTRUCTURE PARK PROPOSED BULKHEAD

Scale: 1"=150'

0 75 150 300 450 FEET

Drawing No.

P-4

FIGURE 4

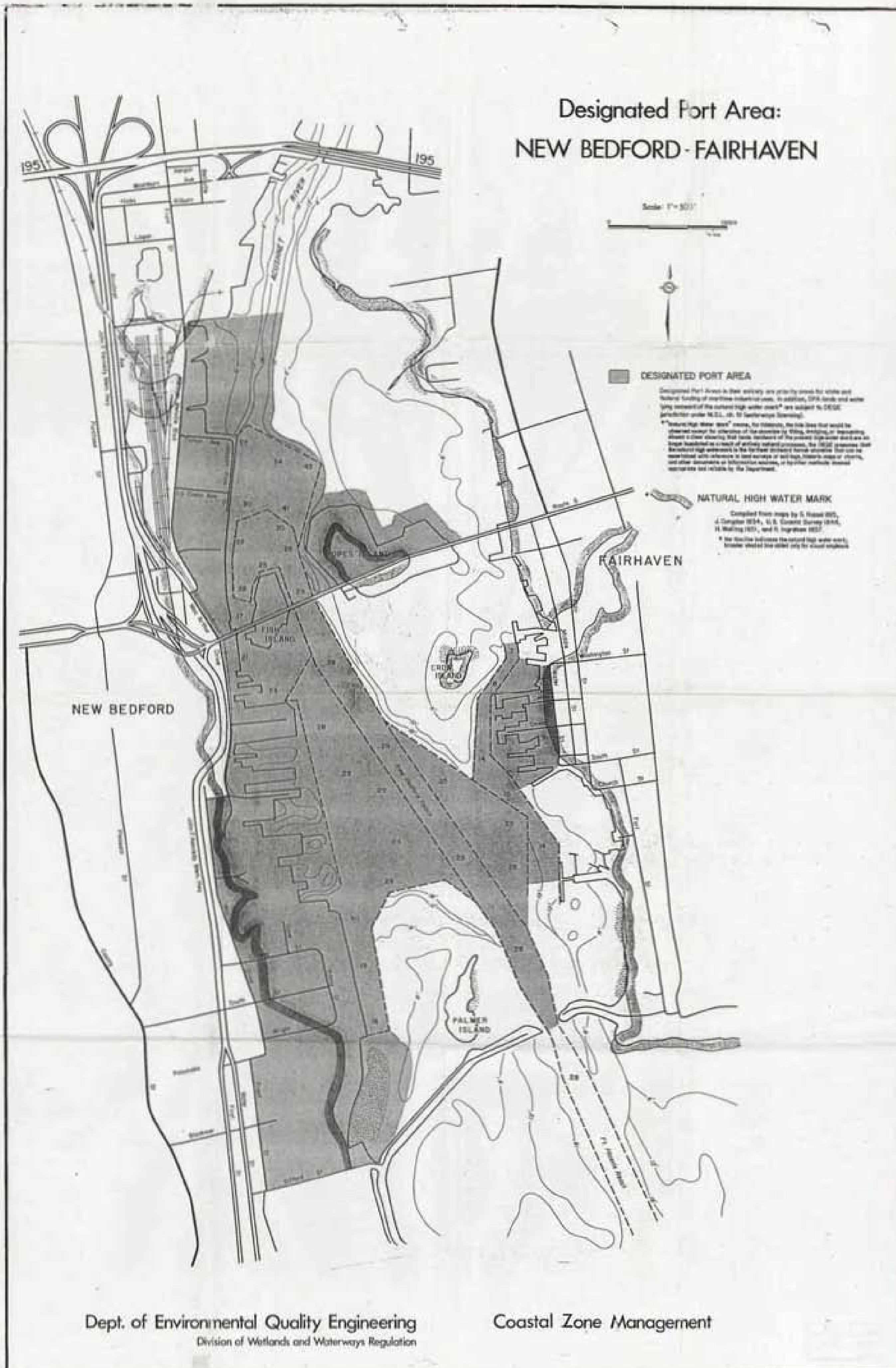

Designated Port Area:
NEW BEDFORD - FAIRHAVEN
DESIGNATED PORT AREA
NATURAL HIGH WATER MARK
FAIRHAVEN
NEW BEDFORD
FISH ISLAND
CROW ISLAND
PALMER ISLAND
195
Dept. of Environmental Quality Engineering
Division of Wetlands and Waterways Regulation
Coastal Zone Management

FIGURE 5

184 HIGH STREET
SUITE 502
BOSTON MA 02110
(617) 728-0070

REVISIONS

NO.	DATE	DESCRIPTION
1.	[illegible]	PRELIMINARY LAYOUT
2.	[illegible]	PRELIMINARY ASSESSMENT
3.	[illegible]	FIELD LOCATION
4.	[illegible]	ADD. FED. RESOURCE
5.	[illegible]	FINAL BULKHEAD ALIGNMENT

INTER-TIDAL

SUB-TIDAL

INTER-TIDAL SALT MARSH

APEX TEST PIT

PREPARED FOR:

THE NEW BEDFORD HARBOR DEVELOPMENT COMMISSION AND THE TOWN OF FAIRHAVEN, MASSACHUSETTS

DRAWING TITLE:

SOUTH TERMINAL MARINE INFRASTRUCTURE PARK 2010 FEDERAL RESOURCE AREA ASSESSMENT

Scale: 1"=150'

0 75 150 300 400 FEET

Date 3/24/10	Drawing No.
Proj. Mgr.	
Design	
Check GM	P-1
Drawn RCD	
Job. No. 8816	
Last Rev. 7/2/10	

FIGURE 6

Fish Smart—Use this Chart

Fish Smart-Use this Chart
¡Pesque con cabeza! Utilice esta gráfica
Pesque esperto-Use este mapa

Don't eat any fish
No coma pescado
Não coma peixe

Don't eat any lobster
No coma langosta
Não coma lagosta

Don't eat any shellfish
No coma mariscos
Não coma mariscos

Don't eat any bottom fish:
No coma pescado de fondo:
Não coma peixe de fundo:

- *flounder*
- *lenguado*
- *solha*

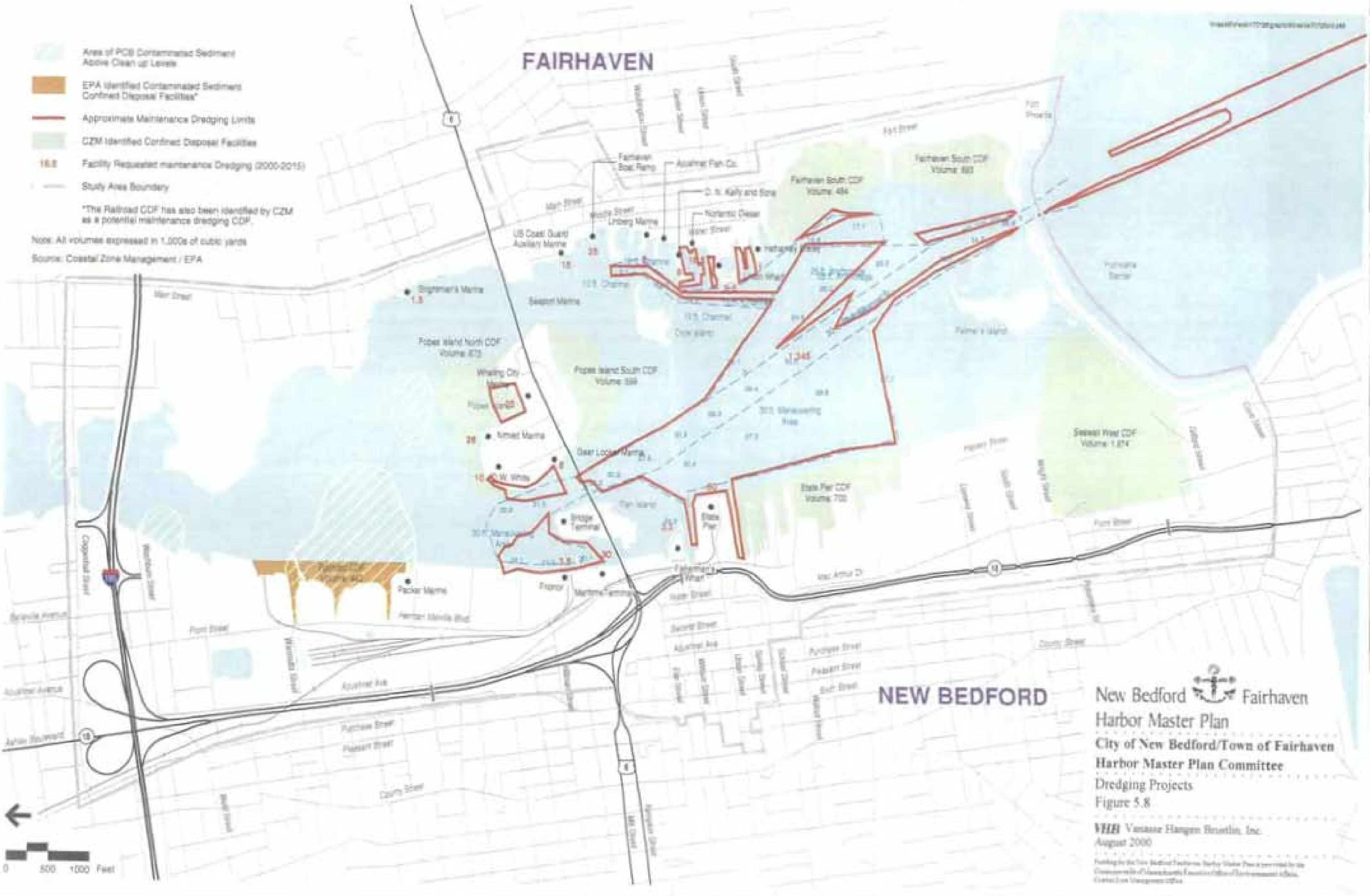
- *tautog*
- *tautoga*
- *bodião da ostra*

- *scup*
- *sargo*
- *sargo*

- *eel*
- *anguila*
- *anguila*

Map Produced By The US EPA New England GIS Center
30 May 2003

FIGURE 7



New Bedford Fairhaven
Harbor Master Plan

City of New Bedford/Town of Fairhaven
Harbor Master Plan Committee

Dredging Projects
Figure 5.8

VHB Vanasse Hangen Brustlin, Inc.
August 2000

FIGURE 8

Apex Companies, LLC
1 WAMSUTTA STREET, SUITE 8
NEW BEDFORD, MA 02740
(617) 728-0070
184 HIGH STREET, SUITE 502
BOSTON MA 02110
(617) 728-0070

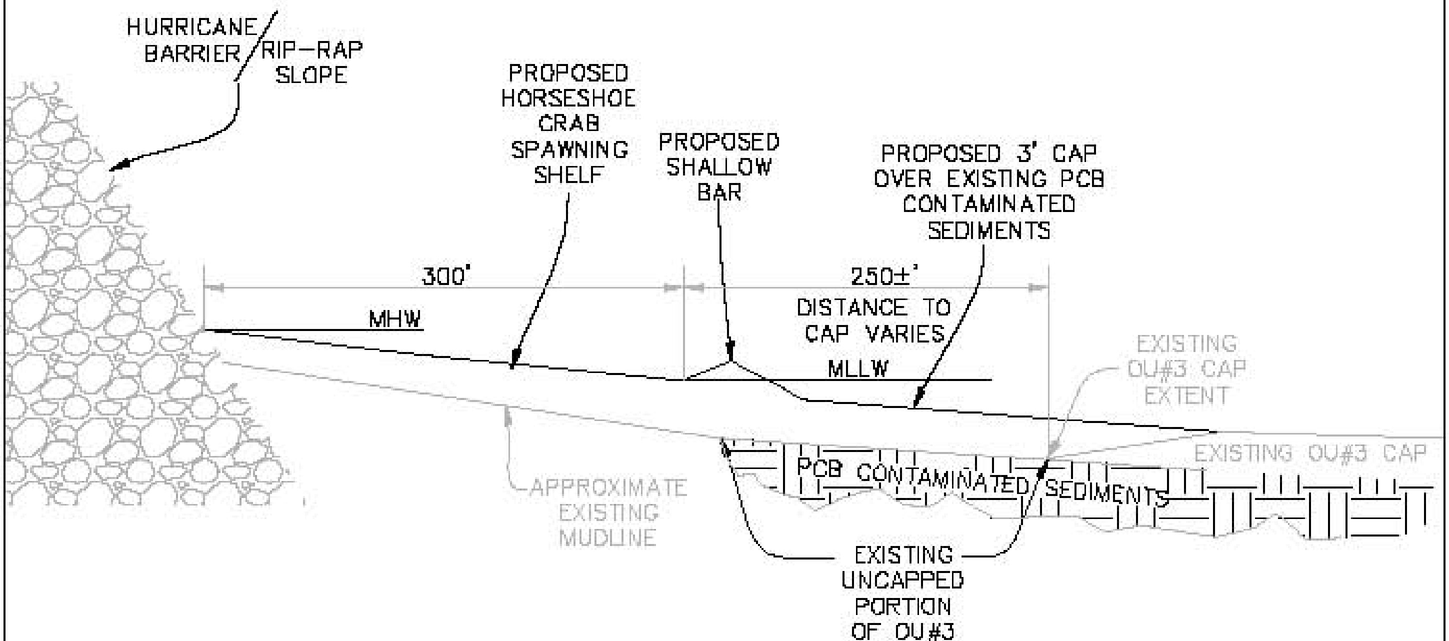
Mitigation Project Locus Map

SOUTH TERMINAL MARINE INFRASTRUCTURE PARK
NEW BEDFORD, MA

Scale: 1"=1500'

0 750 1500 2250

FIGURE 9



Scale: NOT TO SCALE

EXAMPLE COASTAL BEACH CREATION AREA OU#3 CAP LOCATION

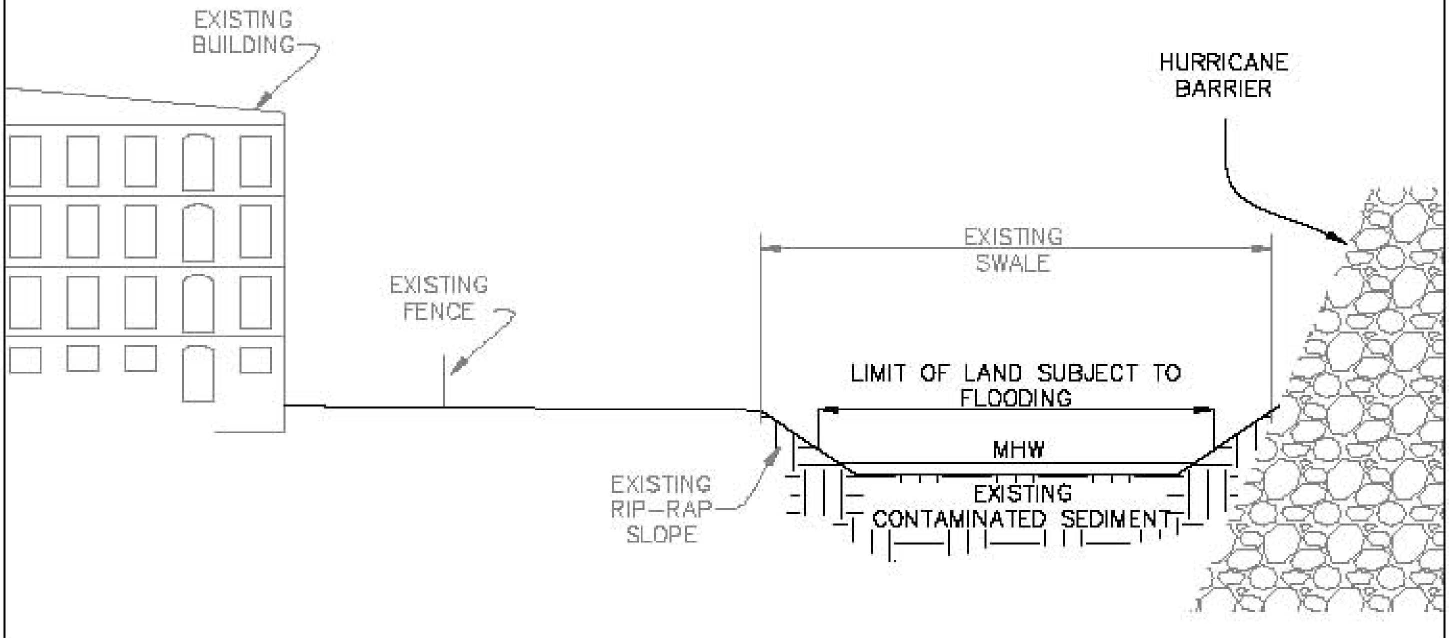
SOUTH TERMINAL CDF NEW BEDFORD, MA

Apex Companies, LLC
1 WAMSUTTA STREET, SUITE 8
NEW BEDFORD, MA 02740
(617) 728-0070
184 HIGH STREET, SUITE 502
BOSTON MA 02110
(617) 728-0070

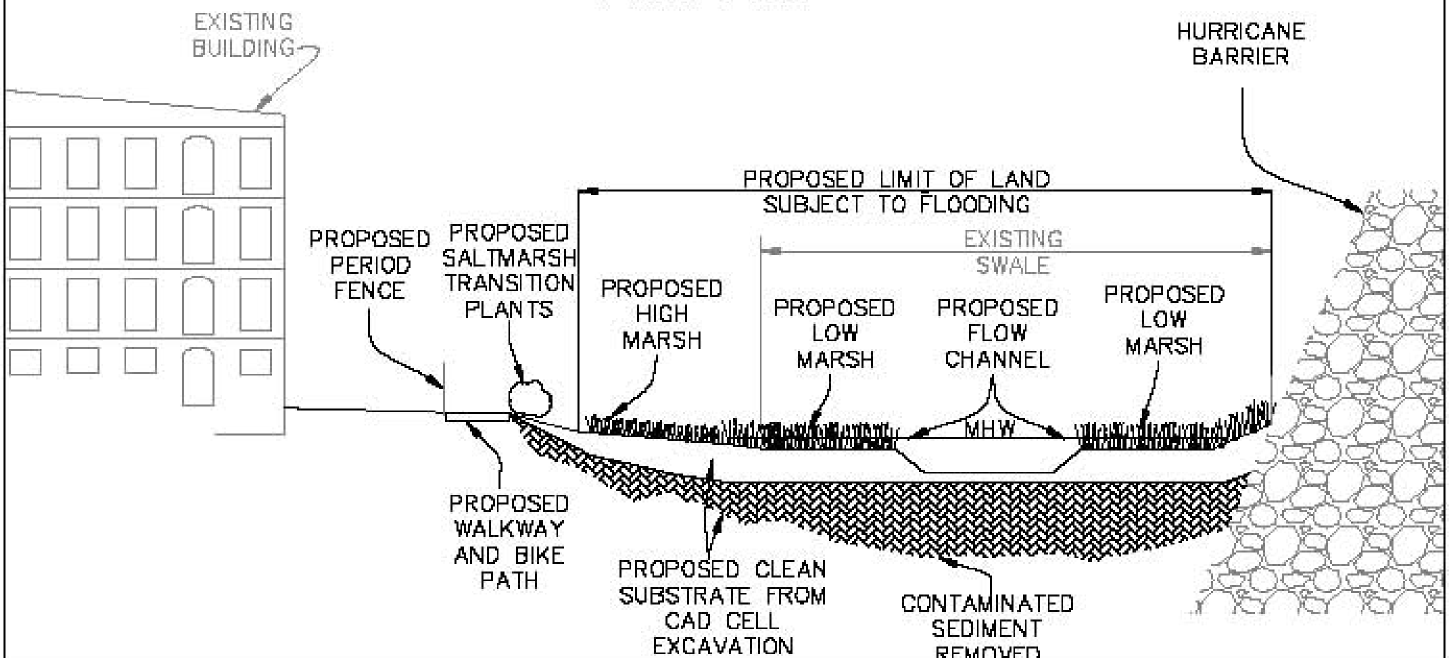
NEW BEDFORD HARBOR
DEVELOPMENT COMMISSION
106 CO-OP WHARF
NEW BEDFORD, MASSACHUSETTS
02740
(508) 961-3000

FIGURE 10

EXISTING



PROPOSED



Scale: 1"=30'

0 15 30 60

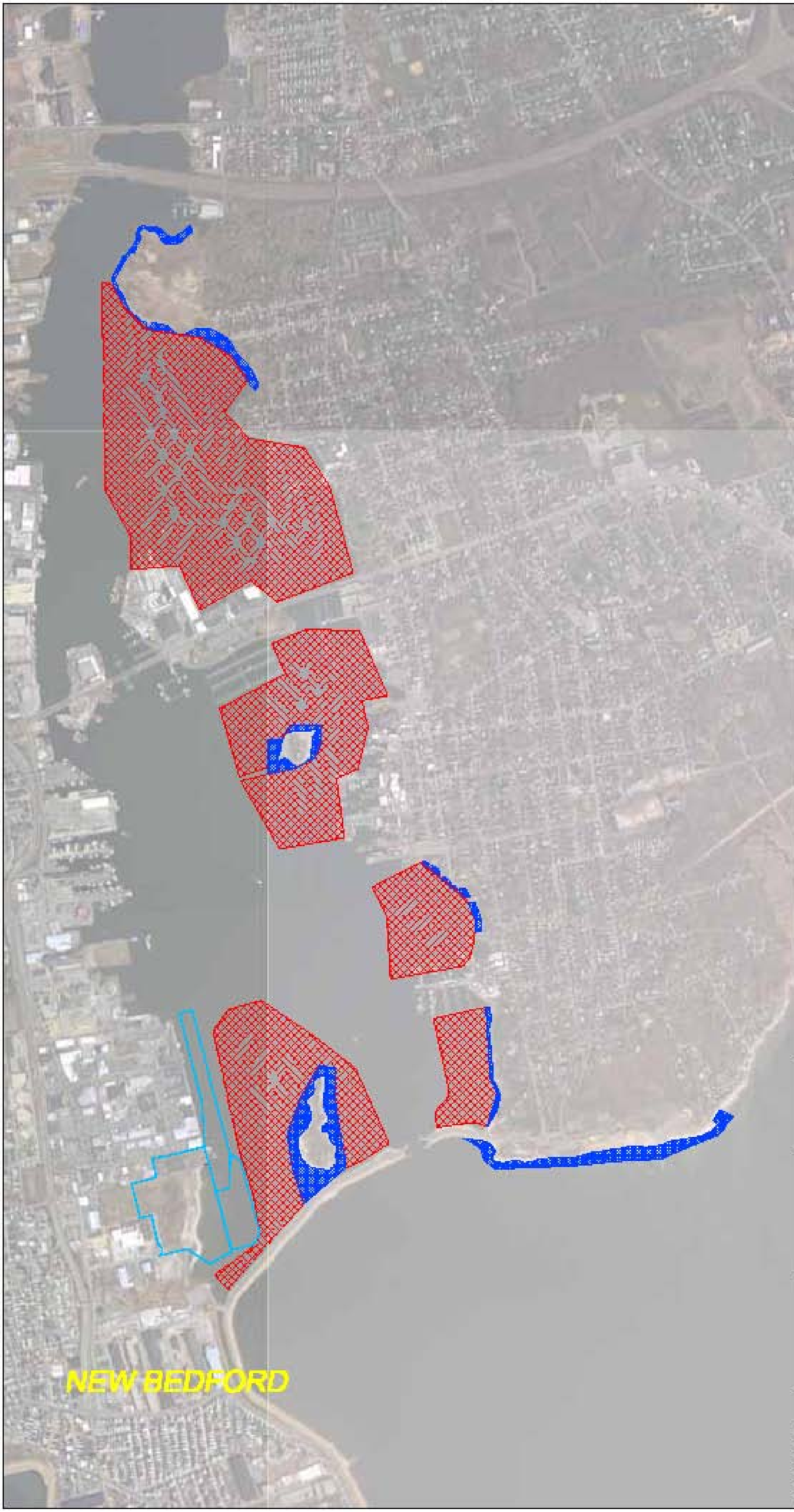
HURRICANE BARRIER RESOURCE AREA ENHANCEMENT

SOUTH TERMINAL CDF NEW BEDFORD, MA

Apex Companies, LLC
1 WAMSUTTA STREET, SUITE B
NEW BEDFORD, MA 02740
(617) 728-0070
184 HIGH STREET, SUITE 502
BOSTON MA 02110
(617) 728-0070

NEW BEDFORD HARBOR DEVELOPMENT COMMISSION
106 CO-OP WHARF
NEW BEDFORD, MASSACHUSETTS
02740
(508) 961-3000

FIGURE 11



Apex Companies, LLC

184 HIGH STREET
SUITE 502
BOSTON MA 02110
(617) 728-0070

REVISIONS

No.	DATE	DESCRIPTION
1.	[illegible]	PRELIMINARY LAYOUT
2.	[illegible]	PRELIMINARY ASSESSMENT
3.	4/16/10	FIELD LOCATION
4.	[illegible]	ADD. FED. RESOURCE

SUB-TIDAL (0 TO -10 FT MLLW)

INTERTIDAL

PREPARED FOR:

THE NEW BEDFORD
HARBOR DEVELOPMENT
COMMISSION
NEW BEDFORD,
MASSACHUSETTS

SOUTH TERMINAL
MARINE
INFRASTRUCTURE PARK
SIMILAR HABITATS
WITHIN NEW BEDFORD
HARBOR

Scale 1"=500'

0 250 500 1000 1500 FEET

Date	3/24/10
Proj. Mgr.	
Design	
Check	DM
Drawn	SRD
Job. No.	8013
Last Rev.	2/2/10

Drawing No.

P-1

FIGURE 12

Apex Companies, LLC

1 WAMSUTTA STREET
SUITE 6
NEW BEDFORD, MA 02740
(508) [illegible]

184 HIGH STREET
SUITE 502
BOSTON MA 02110
(617) 728-0070

REVISIONS

NO.	DATE	DESCRIPTION

PREPARED FOR:

THE NEW BEDFORD
HARBOR DEVELOPMENT
COMMISSION

DRAWING TITLE:

SOUTH TERMINAL
MARINE
INFRASTRUCTURE PARK
1911 POTOMSKA MILLS
OVERLAY

Scale: 1"=100'

0 50 100 200 300 FEET

Date	[illegible]	Drawing No.
Proj. Mgr.	JAB	
Design	[illegible]	
Check	[illegible]	A-1
Drawn	[illegible]	
Job No.	[illegible]	
Last Rev.	[illegible]	

APPENDIX 1

Jennifer Ann James

Wetland Biologist/Environmental Scientist

TECHNICAL EXPERTISE

- Wetlands, regulatory and environmental issues
- Wetland delineation and evaluation
- Benthic surveys
- Natural resource habitat assessment
- Permitting
- Environmental management/ land management plans
- Flora and fauna surveys

PROJECT ASSIGNMENT
Environmental Scientist

YEARS OF EXPERIENCE
Maguire: Since 2005
Total: Since 2001

EDUCATION
BS/2001/Wildlife Biology/ University of Rhode Island
MS/2010/Wetland Biology/ University of Rhode Island (in progress)

PROFESSIONAL TRAINING
OSHA 40-Hour HazWhopper
Wildlife Certification
Hunter Safety Course

PROFESSIONAL REGISTRATIONS
RI Soil Evaluator D-4081
Wildlife Society Member
Society of Wetland Scientists
New England Invasive Plant Group

PROFESSIONAL PROFILE

Ms. James is a wetland biologist and an environmental scientist skilled at managing individual and team projects related to wetlands, regulatory and environmental issues. Her experience includes wetland delineation and evaluation, natural resource habitat assessment, benthic surveys and analysis and permitting for major infrastructure design projects. Initial projects have involved field-related activities from soil and groundwater sampling to environmental management planning. Recently she has conducted a number of regulatory-required assessments including wetland delineation, permitting, environmental assessments, terrestrial and benthic habitat analysis and environmental management plans for state / federal agencies.

REPRESENTATIVE PROJECTS

Environmental Assessment Report and wetland delineation, Anguilla Landfill, St. Croix USVI: As part of the closure of the Anguilla Landfill a Coastal Zone Management permit was submitted this included an environmental assessment report (EAR). As part of the EAR a terrestrial resource review, wetland resource delineation and analysis, benthic survey and impact analysis for the project were preformed. Additional services include the overall impact of the project on the island and the coastal resources, water quality management and extensive mitigation efforts on the neighboring salt ponds, mangrove wetlands and Caribbean Sea.

Environmental Assessment Report and Natural Resource Survey, Diageo Distillery, St. Croix USVI: As part of the construction of a new distillery for Captain Morgan Rum a Major Tier 1 Coastal Zone Management permit was submitted this included an environmental assessment report (EAR). As part of the EAR are a terrestrial resource review, wetland resource delineation and analysis, benthic survey, endangered species review and impact analysis were performed. Due to the location of this project an extensive archaeological review was necessary and coordination with the Virgin Island State Preservation Officer was required.

Environmental Assessment Report and Natural Resource Survey, Bovoni Landfill, St. Thomas USVI: As part of the closure of the Bovoni Landfill a terrestrial resource study including endangered species mitigation (terrestrial and marine), CZM Permits and over five acres of wetland mitigation was conducted in accordance with EPA and Army Corps of Engineers. Additional permits included stormwater pollution prevention plans and air permits for the operation of the gas flare.

Permitting, Oak Bluffs Ferry Terminal/Pier, Martha's Vineyard, MA: Drafted permits for new construction of the Steamship Authority pier in Oak Bluffs that was being extended over the ocean and thus had potential impacts on endangered species. The permitting required a Notice of Intent, Essential Fish Habitat Assessments, Stormwater Management Policy, and Chapter 91 License.

Feasibility Study, MA Maritime Academy, Buzzard's Bay, MA: Prepared initial permit review and initial review of essential fish habitat which would be affected by maintenance dredging and instillation of new docks at the MMA. Additional review of what impacts these structures would have on other endangered species and eel grass. In addition to permit and endangered species review, the academy wanted more information about different types of aquaculture practices which could be used as part of this project.

Phase I Site Investigation and Wetland Permit Consulting, Cross Mills Fire Department, Charlestown, RI: This Phase I Environmental Assessment determined the potential for any hazardous materials or oil release and outlined potential problems building a new fire station within 50 feet of freshwater wetlands and under CRMC regulations.

Wetland Delineation and Permitting for Nickerson State Park, Brewster, MA: Delineated freshwater wetlands throughout a 1,900-acre State Park. Prepared Eastern Box Turtle work plan for Natural Heritage for the *Protection of the Endangered Eastern Box Turtle*. Prepared a Notice of Intent (NOI) for the local Conservation Commission and for MADEP, and attended public meetings. Coordinated and permitted a sewer replacement and electrical line replacement project for the Park with Massachusetts Historical, MADEP, the local Conservation Commission, and the Natural Heritage and Endangered Species Program.

Wetland Delineation and NOI Submittal, North Adams, MA: Delineated Freshwater vegetated wetlands for municipal road reconstruction. All permits were submitted and prepared for MADEP and the local conservation commission. **Wetland Delineation, Pearl Street Sewer Connection, Gardner, MA:** Delineated bordering freshwater wetlands for a section of road approximately five miles long.

Permitting and Wetland Delineation, WBDC Sewer Construction, Shrewsbury, MA: Delineated freshwater wetlands and prepared a NOI for the WBDC to construct a cross-county sewer line which connected to an undeveloped parcel. Prepared all documents and attended public meetings for the Conservation Commission.

Permitting and Wetlands Delineation, Gorton Pond, Warwick, RI: Delineated freshwater vegetated wetlands containing state endangered species. Prepared a preliminary determination on behalf of Warwick for the Rhode Island Department of Environmental Management (RIDEM).

Wetland Delineation for Road Construction, Hubbardston, MA: Delineated bordering vegetated wetlands for approximately one-and-a-half miles of road for a municipal road reconstruction project.

Permitting Terminal License, St. Croix Renaissance Group (SCRG), St. Croix, U.S. Virgin Islands (USVI): Prepared a terminal license application for EPA for a large-scale oil storage and oil transfer facility in the USVI. Follow-up documentation for a U.S. Coast Guard submittal was also prepared.

Public Perception, RI WINDS, RI: Reviewed public documents concerning the use of wind power for New England. Authored document defining public perception of large public works projects in Southern Massachusetts and all of Rhode Island. Documents created for the Energy Council of Rhode Island and the Governor of Rhode Island.

Wetland Delineation and NOI Submittal, Robins Road, Westborough, MA: Delineated freshwater vegetated wetlands and an ACOE (area of critical environmental concern) for municipal road reconstruction. All permits were submitted and prepared for MADEP and the local Conservation Commission.

Permitting/Wetland Delineation, Private Owner, Lincoln RI: Delineated freshwater vegetated wetlands and prepared permit deliverables for a private owner to expand on current building. Deliverables were prepared for RIDEM.

Permitting/Wetland Delineation, CVS Corporation, Smithfield, RI: Delineated freshwater vegetated wetlands and prepared permitting associated with parking lot expansion for RIDEM.

Coastal Resources Management Council (CRMC) Assent Application, Conanicut Yacht Club, Jamestown, RI: Created supporting documentation for the repairs to an existing seawall in accordance with CRMC regulations and concerns. Also permitted additional docks and building repair work to be done within the coastal zone.

Environmental Assessment, Togus, ME: Field surveying done to asses the ecological communities and the potential effects of development on a local National Guard Base. Completed inventory of flora and fauna.

Permitting and Delineation, Dexter Road, East Providence, RI: Delineated coastal vegetated wetlands and also inland vegetated wetlands. Also delineated areas of critical concern. Prepared permitting for RIDEM.

Wetland Delineation and Permitting, Parker Pond, Gardner, MA: Delineated wetland boundaries for the replacement of sewer lines running under land under water. Also drafted permits for borings and pipe-bursting activities.

Environmental Management Plan, Stone's Ranch Military Base, East Lyme CT: Created an environmental improvement and habitat management plan for the Connecticut U.S. Army National Guard. Plan was to be implemented and utilized by the entire base for any future development and maintenance of natural communities on the base. Created plan for over 1,800 acres of land. Incorporated plans for invasive species management, land-use trends, wildlife and fisheries habitat improvement, timber harvest, and rare species management.

Additional Experience

Small Mammal Surveying: Surveyed different state-owned management areas for the purpose of cataloging species and abundance present in different areas of Rhode Island.

Freshwater Fish Population Surveying: Surveyed different freshwater lakes, ponds and streams throughout Rhode Island for the purpose of cataloging species and abundance in difference areas of Rhode Island for the Department of Environmental Management.

Osprey Population Study: Responsible for all Osprey-related data collected for the State of Rhode Island. Required field work to conduct visual observations of nesting sites and dynamics of the species. Published annual newsletter stating the yearly finds and other general Osprey information.

TABLE 1A: SUMMARY SITE SPECIFIC AVIAN INFORMATION (RAW)

Species Name	Species Prioritization for Bird Conservation Region 30 (Mid-Atlantic/Southern New England)	Number of Mass Audubon Sightings Within Bristol County Between 2000-2010	Paskamansett Bird Club 2007 Christmas Bird Count****	Field Observation 1: Sighted New Bedford and Fairhaven Between 2005-2008 By New Bedford Amateur Bird Watcher Dan Harper*	Field Observation 2: 1987 New Bedford Superfund Site Bird Survey**	Field Observation 3: Mass Breeding Bird Atlas New Bedford North - 06***
Acadian Flycatcher		2				
Accipiter sp.		6				
American Bittern	M	6				
American Black Duck	HH	9793	341	X	X	
American Black Duck x Mallard (hybrid)		13				
American Coot		295				
American Crow		2423	126	X		X
American Golden-Plover	H	4				
American Goldfinch		2797	151	X		X
American Kestrel		23	1			
American Oystercatcher	HH	347		X		X
American Pipit		135				
American Redstart		160				
American Robin		10264	640	X	X	X
American Tree Sparrow		505	140			
American White Pelican		3				
American Wigeon	M	619				
American Woodcock	HH	15				
Arctic Tern		1				
Bald Eagle	M	29				
Baltimore Oriole	H	342		X		X
Bank Swallow		129				
Barn Swallow		1871			X	X
Barnacle Goose		1				
Barred Owl		3				
Barred Owl		3				
Barrow's Goldeneye		16	1	X		
Bay-breasted Warbler	H	3				
Belted Kingfisher		98	5	X		
Black Guillemot		1				
Black Scoter	H	6135	1			
Black Skimmer	M	2				
Black Tern		16				
Black Vulture		40				
Black-and-white Warbler	H	53				
Black-bellied Plover	H	416				
Black-billed Cuckoo		11				
Blackburnian Warbler	M	1				
Black-capped Chickadee		3021	221	X	X	X
Black-crowned Night-Heron	M	48			X	X
Black-headed Gull		3				
Black-necked Stilt		45				
Blackpoll Warbler		76				
Black-throated Blue Warbler		7				
Black-throated Green Warbler		13				
Blue Grosbeak		1				
Blue Jay		1932	185	X		X
Blue-gray Gnatcatcher		79				X
Blue-headed Vireo		6				
Blue-winged Teal		24				
Blue-winged Warbler	HH	148				X
Bobolink		106				
Bonaparte's Gull		159	4	X		
Brant	HH	2899	65	X		
Broad-winged Hawk	H	25				
Brown Creeper		49	5			
Brown Thrasher	H	58	2	X		
Brown-headed Cowbird		2574	6			X
Bufflehead	H	8219	349	X		
Buteo sp.		5				
Cackling Goose		1				
Calliope Hummingbird		4				
Canada Goose	H	21380	964	X		X
Canada Warbler	M	5				
Canvasback	H	619				
Carolina Wren		1234	58	X		X
Cattle Egret		2				
Cave Swallow		2				
Cedar Waxwing		1505	5	X		X
Chestnut-sided Warbler		9				
Chimney Swift	H	245		X	X	X
Chipping Sparrow		987		X		X
Clapper Rail	H	2				

TABLE 1A: SUMMARY SITE SPECIFIC AVIAN INFORMATION (RAW)

Species Name	Species Prioritization for Bird Conservation Region 30 (Mid-Atlantic/Southern New England)	Number of Mass Audubon Sightings Within Bristol County Between 2000-2010	Paskamansett Bird Club 2007 Christmas Bird Count****	Field Observation 1: Sighted New Bedford and Fairhaven Between 2005-2008 By New Bedford Amateur Bird Watcher Dan Harper*	Field Observation 2: 1987 New Bedford Superfund Site Bird Survey**	Field Observation 3: Mass Breeding Bird Atlas New Bedford North - 06***
Clay-colored Sparrow		3				
Cliff Swallow		6				
Common Eider	H	46554	420	X		
Common Goldeneye	M	6862	440	X		
Common Grackle		4374	12	X		X
Common Loon		840	13	X		
Common Merganser		665	1	X		
Common Nighthawk		2				
Common Raven		15				
Common Redpoll		48				
Common Tern	M	4564		X		
Common Yellowthroat		545			X	X
Cooper's Hawk		148	2	X		X
Dark-eyed Junco		2207	182	X		
Dickcissel		2				
Double-crested Cormorant		9039		X	X	
Downy Woodpecker		787	44			X
Dunlin	H	6103	8			
Eastern Bluebird		444				
Eastern Kingbird	H	183		X		X
Eastern Meadowlark		182	43			
Eastern Phoebe		191				X
Eastern Screech-Owl		32				X
Eastern Towhee	H	583	19			X
Eastern Wood-Pewee		82				
Empidonax sp.		8				
Eurasian Wigeon		7				
European Starling		45904	713	X	X	X
Field Sparrow	H	146	18			
Fish Crow		73				
Forster's Tern	H	15				
Fox Sparrow		40	2			
Gadwall	M	87	17			X
Glaucous Gull		2				
Glossy Ibis	H	150				
Golden-crowned Kinglet		401	10			
Grasshopper Sparrow	M	5				
Gray Catbird	M	1790	8	X		X
Great Black-backed Gull		4222	37	X	X	
Great Blue Heron		522	8			
Great Cormorant		771	10			
Great Crested Flycatcher	H	181		X		X
Great Egret		1226			X	
Great Horned Owl		23	2			
Greater Scaup	H	3158	2085	X		
Greater White-fronted Goose		6				
Greater Yellowlegs	H	593				
Greater/Lesser Scaup		526				
Green Heron		80				X
Green-winged Teal	M	192				
Hairy Woodpecker		101	5			X
Harlequin Duck	M	146				
hawk sp.		13				
Hermit Thrush		160	3			
Herring Gull		53140	503	X	X	
Hooded Merganser	M	1000	15			
Hooded Warbler		4				
Horned Grebe	H	973	158	X		
Horned Lark		686	171			X
House Finch		1746	96	X		X
House Sparrow		3834	331	X		X
House Wren		175			X	X
Iceland Gull		2				
Indigo Bunting		36				
Killdeer	M	401			X	X
Lapland Longspur		1				
Laughing Gull		641				
Least Bittern	M	1			X	
Least Flycatcher		52				
Least Sandpiper	M	1695				
Least Tern	H	2362		X	X	X
Lesser Black-backed Gull		7				
Lesser Scaup	H	1310	19			

TABLE 1A: SUMMARY SITE SPECIFIC AVIAN INFORMATION (RAW)

Species Name	Species Prioritization for Bird Conservation Region 30 (Mid-Atlantic/Southern New England)	Number of Mass Audubon Sightings Within Bristol County Between 2000-2010	Paskamansett Bird Club 2007 Christmas Bird Count****	Field Observation 1: Sighted New Bedford and Fairhaven Between 2005-2008 By New Bedford Amateur Bird Watcher Dan Harper*	Field Observation 2: 1987 New Bedford Superfund Site Bird Survey**	Field Observation 3: Mass Breeding Bird Atlas New Bedford North - 06***
Lesser Yellowlegs	M	236				
Lincoln's Sparrow		2				
Little Blue Heron	M	14				
Long-billed Dowitcher		2				
Long-tailed Duck	H	498	32	X		
Magnolia Warbler		16				
Mallard	H	5634	577	X	X	X
Manx Shearwater	M	1				
Marsh Wren	H	17				
Merlin		35	4			
Monk Parakeet		21				
Mourning Dove		2587	229		X	X
Mourning Warbler		0				
Mute Swan		2336	51	X	X	X
Nashville Warbler		7				
Nelson's Sparrow	M	13				X
Northern Cardinal		2480	128	X		X
Northern Flicker	H	533	28	X		X
Northern Gannet	H	407				
Northern Harrier		186	4			
Northern Mockingbird		580	27	X	X	X
Northern Parula		19				
Northern Pintail	M	1508	4			
Northern Rough-winged Swallow		111				X
Northern Saw-whet Owl		1				
Northern Shoveler		7				
Northern Shrike		2				
Northern Waterthrush		15				
Olive-sided Flycatcher		1				
Orange-crowned Warbler		10				
Orchard Oriole		28				X
Osprey		1703		X		
Ovenbird		218				
Palm Warbler		25				
Pectoral Sandpiper		50				
peep sp.		106		X		
Peregrine Falcon		32	1	X	X	
Philadelphia Vireo		1				
Pied-billed Grebe		51				
Pileated Woodpecker		1				
Pine Siskin		1278				
Pine Warbler		144				X
Piping Plover	HH	723				
Prairie Warbler	HH	48				
Purple Finch		92	6			
Purple Martin		22				
Purple Sandpiper	H	910				
Red Knot	HH	52				
Red-bellied Woodpecker		404	13			X
Red-breasted Merganser	M	4552	60	X		
Red-breasted Nuthatch		73	7			
Red-eyed Vireo		167				X
Redhead		10				
Red-necked Grebe		8				
Red-shouldered Hawk		124	11			X
Red-tailed Hawk		467	8	X		
Red-throated Loon	HH	459				
Red-winged Blackbird		4847		X	X	X
Ring-billed Gull		21388	876	X		
Ring-necked Duck		648				
Ring-necked Pheasant		3	1			
Rock Pigeon		2876	365	X	X	X
Roseate Tern	HH	2827				
Rose-breasted Grosbeak		38				X
Rough-legged Hawk		2	1			
Ruby-crowned Kinglet		61	1			
Ruby-throated Hummingbird		269				X
Ruddy Duck	M	707	3			
Ruddy Turnstone	HH	987				
Ruffed Grouse		1				
Rusty Blackbird	H	6				
Saltmarsh Sparrow	HH	606				X
Sanderling	HH	4299				

TABLE 1A: SUMMARY SITE SPECIFIC AVIAN INFORMATION (RAW)

Species Name	Species Prioritization for Bird Conservation Region 30 (Mid-Atlantic/Southern New England)	Number of Mass Audubon Sightings Within Bristol County Between 2000-2010	Paskamansett Bird Club 2007 Christmas Bird Count****	Field Observation 1: Sighted New Bedford and Fairhaven Between 2005-2008 By New Bedford Amateur Bird Watcher Dan Harper*	Field Observation 2: 1987 New Bedford Superfund Site Bird Survey**	Field Observation 3: Mass Breeding Bird Atlas New Bedford North - 06***
Savannah Sparrow		272	15			X
Scarlet Tanager		58				
scoter sp.		497				
Seaside Sparrow	HH	143				
Sedge Wren	M	1				
Semipalmated Plover	M	2537		X		
Semipalmated Sandpiper	H	1720				
Sharp-shinned Hawk		76	5	X		
Short-billed Dowitcher	H	250				
Short-billed/Long-billed Dowitcher		54				
Short-eared Owl		11				
Snow Bunting		288	83			
Snow Goose		2				
Snowy Egret	M	791		X	X	
Solitary Sandpiper	H	17				
Song Sparrow		3605	163	X	X	X
Spotted Sandpiper	M	236				X
Sterna sp.		20				
Stilt Sandpiper		1				
Surf Scoter	H	4147	14			
Surf/Black Scoter		111				
swallow sp.		263				
Swallow-tailed Kite		1				
Swamp Sparrow		226	2			
Tennessee Warbler		3				
Tree Swallow		16898		X	X	
Tricolored Heron	M	7				
Tufted Duck		18				
Tufted Titmouse		2046	180		X	X
Turkey Vulture		1132	5			X
Veery		88				
Vesper Sparrow		2				
Virginia Rail		5				
warbler sp.		60				
Warbling Vireo		56				
Western Sandpiper	M	2				
Whimbrel	HH	50				
White-breasted Nuthatch		604	21			X
White-crowned Sparrow		228	1			
White-eyed Vireo		76			X	
White-rumped Sandpiper	H	66				
White-throated Sparrow		1517	247	X		
White-winged Scoter	H	2511	23			
Wild Turkey		131	17			
Willet	H	1349				X
Willow Flycatcher	H	101				X
Wilson's Phalarope	H	4				
Wilson's Snipe		157				
Wilson's Storm-Petrel		36				
Wilson's Warbler		2				
Winter Wren		71				
Wood Duck	M	165		X		X
Wood Thrush	HH	157				
Worm-eating Warbler	H	2				
Yellow Warbler		1483				X
Yellow-bellied Flycatcher		2				
Yellow-bellied Sapsucker		11				
Yellow-billed Cuckoo		32				
Yellow-breasted Chat		11	1			
Yellow-crowned Night-Heron	M	1				
Yellow-rumped Warbler		1394	10	X		
Yellow-throated Vireo	H	3				

Species Prioritization for Bird Conservation Region 30 (Mid-Atlantic/Southern New England)
HH = Highest Priority
H = High Priority
M = Moderate Priority

Notes:
1). Mass Audubon bird sighting data compiled via archived data collected via eBird, an interactive computerized database that allows individual birdwatchers to report data online.

2). Bird Conservation Regions were formulated via the North American Bird Conservation Initiative, a forum of governmental agencies, private organizations, and bird initaives helping partners across the continent meet common bird conservation objectives. Priority Species for Bird

TABLE 1A: SUMMARY SITE SPECIFIC AVIAN INFORMATION (RAW)

Species Name	Species Prioritization for Bird Conservation Region 30 (Mid-Atlantic/Southern New England)	Number of Mass Audubon Sightings Within Bristol County Between 2000-2010	Paskamansett Bird Club 2007 Christmas Bird Count****	Field Observation 1: Sighted New Bedford and Fairhaven Between 2005-2008 By New Bedford Amateur Bird Watcher Dan Harper*	Field Observation 2: 1987 New Bedford Superfund Site Bird Survey**	Field Observation 3: Mass Breeding Bird Atlas New Bedford North - 06***

Conservation Region 30 (which includes New Bedford Harbor) were produced by the Atlantic Coast Joint Venture, another partnership of federal, state, and private entities formulated to improve bird habitat conservation within the Atlantic Flyway, and includes the U.S. Fish and Wildlife Service among its membership and leadership.

* - Amateur bird watching results published on Web Log by Dan Harper at http://www.danielharper.org/blog/?page_id=454. From 2005 - 2008 Mr. Harper recorded bird sightings within New Bedford and Fairhaven. At that time, Mr. Harper was the minister for the First Unitarian Church of New Bedford. Mr. Harper currently resides in Palo Alto, California.

** - This study specifically contrasted shorebird populations within the Inner New Bedford Harbor, to those at a location immediately outside of the Hurricane Barrier in Fairhaven, Massachusetts.

*** - This study counted the birds within the New Bedford Hurricane Barrier during breeding months (May 15 - August 1). Birds present within this time-frame were assumed to be breeding birds. .

**** - This study counted the birds on Christmas in 2007 in Dartmouth, New Bedford, Acushnet, Fairhaven, and Mattapoisett.

TABLE 1B: SUMMARY SITE SPECIFIC AVIAN INFORMATION (INITIAL SORT)
(Includes only birds observed by one of three Field Observers)

Species Name	Species Prioritization for Bird Conservation Region 30 (Mid-Atlantic/Southern New England)	Number of Mass Audubon Sightings Within Bristol County Between 2000-2010	Paskamansett Bird Club 2007 Christmas Bird Count****	Field Observer 1: Sighted New Bedford and Fairhaven Between 2005-2008 By New Bedford Amateur Bird Watcher Dan Harper*	Field Observer 2: 1987 New Bedford Superfund Site Bird Survey**	Field Observer 3: Mass Breeding Bird Atlas New Bedford North - 06***
American Black Duck	HH	9793	341	X	X	
American Crow		2423	126	X		X
American Goldfinch		2797	151	X		X
American Oystercatcher	HH	347		X		X
American Robin		10264	640	X	X	X
Baltimore Oriole	H	342		X		X
Barn Swallow		1871			X	X
Barrow's Goldeneye		16	1	X		
Belted Kingfisher		98	5	X		
Black-capped Chickadee		3021	221	X	X	X
Black-crowned Night-Heron	M	48			X	X
Blue Jay		1932	185	X		X
Blue-gray Gnatcatcher		79				X
Blue-winged Warbler	HH	148				X
Bonaparte's Gull		159	4	X		
Brant	HH	2899	65	X		
Brown Thrasher	H	58	2	X		
Brown-headed Cowbird		2574	6			X
Bufflehead	H	8219	349	X		
Canada Goose	H	21380	964	X		X
Carolina Wren		1234	58	X		X
Cedar Waxwing		1505	5	X		X
Chimney Swift	H	245		X	X	X
Chipping Sparrow		987		X		X
Common Eider	H	46554	420	X		
Common Goldeneye	M	6862	440	X		
Common Grackle		4374	12	X		X
Common Loon		840	13	X		
Common Merganser		665	1	X		
Common Tern	M	4564		X		
Common Yellowthroat		545			X	X
Cooper's Hawk		148	2	X		X
Dark-eyed Junco		2207	182	X		
Double-crested Cormorant		9039		X	X	
Downy Woodpecker		787	44			X
Eastern Kingbird	H	183		X		X
Eastern Phoebe		191				X
Eastern Screech-Owl		32				X
Eastern Towhee	H	583	19			X
European Starling		45904	713	X	X	X
Gadwall	M	87	17			X
Gray Catbird	M	1790	8	X		X
Great Black-backed Gull		4222	37	X	X	
Great Crested Flycatcher	H	181		X		X
Great Egret		1226			X	
Greater Scaup	H	3158	2085	X		
Green Heron		80				X
Hairy Woodpecker		101	5			X
Herring Gull		53140	503	X	X	
Horned Grebe	H	973	158	X		
Horned Lark		686	171			X
House Finch		1746	96	X		X
House Sparrow		3834	331	X		X
House Wren		175			X	X
Killdeer	M	401			X	X
Least Bittern	M	1			X	
Least Tern	H	2362		X	X	X
Long-tailed Duck	H	498	32	X		
Mallard	H	5634	577	X	X	X
Mourning Dove		2587	229		X	X
Mute Swan		2336	51	X	X	X
Nelson's Sparrow	M	13				X
Northern Cardinal		2480	128	X		X
Northern Flicker	H	533	28	X		X
Northern Mockingbird		580	27	X	X	X
Northern Rough-winged Swallow		111				X
Orchard Oriole		28				X
Osprey		1703		X		
peep sp.		106		X		
Peregrine Falcon		32	1	X	X	
Pine Warbler		144				X
Red-bellied Woodpecker		404	13			X
Red-breasted Merganser	M	4552	60	X		

TABLE 1B: SUMMARY SITE SPECIFIC AVIAN INFORMATION (INITIAL SORT)
(Includes only birds observed by one of three Field Observers)

Species Name	Species Prioritization for Bird Conservation Region 30 (Mid-Atlantic/Southern New England)	Number of Mass Audubon Sightings Within Bristol County Between 2000-2010	Paskamansett Bird Club 2007 Christmas Bird Count****	Field Observer 1: Sighted New Bedford and Fairhaven Between 2005-2008 By New Bedford Amateur Bird Watcher Dan Harper*	Field Observer 2: 1987 New Bedford Superfund Site Bird Survey**	Field Observer 3: Mass Breeding Bird Atlas New Bedford North - 06***
Red-eyed Vireo		167				X
Red-shouldered Hawk		124	11			X
Red-tailed Hawk		467	8	X		
Red-winged Blackbird		4847		X	X	X
Ring-billed Gull		21388	876	X		
Rock Pigeon		2876	365	X	X	X
Rose-breasted Grosbeak		38				X
Ruby-throated Hummingbird		269				X
Saltmarsh Sparrow	HH	606				X
Savannah Sparrow		272	15			X
Semipalmated Plover	M	2537		X		
Sharp-shinned Hawk		76	5	X		
Snowy Egret	M	791		X	X	
Song Sparrow		3605	163	X	X	X
Spotted Sandpiper	M	236				X
Tree Swallow		16898		X	X	
Tufted Titmouse		2046	180		X	X
Turkey Vulture		1132	5			X
White-breasted Nuthatch		604	21			X
White-eyed Vireo		76			X	
White-throated Sparrow		1517	247	X		
Willet	H	1349				X
Willow Flycatcher	H	101				X
Wood Duck	M	165		X		X
Yellow Warbler		1483				X
Yellow-rumped Warbler		1394	10	X		

Species Prioritization for Bird Conservation Region 30 (Mid-Atlantic/Southern New England)
HH = Highest Priority
H = High Priority
M = Moderate Priority

Notes:
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2). Bird Conservation Regions were formulated via the North American Bird Conservation Initiative, a forum of governmental agencies, private organizations, and bird initaives helping partners across the continent meet common bird conservation objectives. Priority Species for Bird Conservation Region 30 (which includes New Bedford Harbor) were produced by the Atlantic Coast Joint Venture, another partnership of federal, state, and private entities formulated to improve bird habitat conservation within the Atlantic Flyway, and includes the U.S. Fish and Wildlife Service among its membership and leadership.
* - Amateur bird watching results published on Web Log by Dan Harper at http://www.danielharper.org/blog/?page_id=454. From 2005 - 2008 Mr. Harper recorded bird sightings within New Bedford and Fairhaven. At that time, Mr. Harper was the minister for the First Unitarian Church of New Bedford. Mr. Harper currently resides in Palo Alto, California.
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**** - This study counted the birds on Christmas in 2007 in Dartmouth, New Bedford, Acushnet, Fairhaven, and Mattapoisett.

TABLE 1C: SUMMARY SITE SPECIFIC AVIAN INFORMATION (SECOND SORT)
(Includes only birds observed by Observer 2 or 3)

Species Name	Species Prioritization for Bird Conservation Region 30 (Mid-Atlantic/Southern New England)	Number of Mass Audubon Sightings Within Bristol County Between 2000-2010	Paskamansett Bird Club 2007 Christmas Bird Count****	Field Observer 1: Sighted New Bedford and Fairhaven Between 2005-2008 By New Bedford Amateur Bird Watcher Dan Harper*	Field Observer 2: 1987 New Bedford Superfund Site Bird Survey**	Field Observer 3: Mass Breeding Bird Atlas New Bedford North - 06***
American Black Duck	HH	9793	341	X	X	
American Crow		2423	126	X		X
American Goldfinch		2797	151	X		X
American Oystercatcher	HH	347		X		X
American Robin		10264	640	X	X	X
Baltimore Oriole	H	342		X		X
Barn Swallow		1871			X	X
Black-capped Chickadee		3021	221	X	X	X
Black-crowned Night-Heron	M	48			X	X
Blue Jay		1932	185	X		X
Blue-gray Gnatcatcher		79				X
Blue-winged Warbler	HH	148				X
Brown-headed Cowbird		2574	6			X
Canada Goose	H	21380	964	X		X
Carolina Wren		1234	58	X		X
Cedar Waxwing		1505	5	X		X
Chimney Swift	H	245		X	X	X
Chipping Sparrow		987		X		X
Common Grackle		4374	12	X		X
Common Yellowthroat		545			X	X
Cooper's Hawk		148	2	X		X
Downy Woodpecker		787	44			X
Eastern Kingbird	H	183		X		X
Eastern Phoebe		191				X
Eastern Screech-Owl		32				X
Eastern Towhee	H	583	19			X
European Starling		45904	713	X	X	X
Gadwall	M	87	17			X
Gray Catbird	M	1790	8	X		X
Great Crested Flycatcher	H	181		X		X
Green Heron		80				X
Hairy Woodpecker		101	5			X
Horned Lark		686	171			X
House Finch		1746	96	X		X
House Sparrow		3834	331	X		X
House Wren		175			X	X
Killdeer	M	401			X	X
Least Tern	H	2362		X	X	X
Mallard	H	5634	577	X	X	X
Mourning Dove		2587	229		X	X
Mute Swan		2336	51	X	X	X
Nelson's Sparrow	M	13				X
Northern Cardinal		2480	128	X		X
Northern Flicker	H	533	28	X		X
Northern Mockingbird		580	27	X	X	X
Northern Rough-winged Swallow		111				X
Orchard Oriole		28				X
Peregrine Falcon		32	1	X	X	
Pine Warbler		144				X
Red-bellied Woodpecker		404	13			X
Red-eyed Vireo		167				X
Red-shouldered Hawk		124	11			X
Red-winged Blackbird		4847		X	X	X
Rock Pigeon		2876	365	X	X	X
Rose-breasted Grosbeak		38				X
Ruby-throated Hummingbird		269				X
Saltmarsh Sparrow	HH	606				X
Savannah Sparrow		272	15			X
Snowy Egret	M	791		X	X	
Song Sparrow		3605	163	X	X	X
Spotted Sandpiper	M	236				X
Tree Swallow		16898		X	X	
Tufted Titmouse		2046	180		X	X
Turkey Vulture		1132	5			X
White-breasted Nuthatch		604	21			X
White-eyed Vireo		76			X	
Willet	H	1349				X
Willow Flycatcher	H	101				X
Wood Duck	M	165		X		X
Yellow Warbler		1483				X

Species Prioritization for Bird Conservation Region 30 (Mid-Atlantic/Southern New England)
HH = Highest Priority

TABLE 1C: SUMMARY SITE SPECIFIC AVIAN INFORMATION (SECOND SORT)
(Includes only birds observed by Observer 2 or 3)

Species Name	Species Prioritization for Bird Conservation Region 30 (Mid-Atlantic/Southern New England)	Number of Mass Audubon Sightings Within Bristol County Between 2000-2010	Paskamansett Bird Club 2007 Christmas Bird Count****	Field Observer 1: Sighted New Bedford and Fairhaven Between 2005-2008 By New Bedford Amateur Bird Watcher Dan Harper*	Field Observer 2: 1987 New Bedford Superfund Site Bird Survey**	Field Observer 3: Mass Breeding Bird Atlas New Bedford North - 06***

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M = Moderate Priority

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*** - This study counted the birds within the New Bedford Hurricane Barrier during breeding months (May 15 - August 1). Birds present within this time-frame were assumed to be breeding birds. .
**** - This study counted the birds on Christmas in 2007 in Dartmouth, New Bedford, Acushnet, Fairhaven, and Mattapoisett.

TABLE 1D: SUMMARY SITE SPECIFIC AVIAN INFORMATION (THIRD SORT)
(Includes only birds observed by Observer 2 or 3 and are Priority Species Within Bird Conservation Region 30)

Species Name	Species Prioritization for Bird Conservation Region 30 (Mid-Atlantic/Southern New England)	Number of Mass Audubon Sightings Within Bristol County Between 2000-2010	Paskamansett Bird Club 2007 Christmas Bird Count****	Field Observer 1: Sighted New Bedford and Fairhaven Between 2005-2008 By New Bedford Amateur Bird Watcher Dan Harper*	Field Observer 2: 1987 New Bedford Superfund Site Bird Survey**	Field Observer 3: Mass Breeding Bird Atlas New Bedford North - 06***
American Black Duck	HH	9793	341	X	X	
American Oystercatcher	HH	347		X		X
Baltimore Oriole	H	342		X		X
Black-crowned Night-Heron	M	48			X	X
Blue-winged Warbler	HH	148				X
Canada Goose	H	21380	964	X		X
Chimney Swift	H	245		X	X	X
Eastern Kingbird	H	183		X		X
Eastern Towhee	H	583	19			X
Gadwall	M	87	17			X
Gray Catbird	M	1790	8	X		X
Great Crested Flycatcher	H	181		X		X
Killdeer	M	401			X	X
Least Tern	H	2362		X	X	X
Mallard	H	5634	577	X	X	X
Nelson's Sparrow	M	13				X
Northern Flicker	H	533	28	X		X
Saltmarsh Sparrow	HH	606				X
Snowy Egret	M	791		X	X	
Spotted Sandpiper	M	236				X
Willet	H	1349				X
Willow Flycatcher	H	101				X
Wood Duck	M	165		X		X

Species Prioritization for Bird Conservation Region 30 (Mid-Atlantic/Southern New England)
HH = Highest Priority
H = High Priority
M = Moderate Priority

Notes:
1). Mass Audubon bird sighting data compiled via archived data collected via eBird, an interactive computerized database that allows individual birdwatchers to report data online.
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**** - This study counted the birds on Christmas in 2007 in Dartmouth, New Bedford, Acushnet, Fairhaven, and Mattapoisett.

APPENDIX 2

nabci | partnerships & plans | tools & resources | news & events

nabci

Advancing integrated bird conservation in North America

Links to other NABCI efforts:

NABCI International

NABCI Mexico

NABCI Canada

Integrated bird conservation is about conserving birds:

- Across geopolitical boundaries
- Across taxonomic groups
- Across landscapes

It's about people working together to secure the future for North America's wild birds.

Welcome to the official Web site of the United States NABCI Committee.

The U.S. North American Bird Conservation Initiative (NABCI) Committee is a forum of government agencies, private organizations, and bird initiatives helping partners across the continent meet their common bird conservation objectives.

The Committee's strategy is to foster coordination and collaboration on key issues of concern, including coordinated bird monitoring, conservation design, private land conservation, international conservation, and institutional support in state and federal agencies for integrated bird conservation.

U.S. NABCI Committee January 2010 meeting summary

Next U.S. NABCI Committee meeting: August 2010 in Arlington, Virginia

U.S. NABCI Subcommittees:

Policy and Legislative
Monitoring and Database Management Team
Private Lands
Conservation Design
Communications
State of the Birds

Tri-national NABCI Committee is the international expression of NABCI and serves to increase cooperation and effectiveness of bird conservation efforts among the three countries.

News: NABCI and Association of Joint Venture Management Boards announce 2010 bird conservation award winners: Gary Myers, Kirk Nelson, and Charles Baxter. Read more here...

News: On March 11, Secretary of the Interior Ken Salazar released the 2010 State of the Birds Report, the first themed State of the Birds report which explores the vulnerability of birds and their habitats to climate changes across the major biomes of the United States.
For more information, visit:

State of the Birds Web site

News: Field Guide to the 2008 Farm Bill for Fish and Wildlife Conservation, a publication of U.S. NABCI and the Intermountain West Joint Venture, is now available! Version 1.1
You can also read the Farm Bill Guide online at www.nabci-us.org/fbguidehome.htm

The All-Bird Bulletin - News and information from the U.S. NABCI Committee

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Bird Conservation Regions | Species Assessment | Bird Info and Data | Events | News

Last updated January 2010

Bird Conservation Regions (BCRs)

View an interactive BCR Map with BCR descriptions, contacts, and links to bird conservation plans.

or use Acrobat Reader or similar program to download the following documents:
Bird Conservation Region Map | Bird Conservation Region Descriptions

Don't have Adobe Acrobat Reader? Get it free online.To access ArcInfo files of the BCRs, click here.

What are Bird Conservation Regions? Bird Conservation Regions (BCRs) are ecologically distinct regions in North America with similar bird communities, habitats, and resource management issues. BCRs are a single application of the scale-flexible hierarchical framework of nested ecological units delineated by the Commission for Environmental Cooperation (CEC). The CEC framework comprises a hierarchy of 4 levels of ecoregions. At each spatial level, spatial resolution increases and ecoregions encompass areas that are progressively more similar in their biotic (e.g., plant and wildlife) and abiotic (e.g., soils, drainage patterns, temperature, and annual precipitation) characteristics. BCRs may be partitioned into smaller ecological units when finer scale conservation planning, implementation, and evaluation are necessary. Conversely, BCRs may be aggregated to facilitate conservation partnerships throughout the annual range of a group of species, recognizing that migratory species may use multiple BCRs throughout their annual life cycle. BCRs also facilitate domestic and international cooperation in bird conservation because these areas of relatively homogenous habitats and bird communities traverse state, provincial, and national borders.

How were BCRs developed? A mapping team comprised of members from United States, Mexico, and Canada assembled at the first international NABCI workshop held in Puebla, Mexico, in November 1998, to develop a consistent spatial framework for bird conservation in North America. After agreeing on general principles and considering numerous ecoregion delineations, they adopted CEC's hierarchical framework of nested ecological units. The team's US members met in December of that year in Memphis, Tennessee, to apply the framework to the United States and developed a proposed map of BCRs. BCRs were created by aggregating CEC level II, III, and IV ecoregions in combinations that reflect current understanding of bird species distribution and life history requirements. The map was presented to and approved by the US NABCI Committee during its November 1999, meeting.The map is a dynamic tool. Its BCR boundaries will change over time as new scientific information becomes available. It is expected that the map will be updated every three years, with the next update occurring in November 2002.

What are the primary purposes of BCRs? The primary purposes of BCRs, as proposed by the mapping team in 1998 and approved in concept by the US Committee in 1999, are to:

- facilitate communication among the bird conservation initiatives;
- systematically and scientifically apportion the US into conservation units;
- facilitate a regional approach to bird conservation;
- promote new, expanded, or restructured partnerships; and
- identify overlapping or conflicting conservation priorities.

As integrated bird conservation progresses in North America, Bird Conservation Regions should ultimately function as the primary units within which biological foundation issues are resolved, the landscape configuration of sustainable habitats is designed, and priority projects originate.

- For more information on the ecological framework and the philosophy behind the development of BCRs, download the following document:
  A Proposed Framework for Delineating Ecologically-based Planning, Implementation, and Evaluation Units for Cooperative Bird Conservation in the US

- For more information on BCRs and their relationship to Joint Ventures, download the following document:
  BCRs and JVs: Evolving Roles for Bird Conservation Delivery

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Last updated January 2010

North American Bird Conservation Initiative

Bird Conservation Regions

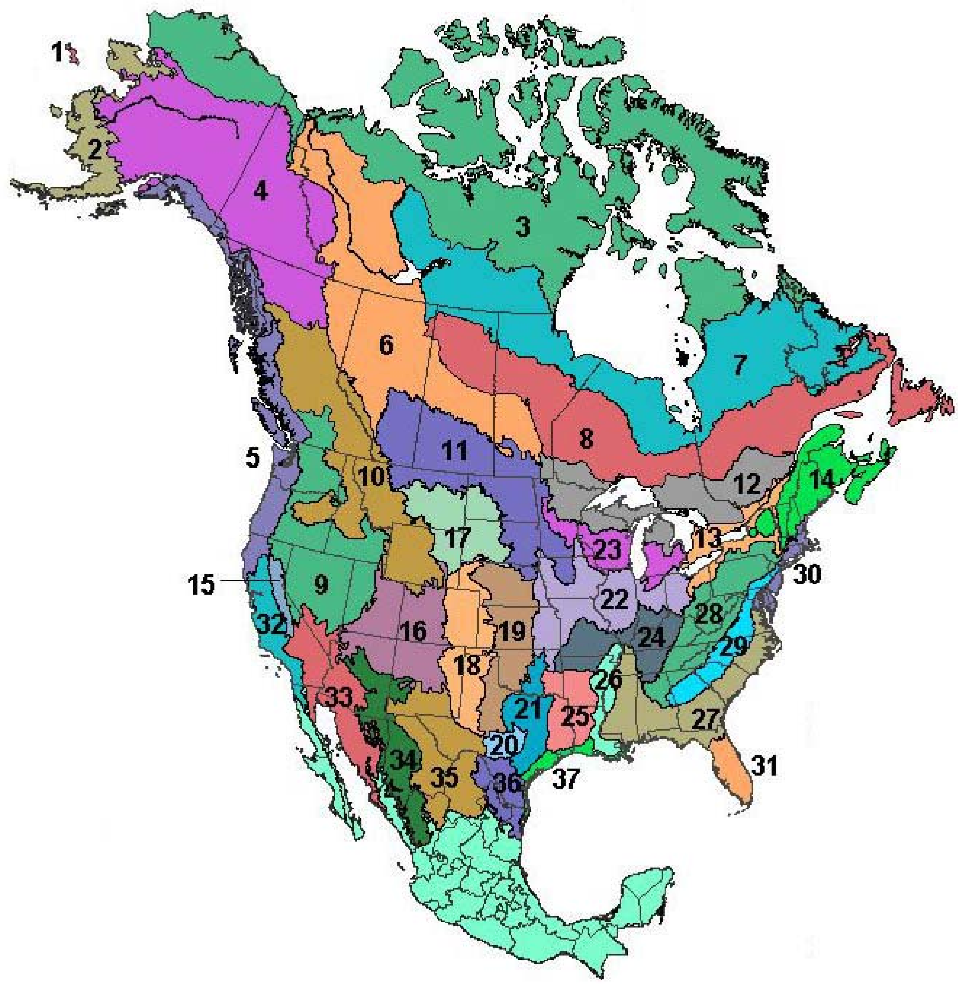
Initiative de conservation des oiseaux de l'Amérique du Nord

Regiones NABCI para la conservación de la Avifauna de Norteamérica

- 1. Aleutian/Bering Sea Islands
- 2. Western Alaska
- 3. Arctic Plains and Mountains
- 4. Northwestern Interior Forest
- 5. Northern Pacific Rainforest
- 6. Boreal Taiga Plains
- 7. Taiga Shield and Hudson Plains
- 8. Boreal Softwood Shield
- 9. Great Basin
- 10. Northern Rockies
- 11. Prairie Potholes
- 12. Boreal Hardwood Transition
- 13. Lower Great Lakes/St. Lawrence Plain
- 14. Atlantic Northern Forest
- 15. Sierra Nevada
- 16. Southern Rockies/Colorado Plateau
- 17. Badlands and Prairies
- 18. Shortgrass Prairie
- 19. Central Mixed-grass Prairie
- 20. Edwards Plateau
- 21. Oaks and Prairies
- 22. Eastern Tallgrass Prairie
- 23. Prairie Hardwood Transition
- 24. Central Hardwoods
- 25. West Gulf Coastal Plain/Ouachitas
- 26. Mississippi Alluvial Valley
- 27. Southeastern Coastal Plain
- 28. Appalachian Mountains
- 29. Piedmont
- 30. New England/Mid-Atlantic Coast
- 31. Peninsular Florida
- 32. Coastal California
- 33. Sonoran and Mohave Deserts
- 34. Sierra Madre Occidental
- 35. Chihuahuan Desert
- 36. Tamaulipan Brushlands
- 37. Gulf Coastal Prairie
- 38. Islas Marías
- 39. Sierras de Baja California
- 40. Desierto de Baja California
- 41. Islas del Golfo de California
- 42. Sierra y Planicies de El Cabo
- 43. Planicie Costera, Lomeríos y Cañones de Occidente
- 44. Marismas Nacionales
- 45. Planicie Costera y Lomeríos del Pacífico Sur
- 46. Sur del Altiplano Mexicano
- 47. Eje Neovolcánico Transversal
- 48. Sierra Madre Oriental
- 49. Planicie Costera y Lomeríos Secos del Golfo de México
- 50. Cuenca del Río Balsas
- 51. Valle de Tehuacán–Cuicatlán
- 52. Planicie Costera y Lomeríos Húmedos del Golfo de México
- 53. Sierra Madre del Sur
- 54. Sierra Norte de Puebla–Oaxaca
- 55. Planicie Noroccidental de Yucatán
- 56. Planicie de la Península de Yucatán
- 57. Isla Cozumel
- 58. Altos de Chiapas
- 59. Depresiones Intermontanas
- 60. Sierra Madre de Chiapas
- 61. Planicie Costera del Soconusco
- 62. Archipiélago de Revillagigedo
- 63. Isla Guadalupe
- 64. Arrecife Alacranes
- 65. Los Tuxtlas
- 66. Pantanos de Centla–Laguna de Términos
- 67. Hawaii
- • Important Bird Area (displayed for Mexico only)

Bird Conservation Region 30

New England/Mid-Atlantic Coast



Note: Hawaii (not shown) is BCR 67

Description: This area has the densest human population of any region in the country. Much of what was formerly cleared for agriculture is now either in forest or in residential use. The highest priority birds are in coastal wetland and beach habitats, including the Saltmarsh Sharp-tailed Sparrow and Nelson's Sharp-tailed Sparrow, Seaside Sparrow, Piping Plover, American Oystercatcher, American Black Duck, and Black Rail. The region includes critical migration sites for Red Knot, Ruddy Turnstone, Sanderling, Semipalmated Sandpiper, and Dunlin. Most of the continental population of the endangered Roseate Tern nests on islands off the southern New England states. Other terns and gulls nest in large numbers, and large mixed colonies of herons, egrets, and ibis may form on islands in the Delaware and Chesapeake Bay regions. Estuarine complexes and embayments created behind barrier beaches in this region are extremely important to wintering and migrating waterfowl, including approximately 65 percent of the total wintering American Black Duck population, along with large numbers of Greater Scaup, Tundra Swan, Gadwall, Brant, and Canvasback. Exploitation and pollution of Chesapeake Bay and other coastal zones, and the accompanying loss of submerged aquatic vegetation, have significantly reduced their value to waterfowl.

Bird Conservation Plans

Landbirds - Mid-Atlantic Coastal Plains, Southern New England
Shorebirds - Northern Atlantic
Waterbirds - Mid Atlantic/New England/Maritimes
Waterfowl - Atlantic Coast Joint Venture Waterfowl Implementation Plan
All Birds -New England/Mid-Atlantic Coast BCR

Implementation Plan, Atlantic Coast Joint Venture Strategic Plan

Joint Venture area: Atlantic Coast

Atlantic Coast Joint Venture

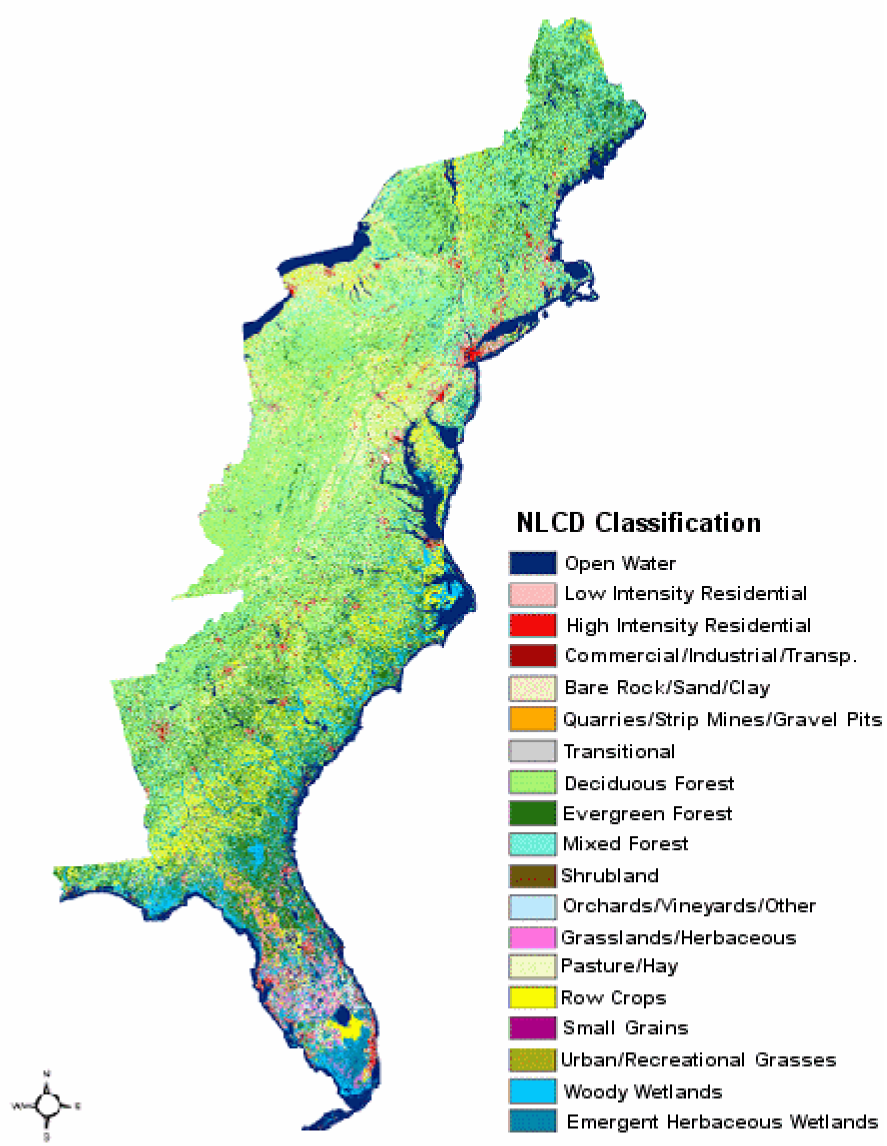
About Us

What is the Atlantic Coast Joint Venture?

The Atlantic Coast Joint Venture (ACJV) is a partnership focused on the conservation of habitat for native birds in the Atlantic Flyway of the United States from Maine south to Puerto Rico. The joint venture is a partnership of the 18 states and commonwealths and key federal and regional habitat conservation agencies and organizations in the joint venture area. The joint venture was originally formed as a regional partnership focused on the conservation of waterfowl and wetlands under the North American Waterfowl Management Plan in 1988 and has since broadened its focus to the conservation of habitats for all birds consistent with major national and continental bird conservation plans and the North American Bird Conservation Initiative.

This joint venture includes a total area of 283 million acres (442,000 square miles) representing 12% of the total area of the United States. It is the most densely populated region in the United States with a total of over 105 million people living in the area.

There is a tremendous diversity of ecosystems and habitats in the joint venture area from the boreal forests and rocky coastline at the northern reaches of the joint venture in Maine to the tropical mangrove swamps and coral reefs of Florida and Puerto Rico to the south and from the rugged peaks of the Appalachian Mountains in the west to the low-lying Atlantic Coastal Plain with its many coastal rivers, bays and estuaries forming the joint venture's eastern boundary. The Atlantic Ocean coastline extends for 2,069 miles from Maine to Florida with a combined shoreline of all tidal areas along the coast adding up to 28,673 miles. The variety of habitats in the joint venture supports a high abundance and diversity of bird species including 37 native species of waterfowl, 40 species of shorebirds, 72 species of colonially-nesting waterbirds (including pelagic species) and over 200 landbird species.



Landcover types within the joint venture boundary.

Mission Statement

The Atlantic Coast Joint Venture will provide a forum for federal, state, regional and local partners to coordinate and improve the effectiveness of bird habitat conservation planning, delivery and evaluation in the Atlantic Flyway.

ACJV Strategy

The objectives, strategies and measures of achievement for the ACJV can be grouped into three major components: *Biological Foundation, Conservation Coordination and Delivery, and Communication and Outreach*. Each of these three components is described in the ACJV Strategic Plan approved in July, 2004. The plan contains the goal(s) of each component, objectives and strategies are described for reaching each goal and overall and annual measures of achievement. The Plan was recently updated and revised in 2009.

Download the ACJV Strategic Plan *(2.67 MB Adobe pdf file)*

You will need Adobe Acrobat Reader software to open this document. If you do not have this software, you may obtain it free of charge by following the link above.

This page was last updated on 04/09/2010 16:01:24

What is the Atlantic Coast Joint Venture? | Partners | Joint Venture Structure | Joint Ventures – What Are They?

Skip navigation links

Atlantic Coast Joint Venture

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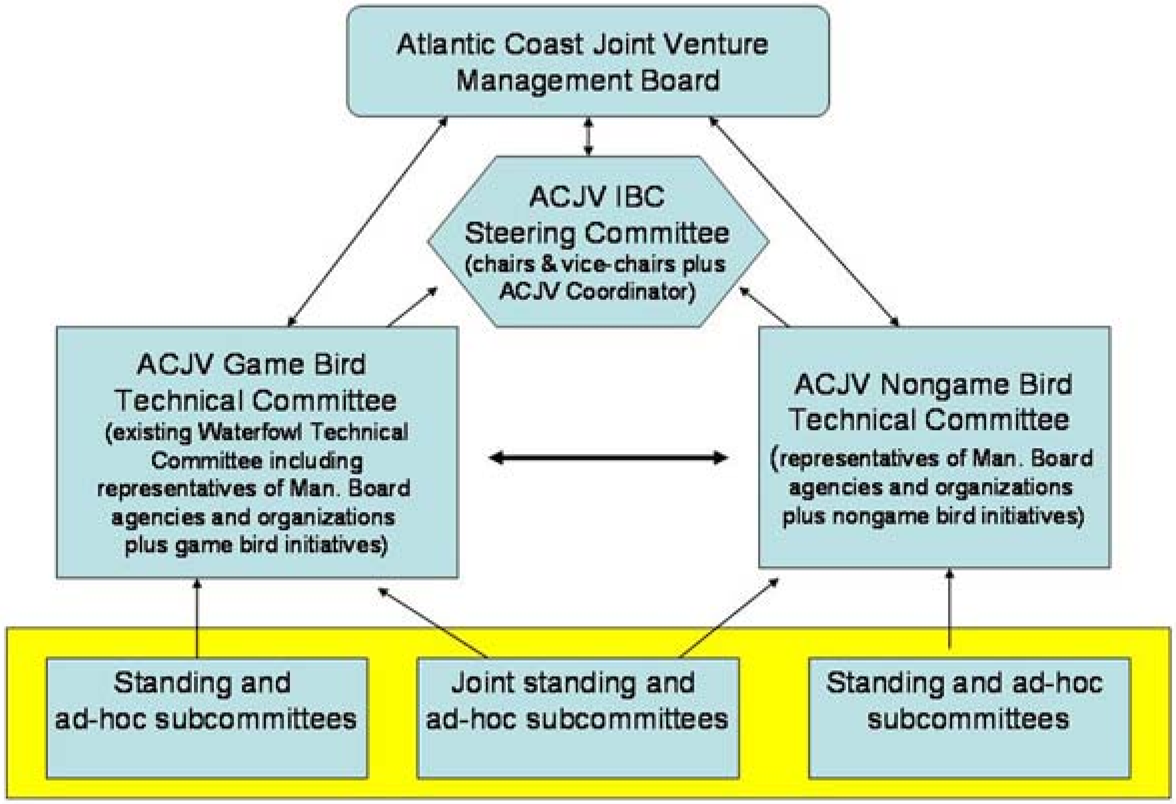
Joint Venture Structure



Board and Committees—Management Board

The ACJV Management Board is comprised of representatives from the organizations that form the joint venture partnership. Their purpose is to provide overall leadership, guidance, resources and support to the joint venture partnership for the planning and delivery of bird habitat conservation in the joint venture area. Each member is responsible for ensuring that their member organization contributes to the overall goals of the ACJV.

Name	Affiliation	Telephone	E-mail

Jon Andrew, Regional Refuge Chief	U.S. Fish and Wildlife Service, Region 4		jon_andrew@fws.gov
John Austin, Acting Director of Wildlife	Wildlife Division, Vermont Fish and Wildlife Department	(802)241-3707	JohnM.Austin@state.vt.us
Tim Breault, Director, Division of Habitat and Species Conservation	Florida Fish and Wildlife Commission	(850)488-3831	Tim.Breault@MyFWC.com
Gwen Brewer, Science Program Manager	Natural Heritage Program, Maryland DNR	(410)260-8558	gbrewer@dnr.state.md.us
David Cobb, Chief	NC Wildlife Resources Commission	(919)733-7291	cobbdt@mail.wildlife.state.nc.us
Jose Cruz-Burgos	PR Department of Natural & Environmental Resources	(787)999-2200	jcruzburgos@drna.gobierno.pr
Calvin Dubrock, Bureau Director	PA Game Commission	(717)787-5529	cdubrock@state.pa.us
Robert Ellis, Assistant Director	VA Department of Game & Inland Fisheries	(804)367-6482	robert.ellis@dgif.virginia.gov
Ken Elowe, Director	ME Department of Inland Fisheries & Wildlife	(207)287-5252	ken.elowe@maine.gov
Patrick Emory, Director	DE Division of Fish and Wildlife	(302)739-5295	patrick.emory@state.de.us
James Fenwood	U.S.D.A. Forest Service		jfenwood@fs.fed.us
Dan Forster, Director	GA Department of Natural Resources	(770)918-6401	dan_forster@dnr.state.ga.us
John Frampton, Director	SC Department of Natural Resources	(803)734-4007	framptonj@dnr.sc.us

Larry Herrighty, Deputy Director	NJ Division of Fish and Wildlife	(609)292-6685	Larry.Herrighty@dep.state.nj.us
Greg Smith, Director	USGS Patuxent Wildlife Research Center	(301)497-5503	smithg@usgs.gov
Catherine Sparks, Chief of Wildlife & Forestry	RI Division of Fish & Wildlife	(401)6473367	catherine.sparks@dem.ri.gov
Craig LeSchack, Director of Conservation Programs	Ducks Unlimited, Inc.	(843)745-9110	cleschack@ducks.org
Wayne MacCallum, Director	MA Division of Fisheries & Wildlife	(508)389-6300	wayne.maccallum@state.ma.us
Marvin Moriarty, Regional Director, Region 5	U.S. Fish and Wildlife Service	(413)253-8300	Marvin_Moriarty@fws.gov
Edward Parker, Chief	CT Department of Environmental Protection	(860)424-3010	edward.parker@po.state.ct.us
Patricia Riexinger, Director	NY Department of Environmental Conservation	(518)402-8924	pxriexin@gw.dec.state.ny.us
Mike Slattery, Director	National Fish and Wildlife Foundation	(202)857-0166	mike.slattery@nfwf.org
Terry Sullivan, Director of Government Relations, Eastern Region	The Nature Conservancy	(401)270-9132	terry_sullivan@tnc.org
Steven Weber, Executive Director	NH Fish & Game Department	(603)271-3511	sweber@nh.gov
Ray Whittemore, Director, Conservation Programs, Annapolis Office	Ducks Unlimited	(603)487-2175	rwhittemore@ducks.org
Scot Williamson, Vice President	Wildlife Management Institute	(802)748-6717	wmisw@together.net

Game Bird Technical Committee

The ACJV Game Bird Technical Committee comprises staff members of joint venture member agencies and organizations appointed by their respective management board members and representatives of migratory game bird initiatives relevant to the ACJV area. ACJV staff serve as ex-officio members of this committee. The purpose of the ACJV Game Bird Technical Committee is to provide input, guidance and assistance on waterfowl and other game bird conservation in the joint venture based on the best available information to the management board and staff. This committee is responsible for the technical aspects of the planning and delivery of the North American Waterfowl Management Plan and other game bird plans in the joint venture area. Although the technical committee is focused primarily on waterfowl and other game bird science and delivery of conservation to benefit game birds, it is also aware of the efforts of the other bird conservation initiatives in order to make better informed decisions in delivering bird habitat conservation actions. The game bird technical committee will coordinate activities with the ACJV Nongame Bird Technical Committee, the Black Duck Joint Venture Technical Committee, and the Atlantic Flyway Migratory Game Bird Technical Section. This committee shall appoint standing and ad hoc subcommittees as needed to accomplish its objectives.

Nongame Bird Technical Committee

The ACJV Nongame Bird Technical Committee comprises staff members of joint venture member agencies and organizations appointed by their respective management board members and other representatives of the major continental, national and regional bird conservation initiatives in the joint venture area as appropriate. ACJV staff serve as ex-officio members of this committee. The Nongame Technical Committee recognizes and builds upon the existing infrastructure and responsibilities of continental and national bird initiatives including Partners in Flight, U.S. Shorebird Conservation Plan and Waterbird Conservation for the Americas. The purpose of the Nongame Bird Technical Committee is to provide guidance on integrating biological planning, conservation design, conservation delivery and evaluation among the major nongame bird conservation initiatives operating within the joint venture area and to compile and provide priority actions for consideration by the ACJV member agencies and organizations. The game bird technical committee will coordinate activities with the ACJV Game Bird Technical Committee and the Atlantic Flyway Migratory Nongame Bird Technical Section. This committee shall appoint standing and ad hoc subcommittees as needed to accomplish its objectives.

Waterfowl Technical Committee

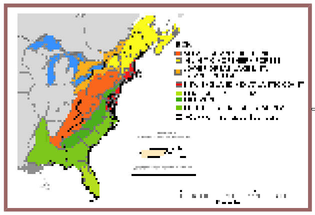
The purpose of the Atlantic Coast Joint Venture Waterfowl Technical Committee (WTC) is to provide input and guidance to the management board and staff on waterfowl conservation in the joint venture based on the best information available. The WTC has the primary responsibility for translating the objectives of the North American Waterfowl Management Plan to the ACJV area and implementing projects to achieve those objectives.

Joint Venture Staff

The ACJV staff are employees of the U.S. Fish and Wildlife Service and coordinate the day to day activities of the joint venture partnership related to the biological foundation, conservation coordination and delivery and communication and outreach. The ACJV Coordinator has overall responsibility for achieving the goals of the joint venture, hiring and supervising joint venture staff, managing the budget, maintaining contacts with the joint venture management board and technical committees, seeking additional funding, and ensuring compliance with U.S. Fish and Wildlife Service policies. The Assistant Joint Venture and/or BCR coordinators are responsible for compiling the results of biological planning, maintaining partnerships, and coordinating the delivery of habitat conservation within specific regions of the joint venture (See map for these regions). The ACJV Science Coordinator has overall responsibility for the biological foundation of the joint venture including biological planning, conservation design, research, evaluation and information management. The ACJV GIS Analyst is responsible for developing and maintaining a GIS database for the ACJV. (This position is filled initially through an intra-agency agreement with USGS). The ACJV Communications/Outreach Coordinator coordinates all aspects of outreach and communications for the joint venture including accomplishment tracking and reporting, Web site development and maintenance, congressional outreach planning and developing specific outreach products for specific audiences, including Congress.

Contact the ACJV staff members.

BCR Steering Committees



Click here to see the

There are eight Bird Conservation Regions (BCRs) partially or wholly within the joint venture boundary. In each of these BCRs, the ACJV is or will be leading, supporting or facilitating integrated bird conservation planning by hosting workshops, writing conservation plans, developing GIS and other conservation tools and facilitating project development. In each of the BCRs where there are active planning efforts underway, a steering committee made up of a representative from each of the states in the BCR and other key partners is guiding this effort. These BCR steering committees

eight BCR regions in the ACJV.	provide guidance on developing and implementing bird conservation plans for the BCR.

State Working Groups

In some states within the ACJV, there are working groups of partners that have come together to plan and implement projects based on priorities in the bird conservation plans at the state level or the portion of a state within a BCR. These working groups can effectively step down regional goals to the state level and prioritize conservation actions within their states. Several states have recently formed bird conservation working groups to help compile information for the bird portion of the state Comprehensive Wildlife Conservation Strategy in their state. The joint venture supports and facilitates the formation of working groups in each state or commonwealth.

Focus Area Working Groups

In some ACJV focus areas or regions, there are working groups of partners that have come together to achieve the goals for that focus area or focus region. Examples include the Great Bay Resource Protection Partnership in New Hampshire, South Carolina Coastal Task Forces, St. Lawrence Valley Working Group in New York, Delaware Bay Partnership (New Jersey, Pennsylvania and Delaware) and Chesapeake Bay Waterfowl Working Group (Maryland, Delaware, Virginia and West Virginia). These partnerships can be particularly effective at pooling funds, resources and match to apply for grants. The Atlantic Coast Joint Venture supports the formation of these local partnerships and may be able to provide seed funds to assist in their development or coordination.

This page was last updated on 07/26/2010 11:33:26

Atlantic Coast Joint Venture

Contact the ACJV Staff

From left to right: Kirsten Luke, Tim Jones, Melanie Steinkamp, Mitch Hartley, Debra Reynolds, Andrew Milliken, Craig Watson

Andrew Milliken, USFWS
Joint Venture Coordinator
300 Westgate Center Dr.
Hadley, MA 01035
Phone: (413) 253-8269
Fax: (413) 253-8424
Andrew_Milliken@fws.gov

Mitch Hartley, USFWS
North Atlantic Coordinator

Tim Jones, USFWS
Science Coordinator
Nelson Lab, Room 209
11410 American Holly Dr.
Laurel, MD 20708
Phone: (301) 497-5674
Fax: (301) 497-5706
Tim_Jones@fws.gov

300 Westgate Center Dr.
Hadley, MA 01035
Phone: (413) 253-8779
Fax: (413) 253-8424
Mitch_Hartley@fws.gov

Melanie Steinkamp, USFWS
Mid-Atlantic Coordinator
Nelson Lab, Room 203
11410 American Holly Drive
Laurel, MD 20708
Phone: (301) 497-5678
Fax: (301) 497-5706
Melanie_Steinkamp@fws.gov

Craig Watson, USFWS
South Atlantic Coordinator
176 Croghan Spur Rd., Suite 200
Charleston, SC 29407
Phone: (843) 727-4707 ext. 304
Fax: (843) 727-4218
Craig_Watson@fws.gov

Brian Smith, American Bird Conservancy
Appalachian Mountain Coordinator
3761 Georgetown Road
Frankfort, KY 40601
Phone: (502) 573-0330 ext. 227
Fax: (502) 573-0335
bsmith@abcbirds.org

Kirsten Luke
GIS Specialist
Panama City Field Office
U.S. Fish and Wildlife Service
1601 Balboa Avenue
Panama City, FL 32405
Phone: (850) 769-0552 x253
Fax: (850) 763-2177
Kirsten_Luke@fws.gov

Debra Reynolds, USFWS
Outreach Coordinator
300 Westgate Center Dr.
Hadley, MA 01035
Phone: (413) 253-8674
Fax: (413) 253-8424
Debra_Reynolds@fws.gov

***Deaf/Hard of Hearing individuals may reach the ACJV through the following relay services:**

- Massachusetts Relay Service
- Maryland Relay
- Relay South Carolina
- Relay North Carolina


Atlantic Coast Joint Venture Staff
Existing and *Proposed*
Mitch Hartley, Assistant Coordinator, North
Turners Falls, MA
States: ME, NH, VT, NY, MA, RI, CT
BCR's: LGL-SL, ANF, NE-MA
Other: Coordinate w/EHJV, Canada
Andrew Milliken, ACJV Coordinator
Hadley, MA
Debra Reynolds, Outreach Coordinator
Hadley, MA
Tim Jones, Science Coordinator
Laurel, MD
Kirsten Luke, GIS Technician
(Contract)
Database Technician
Laurel, MD
Melanie Steinkamp, Assistant Coordinator, Mid-Atlantic
Laurel, MD
States: NJ, PA, DE, MD, VA, WV
BCR's: NE-MA, Northern Piedmont
Other: Chesapeake Bay & Delaware Bay Working Group
Craig Watson, Assistant Coordinator, South
Charleston, SC
States: NC, SC, GA, FL, PR
BCR's: SAMBI, Southern Piedmont, Pen. FL, PR-VI
Other: Caribbean, Mexico
Brian Smith, Appalachian Mountain BCR Coordinator
Frankfort, KY

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Priority Bird Species in Bird Conservation Regions partially or wholly within the Atlantic Coast Joint Venture

	BCR 13 (Lower Great Lakes/St. Lawrence Plain)	**BCR 14** (Atlantic Northern Forest)	**BCR 30** (Mid-Atlantic/Southern New England)	**BCR 27** (Southeastern Coastal Plain)	**BCR 28** (Appalachian Mountains)	**BCR 29** (Piedmont)	**BCR 31 (Peninsular Florida)**
Acadian Flycatcher				M	H	M	
American Avocet			M	H			H
American Bittern	H	M	M	H	M	M	H
American Black Duck	HH	HH	HH	HH	HH	M	
American Coot				HH		M	
American Kestrel (Southeast.)							HH
American Golden Plover	H	H	H	H			H
American Kestrel				H			
American Oystercatcher		M	HH	H			HH
American Redstart		H					
American White Pelican				H			M
American Wigeon			M	H			
American Woodcock	H	HH	HH	HH	HH	H	H
Anhinga							H
Antillean Nighthawk							H
Arctic Tern		H					
Atlantic Brant		M	HH				
Atlantic Puffin		M					
Audubon's Shearwater			H	HH			HH
Bachman's Sparrow			M	H	M	H	H
Bachman's Warbler				HH			HH
Bald Eagle		M	M	M	M		
Baltimore Oriole	M		H			M	
Band-rumped Storm-Petrel				H			
Bank Swallow	M	M					
Barn Owl				M			
Barn Swallow		M					
Barrows Goldeneye	H	HH					
Bay-breasted Warbler	M	HH	H				
Bermuda Petrel				HH			
Bewick's Wren						H	
Bewick's Wren, Appalachian population					HH		
Bicknell's Thrush		HH	H	H	M		H
Black Guillemot		H					
Black Rail			HH	H		M	H
Black Scoter		H	H	HH			
Black Skimmer				H			HH
Black Skimmer			M				
Black Tern	M			H			H
Black Vulture				M			
Black-and-white Warbler			H		M		
Black-backed Woodpecker		M					
Black-bellied Plover	M	H	H	M			M
Black-billed Cuckoo	H	M			H	M	
Black-necked Stilt							M
Blackburnian Warbler		M	M		M		
Black-capped Chickadee, Southern Blue Ridge population					M		
Black-capped Petrel				H			H
Black-crowned Night Heron	M	H	M	H			
Black-legged Kittiwake		M					
Blackpoll Warbler		M		M			
Black-throated Blue Warbler	M	H		M			M
Black-whiskered Vireo							H
Black-throated Green Warbler		M		HH			
Blue-winged Teal	M			H			
Blue-winged Warbler	H	H	HH		HH	M	
Bobolink	M	H		M			M
Bonaparte's Gull	M			M			M
Boreal Chickadee		H					
Boreal Owl		M					
Brant				HH			
Bridled Tern			H	H			
Broad-winged Hawk			H		M		
Brown Booby							H
Brown Creeper		M					
Brown Noddy							M
Brown Pelican				H			H
Brown Thrasher	H		H	H	M	M	
Brown-headed Nuthatch			M	H	H	HH	HH

Buff-breasted Sandpiper	H		H	HH	M	H	HH
Bufflehead			H				
Burrowing Owl				M			H
Canada Goose, resident population				MC			
Canada Goose, Atlantic Population	HH	H	HH	HH	H	H	
Canada Goose, North Atlantic Population			H				
Canada Warbler	M	HH	M		H		
Canvasback	H		H	HH			H
Cape May Warbler		H		M			M
Carolina Wren						M	
Cattle Egret				MC			MC
Cerulean Warbler	HH		M	HH	HH	M	
Chesnut-sided Warbler		H					
Chimney Swift	M	H	H	H	H	H	
Chuck-will's-widow				H	M	H	H
Clapper Rail			H	M			H
Coastal Plain Swamp Sparrow			M	M			
Common Eider		HH	H				
Common Goldeneye	HH	M	M	H			
Common Ground-Dove				HH			H
Common Loon	M	M		H			
Common Merganser	M						
Common Moorhen				H			
Common Nighthawk		H					H
Common Snipe			M				
Common Tern	H	H	M	HH			H
Connecticut Warbler				M			M
Cooper's Hawk				M			
Cory's Shearwater			M	H			
Crested Caracara							HH
Dickcissel						M	
Double-crested Cormorant				MC			M
Dunlin	M		H	H			H
Eastern Kingbird			H	H		M	
Eastern Meadowlark	M			H	M	M	H
Eastern Towhee			H	H	M	M	
Eastern Wood-Pewee		H		H	M	M	
Florida Scrub Jay							HH
Field Sparrow	H		H	H	H	M	M
Forster's Tern			H	M			M
Gadwall			M				
Glossy Ibis			H	H			H
Golden Eagle					H		
Golden-winged Warbler	HH		M		HH		
Grasshopper Sparrow	M		M	H	M	H	
Grasshopper Sparrow (floridanus)							HH
Gray Catbird			M				
Gray Jay		M					
Gray Kingbird							M
Great Black-backed Gull				MC			
Great Cormorant		HH					
Great Crested Flycatcher			H				
Great White Heron							HH
Great Egret				M			M
Greater Flamingo							H
Greater Scaup	H	M	H				
Greater Shearwater		HH	H	H			
Greater Snow Goose	M	MC		HH			
Greater Yellowlegs	M		H	M			M
Green-winged Teal			M				
Gull-billed Tern			HH	H			H
Harlequin Duck		HH	M				
Henslow's Sparrow	HH		M	HH	HH	M	HH
Herring Gull		H		MC			
Hooded Merganser			M			H	
Hooded Warbler				M	H		
Horned Grebe		M	H	H		M	H
Horned Lark		M					
Hudsonian Godwit	M	M	H				
Indigo Bunting				M	M	M	
Ipswich Savannah Sparrow		HH	M				

Ivory-billed Woodpecker				HH			HH
Kentucky Warbler			H	H	HH	H	
Killdeer		M	M				
King Rail	H		M	H	M	H	H
Kirtland's Warbler				HH			HH
Lark Sparrow					M		
Laughing Gull				MC			
Le Conte's Sparrow				H		M	H
Leach's Storm-Petrel		M					
Least Bittern	M		M	H		M	H
Least Sandpiper	M	M	M	H		M	H
Least Tern			H				H
Lesser Scaup	HH		H	HH			H
Lesser Yellowlegs			M	H		M	H
Limpkin				HH			HH
Little Blue Heron			M	H		M	H
Little Gull	H						
Loggerhead Shrike	M		M	HH	M	H	HH
Long-billed Curlew				HH			HH
Long-eared Owl		H					
Long-tailed Duck	HH	M	H				
Louisiana Waterthrush			H	M	H		
Mallard	M	MC	H	HH	M	M	
Magnificent Frigatebird							HH
Mangrove Cuckoo							H
Manx Shearwater			M	H			
Marbled Godwit	M		H	H			H
Marsh Wren			H	M			M
Masked Booby							H
Mississippi Kite				M			
Mottled Duck				M			HH
Nelson's Sharp-tailed Sparrow		HH	M	H			H
Northern Bobwhite	M		H	H	M	H	H
Northern Flicker	M	M	H	H	M	M	H
Northern Gannet		H	H	H			H
Northern Goshawk		M					
Northern Goshawk, Appalachian Population					H		
Northern Harrier	M	M		M			H
Northern Parula		M		M			
Northern Pintail	H		M	HH			H
Northern Saw-whet					M		
Olive-sided Flycatcher		H			M		
Orchard Oriole				M		M	
Osprey							M
Ovenbird		M					
Painted Bunting				HH		M	HH
Palm Warbler		M					
Pectoral Sandpiper	M			M			M
Peregrine Falcon		M		M	M		M
Pied-billed Grebe	M			H		M	M
Pine Grosbeak		M					
Pine Warbler				M		M	
Piping Plover	HH	HH	HH	HH		M	HH
Prairie Warbler (Florida)							HH
Prairie Warbler	M		HH	H	HH	HH	
Prothonotary Warbler	M		H	H	M	M	M
Purple Finch		H					
Purple Gallinule				HH			H
Purple Martin					M		
Purple Sandpiper		HH	H				
Purple Swamphen							MC
Razorbill		H	M	H			
Red Crossbill, Appalachian population					H		
Red Knot	M	H	HH	H			H
Red Phalarope		H	M	H			
Red-bellied Woodpecker				M			
Red-breasted Merganser			M				
Red-cockaded Woodpecker			M	HH	M	H	HH
Reddish Egret				M			HH
Redhead	M			HH			H
Red-headed Woodpecker	M		M	H	M	M	H
Red-necked Grebe		H					

Red-necked Phalarope		HH	M				
Red-shouldered Hawk				M			
Red-throated Loon		M	HH	H			H
Roseate Spoonbill							H
Roseate Tern			HH	H			HH
Rose-breasted Grosbeak	M	M					
Royal Tern			M	M			M
Ruddy Duck			M				
Ruddy Turnstone		H	HH	H			H
Ruffed Grouse		M			M	M	
Rusty Blackbird	M	H	H	H		H	H
Sacred Ibis							MC
Saltmarsh Sharp-tailed Sparrow			HH	HH			HH
Sanderling	M	M	HH	H			H
Sandhill Crane (FL subspecies)							M
Sandhill Crane				HH	M		M
Sandwich Tern			H	H			H
Seaside Sparrow (Atl. Coast races)							HH
Seaside Sparrow (Gulf Coast races)							H
Scarlet Tanager	M				M	M	
Seaside Sparrow (Cape Sable)							HH
Seaside Sparrow			HH	H			
Sedge Wren			M	M	M	M	M
Semipalmated Plover		M	M	M			M
Semipalmated Sandpiper	M	HH	H	H			H
Sharp-shinned Hawk						M	
Short-billed Dowitcher	H	H	H	H			H
Short-eared Owl	M	M		H	M	M	
Smooth-billed Ani							HH
Short-tailed Hawk							HH
Snail Kite							HH
Snowy Egret			M			M	M
Snowy Plover				HH			HH
Solitary Sandpiper	H		H	H	M		H
Sooty Shearwater							H
Sooty Tern							M
Song Sparrow	M			HH			
Sora			M			M	
Spotted Sandpiper			M	M			M
Stilt Sandpiper				H			H
Summer Tanager				M			
Surf Scoter		M	H				
Swainson's Warbler			M	H	H	M	
Swallow-tailed Kite				H			HH
Tricolored Heron			M	H			H
Tundra Swan	H		H	HH			
Upland Sandpiper	M	H	M	H	M	H	H
Veery		H					
Vesper Sparrow		M		H			H
Virginia Rail	M			HH		M	
Western Sandpiper			M	H	M	M	H
Whimbrel	M	H	HH	HH			H
Whip-poor-will		M	H		H	H	
White-breasted Nuthatch							HH
White Ibis				H			H
White-crowned Pigeon							H
White-eyed Vireo				M			
White-rumped Sandpiper			H				
White-tailed Kite							HH
White-tailed Tropicbird				H			
White-throated Sparrow				H		M	
White-winged Scoter	M		H	H			
Whooping Crane				HH	H	M	HH
Willet		M	H	H			
Willow Flycatcher	M		H	HH	M		
Wilson's Phalarope	M		H	H			H
Wilson's Plover			H	H			HH
Wilson's Snipe	M	M		H		M	
Wood Duck	H	M	M	HH		H	M
Wood Stork				HH		M	HH
Wood Thrush	H	HH	HH	H	HH	H	
Worm-eating Warbler	M		H	H	HH	M	
Yellow Rail	M	M		H			H
Yellow-bellied Flycatcher		M			M		

Yellow-bellied Sapsucker		H				M	
Yellow-bellied Sapsucker, Appalachian Population					H		
Yellow-billed Cuckoo				H			
Yellow-breasted Chat					M		
Yellow-crowned Night Heron			M	H			H
Yellow-throated Vireo			H	M	M	M	
Yellow-throated Warbler				M	M	M	

HH = Highest Priority
H = High Priority
M = Moderate Priority
MC = Management Concern (Overabundant species in need of management)

Rules For Species Prioritization

Priority	**Criteria/Rule**
HIGHEST	High BCR Concern and High BCR Responsibility and (High or Moderate Continental Concern)
HIGH	High Continental Concern and Moderate BCR Responsibility OR Moderate BCR Concern and High BCR Responsibility OR High BCR Concern and Moderate BCR Responsibility OR Non-breeding High Continental Concern species whose primary area of spring or fall migration overlaps the BCR
MODERATE	Moderate BCR Concern and Moderate BCR responsibility OR High Continental Concern and Low BCR Responsibility OR High BCR Concern and Low BCR Responsibility and Regionally Threatened Species (PIF Tier IIC) OR High BCR Responsibility and Low BCR Concern OR Sub-species of Regional Importance

Sources:
BCR 13, 14, 27, 30 based on approved BCR plans (http://www.acjv.org/bird_conservation_regions.htm)
BCR 29 based on ACJV and partner input, list prepared by Chuck Hunter, BCC list, list likely to change with additional input
BCR 28 based on Appalachian Mountains JV, ACJV staff and partner input, BCC list, list likely to change with additional input
BCR 31 based on list prepared by Chuck Hunter, BCC list, FNAI list, FFWCC list, FBCI partner input

Short-eared Owl Photo © Jim Fenton

**Requires Adobe Acrobat Reader; click here for more information.*

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APPENDIX 3

Mass Audubon
Protecting the Nature of Massachusetts

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Mass Audubon eBird

- Welcome
- What is eBird?
- Who uses eBird?
- Why should I eBird?
- How do I eBird?
- Go to Mass Audubon eBird
- Bird Conservation

Mass Audubon eBird

Good News for Massachusetts Birds!

Mass Audubon and the Cornell Lab of Ornithology are collaborating to promote the revision of a powerful new tool for protecting native birdlife with the release of eBird 2.0 at www.ebird.org, an updated version of the powerful Internet-based program currently used by thousands of birders. eBird is a free, user-friendly way for birders across North America to record, archive, and share their observations at any hour of the day. The data come to life via eBird's colorful new interactive maps. It is also an important tool for conservation, providing researchers with a comprehensive picture of the abundance and distribution of birds. Observations entered by birders will support the objectives of Mass Audubon's major bird conservation programs, including its Important Bird Area (IBA) program, biological inventories of our 30,000 acres of wildlife sanctuaries, and other new programs we are developing.

In addition to a completely new look and feel, eBird 2.0 has a streamlined data entry process and a suite of new output tools geared toward the interests of today's birders. On customized "My eBird" pages users can now view their life, state and county lists—all generated automatically as individual reports are entered.

There are two primary ways to search the data: by location and by species. For example, trip-planners can view a list of all the species recorded near their destination. Those interested in learning more about a particular species can view maps and charts showing seasonal distribution and frequency of reports. eBird allows participants to do more than just record sightings; it helps them understand how their observations fit into the big picture.

Mass Audubon and Cornell encourage citizen ornithologists to record species from their backyard, favorite Mass Audubon sanctuary, IBA, or other publicly accessible birding spot in Massachusetts in a user-friendly system. Massachusetts birders have thousands of checklists into eBird and the new improvements will enhance birders' ability to instantly retrieve and analyze not only their own data, but also that of all contributors to a particular list. Please help Mass Audubon and Cornell make Massachusetts's birdlife the most thoroughly documented state avifauna in eBird's national database.

Learn more!

Learn more about eBird, including how you can contribute:

- What is eBird?
- Who uses eBird?
- Why should I use eBird?
- How do I use eBird?
- Start eBirding now!

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What is eBird?

Simple, yet powerful

eBird is an easy to use, interactive, computerized database that provides a simple way for you to keep track of the birds you see, anywhere, anytime. You can retrieve information on your bird observations—from your backyard to your neighborhood to your favorite bird-watching locations—any time you want. And you can also access the entire database to find out what other eBirders are reporting from across Massachusetts.

Perhaps the most exciting thing about eBird is that your records, combined with those of other observers, become a powerful tool for bird conservation by supplying scientifically useful data on species distribution and movement patterns in Massachusetts and across the continent.

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APPENDIX 4

Yet Another Unitarian Universalist

Since 2005: progressive spirituality from a postmodern heretic and unashamed intellectual

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Birds of New Bedford harbor

From August, 2005, to September, 2008, including the following locales:
New Bedford's inner harbor from Rte. I-195 south, including water, islands, wetlands, and block or so inland;
Outer harbor as visible from hurricane barrier and Fort Phoenix state park;
Downtown neighborhood bounded by Spring St., County St., and U.S. 6.;
Fort Phoenix State Park in Fairhaven;
Riverside Cemetery in Fairhaven, including wetlands and open land to the harbor and Acushnet River.

Relative abundance, based on my limited observations and estimates:

- ab=abundant, 500-1,000 per day
- vc=very common, 100-499 per day
- com=common, 10-99 per day
- unc=uncommon, 1-9 per day
- rare, 1-10 per season
- no indication given for apparent strays, or if insufficient data

The List

Gaviiformes
Common Loon (unc winter, unc spring)
Podicipediformes
Horned Grebe (unc winter, unc spring)
Pelecaniformes
Double-crested Cormorant (summer, fall)
Ciconiiformes
Snowy Egret (summer)
Anseriformes
Mute Swan (unc winter)
Canada Goose (com fall, com winter)
Brant (com-vc winter, com spring)
Wood Duck (summer)
Mallard (com summer, fall, winter, spring)
American Black Duck (unc winter, unc spring)
Greater Scaup (com fall, com winter)
Common Eider (com winter, com spring)
Long-tailed Duck (com winter, com spring)
Common Goldeneye (com fall, com winter, unc spring)
Barrow's Goldeneye (rare winter)
Bufflehead (com fall, com-vc winter, com spring)
Red-breasted Merganser (com winter, com spring)
Common Merganser (unc fall, unc winter, unc spring)

Falconiformes
Osprey (fall)
Sharp-shinned Hawk (winter)
Cooper’s Hawk (winter)
Northern Goshawk (winter)
Peregrine Falcon (winter)
Red-tailed Hawk (fall)
Charadriiformes
Semipalmated Plover (summer)
American Oystercatcher (summer)
Peeps (Calidris spp.) (summer)
Ring-billed Gull (vc-ab summer, fall, winter, spring)
Great Black-backed Gull (com summer, fall, winter, spring) nesting colony
Herring Gull (ab summer, fall, winter, spring) nesting colony
Bonaparte’s Gull (com summer, fall)
Common Tern (summer)
Least Tern (summer)
Columbiformes
Rock Pigeon (ab summer, fall, winter, spring)
Apodiformes
Chimney Swift (spring, summer)
Coraciiformes
Belted Kingfisher (summer)
Piciformes
Northern Flicker (summer, unc winter)
Passeriformes
Great Crested Flycatcher (spring)
Tree Swallow (summer)
Eastern Kingbird (spring)
Blue Jay (spring, summer)
American Crow (com summer, fall, winter, spring)
Black-capped Chickadee (spring, summer)
Carolina Wren (spring)
American Robin (com winter, spring, summer, fall)
Gray Catbird (spring, summer)
Northern Mockingbird (spring, summer, fall)
Brown Thrasher (spring)
European Starling (ab summer, fall, winter, spring)
American Goldfinch (winter)
Cedar Waxwing (winter)
Yellow-rumped Warbler (winter)
Rufous-sided Towhee (spring)
Chipping Sparrow (com spring, summer)
Lark Sparrow (winter)
Song Sparrow (com-vc fall, winter, spring)
White-throated Sparrow (winter, spring)
Dark-eyed Junco (summer, fall)
Northern Cardinal (com winter, spring)
Red-winged Blackbird (fall, spring)
Baltimore Oriole (spring)
Common Grackle (spring)

House Finch (winter, spring, summer)
House Sparrow (vc fall, winter)

Note: Unfortunately, May is one of my busiest months at work and so I have missed most of the spring migration the past two years.

Where to bird

New Bedford harbor is primarily a marine industrial landscape, interspersed with dense residential development on the Fairhaven side, and a mixed urban setting on the New Bedford side. There are two urban green spaces on the Fairhaven side: Fort Phoenix State Park, and Riverside Cemetery. The heavy human development means we see lots of Rock Pigeons, House Sparrows, and European Starlings. Major points of interest for birders include the Herring Gull nesting colony on the rooftops of downtown New Bedford, and wintering ducks and waterfowl on the waters of the harbor. New Bedford harbor is probably not worth a trip for those living elsewhere, but it can provide interest if you're here anyway.

Summer: June 21 to September 20 — Summer is dominated by gulls, starlings, pigeons, and House Sparrows. Heavy recreational use by humans tends to keep birds away. Post-breeding dispersal and early fall migrants liven up late summer.

Fall: September 21 to December 20 — Beginning in October, ducks and other water birds beging to move into the area. By December, waterfowl have reached their highest concentrations, and the birding can sometimes be quite good.

Winter: December 21 to March 20 — Waterfowl continue on the harbor through March or April, with gradually decreasing numbers. Occasional raptors over the harbor. Early spring migrants may be seen at Fort Phoenix and Riverside Cemetery.

Spring: March 21 to June 20 — Spring migrants can be seen in Riverside Cemetery and at Fort Phoenix. Herring Gulls breed in late spring and early summer in the diffuse nesting colony on the roofs of downtown New Bedford (some nests visible from the roof of the Elm St. parking garage).

Best places to bird New Bedford harbor, roughly in order of interest:

- Pope's Island off Route 6, including the city park on south and the parking lot on north (best in winter; can see most of inner harbor). Also: Route 6 bridges across the harbor (from here, can see the parts of harbor not visible from Pope's Island; seals in winter)
- Fort Phoenix State Reservation including Fairhaven side of hurricane barrier (best in winter; good views of outer and inner harbor; small areas of wetlands and forests)
- New Bedford side of hurricane barrier including Palmer Island (best in winter; can see much of inner harbor as well as outer harbor; Palmer's Island sometimes shelters migrants)
- Riverside Cemetery, 274 Main St., Fairhaven and Marsh Island (year-round; Marsh Is. had wetlands, view of entire upper harbor)
- S end of Main St. in Fairhaven (this cove cannot be easily seen from other vantage points mentioned)
- End of State Pier in New Bedford (easily accessible from downtown, can see much of the inner harbor, seals and waterfowl close by in winter)
- Roof of Elm St. Parking Garage, downtown New Bedford (in June, watch Herring Gull nests on nearby rooftops)

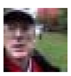
3 Responses to "Birds of New Bedford harbor"

1. *Mary Anne McQuillan* says:
January 8, 2007 at 6:19 pm

Hi,
Have you looked north from the Coggeshall St brige over the Acushnet River next to Nye Lubricants? There are usually birds along the marsh on the Fairhaven side. Also, there is a small park in Acushnet along the upper part of the "remediated" river north of where the Wood St. bridge crosses from NB to Acushnet.
Fair Winds,
Mary Anne

2. *Claire* says:
March 4, 2007 at 10:35 am

Not sure if you can comment but I was at Gull Island yesterday and noticed some rather large black birds. I think they may be cormorants but it seems this is not the time of year for them, according to your notes here. I didn't get a close look at them. Any ideas what they might be?

3.  *Administrator* says:
March 5, 2007 at 7:54 pm

Claire — Along the South Coast, you could see both Great Cormorants and Double-Crested Cormorants during the winter, according to the standard reference "Birds of Massachusetts" by Richard Veit and Wayne R. Petersen (Mass Audubon, 1993). Also, both cormorants have been reported within 25 miles of New Bedford during the last two Christmas Bird Counts. The only thing the list above indicates is that I have not seen either cormorant in the small area I keep track of — that doesn't mean they're not here, it just means that I haven't seen them.

Remember too that Gull Island is outside the area that I keep tabs on. And I would expect to see both cormorants along the coast during winter within a few miles of New Bedford harbor. Cormorants are pretty distinctive, so if you think you saw one, you probably did.

Leave a Reply

Name (required)

Mail (will not be published) (required)

Website

Comments may be held for moderation at any time. See comments policy. Please be patient.

Submit Comment

- Search for:

Search

- ## Past posts

July 2010

S	M	T	W	T	F	S
				1	2	3
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« Jun

- ## New? Start here!

Contents (archives, categories)

Index (tags)

Site map

2010 Summer road trip

6/29 UMinn Sacred Harp

7/3 Pioneer Valley All Day Singing

7/4 Preach at First Parish, Concord, Mass.

7/10-16 Ferry Beach RE Week

7/24 Jolly Mem. All Day Singing

-

Blogs | Online Periodicals

More blogs

Hover over link for a brief description.

- ## Academics & professionals
  - Forbidden Gospels
  - Useful Arts
- ## Books and authors
  - A Commonplace Book
  - Barbara Pym Society
  - Children's books
  - Indran Amirthanayagam
  - Read Roger
  - Will Shetterly
- ## Cultural creators
  - City Mama
  - En Mexico
  - Henry Mollicone
  - Renewable Music
  - Sartorialist
  - Writewrite
- ## Cultural detritus
  - Altered Barbie blog
  - Order of the Stick
  - Tallturtle
  - Tea Pages
- ## Cultural entrepreneurs
  - Condomania
  - Freelancer's Union blog
  - Jam by the spoonful
  - Ripe Life Coaching
  - Wordpress Foundation

- ## Eco-stuff
  - Better rail travel
  - BP oil spill coverage
  - Collective Roots
  - Fish Island
  - Transport Politic
- ## Emergent | Congregational Change
  - Brian McLaren
  - Seth's Blog
  - Ten Minutes or Less
- ## Open source and alternative applications
  - Books: Forgotten Books
  - Books: Internet Archive
  - Books: Project Gutenberg
  - Browser: Firefox
  - Calendar: 30 Boxes
  - Online docs: Zoho
  - Search: Clusty
- ## Political
  - Archdruid's Report
  - Faith in Public Life blog
  - Our Bodies, Our Blog
- ## Religious education
  - Phil's Little Blog
  - Religious Education in Palo Alto
- ## Religious left
  - Boy in the bands
  - Quaker Theology
  - Rabbi Michael
  - Rose Garden Yoga
  - Sermons in stones
  - Synablog
  - Wild Hunt

- **Science & tech**
  - Diaspora (Facebook sucks)
  - Inside Silicon Valley
  - Invasive species weblog
  - Nature magazine
- **Sf**
  - eI
  - Fluff the Plush Cthulhu
  - FOGcon
  - Locus
  - Making Light
  - Mundane sf
- **Trad music**
  - Bay Area Sacred Harp
  - Berkeley Sacred Harp Blog
  - BFX10 Early Music Festival
  - Chant Village
  - New England Folk Festival
  - Norumbega Harmony
  - Now shall my inward joys arise
- **Unitarian Universalism**
  - Carrots and ginger
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  - WordPress.org

APPENDIX 5

An Introduction to Atlas Methodology

Creating a Breeding Bird Atlas: The Basics

Jim Fenton

Breeding bird atlases follow a standard field technique and protocol. Most simply described, an atlas divides the county, state or province into equally sized blocks or squares. Each square is surveyed for the presence of breeding birds. The breeding status of the species is determined by evaluating the behavior of the birds, and comparing what is observed to a set of predetermined breeding criteria.

After all blocks are surveyed, the information regarding the strength of the breeding evidence is collated for all species in all blocks. This creates a data set of the distribution of all breeding species in the area – a detailed and repeatable snapshot of the distribution of the breeding birds.

Atlas methods are firmly established and should be followed conscientiously to assure compatibility between the data from Atlas 1 and Atlas 2. They will help you to focus your energy in the field. To accurately measure changes in bird distribution over time and use the data to set conservation priorities, we need to ensure consistency in the details of data collection.

NOTE: This is an *abbreviated* outline of atlas methods, designed to give the newcomer a general understanding of the work involved. Please use these pages as a primer, but not as your detailed guide to atlas methodology.

Frequently asked questions on *Atlasing*

- How large is a survey area?
- How do I know if I found a breeding bird?
- When do I survey?
- For how long do I survey?
- When is my block finished?
- What about teamwork and safety?
- Help! How do I choose where to look in my block?

How large is a survey area?

Atlas survey areas are created by dividing the state into small blocks. Each block is given a unique name. These blocks, which are exactly the same blocks used in Atlas 1 and in the Massachusetts Butterfly Atlas and Massachusetts Herpetological Atlas, are 1/6th of a 7 1/2 X 7 1/2 minute USGS quadrangle map – most of you know these maps as topo maps. Each block is about 10 mi^2, and there are approximately 1055 blocks in the state. The blocks can be located using the MassGIS Breeding Bird Atlas 2 mapping tool, which allows volunteers to find the name of a block anywhere in the state, and can be printed using the USGS map printing tool.

The number of blocks assigned to a volunteer depends mainly on how much time the volunteer can commit during the survey period. Blocks must be surveyed for a minimum of 20 hours, so it is difficult for any one volunteer to complete more than four blocks in a single field season.

While surveying your block your goal is to find as many breeding species as you can. Once you *Confirm* breeding for a species you don't need to collect any more information on that species, unless it is a state or federally listed species.

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How do I know if I found a breeding bird?

Most birds that you see from May 15 – July 1 are breeding adults or recently fledged young. There are species that are present in Massachusetts during the summer that do not breed (e.g. Ring-billed Gull), but we would still like to know that you saw those species in your block. Atlas volunteers should try to find all the species in their blocks and to gather clues to confirm that the species is breeding. Watching birds for signs of their reproductive status may sound tedious, but you'll soon discover that this is the most fascinating part of this work. Some behaviors provide stronger evidence of breeding than others, so you will have a choice of three levels of evidence: Possible, Probable, and Confirmed breeding. (Please review the complete list of breeding and behavior codes.

While the first goal of the Atlas is to find all the species in the block, the second goal is to collect the strongest evidence of breeding for each species.

It is very important to not disrupt or disturb breeding birds – don't play tapes and don't approach nests or young. You can collect all the information you need by carefully watching the birds.

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When do I survey?

- Time of Year: Blocks will be surveyed when most species are breeding, typically

from May 15 – August 1, although after July 10 it can become difficult to separate recently fledged young from adults. Some species breed well before May 15, and we encourage you to visit your block for the early breeders as well.
- Safe Dates: To streamline the task of collecting data on breeders, not migrants, we have assigned a Safe Date for each breeding species. The Safe Date is the period when most passage migrants will have left, and when our breeding behavior codes for Possible or Probable breeding are most accurate. The Confirmed code, as the name implies, has less error, and this is the only set of codes that can be used before the Safe Date.
- Time of Day: Birds are most active early in the morning and from late in the afternoon to the early evening. On cooler days, the period of morning activity may be lengthened, and on warmer days it may be shortened.

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For how long do I survey?

Each block must be surveyed for at least 20 hours. The amount of time needed to survey a block completely depends on topography, habitat complexity and diversity, accessibility of habitats, and the skill level of the volunteer. If you are working with other volunteers and you are *together* in the field, count each hour as one hour. If you work independently during surveys, count volunteer hours separately (e.g., two volunteers working independently should record two hours of survey time).

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When is my block finished?

The amount of time needed to completely survey a block depends on topography, habitat complexity and diversity, accessibility of habitats, and to some extent, the skill level of the volunteer. The rate of new species additions declines after 10-15 hours, and the rate of upgrades declines after 30 total hours. Most blocks can be called "finished" after 30 hours - but atlasers can spend as much time as they want to in a block.

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What about teamwork and safety?

Working in pairs, or even in larger teams, is a great way to get the block done quickly, and to maximize your block totals. Two or more people working a block and reporting species found to one another via cell phone can help you to focus your work – and it makes the work more fun. If you had four people working in different locations within a block, and you each spent from 6:30 am to 11:30 am censusing different habitats within the block and communicating Confirmations to each other via cell phone or text message, you would have accomplished 20 hours in the block.

Your safety is extremely important to us. Working in pairs or teams is encouraged. Please don't survey alone at night. Don't trespass on posted land. If your atlas work takes you out into remote areas or out in a boat, don't go alone. Be sensible – follow all biking, wilderness, and boat safety laws and precautions. Let people know where you are going and when you expect to return. Carry a charged cell phone – and please remember that if a situation doesn't feel safe, it probably isn't safe.

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Help! How do I choose where to look in my block?

One of the exciting things about the fieldwork is getting to know new areas, and discovering new birding "patches". This can also be daunting. If you know your area well, chances are you know how you would cover the area if you were doing a "Big Day" - you'd want to get the maximum number of breeding species in the minimum amount of time. Remember that different species prefer different habitats. Therefore to find as many breeding species as possible, you will want to visit all the different habitats in your block.

Study your map. Use Google Earth or Google Map to view recent aerial photos. Study your list of species found in the block during Atlas 1. If you don't know the songs of all the potential bird species in your block, try to learn a few each day (the *Birding By Ear* series, by Richard Walton, is a great tool). *The Birder's Handbook* (by Ehrlich, Dobkin and Wheye) can help you interpret behavior.

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What do I look and listen for?

It is important to bird with some expectation for what you may see; "Chance" favors the prepared mind. Every atlaser develops a personalized way of looking for breeding evidence, and, after you have finished your first block you too will have your own style. The most important thing is to know the likely species, know the breeding codes, listen carefully, watch birds closely, and expect the unexpected. Your ears will lead you to singing birds, and once you know the sound, your ears will also lead you to begging young birds.

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How do I keep track of my data in the field?

The paper-less office was a great idea in theory; but it turns out that paper trails are indispensable on research projects. Don't rely on your memory while you are in the field – write everything down, or record it in your PDA/Pocket PC! Please download a field checklist (PDF 410KB) to carry with you. We encourage you to fill-out the checklist in the field, and then enter the data online shortly after you return from the field. Although this seems redundant, the only way we can check for errors in data entry is for you to also send in a paper copy of your field card.

Many people have their own strategies for taking field notes – notebooks, PDAs/Pocket PCs etc. If you use a paper notebook to record field notes, please download and fill out an Atlas 2 checklist, and enter your data promptly (in case you lose your notebook!) You can then send us a copy of the checklist at the end of the field season.

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Where do I enter my field data online?

We have partnered with USGS biologists to build a data entry tool for Atlas 2. They have managed the data for many other Atlas projects, and the collaboration is a great benefit. When you have been assigned your block, you will be given access to the data entry portion of the site, although the Results portion of the site is open to anyone.

This site has a block map downloading tool, helps you keep track of data from the blocks you are working on, the hours you have spent in the blocks, the species you have reported, reports any problems with the data codes or species entered. Those not registered for the Atlas still use the site to review the results from Atlas 1 or Atlas 2.

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Are rare species reported differently?

This is some of the most important information we will collect during this project. We need exact point locations and Rare Bird Reporting Forms for state and federally listed and species. Please alert your Regional Coordinator if you find Species of Special Concern, a Threatened or Endangered Species, or a species with "N" in the Status column of the checklist. As always, double check the ID, and call in others if you are unsure.

Species that are listed as "L" "C" or "I" on the checklist only need to be mapped - they do not need a Rare Bird Report form.

Creating the point location is easy-just make a copy of your block map, put an "X" on the map where you found the species, write your name, the block name, and include the species and dates on the map. Please mail the completed form to:

Mass Audubon - Breeding Bird Atlas 2
208 S. Great Road
Lincoln, MA 01773

Information on state and federally listed species will be sent to the Natural Heritage database. In the case of the targeted Mass Audubon species, we will use these maps to help design future projects.

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Can I report single species or additional sightings?

Once you know how to do the fieldwork, you will begin to notice breeding birds everywhere – at the beach or near your office or school. We need all of those sightings. Please don't rely on your memory –

write them down! It is easy to figure out the block you were in by looking at the MassGIS mapping tool. As long as you know the block name, the species, the behavior code, and the date you can contribute to Atlas 2 by entering them at the data entry site as an Incidental Sighting.

If you are not a registered atlaser you can still enter your sightings using the Report a Breeding Bird link to our Single Sighting tool. If you know the species, date, behavior and location you can send us information of all the breeding birds you see.

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Where do I sign up?

Simply complete our online Atlas Volunteer sign-up form. Based on your answers, we will assign you to a region. The Regional Coordinator will assign you a block.

If this is too great a time commitment, you can help us by learning the codes for breeding and reporting your observations of breeding birds on the data entry page for single bird observations.

If you have read this far, chances are you are already interested in helping us with this important conservation effort. Please don't let a lack of experience hold you back. Learning the ropes is half the fun of *atlasing*. ***And We Need You!***

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Safe Dates and Preferred Habitats

This table summarizes the most frequently used breeding habitats for a species, and lists the Safe Date period. The Safe Date is the period when most migrants will have left, and those birds that remain are likely nesters. Safe dates are also the only period when you can use our breeding behavior codes for Observed, Possible or Probable. Both the Courtship code of Probable, and the Confirmed code can be used before, during or after the Safe Date.

All species in **bold face type** are rare breeders, and require maps and further documentation. See the handbook on Reporting Rare Species.

Species	Safe Dates	Habitat
Canada Goose	4/15-8/1	Shore or islands in any wetland
Mute Swan	4/15-8/1	Large ponds and marshes
Wood Duck	5/1-8/5	Wooded swamps, freshwater marshes, streams, rivers
Gadwall	5/15-8/5	Fresh/brackish water or saltmarsh
American Wigeon	5/15-8/5	Fresh/brackish pond or marsh
Am. Black Duck	5/1-8/5	Most wetlands, from beaver ponds to saltmarsh
Mallard	5/1-8/5	All wetlands, occasionally suburban yards with swimming pools
Blue-winged Teal	5/10-8/5	Fresh/brackish pond or marsh
North. Shoveler	5/15-8/5	Fresh/brackish pond or marsh
North. Pintail	5/15-8/5	Fresh/brackish pond or marsh
Green-winged Teal	5/15-8/5	Fresh/brackish pond or marsh
Ring-necked Duck	5/25-8/5	Wooded swamps, beaver ponds, stump ponds
Common Eider	5/15-8/1	Coastal islands
Hooded Merganser	5/15-8/5	Wooded swamps, freshwater marshes, streams
Common Merganser	5/10-8/5	Lake or river
Red-breasted Merganser	6/1-8/5	Coastal marsh
Ruddy Duck	5/15-8/1	Fresh/brackish pond or marsh
Ring-necked Pheasant	5/1-8/15	Open scrub, pastures, fields
Ruffed Grouse	1/1-12/31	Mixed upland woods
Wild Turkey	1/1-12/31	Mature deciduous woods, edge
North. Bobwhite	4/30-8/15	Open scrub, pastures, fields
Common Loon	6/1-8/1	Lakes and ponds
Pied-billed Grebe	5/10-8/1	Fresh/brackish reedy pond or marsh
Leach's Storm-Petrel	6/1-8/15	Coastal Islands

Double-cres. Cormorant	5/10-8/5	Islands on coast or lake
Great Cormorant	5/1-8/5	Islands on coast
American Bittern	5/15-8/1	Fresh/brackish reedy pond or marsh
Least Bittern	5/25-8/1	Fresh/brackish reedy pond or marsh
Great Blue Heron	5/1-7/15	Wooded swamps, beaver ponds, islands
Great Egret	5/15-7/15	Islands on coast or lake
Snowy Egret	5/15-7/15	Coastal Islands
Little Blue Heron	5/15-7/15	Coastal Islands
Tricolored Heron	5/25-7/15	Coastal Islands
Cattle Egret	5/10-7/15	Coastal Islands
Green Heron	5/10-8/1	Woody growth near marshes or open water
Black-crown. Night-Heron	5/5-7/15	Coastal Islands
Yellow-crown. Night-Heron	5/5-7/15	Coastal Islands
Glossy Ibis	5/1-7/15	Coastal Islands
Black Vulture	5/10-8/15	Woods, cliffs, caves, buildings
Turkey Vulture	5/10-8/15	Woods, cliffs, caves, buildings
Osprey	5/10-8/15	Coastal marshes; rarely large wetlands inland
Bald Eagle	4/15-8/15	Margins of large lakes, rivers
North. Harrier	5/10-8/20	Coastal dunes, beaches, marshes, heathlands
Sharp-shinned Hawk	5/10-8/1	Conifers in mature woodlands
Cooper's Hawk	5/5-8/1	Mixed woodlands, groves, copses
Northern Goshawk	4/10-8/15	Mature, mixed woodlands
Red-shouldered Hawk	4/10-8/15	Wet mixed forests, swamps
Broad-winged Hawk	5/15-7/25	Mature, mixed woodlands
Red-tailed Hawk	4/15-8/1	Mature woodlands, often near edges
American Kestrel	5/10-7/20	Open country, scattered trees, edge
Merlin	5/10-7/20	Conifers
Peregrine Falcon	5/15-8/1	Cliffs, tall buildings, towers
Clapper Rail	5/15-8/1	salt and brackish marsh
King Rail	5/15-8/1	Fresh/brackish reedy pond or marsh
Virginia Rail	5/15-8/1	Salt, fresh, or brackish pond or marsh
Sora	5/15-7/25	Fresh/brackish reedy pond or marsh
Com. Moorhen	5/25-8/15	Fresh/brackish reedy pond or marsh
American Coot	6/1-8/15	Fresh/brackish reedy pond or marsh

Sandhill Crane	5/1-8/1	Extensive, freshwater marsh or bog
Piping Plover	5/15-8/15	Coastal, sandy beach
Killdeer	4/20-7/1	Open, sparsely vegetated areas; flat rooftops
Am. Oystercatcher	5/15-8/15	Upper portions of coastal beach, dunes
Willet	5/15-7/15	Coastal beach, dunes, saltmarsh
Spotted Sandpiper	5/25-7/5	Coastal shores, shores of freshwater lakes, ponds, rivers, streams
Upland Sandpiper	5/20-7/15	Extensive grasslands, especially airports
Least Sandpiper	5/25-6/15	Variety of coastal habitats
Wilson's Snipe	5/20-8/1	Bog, wet meadow
Am. Woodcock	4/15-7/15	Forest edges
Wilson's Phalarope	6/1-7/25	Saltmarsh
Laughing Gull	5/1-8/1	Coastal islands
Ring-billed Gull	5/1-8/1	Lakes, reservoirs
Herring Gull	5/1-8/1	Coastal shores/islands, flat rooftops
Lesser Black-back. Gull	5/1-8/1	Coastal shores/islands
Greater Black-back. Gull	5/1-8/1	Coastal islands
Roseate Tern	6/1-8/5	Coastal islands
Common Tern	6/1-8/5	Coastal islands, saltmarsh
Arctic Tern	6/1-8/5	Coastal sandy beaches, islands
Forster's Tern	6/1-8/5	Saltmarsh
Least Tern	5/25-8/15	Coastal sandy beach, esp dredge spoils
Black Skimmer	6/1-8/1	Coastal, sandy beach
Black Guillemot	6/1-8/1	Coastal rock ledge
Rock Pigeon	1/1-12/31	Buildings, bridges, towers in urban areas, farms
Mourning Dove	4/1-8/15	Suburbs, woodlots, farmlands
Monk Parakeet	6/1-8/1	Urban streets, large trees, telephone poles
Black-billed Cuckoo	6/5/8/15	Forested habitats, edge
Yellow-billed Cuckoo	6/5-8/15	Forested habitats, edge
Barn Owl	4/1-8/1	Open habitats
Eastern Screech-Owl	4/1-8/1	Open deciduous forests, woodlots, orchards, residential areas
Great Horned Owl	1/1-12/31	Wide variety of habitats from forest to farmland
Barred Owl	4/1-7/15	Moist woods, wooded swamps, bottomlands.
Long-eared Owl	4/1-8/1	Conifers
Short-eared Owl	5/1-8/1	Extensive coastal grassland/heathland

North. Saw-whet Owl	4/15-8/15	Mixed moist woods with conifers
Com. Nighthawk	6/5-8/1	Barren habitats including river bars and flat rooftops
Chuck-will's-widow	6/1-7/15	Scrub Oak
Whip-poor-will	5/25-7/15	Secondary forest, copses, pine barrens, scrub oak, edge
Chimney Swift	5/25-8/15	Urban chimneys
Ruby-throated Hum.	6/1-8/1	Open woodland, rural and suburban gardens, edge
Belted Kingfisher	5/1-8/10	Stream, river, lake, or bay shore with banks
Red-headed Woodpecker	5/20-8/25	Open country with scattered trees
Red-bellied Woodpecker	4/15-8/1	Older-growth forest and woodlots
Yellow-bellied Sapsucker	5/20-8/1	higher-elevation hardwoods
Downy Woodpecker	5/1-7/25	Forests, copses, suburbs
Hairy Woodpecker	4/25-7/20	Forests
North. Flicker	5/25-7/25	Forests, parks,
Pileated Woodpecker	1/1-12/31	Matured forest, especially bottomland
Olive-sided Flycatcher	6/5-8/1	Spruce/Larch bog
Eastern Wood-Pewee	6/5-8/1	Mature forest
Yellow-bellied Flycatcher	6/5-8/1	Spruce/Sphagnum bog
Acadian Flycatcher	6/5-8/1	Red Maple swamp (SE) and Hemlock (elsewhere)
Alder Flycatcher	6/5-8/1	Shrub (esp. Alder) swamp
Willow Flycatcher	6/5-8/1	Shrub (esp. Willow) swamp
Least Flycatcher	5/25-8/5	Open deciduous forests, forest edge
Eastern Phoebe	5/1-8/15	Ledges, bridges, porch sills, etc., usually near water
Great Crested Flycatcher	5/25-8/1	Mature forest, edge
Eastern Kingbird	5/25-7/25	Open habitats, including edge, copses, often near water
Loggerhead Shrike	5/15-8/1	Farmland and other open habitats
White-eyed Vireo	5/15-8/1	Moist areas, thickets, tangle of vines or briers.
Yellow-throated Vireo	5/20-8/10	Open deciduous and mixed forest and riparian woodlands
Blue-headed Vireo	5/15-8/10	Mature coniferous or mixed woods
Warbling Vireo	5/15-8/10	Semi-open borders of river meadows, ponds, and streams
Red-eyed Vireo	6/1-8/10	Mixed and deciduous Woods
Blue Jay	5/1-8/15	Varied; most forest types, thickets, suburban yards, parks
American Crow	3/25-7/15	Conifers in forested areas, woodlots, suburban yards, parks
Fish Crow	5/1-7/15	Mixed woods, woodlots, suburban yards, parks
Common Raven	3/20-7/20	Remote forested areas

Horned Lark	4/25-8/1	Coastal dunes and beaches, abandoned agricultural fields, airports
Purple Martin	5/25-7/1	Open areas; edge of saltmarsh, coastal farmland, and golf courses
Tree Swallow	5/15-7/1	Open areas or woodland edge near wetlands; including saltmarsh
Northern Rough-winged Swallow	5/20-7/1	Often near water, in cavity, pipe, or excavated burrow
Bank Swallow	5/25-7/1	Earthen embankments
Cliff Swallow	5/25-7/1	Eves and sides of old barns and other buildings, bridges
Barn Swallow	5/25-7/1	Structures offering access to interior; barns, garages, porches, sheds, etc.
Black-capped Chickadee	4/1-8/15	Woodlands, orchards, shade trees, yards, and city parks
Tufted Titmouse	4/5-8/1	Deciduous (especially oak) forest, riparian woodlands, and residential areas
Red-breast. Nuthatch	5/15-8/10	Coniferous forest
White-breast. Nuthatch	4/25-8/10	Deciduous forest
Brown Creeper	5/20-8/1	Mature, mixed, and swampy forest, including Atlantic White Cedar swamps
Carolina Wren	4/1-8/15	Wet woods, stream edges with dense thickets, tangles, brush piles, etc.
House Wren	5/20-8/15	Open forests, wood edges, farms, orchards, suburbs, parks, gardens
Winter Wren	5/1-8/5	Cool, moist, coniferous or mixed woods, swamps, bogs, streams, brooks
Sedge Wren	6/1-8/1	Wet meadows, freshwater marshes
Marsh Wren	5/15-8/15	Cattail and other tall marshes, including saltmarsh edges
Golden-crowned Kinglet	5/10-8/1	Coniferous woods
Ruby-crowned Kinglet	5/20-8/1	Coniferous woods
Blue-gray Gnatcatcher	5/15-8/1	Wooded edges along ponds, rivers, streams, swamps, beaver ponds
Eastern Bluebird	5/1-8/15	Fields with scattered trees; farmland, orchards, pastures, etc.
Veery	5/25-8/10	Moist mixed forest
Bicknell's Thrush	6/1-8/10	High elevation spruce/fir forest
Swainson's Thrush	6/1-8/10	High elevation spruce/fir forest
Hermit Thrush	5/10-9/10	Damp mixed forest with dense undergrowth including pine barrens
Wood Thrush	5/25-8/10	Mature forest
Am. Robin	5/1-9/1	Almost anywhere except the most open habitats such as marsh, grasslands
Gray Catbird	5/20-8/15	Dense tangles and thickets
North. Mockingbird	5/5-8/15	Suburban or semi-rural habitats with thickets, brushy forest edges, hedgerows

Brown Thrasher	5/15-8/10	Dry second-growth; powerlines, overgrown pastures, coastal thickets
European Starling	1/1-12/31	Everywhere except remote rural areas
Cedar Waxwing	6/10-8/15	Second-growth forest, parks, orchards, gardens, and margins of waterways
Blue-winged Warbler	5/20-8/1	Old, brushy fields, copses, edge with low undergrowth, powerline cuts
Golden-winged Warbler	5/20-8/1	Damp brushy fields, powerline cuts
Brewster's Warbler	5/20-8/1	Old, brushy fields, copses, edge with low undergrowth, powerlines
Lawrence's Warbler	5/20-8/1	Old, brushy fields, copses, edge with low undergrowth, powerlines
Tennessee Warbler	6/1-8/1	Coniferous forest
Nashville Warbler	5/25-8/15	Open Scrub Oak woodlands (SE), overgrown pastures, bogs (C, W)
Northern Parula	6/1-8/10	Woodlands with *Usnea* lichen
Yellow Warbler	5/25-8/1	Margins of freshwater marsh, other wet brushy areas, farmland
Chestnut-sided Warbler	5/25-8/1	Brushy, open second-growth, edges
Magnolia Warbler	6/5-8/10	Coniferous forest
Black-throat. Blue Warbler	5/25-8/10	Mixed woods with dense understory, esp. Mountain Laurel
Yellow-rumped Warbler	5/25-8/10	Mature White Pines (SE), coniferous forest (C, W)
Black-throat. Green Warb.	5/25-8/5	Coniferous and mature mixed forest
Blackburnian Warbler	5/25-8/5	Coniferous forest
Pine Warbler	5/1-8/5	Variety of pine forest types
Prairie Warbler	5/25-8/1	Brushy fields, powerline cuts, edges
Blackpoll Warbler	6/10-8/10	High elevation spruce, Balsam Fir forest
Cerulean Warbler	6/1-8/1	Mature, moist deciduous forest
Black-and-white Warbler	5/25-8/1	Mainly deciduous forest
American Redstart	6/1-8/1	Secondary forest, copses
Prothonotary Warbler	6/1-8/1	Variety of deciduous or mixed forest types, saplings in field edge bordered by forest, wooded swamps
Worm-eating Warbler	5/20-8/1	Brushy undergrowth of rocky, wooded hillsides and ravines, usually near water
Ovenbird	5/20-8/5	Open forests with little or no understory vegetation and ample leaf litter
North. Waterthrush	5/20-7/25	Wooded swamps, bogs, backwaters
Louisiana Waterthrush	5/10-7/20	Rocky streams in deciduous or mixed forest
Kentucky Warbler	6/1-8/1	Wet thickets, dense understory in moist or wet deciduous forest, bottomland
Mourning Warbler	6/5-8/10	High elevation; dense, early second growth, tangles, esp. raspberry

		canes in clearcut
Common Yellowthroat	6/1-8/10	Brushy areas, thickets, powerline cuts, preferably wet
Hooded Warbler	6/1-8/1	Moist thickets in woodlands
Canada Warbler	6/5-8/1	Thick undergrowth in moist deciduous or mixed forest; cedar swamp, Red Maple (SE)
Yellow-breasted Chat	6/1-8/5	Thickets, esp. regenerating fields and pastures
Scarlet Tanager	5/25-8/10	Mature deciduous forest
Eastern Towhee	5/1-8/10	Dry, open forest, edge, brushy habitats, including coastal thickets, powerline cuts
Chipping Sparrow	5/1-8/15	Open mixed forest, suburbs, parks, and cemeteries with conifers
Clay-colored Sparrow	6/1-8/1	Shrubby grasslands
Field Sparrow	5/1-8/5	Brushy areas, weedy fields, powerline cuts
Vesper Sparrow	5/10-8/5	Short grass areas, agricultural fields, clearings in pine barrens, coastal moors
Savannah Sparrow	5/10-8/1	Grasslands, including airports, hayfields
Grasshopper Sparrow	5/25-8/10	Grasslands, including airports, hayfields
Henslow's Sparrow	6/1-8/1	Weedy fields, wet meadows
Nelson's Sharp-tail. Sparrow	6/1-8/1	Saltmarsh
Saltmarsh Sharp-tail. Sparrow	5/25-8/10	Saltmarsh
Seaside Sparrow	5/25-8/10	Saltmarsh
Song Sparrow	5/1-8/10	Forest edge, brushy areas, marsh edges, suburbs
Lincoln's Sparrow	6/1-8/1	High elevation boreal bog
Swamp Sparrow	5/1-8/5	Freshwater wetlands including cattail marsh, swamps, river meadow, and pond edges
White-throated Sparrow	5/20-8/20	Scrubby habitats esp with conifers (C, W); Red Maple, Atlantic White Cedar (SE)
Slate-colored Junco	5/1-9/5	Edges in coniferous or mixed woodlands; saplings and brushy thickets at higher elevations
North. Cardinal	4/15-8/20	Suburban or semi-rural areas; forest edge, woodlots, thickets, parks, gardens
Rose-breasted Grosbeak	5/25-8/5	Deciduous and mixed forest, woodlots, shade trees of parks and suburbs
Indigo Bunting	5/25-8/10	Brushy habitats including forest edge, overgrown fields, powerline cuts
Bobolink	6/1-8/1	Grasslands, including airports, hayfields
Red-winged Blackbird	5/1-7/15	Wide variety of densely vegetated freshwater habitats, higher saltmarsh
Eastern Meadowlark	5/5-7/25	Extensive grasslands, including airports, margins of saltmarsh

Rusty Blackbird	5/25-7/25	Boreal bog
Common Grackle	5/15-7/10	Wide variety of urban and rural habitats from open forest to fresh and salt marshes, parks, etc.
Brown-headed Cowbird	5/1-7/15	Virtually all habitats; anywhere host species are found
Orchard Oriole	5/25-7/15	Open, patchy forest, copses, often near river, stream, or pond
Baltimore Oriole	5/25-8/1	Open deciduous forest, shade trees in urban or rural areas
Purple Finch	5/25-8/10	Conifers in mixed woods, suburbs, parklands
House Finch	4/15-8/1	Scattered trees- especially conifers- mainly in residential areas
Red Crossbill	5/1-7/15	Coniferous forest
White-winged Crossbill	5/1-7/15	Coniferous forest
Pine Siskin	5/1-7/15	Conifers
American Goldfinch	6/1-8/1	Forest edge, copses, brushy areas, marsh edges, residential
Evening Grosbeak	5/25-8/15	Mixed forest
House Sparrow	1/1-12/31	Residential, farms

Breeding Codes

The Massachusetts Breeding Bird Atlas 2 will use the following codes for describing bird behavior. It is worthwhile to study the codes and know them well – this is what you are looking for in the field. Breeding birds are often short on time, and careful observation of an actively nesting bird will usually uncover one of these behaviors. Remember to try to upgrade a species code, and pay attention to the Safe Dates. Breeding Codes are listed below and you can download full breeding codes (PDF 27KB), or abbreviated breeding codes (PDF 66KB).

OBSERVED: (all observations must be within Safe Dates)

O — Species known to breed in Mass, but seen "passing through" (e.g. vultures, gulls), or a colonial species observed with no colony found in block, or a bird seen in unsuitable nesting habitat. Only use this code when no further evidence of breeding is uncovered. Work to upgrade these species if you suspect they are breeding in the block!

POSSIBLE: (all observations must be within Safe Dates)

X — Male or female seen or heard in suitable nesting habitat but no further evidence of breeding is uncovered. This includes a single drumming woodpecker, **although the species must be seen to ID the woodpecker**.

PROBABLE: (all observations must be within Safe Dates)

P — A pair (male and female together) seen in suitable nesting habitat.

S — Permanent territory presumed through song, heard at same location on at least two occasions, 7 days (or more) apart. This code can be used for drumming woodpeckers – **although the species must be seen to ID the woodpecker**. Both observations must be within Safe Dates.

T — Permanent territory presumed through defense of territory (often one male chasing another). This is a tricky code to use, and if the bird is watched longer, you'll probably find better evidence.

A — Agitated behavior or anxiety calls from adult. These calls are frequently directed at cats or snakes. Don't use this code if the bird is responding to "pishing". If the call is directed at you, back off. Much like "T" code, watch for better evidence.

C — **(NEW: OK to use outside of the Safe Dates, except for ducks)** Courtship behavior seen. Some species have courtship feeding rituals (e.g. cuckoos), some raptors have spectacular courtship displays (Broad-winged and Red-tailed Hawks, falcons), and this is one of the best codes to use for hummingirds. Consult "The Birder's Handbook" for succinct display descriptions.

N	Visiting probable nest site. **Do not approach nests to check contents!** Some nests are too high (e.g. the tops of trees) or enclosed (e.g. chimneys) for the contents to be seen. Listen for calls of begging young and watch for food deliveries to upgrade to Confirmed. If neither is seen or heard, the birds may still be on eggs – return a few days later if you can.
B	Building a nest by a wren, or excavation of holes by woodpeckers. Wrens often build "dummy" nests – a series of nests of which none may be used. Woodpeckers will excavate roost holes as well as nest holes. Don't despair – finding a wren nest means you are very close to a Confirmation. It is usually easy to Confirm wrens with CF, and woodpeckers with CF or NY.

CONFIRMED: (can be use at any time)

ON	Occupied nest: adult seen sitting on nest and likely incubating eggs or brooding hatchlings. No eggs or young seen.
CN	Carrying nesting material, such as sticks, grass, bark, etc. Don't use for wrens, crows, Monk Parakeet, or for colonial species for which you never find a colony (e.g. Great Blue Heron).
NB	Nest building at the actual nest-site. Don't use for wrens – attempt to upgrade wrens with CF or by the noisy NY. Don't use for Monk Parakeet.
PE	Physiological evidence of breeding (e.g. highly vascularized brood patch or egg in oviduct, based on bird in hand.). To be used by bird banders.
DD	Distraction display or injury feigning. Look for this in Killdeer and in many other species – other shorebirds, rails, some ducks, some warblers.
UN	Used nest or eggshells found. Caution: these must be carefully identified if they are to be accepted.
PY	Precocial young. Flightless young of precocial species restricted to the natal area by dependence on adults or limited mobility.
FL	Recently fledged young (either precocial or altricial) incapable of sustained flight, restricted to natal area by dependence on adults or limited mobility.
CF	Carrying food: adult carrying food for the young. Don't use for crows, Common Raven, raptors, gulls or terns unless you see them go into a nest site.
FY	Adult feeding recently fledged young. Adults feeding Brown-headed Cowbird young confirms both the host species and the cowbird.
FS	Adult carrying fecal sac. Fecal sacs, white membranous pellets excreted by the young, are usually carried from the nest then dropped. Occasionally birds drop them in the same place, and they form a spattered whitewash on cars, pavement, decks etc.
NE	Nest with egg(s). **Do not approach nests to check contents!** If you have the time to watch a bird through binoculars or with a scope, watch as the incubating bird turns the eggs in the nest. Many birds remove eggshells, and you'll find them on the ground sometimes – they can be difficult to identify! Nests containing Brown-headed Cowbird eggs confirms both the host species and the cowbird.
NY	Nest with young seen or heard. Frequently used code – young are usually noisy when parents return with food. Learn the sounds of begging young birds, and let that direct you to the general area of the nest where you can identify the parents.

Breeding Codes

Observed: Use during Safe Dates for species known to breed in Massachusetts, but only seen "passing through" your block. Record date in column. Examples; vultures seen in transit through block, late migrants out of habitat, or colonial nesting birds without a colony.

Possible: Use during Safe Dates for male or female seen or heard in suitable nesting habitat but no further evidence of breeding was uncovered. Record date in column.

Probable: With the exception of the "C" code, only use during Safe Dates. Record date and code.

- **P** A pair (male and female, together, not fighting) seen in suitable nesting habitat.
- **S** Permanent territory presumed through song (or drumming), heard at same location on at least two occasions, 7 days (or more) apart.
- **T** Permanent territory presumed through defense. Most birds will not tolerate another bird of the same species, other than their mate or young, near them while nesting. Birds are quite aggressive when breeding, and some territory squabbles are intense.
- **A** Agitated behavior or anxiety calls from adult.
- **C** Courtship and/or reproductive behavior seen or heard. (OK to use out of Safe Dates, but not out of Safe Dates for ducks).
- **N** Visiting probable nest site (e.g. the tops of trees, chimneys).
- **B** Building a nest by a wren, or excavation of holes by single woodpeckers.

Confirmed: (can be used outside of Safe Dates) Record date and code.

- **ON** Occupied nest: adult seen sitting on nest and likely incubating eggs or brooding.
- **CN** Carrying nesting material, such as hair, sticks, grass, bark, etc.
- **NB** Nest building at the actual nest-site.
- **PE** Physiologic evidence of breeding (e.g. brood patch or egg in oviduct.).
- **DD** Distraction display or injury feigning.
- **UN** Used nest or eggshells found.
- **PY** Precocial young (downy, capable of walking – think duck hatchling) .
- **FL** Recently fledged young (either precocial or altricial) incapable of sustained flight.
- **CF** Carrying food: adult carrying food for the young.
- **FY** Adult feeding recently fledged young.
- **FS** Adult carrying fecal sac.
- **NE** Nest with egg(s).
- **NY** Nest with young seen or heard.

Dates and Hours of Atlas Trips: Please record all trips.

Date	Hours	Date	Hours	Date	Hours

Breeding Codes

OBServed: Use during Safe Dates for species known to breed in Massachusetts, but only seen "passing through" your block. Record date in column. Examples; vultures seen in transit through block, late migrants out of habitat, or colonial nesting birds without a colony.

POSSible: Use during Safe Dates for male or female seen or heard in suitable nesting habitat but no further evidence of breeding was uncovered. Record date in column.

PROBable: Only use during Safe Dates, except for the "C" code. Record date & code.

P A pair (male and female, together, not fighting) seen in suitable nesting habitat.
S Permanent territory presumed through song (or drumming), heard at same location on at least two occasions, 7 days (or more) apart, both singing dates during safe dates.
T Permanent territory presumed through defense. Most birds will not tolerate another bird of the same species, other than their mate or young, near them while nesting. Birds are quite aggressive when breeding, and some territory squabbles are intense.
A Agitated behavior or anxiety calls from adult.
C Courtship and/or reproductive behavior seen or heard. (OK to use out of Safe Dates, but not out of Safe Dates for ducks). Consult "Birder's Handbook" for breeding displays.
N Visiting probable nest site, no nest seen (e.g. the tops of trees, nest boxes, chimneys).

B Building a nest by a wren, or excavation of holes by single woodpeckers.

CONFirmed: (can be used outside of Safe Dates) Record date & code.

ON Occupied nest: adult seen sitting on nest and likely incubating eggs or brooding.
CN Carrying nesting material, such as hair, sticks, grass, bark, etc.
NB Nest building at the actual nest-site.
PE Physiologic evidence of breeding (e.g. brood patch or egg in oviduct.).
DD Distraction display or injury feigning.
UN Used nest or eggshells found.
PY Precocial young (downy, capable of walking – think duck hatchling) .
FL Recently fledged young (either precocial or altricial) incapable of sustained flight.
CF Carrying food: adult carrying food for the young.
FY Adult feeding recently fledged young.
FS Adult carrying fecal sac.
NE Nest with egg(s).
NY Nest with young seen or heard.

Mass. Breeding Bird Atlas 2 Field Checklist

Circle One: Primary or Supporting

Atlaser Name(s) ____________________
____
Phone ____________________
Email ____________________
Do you live in the block? ________
Have you mapped all **bold** species? ________
Have you entered all data into USGS? ________

Block Name ________
____
Year ________
Record all hours on back page. Thank You!

Submit **maps and forms** via USGS data entry link.
E= Listed by Natural Heritage as Endangered
T= Listed by Natural Heritage as Threatened
SC= Listed by Natural Heritage as Special Concern
N= has NOT YET NESTED in state
L= LOCAL and/or Rare breeder, submit map, no form
Submit maps only, no form needed, via mail.
C= map only those in natural CAVITIES.
I= map only INLAND records.

After all data entry is complete, please mail a **copy of this card** and all **maps** of special species to:
Mass Audubon
Breeding Bird Atlas 2
208 S. Great Road
Lincoln, MA 01773

Mass Audubon
Protecting the Nature of Massachusetts

			OBS	POSS	PROB		CONF	
Species	Safe Date	Status	Date	Date	Date	Code	Date	Code
Canada Goose	4/15-8/1							
Mute Swan	4/15-8/1							
Wood Duck	5/1-8/5							
Gadwall	5/15-8/5							
Am. Wigeon	5/15-8/5	L						
Am. Black Duck	5/1-8/5							
Mallard	5/1-8/5							
Blue-winged Teal	5/10-8/5							
North. Shoveler	5/15-8/5	L						
North. Pintail	5/15-8/5							
Green-winged Teal	5/15-8/5							
Ring-necked Duck	5/25-8/5	L						
Com. Eider	5/15-8/1	L						
Hooded Merg.	5/15-8/5							
Common Merg.	5/10-8/5							
Red-breasted Merg.	6/1-8/5	L						
Ruddy Duck	5/15-8/1	L						
Ring-necked Pheasant	5/1-8/15							
Ruffed Grouse	1/1-12/31							
Wild Turkey	1/1-12/31							
North. Bobwhite	4/30-8/15							

			OBS	POSS	PROB		CONF	
Species	Safe Date	Status	Date	Date	Date	Code	Date	Code
Common Loon	6/1-8/1	**SC**						
Pied-billed Grebe	5/10-8/1	**E**						
Leach's Storm-Petrel	6/1-8/15	**E**						
Double-cres. Cormorant	5/10-8/5	I						
Great Cormorant	5/1-8/5	L						
Am. Bittern	5/15-8/1	**E**						
Least Bittern	5/25-8/1	**E**						
Great Blue Heron	5/1-7/15							
Great Egret	5/15-7/15	I						
Snowy Egret	5/15-7/15							
Little Blue Heron	5/15-7/15							
Tricolored Heron	5/25-7/15	L						
Cattle Egret	5/10-7/15	L						
Green Heron	5/10-8/1							
Bl-crown. Night-Heron	5/5-7/15							
Yel.-crown. N.-Heron	5/5-7/15	L						
Glossy Ibis	5/1-7/15							
Black Vulture	5/10-8/15	L						
Turkey Vulture	5/10-8/15							
Osprey	5/10-8/15	I						
Bald Eagle	4/15-8/15	**E**						
North. Harrier	5/10-8/20	**T**						
Sharp-shinned Hawk	5/10-8/1	**SC**						
Cooper's Hawk	5/5-8/1							
North. Goshawk	4/10-8/15							
Red-shouldered Hawk	4/10-8/15							
Broad-winged Hawk	5/15-7/25							
Red-tailed Hawk	4/15– 8/1							
Am. Kestrel	5/10-7/20	L						
Merlin	5/10-7/20	N						
Peregrine Falcon	5/15-8/1	**E**						
Clapper Rail	5/15-8/1							
King Rail	5/15-8/1	**T**						
Virginia Rail	5/15-8/1							
Sora	5/15-7/25	L						
Com. Moorhen	5/25-8/15	**SC**						
Am. Coot	6/1-8/15	L						
Sandhill Crane	5/1- 8/1	L						

			OBS	POSS	PROB		CONF	
Species	Safe Date	Status	Date	Date	Date	Code	Date	Code
Piping Plover	5/15-8/15	**T**						
Killdeer	4/20-7/1							
Am. Oystercatcher	5/15-8/15							
Willet	5/15-7/15							
Spotted Sandpiper	5/25-7/5							
Upland Sandpiper	5/20-7/15	**E**						
Least Sandpiper	5/25-6/15	L						
Wilson's Snipe	5/20-8/1	L						
Am. Woodcock	4/15-7/15							
Wilson's Phalarope	6/1-7/25	L						
Laughing Gull	5/1-8/1							
Ring-billed Gull	5/1-8/1	L						
Herring Gull	5/1-8/1	I						
Les. Black-back. Gull	5/1-8/1	N						
Gr. Black-back. Gull	5/1-8/1	I						
Roseate Tern	6/1-8/5	**E**						
Common Tern	6/1-8/5	**SC**						
Arctic Tern	6/1-8/5	**SC**						
Forster's Tern	6/1-8/5	L						
Least Tern	5/25-8/15	**SC**						
Black Skimmer	6/1-8/1							
Black Guillemot	6/1-8/1	N						
Rock Pigeon	1/1-12/31							
Mourning Dove	4/1-8/15							
Monk Parakeet	6/1-8/1	N						
Black-billed Cuckoo	6/5/8/15							
Yellow-billed Cuckoo	6/5-8/15							
Barn Owl	4/1-8/1	**SC**						
Eastern Screech-Owl	4/1-8/1							
Great Horned Owl	1/1-12/31							
Barred Owl	4/1-7/15							
Long-eared Owl	4/1-8/1	**SC**						
Short-eared Owl	5/1-8/1	**E**						
North. Saw-whet Owl	4/15-8/15							
Com. Nighthawk	6/5-8/1							
Chuck-will's-widow	6/1-7/15	N						
Whip-poor-will	5/25-7/15							

			OBS	POSS	PROB		CONF	
Species	Safe Date	Status	Date	Date	Date	Code	Date	Code
Chimney Swift	5/25-8/15	C						
Ruby-throated Hum.	6/1-8/1							
Belted Kingfisher	5/1-8/10							
Red-headed Woodpecker	5/20-8/25							
Red-bellied Woodpecker	4/15-8/1							
Yellow-bellied Sap.	5/20-8/1							
Downy Woodpecker	5/1-7/25							
Hairy Woodpecker	4/25-7/20							
North. Flicker	5/25-7/25							
Pileated Woodpecker	1/1-12/31							
Olive-sided Flycatcher	6/5-8/1	L						
Eastern Wood-Pewee	6/5-8/1							
Yellow-bellied Flycatcher	6/5-8/1	N						
Acadian Flycatcher	6/5-8/1							
Alder Flycatcher	6/5-8/1							
Willow Flycatcher	6/5-8/1							
Least Flycatcher	5/25-8/5							
Eastern Phoebe	5/1-8/15							
Great Crested Fly.	5/25-8/1							
Eastern Kingbird	5/25-7/25							
Loggerhead Shrike	5/15-8/1	L						
White-eyed Vireo	5/15-8/1							
Yellow-throated Vireo	5/20-8/10							
Blue-headed Vireo	5/15-8/10							
Warbling Vireo	5/15-8/10							
Red-eyed Vireo	6/1-8/10							
Blue Jay	5/1-8/15							
American Crow	3/25-7/15							
Fish Crow	5/1-7/15							
Com. Raven	3/20-7/20	L						
Horned Lark	4/25-8/1							
Purple Martin	5/25-7/1	L						
Tree Swallow	5/15-7/1							
N. Rough-wing. Swallow	5/20-7/1							
Bank Swallow	5/25-7/1							
Cliff Swallow	5/25-7/1	L						
Barn Swallow	5/25-7/1							

			OBS	POSS	PROB		CONF	
Species	Safe Date	Status	Date	Date	Date	Code	Date	Code
Black-cap. Chickadee	4/1-8/15							
Tufted Titmouse	4/5-8/1							
Red-breast. Nuthatch	5/15-8/10							
White-breast. Nuthatch	4/25-8/10							
Brown Creeper	5/20-8/1							
Carolina Wren	4/1-8/15							
House Wren	5/20-8/15							
Winter Wren	5/1-8/5							
Sedge Wren	6/1-8/1	**E**						
Marsh Wren	5/15-8/15							
Golden-crowned Kinglet	5/10-8/1							
Ruby-crowned Kinglet	5/20-8/1							
Blue-gray Gnatcatcher	5/15-8/1							
Eastern Bluebird	5/1-8/15	C						
Veery	5/25-8/10							
Bicknell's Thrush	6/1-8/10	L						
Swainson's Thrush	6/1-8/10							
Hermit Thrush	5/10-9/10							
Wood Thrush	5/25-8/10							
Am. Robin	5/1-9/1							
Gray Catbird	5/20-8/15							
North. Mockingbird	5/5-8/15							
Brown Thrasher	5/15-8/10							
European Starling	1/1-12/31							
Cedar Waxwing	6/10-8/15							
Blue-winged Warbler	5/20-8/1							
Golden-winged Warbler	5/20-8/1	**E**						
Brewster's Warbler	5/20-8/1							
Lawrence's Warbler	5/20-8/1							
Tennessee Warbler	6/1-8/1	N						
Nashville Warbler	5/25-8/15							
North. Parula	6/1-8/10	**T**						
Yellow Warbler	5/25-8/1							
Chestnut-sided Warbler	5/25-8/1							
Magnolia Warbler	6/5-8/10							
Black-throat. Blue Warbler	5/25-8/10							
Yellow-rumped Warbler	5/25-8/10							

			OBS	POSS	PROB		CONF	
Species	**Safe Date**	**Status**	**Date**	**Date**	**Date**	**Code**	**Date**	**Code**
Black-throat. Green Warb.	5/25-8/5							
Blackburnian Warbler	5/25-8/5							
Pine Warbler	5/1-8/5							
Prairie Warbler	5/25-8/1							
Blackpoll Warbler	6/10-8/10	**SC**						
Cerulean Warbler	6/1-8/1	L						
Black-and-white Warb.	5/25-8/1							
American Redstart	6/1-8/1							
Prothonotary Warbler	6/1-8/1	L						
Worm-eating Warbler	5/20-8/1							
Ovenbird	5/20-8/5							
North. Waterthrush	5/20-7/25							
Louisiana Waterthrush	5/10-7/20							
Kentucky Warb.	6/1-8/1	N						
Mourning Warb.	6/5-8/10	**SC**						
Com. Yellowthroat	6/1-8/10							
Hooded Warb.	6/1-8/1	L						
Canada Warb.	6/5-8/1							
Yellow-breasted Chat	6/1-8/5							
Scarlet Tanager	5/25-8/10							
Eastern Towhee	5/1-8/10							
Chipping Sparrow	5/1-8/15							
Clay-colored Sparrow	6/1-8/1	L						
Field Sparrow	5/1-8/5							
Vesper Sparrow	5/10-8/5	**T**						
Savannah Sparrow	5/10-8/1							
Grasshopper Sparrow	5/25-8/10	**T**						
Henslow's Sparrow	6/1-8/1	**E**						
Nelson's Sharp-tail. Spar.	6/1-8/1	N						
Saltmarsh Sharp-tail. Spar.	5/25-8/10							
Seaside Sparrow	5/25-8/10							
Song Sparrow	5/1-8/10							
Lincoln's Sparrow	6/1-8/1	L						
Swamp Sparrow	5/1-8/5							
White-throated Sparrow	5/20-8/20							

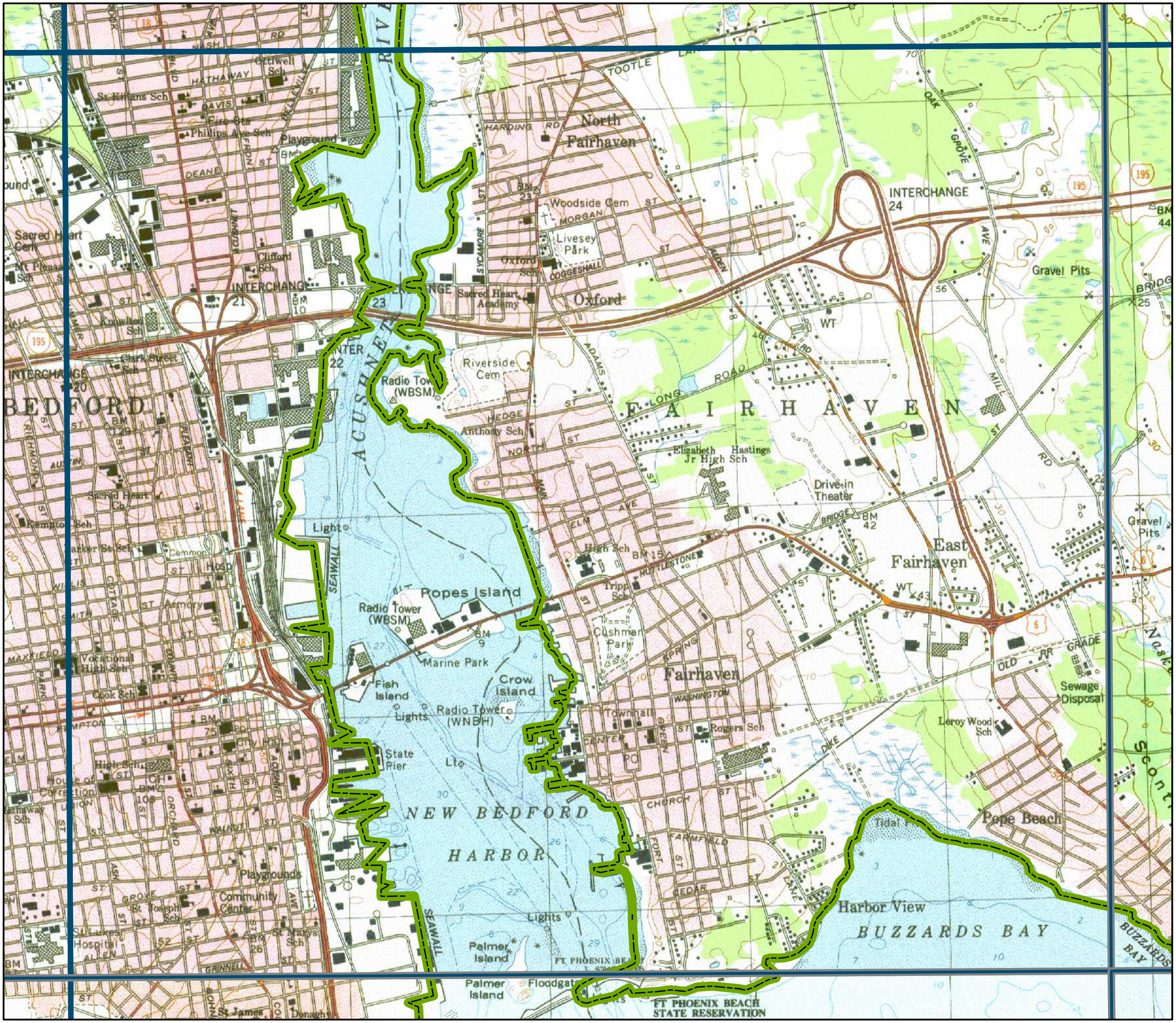
			OBS	POSS	PROB		CONF	
Species	Safe Date	Status	Date	Date	Date	Code	Date	Code
Dark-eyed Junco	5/1-9/5							
North. Cardinal	4/15-8/20							
Rose-breasted Grosbeak	5/25-8/5							
Indigo Bunting	5/25-8/10							
Bobolink	6/1-8/1							
Red-winged Blackbird	5/1-7/15							
Eastern Meadowlark	5/5-7/25							
Rusty Blackbird	5/25-7/25	L						
Common Grackle	5/15-7/10							
Brown-headed Cowbird	5/1-7/15							
Orchard Oriole	5/25-7/15							
Baltimore Oriole	5/25-8/1							
Purple Finch	5/25-8/10							
House Finch	4/15-8/1							
Red Crossbill	5/1-7/15	L						
White-winged Crossbill	5/1-7/15	L						
Pine Siskin	5/1-7/15							
American Goldfinch	6/1-8/1							
Evening Grosbeak	5/25-8/15							
House Sparrow	1/1-12/31							

Additional Species and Notes

Massachusetts Breeding Bird Atlas II (2007-2011)

Block: 1606

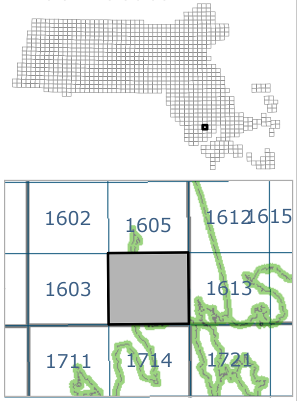
New Bedford North - 06



Map Key

- Atlas block border
- Topo border
- County line

Block locator



0 0.25 0.5 1 Mile

Date generated: Mar 05, 2008

More info: http://www.massaudubon.org/birdatlas/bba2 | To print a map: http://www.pwrc.usgs.gov/bba
Topographic data from Office of Geographic and Environmental Information (MassGIS),
Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs

USGS
North American BBA Explorer

Mass Audubon
Protecting the Nature of Massachusetts

Massachusetts 2007-2011

Results by Block

Draft Results Summary for 1606/ New Bedford North - 06 (Bristol)

All results DRAFT until final review / publication. select another bloc

SUMMARY:
60 total species: 46 CO, 14 PR, (plus 4 OB)
28 species in MA1974

Results last updated: 10 Sep 2010 view missing species

Species List

Species	Best Evidence	Other details
Canada Goose	● CO FL	
Mute Swan	● CO ON	
Wood Duck	◑ PR P	
Gadwall	● CO PY	
Mallard	● CO FL	
Ring-necked Pheasant		
Green Heron	● CO FY	
Black-crowned Night-Heron	○ OB O	
Turkey Vulture	◑ PR C	
Cooper's Hawk	◑ PR P	
Red-shouldered Hawk	● CO CN	
Piping Plover		
Killdeer	◑ PR C	
American Oystercatcher	◑ PR C	
Willet	◑ PR T	
Spotted Sandpiper	◑ PR T	
Least Tern	◑ PR C	
Rock Pigeon	◑ PR C	
Mourning Dove	● CO CN	
Eastern Screech-Owl	● CO FL	
Chimney Swift	● CO CN	
Ruby-throated Hummingbird	● CO CF	
Red-bellied Woodpecker	○ OB O	
Downy Woodpecker	● CO FL	
Hairy Woodpecker	◑ PR C	
Northern Flicker (Yellow-shafted Flicker)	◑ PR C	
Willow Flycatcher	◑ PR S	

Eastern Phoebe	CO FY	
Great Crested Flycatcher	CO NB	
Eastern Kingbird	CO CN	
Red-eyed Vireo	CO FY	
Blue Jay	CO CN	
American Crow	CO FY	
Horned Lark	CO FL	
Northern Rough-winged Swallow	CO FY	
Barn Swallow	CO FY	
Black-capped Chickadee	CO NB	
Tufted Titmouse	CO FL	
White-breasted Nuthatch	CO FY	
Carolina Wren	CO FL	
House Wren	PR P	
Blue-gray Gnatcatcher	CO FY	
American Robin	CO CN	
Gray Catbird	CO CN	
Northern Mockingbird	CO CN	
European Starling	CO FL	
Cedar Waxwing	CO CN	
Blue-winged Warbler	PR P	
Yellow Warbler	CO ON	
Pine Warbler	CO CF	
Common Yellowthroat	CO CF	
Eastern Towhee	OB O	
Chipping Sparrow	CO FY	
Savannah Sparrow		
Nelson's Sharp-tailed Sparrow	OB O	
Saltmarsh Sharp-tailed Sparrow	CO FS	
Song Sparrow	CO CF	
Northern Cardinal	CO FY	
Rose-breasted Grosbeak		
Red-winged Blackbird	CO ON	
Common Grackle	CO CN	
Brown-headed Cowbird	CO FL	
Orchard Oriole	CO CN	
Baltimore Oriole	CO NB	
House Finch	CO FY	
American Goldfinch	CO FL	
House Sparrow	CO CN	

(select a Quad

Arrangement of blocks:

01	04	07	10
02	05	08	11
03	06	09	12

OR block code:

'**Quad**' is used here for topogra
other larger units containing s

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Help & Hints *for atlases in progress*

• Only *reviewed* data are shown in public results.
• This page may show no results (0 species) for the current atlas, but have lots of results fr atlas.
• For atlas participants, the Block Sightings Detail Report may be more useful and includes even those not finalized or reviewed.

APPENDIX 6

SouthCoastTODAY.com/CHRONICLE
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Fri,

Local birders heed the call to help Audubon's National Christmas Bird Count

Photo 1 of 6 | Zoom Photo +

WOODY WOODPECKER: A male downy woodpecker clings to a crab apple tree looking for some food while he's counted for the National Audubon's 108th Christmas Bird Count. PHOTOS BY DAN KING/The Chronicle

December 26, 2007 5:20 PM

By Daniel H. King

Staff Writer

DARTMOUTH — On a crisp, clean Saturday Dec. 22 morning local birders, Mike Boucher, Ken Machado and Beverly King head out on the King Farm to count birds for National Audubon's 108th Annual Christmas Bird Count.

The bird count, which is a 24 hour event, gives local bird enthusiasts a chance to participate in a nationwide bird survey that identifies and records all the species one sees throughout the day and tallies the total number of individuals from each species.

Locally, The Paskamansett Bird Club has been participating in the bird count for over forty years. The count area for this bird club locality covers a 15 mile circle encompassing parts of Dartmouth, New Bedford, Achusnet, Fairhaven and Mattapoisett.

MOST VIEWED STORIES

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Afternoon attack targeted New Bedford stabbing witness

New Bedford man charged again in South End slaying, this time for murder

Stolen Buddha statue gave solace to grieving parents

18-year-old dies in accident at local golf course

Michael M. Moco

Two more cases of West Nile virus reported

Along with the 24 hour bird count there is also count week. Count week runs three days prior to and post of the bird count day, and is similar to the day-long event except only different species are kept track of, not the total number of birds.

"We try to count everything we see," said Paskamansett Bird Club member Mike Boucher as he scoured the King Farm for birds with Mr. Machado and Mrs. King. The farm would be only one stop on Mr. Boucher's and Mr. Machado's long birding day.

They explained they would be visiting Demarest Lloyd State Park, a nice site along Slade's Corner Road, and even counting at their own feeders. They even look along the roads, Mr. Boucher noted, "We drive very slowly and if we see anything we'll stop."

As the three local bird enthusiasts walked carefully on the ice and frozen crackling snow they listened through the stillness in the air and aimed to snag bird songs in between the crushing of their boots.

"Knowing your bird calls is important because we can hear a lot of things we can't see," explained Mr. Boucher, noting, it saves the trouble of trying to track down some of the hiding birds.

As they wind down the farm fields into the swampier parts, the three birders are always stopping to survey the skies and the trees, aiming to dig into their secrets slowly and methodically with binoculars and telephoto lenses. Being thorough is a necessity though when one's trying to count each and every bird they see.

To find even more birds, Mr. Boucher tries pishing the birds out of hiding. Pishing is like a distress call to make birds who are down in a thicket pop up, he explained.

As the path ends to a clearing before the woods, Mr. Boucher decided to walk a new path and remain on the edge of a field rather than enter the winter woodland. "You get more diversity on the edge habitat," he explained.

On the new trail, the birders see bird tracks in the snow along a stream, but the little feet, which they feel may belong to a woodcock, disappear into the cold water leaving no answers and only their researchers guessing. "The bird could have been feeding and just flew up," Mr. Boucher suggested.

Near the bird's tracks along the stream there were also the markings of raccoon, deer and rabbits.

Once the bird counters emerge from the stream and back into edge habitat, they see an enormous red-tailed hawk's nest. The nest, currently empty of any hawk, could have easily been four feet across and two feet deep and was built of sticks in the fork of a pine tree. "You couldn't have asked for a nicer nest," said Mr. Boucher to Mrs. King, whose property the nest is on.

Near the nest a large female sharp-shinned hawk landed. The hawk, ever-aware, sat high up in an oak tree and watched them watching him until he was satisfied and flew away.

As the birders neared their morning walk's completion, they reentered the woods to find the densely criss-crossing tracks of animal critters and the food they were chasing. "As you can see it's not just birds that interest us," noted Mr. Boucher who was examining the tracks, "it's all kinds of natural things."

"It's amazing, the abundance of wildlife you have here," Mr. Boucher says of the farm.

One never realizes the true expanse of the wild until you adventure out on a morning when the snow's soft enough to dent, but too hard to melt. It paints a clean canvas on which all the creature's of the wood tell their stories and leave their marks which would otherwise be hidden.

"I'm amazed at all the tracks, it really shows you there's quite a diversity of wildlife," said Mr. Boucher. "It shows you what's so important about preserving farmland."

For the Audubon Christmas Bird Count, Mr. Boucher explained this year over the 24 hour period the total individual birds counted was 12,417 and there were 89 total species. Some highlights found throughout the Greater New Bedford Area were eight great blue heron, four northern pintail, one barrow's goldeneye (the bird of the day Mr. Boucher noted), four merlins, one peregrine falcon, one ring-necked pheasant, two great-horned owls and 17 wild turkeys among many others.

HOME

Print this Article Email this Article

2007 Christmas Bird Count

Common Loon	13	Rock Pigeon	365	Eastern Meadowlark	43
Horned Grebe	158	Mourning Dove	229	Common Grackle	12
Great Cormorant	10	Great-horned Owl	2	Brown-head.Cowbird	6
Great Blue Heron	8	Belted Kingfisher	5	Purple Finch	6
Mute Swan	51	R.-bellied Woodpecker	13	House Finch	96
Brant	65	Downy Woodpecker	44	American Goldfinch	151
Canada Goose	964	Hairy Woodpecker	5	House Sparrow	331
American Black Duck	341	Northern Flicker	28	Rough-legged Hawk	1
Mallard	577	Horned Lark	171	Peregrine Falcon	1
Northern Pintail	4	Blue Jay	185	Wild Turkey	17
Gadwall	17	American Crow	126		
Greater Scaup	2085	Bl.-capped Chickadee	221		
Lesser Scaup	19	Tufted Titmouse	180	Total Species	89
Scaup species	528	Red-breasted Nuthatch	7	Total Individuals	12,417
Common Eider	420	White-breast. Nuthatch	21		
Long-tailed Duck	32	Brown Creeper	5		
Black Scoter	1	Carolina Wren	58	Yellow-Bellied Saps	CW
Surf Scoter	14	Golden-crowned Kinglet	10	(CW) count week	
White-winged Scoter	23	Ruby-crowned Kinglet	1		
Common Goldeneye	440	Hermit Thrush	3		
Barrow's Goldeneye	1	American Robin	640		
Bufflehead	349	Gray Catbird	8		
Hooded Merganser	15	Northern Mockingbird	27		
Common Merganser	1	Brown Thrasher	2		
Red-breasted Merg.	60	Cedar Waxwing	5		
Ruddy Duck	3	European Starling	713		
Turkey Vulture	5	Yellow-rumped Warbler	10		
Northern Harrier	4	Yellow-breasted Chat	1		
Sharp-shinned Hawk	5	Northern Cardinal	128		
Cooper's Hawk	2	Eastern Towhee	19		
Red-shouldered Hawk	11	American Tree Sparrow	140		
Red-tailed Hawk	8	Field Sparrow	18		
American Kestrel	1	Savannah Sparrow	15		
Merlin	4	Fox Sparrow	2		
Ring-neck. Pheasant	1	Song Sparrow	163		
Dunlin	8	Swamp Sparrow	2		
Herring Gull	503	White-throated Sparrow	247		
Bonaparte's Gull	4	White-crowned Sparrow	1		
Ring-billed Gull	876	Dark-eyed Junco	182		
Great Bl.-backed Gull	37	Snow Bunting	83		

APPENDIX 7

4.6

A WETLAND ANALYSES IN A HIGHLY POLLUTED HARBOR NEW BEDFORD, MASSACHUSETTS USA

Russell Joe Bellmer
Marine Ecologist
New Bedford Superfund Office

New England Division
Corps of Engineers
424 Trepalo Road
Waltham, MA 02254-9149

SUMMARY

Wetlands are important ecological areas for: habitat, nurseries, wildlife foraging, very high productivity, wilderness aesthetics, nature recreation, and nature education In April 1985, the U.S. EPA Environmental Photographic Interpretation Center (EPIC) completed an identification of the vegetated tidal wetlands in the Acushnet River estuary area. This study identified over 160 ha of wetlands using the Federal definition. The Corps of Engineers has regulatory authority over wetlands. The New England Division (NED) of the Corps was requested by the Environmental Protection Agency (EPA), Region I to evaluate these wetlands as part of EPA's superfund activities in the Acushnet River Estuary/New Bedford Harbor, Massachusetts. This study consisted of: field surveys, laboratory tests, and literature search over a 3 yr period from 1985 to 1988.

The area of PCB contamination extends from the northern end of the Acushnet River Estuary to sediments in the vicinity of Clark's Point, Buzzards Bay, a distance of over 10 km (MCZM 1982). Toxic metals such as copper (Cu), chromium (Cr), cadmium (Cd), zinc (Zn), and lead (Pb) were also discharged to these waters by metals manufacturing and textile dying operations. Due to the very high contamination levels; many regulatory biologists were of the opinion, that these wetlands were no longer a significant resource and destruction during clean-up would be acceptable. This paper contains a description and comparison of hydrological, physical, chemical, and biotic conditions within the Acushnet River estuary vegetated tidal wetlands. Since EPAs' proposed remedial action plans may eliminate some of the wetland system within the estuary, it was appropriate to examine the functional integrity of these ecosystems. The results of this study showed that there was no statistical differences: in avifauna habitat utilization; vegetative cover type, stem height, and stem density; in fish species, number of individuals, and weight/length measurements between the reference site and the contaminated site. The utilization by wildlife was high and diverse. The gut contents of the fish species examined showed the usual prey species within an estuary environment. *Pseudopleuronectes americanus* were visually surveyed for neoplasms on their livers none recorded The data indicated an increase of the PCB concentration, from vegetative matter to herbivore/filter feeder to the gull. The metals analyses indicate an elevated levels in most samples, but are not an indication of biomagnification. Concentrations of metals and PCBs in the grass shrimp (*Palaemonetes pugio*) showed a trend reflective of the sediment contamination. The infauna data showed a statistical difference between Site 1 (lower) and Site 2 (higher) in diversity.

There were many administratively important species in the esturay: fisheries: soft-shelled clam (*Mya arenaria*), hard shelled clam (*Mercenaria mercanaria*), American eel (*Anguilla rostrata*), winter flounder (*Pseudopleuronectes americanus*), summer flounder (*Paralichthys dentatus)*, alewives (*Alosa pseudoharengus)*, blue back herring (*Alosa aestivalis)*; avifauna: American black duck, Mallard, Canvasback, Canada Goose, Peregrine Falcon Federal endangered species, Sharp-shinned Hawk State special concern, Least tern State special concern. Despite high levels of PCBs, Cr, Zn, Hg, Pb, Cd, and Cu these wetlands continue to function as effective systems; and from a regulatory and administrative view point have high resource values. Although these data showed no clear evidence for biomagnification, the data does suggest a trend of bioaccumulation. The potential for contaminant release through the food chain does exist and the ramification of PCB pollution are very significant. Therefore, the focus should be on the need for selective sediment removal and site specific wetland restoration.

INTRODUCTION

For decades, tidal wetlands have been known to be valuable as avifauna habitat, fish nursery areas, and mammal foraging areas. Tidal wetlands also have high productivity rates, as well as, aesthetics, recreation, and education values. Teal (1964) estimated 40% of marsh vegetation productivity was exported into the tidal creeks. Odum (1980) presented conclusions that wetland production is exported to coastal waters. Turner (1977) showed the dependence of shrimp fishery on salt marshes. Pomeroy and Wiegert (1981) showed the relationship between blue crab fisheries and salt marshes. Canadian geese feed on a significant amount of the *Spartina* production (Buchsbaum, et. al. 1982). Because of the important values and functions of marshes, several Federal and State wetland protection laws have been put into affect. A study completed in April 1985 by the Environmental Photographic Interpretation Center had identified 9 tidal wetlands (mostly high salt marsh) with a total area of 157.0 ha within a 6 km radius of this estuary. The mouth of the Acushnet river forms New Bedford Harbor (Figure 1) at the confluence with Buzzards Bay. This river (the only tributary) has a mean annual discharge estimated at 0.85 m^3/sec., which represents < 1% of the average tidal prism.

The Acushnet River estuary is part of the Buzzards Bay coastal drainage area and is one of a series of tidal estuaries and bays along the southern coast of Massachusetts. Previous investigations have documented that the upper estuary, north of the Coggeshall Street Bridge, is severely contaminated with polychlorinated biphenyls (PCB's) and heavy metals (NUS 1984). The area of PCB contamination extends from the northern end of the Acushnet River Estuary to sediments in the vicinity of Clark's Point, Buzzards Bay, a distance of over 10 km (MCZM 1982). Toxic metals such as copper (Cu), chromium (Cr), cadmium (Cd), zinc (Zn), and lead (Pb) were also discharged to these waters by metals manufacturing and textile dying operations. Due to the very high contamination levels; many regulatory biologists had the opinion that the wetlands were no longer a significant resource and destruction during clean-up would be acceptable. Preliminary studies focusing on vegetation, ornithology and social values were undertaken to evaluate the existing biological resources. These preliminary studies showed a potentially viable wetland system and the need a for the detailed indepth studies presented in this paper.

The effort presented here was in support of remedial clean up alternatives developed by the Environmental Protection Agency Region I (EPA) to address the sediment contamination issues of the Acushnet River estuary area. One proposed alternative considered sediment dredging and disposal within the wetlands. New England Division Corps of Engineers (NED) was requested to provide technical expertise and assistance in the form of a wetland study to EPA in order to evaluate existing biological functions and values relative to the Clean Water Act. NED's responsibilities consisted of a study focused on contaminant availability and the effects of contamination on the wetland ecosystems. In addition to studying the estuary, a similar tidal marsh and mudflat system on Buzzards Bay was evaluated as a reference site. These studies involved limited field efforts during winter, summer, fall, and spring from February 1985 to May 1988. Since EPA's proposed remedial action plans may eliminate some of the wetland system within the estuary, it was appropriate to examine the functional integrity of these ecosystems. The questions to address were:

- Despite contamination, do these wetlands support a viable and productive community of organisms?
- How do these wetlands compare with a similar, but less contaminated wetland?
- How would these wetlands be rated under Federal and State evaluation procedures?

- Which habitat characteristics should be preserved during the remedial clean-up action?

Study Site Description

Cover Types: Four (4) major cover types are dominant within the estuary: tidal flats, salt marsh, common reed marsh, and upland. These tidal marshes (Sites 1, 3, 4, 5, 9) are primarily located in the upper estuary, and are dominated by high salt marsh vegetation (Figure 2). A predominantly high salt marsh (34.2 ha) similar to the Acushnet River estuary wetlands and in the closest proximity (EPIC 1986) was used as a "reference" site (Site 2). Site 1 has one major tidal creek with extensive lateral and longitudinal ditching. The estuary edge is marked by a peat bank rising from 15 to 30 cm above the intertidal flat with dense aggregates of *Geukensia demissa* Site 3, located directly north of Site 1, fringes a small cove and with a drainage ditch on the landward side. Site 5 consists of *Spartina alterniflora* which forms a narrow fringe around a cove, with a few isolated clumps in the cove of unconsolidated mud. *G. dimessa* is present throughout the *Spartina alterniflora. Mya arenaria* is abundant in the sandy intertidal area. Site 4 is a narrow band of salt marsh which surrounds a cove of unconsolidated mud. *G. demissa* are abundant throughout the tall *Spartina alterniflora* zone. Site 9 is small *Spartina* marsh with a gravel beach, south of site 4. *G. demissa* were uniformly distributed throughout the tall *Spartina alterniflora* and the gravel areas between this vegetation. Two major creeks trisect Site 2 with mouths 6-7 m across and 1-2.5 m depths. The bank is scattered with dense aggregates of *G. dimessa.*

Estuary Characteristics: A large body of data has been collected on the hydrography, sediments and water quality of the Acushnet River estuary by Hoff (1973), Summerhayes, et. al. (1977), EPA (1983), and ACOE (1986). The estuary is shallow, characterized by a well defined channel and extensive shoals and tidal flats. Circulation ranges from weakly stratified (Pritchard, 1975) during periods of high fresh-water discharge to vertically well mixed at other times. The hydrology of the estuary is complex, with constrictions at 3 locations: Coggeshall Street bridge, Popes Island, and the hurricane barrier creating a complex series of eddies and greyers. The tide (mixed semi-diurnal, mean 1.2 m) is the force controlling circulation patterns. Tidal current velocities in the upper estuary are generally low, ranging from 0.0 to 0.3 m/sec. with average velocities of approximately 0.15 m/sec. (ACOE, 1986). Summerhayes, et al.(1977) found that flood current velocities are generally higher than ebb current velocities in this estuary. An asymmetric temporal flow pattern occurs in many marshes in which a briefer period of faster flow characterizes flood tide and longer periods of slower flow occur during ebb tide (Mitch & Gosselink, 1986). Tidal flushing of the upper estuary is estimated at about 1.4 tidal cycles (18.2 hrs), based on tidal prism calculations; detailed estimates based on net flux through the Coggeshall Street Bridge range from 2 days (winter conditions) to 8 days (summer conditions) (R. Geier, pers. comm.). Suspended sediment concentrations in the Acushnet River estuary, which were found to be generally low (< 10 ppm) by Teeter (1987), increased upstream resulting in a turbidity maximum in the upper harbor. The net flux of total suspended materials was found to be in an upstream direction, although contaminant transport was found to be in the opposite direction. Summerhayes, et al. (1977), found that, under average conditions, near bottom concentrations of suspended sediments are generally highest, with peak concentrations occurring during flood tide. Due to the asymmetric current velocities, the silt and clay portions of the suspended load tend to fractionate, resulting in a net import of silt into the estuary and a net export of clay.

Salinities: A large salinity data base has been collected in the vicinity of the Coggeshall Street Bridge, with ranges from 10 to 32 0/00 (ave. 30 0/00). Salinities in the upper estuary ranged from 7 to 31 0/00 (ave. 30 0/00). Vertical salinity gradients varied with an average of 1 0/00. The average horizontal salinity gradient was 4 0/00 per 5000 m Salinity was higher in the low marsh than the high marsh, with salinity fluctuations greatest near mean high water. Interstitial salinities increased from that of the adjacent estuary to a maximum value at the low/high marsh transition and decrease again in a landward direction. Salinity values within low marsh soils are generally fairly constant with depth, whereas in high marsh soils, salinity values fluctuate with depth, depending on seasonal effects (Mitsch & Gosselink, 1986; Frey and Basan, 1978).

METHODS

Sediment Sampling

The sediment sampling methodology used for Site 1 is described in Condike (1986). The reference Site 2 was sampled at random using a grid for the placement of 7 samples. Soil cores were collected 0-15 cm deep (7 cm). The upper layer of sediment was collected using a soil auger; samples were placed in Teflon-lined glass containers, and stored at 4°C. These samples were obtained from high marsh and low marsh. Grain-size analysis was conducted on 1 sample (0.0081 m^2 core) from each station. Due to the large amount of peat in the substrate, the percent of organic material was also measured. Sediment samples taken from

Sites 1 and 2 were analyzed for copper, chromium, lead, zinc and PCB's. Samples taken from Sites 4, 5, and 9 were analyzed for these parameters, plus mercury, and cadmium.

Vegetation Survey

The community-types were defined and delineated reflecting the hydrologic regime and vegetative species composition which dominate within each wetland as defined by Cowardin et al. (1979). *S. patens* community-type has been associated with higher interstitial salinities and more reduced soil conditions than regularly flooded zones of *S. alterniflora* (Teal 1986; Neiring and Warren 1980; Nixon 1980). In order to assess productivity and characterize the composition of plant communities indirect indices of vegetation productivity were measured for Sites 1, 2, 3, 5, & 9 during late summer 1987. Vegetation was sampled along randomly placed transects, which were evenly spaced (100 m intervals) and perpendicular to the estuary. One hundred and fifty (150) sample plots were distributed proportionately according to the size of each site. Within each community, 1 m^2 random sample plots were established. Percent cover and height were measured for all species with a cover greater than 5%. In addition, mean stem density was measured for all species occurring in a sub-plot (0.2 m x 0.5 m). Above-ground vegetative primary productivity was measured at Sites 1, 2, 5 & 9 by collecting all above-ground vegetation within 0.1 m^2 plots. Three (3) samples were taken in each of the major communities (total of 36 samples): 12 samples (4 communities) at Sites 1, and 2; 9 samples (3 communities) at Site 9; and 3 samples (1 community) at Site 5. All vegetation was cut to within 2 cm of the substrate. Ten percent of each sample was dried at 105^{o} C for 48 hrs to determine dry weight.

Mammal Utilization

Mammal utilization was documented by direct observation or signs (ie. tracks, scat, scrapes, nests, dens, burrows, signs of foraging activity). Efforts to attract mammals to scent posts were conducted (4 days) in September 1987. Scent posts (fox urine) were established at 500 m intervals along the wetland/upland boundary on Sites 1, 3, 4, 5, & 9 and were revisited at 3 days(Taber and Cowan 1969). In addition to scent posts, in April 1985, field personnel placed 206 snap-traps (a 206 trap night effort) randomly along the eastern edge of Site1 to collect small mammals. Traps (baited and unbaited) were placed along the salt marsh upland border in grass and shrubs.

Avifauna Survey

To document the abundance and diversity of resident avifauna species during the breeding season, surveys were conducted at Sites 1 & 2 ,during summer 1987. All surveys were begun within 1 hour after sunrise. Three habitats (tidal open water, salt marsh and salt marsh/upland edge) were censused at each site. Only individuals observed using the habitat (foraging, resting, preening, & courtship display) were included in the analysis. Breeding status was confirmed by a nest or observing: copulation, parent with food in bill, or parent feeding newly fledged young. At Site 1, surveys of the open water habitat were conducted from 2 points on the marsh edge. Birds were enumerated in the open water habitat by scanning pre-established segments and recording individuals. All tidal open water, mudflat, and shore habitats were surveyed with the aid of a 20 x 60 spotting scope. The salt marsh and marsh/upland edge habitats were censused using the variable-strip method Emlen (1971). Transects were staked at 100 m intervals. At Site 1, a continuous transect of 800 m was established, and a 900 m transect, split in 2 sections, was established in the marsh/upland edge. At Site 2, an 800 m transect, in 3 sections, and a single transect 800 m on the marsh/upland edge were established.

Benthos Sampling

A stratified random sampling of Sites 1 & 2 benthos was conducted during June and September 1987. Mud bank and tidal creek habitats were sampled in 3 random locations on each Site. Three replicate 1 L. cores (surface area = 0.0081 m^2; depth = 0.12 m) were collected. Each sample was sieved through a 0.5-mm sieve, and all organisms retained were identified and counted. Blotted wet weight biomass was determined to 0.01 g for major taxon groups (Arthropoda, Annelida, Mollusca). Two-way analysis of variance (ANOVA) was used to determine sampling period and station differences in abundance (log (x + 1)) for: Annelida, Oligochaeta, *Polydora ligni* , *Mya arenaria*, taxa number, and biomass (square root). Shannon-Weaver diversity, H' and evenness, J' indices were used to compare Sites and sampling period differences in number of taxa and distribution of abundance among taxa. These indices were computed for each station and date using the mean abundance of each species. Skewedness was calculated for each station and date using the total abundance (sum of all individual species abundances) from each of 3 replicates. Shellfish were sampled by tossing a 0.25 m^2 frame randomly within the station boundaries to obtain 3 replicate samples. Material within the frame was excavated to a depth of 0.1 m, washed through a 1 mm sieve, all organisms retained were identified and counted. Bivalve shell length and gastropod shell height were measured to the nearest millimeter. ANOVA (log (x + 1)) was used to compare sampling periods and stations for: bivalve abundance, bivalve taxa number, gastropod abundance, and bivalve taxa number. One mm increments were used to calculate mean size. Length frequency histograms were developed by summing replicate data for each species. Bivalve species data were grouped into 5 mm size classes.

A limited survey was conducted to statistically compare the benthic fauna (as an indication of secondary production) between a site (Site 1) within the influence of the PCB contamination and one that was relatively unpolluted (Site 2). Sampling took place during two months (June and September) to bracket the summertime recruitment period. In addition, a comparison of Sites 1, 2, 3, 4, 5 & 9 was made in the fall of 1987 emphasizing the wetland-open water interface. Shellfish samples (using a 0.0625 m^2 frame) were stratified at the tidal flat-mud bank interface. Samples were sieved through a 1.0 mm sieve and bivalve shell length and gastropod shell height measured. Comparisons were made using abundance and length frequency data.

Fisheries Population Sampling

Fish populations were sampled with beach seines and minnow traps in summer at 6 Sites. Commercial minnow traps (1/4-inch mesh) were baited and set for two consecutive tidal cycles (24 hours). Seining was conducted with 3/8-inch mesh beach seine (50 by 6 feet or 25 by 4 feet). Seining stations (from 3 to 8 seine hauls) were a pseudo-random distribution. All individuals collected were identified and counted. Twenty individuals per species from each trap sample and 50 specimens per species from each seine sample were preserved and total length and wet weight recorded. The stomach contents (>10 full stomaches) of *Fundulus heteroclitus* and *Pseudopleuronectes americanus* were analyzed. The contents were identified to the lowest practical taxon and grouped into categories which were weighed to the nearest 0.01 g (blotted wet weight).

Bioaccumulation & Body Burden Analysis

To determine the bioaccumulation of PCB's, Cu, Cr, Hg, Pb, Zn, Cd, & aromatic hydrocarbons (PHC's), *G. demissa* were collected during April from Site 2 (5 stations) and 3, 4, 5, & 9 (2 stations each). All *G. demissa* were collected at random locations along a 15 m transect located within the *S. alterniflora* zone. Replicates from 1 station at each Site were analyzed, with the remaining samples archived. On the remaining mussels whole wet weight, shell weight, meat wet weight & length were measured. Within each station, sufficient tissue weight were pooled to form 3 replicate laboratory analyses samples. *Palaemonetes pugio* were collected from randomly generated stations on Sites (1, 2, 3, 4, 5, & 9) during the summer for body burden analysis. Sufficient biomass was obtained to conduct 3 replicate analyses for Cu, Cr, Pb, Zn, Cd, Fe, Hg, & PCB measurements. Standard EPA methods (level 1 QA/QC procedures) for CG and metals analysis were used to measure concentrations for all tissue analyzed.

Fundulus heteroclitus and *Pseudopleuronectes americanus* specimens were collected and analyzed for body burdens of PCB, Cu, Cr, Hg, Pb, Zn, & Cd. The individuals were collected by groups (3 groups: Sites 1, 3, & 5 (group 1); Sites 4 & 9 (group 2); and Site 2 (group 3); pooled analysis of 3 replicates per group and each species was analyzed separately to establish invertebrate-fish food chain, bioaccumulation links, for a total of 18 replicates. The livers of *P. americanus* were visually surveyed for neoplasms.

To determine the bioaccumulation of PCBs in the trophic system; Ring-billed gulls and *Peromyscus leucopus* food chains were sampled (April, 1985); 10 birds and 20 *G. demissa* were collected from 5 stations. In addition, 36 *Orchestia grillus* were collected at 5 stations. *P. leucopus* (15) were trapped at the upland-marsh border. It's food source were collected including: *Distichlis spicata, Spartina alterniflora, Juncus gerardii,* and Orthoptera, Hemiptera, Coleoptera.

In addition, to determine the bioaccumulation of PCBs in the *G. demissa* -- Ring-billed gull food chain, 20 *G. demissa* were collected. At each station *G. demissa* were collected at random points along a 15 meter transect located 1-2 meters below the estuary limit of *S. alterniflora.* Whole wet weight, shell length, shell weight, and meat wet weight were measured. *G. demissa* shells were scrubbed before weighing. Shell length was measured to 0.05 mm, and meats were placed on filter paper for 2 min. before weighing. Ten *G. demissa* from each of the 5 stations were measured (total of 50). Within each station, the meats of 5 *G. demissa* were pooled to form 2 replicate samples for analysis from each of the 5 stations and then frozen. *Melampus bidentatus* were collected, counted, weighed wet, and frozen. *Orchestia grillus* (abundant in the upper estuary) were collected at each station (average of 36) and frozen. Ring-billed gulls were chilled until breast muscle and subcutaneous fat samples could be separated, and the birds sexed, measured, weighed and frozen. *U. Lactuca* and *G. demissa* were collected, during winter, at random locations. Two samples were collected at each stations (total of 10 samples). The samples were washed with sea water, blotted dry, and weighed. One Black duck was killed (shotgun) and frozen until subcutaneous fat and muscle tissure was removed.

The collection of *P.leucopus* food was concentrated at the upland-wetland edge. In April 1985, bayberry fruits, acorns, horse-brier fruits, rose fruits, black grass shoots (*J. gerardi)*, insects (Orthoptera, Hemiptera, Coleoptera), isopods, and millipedes were collected and stored. *M. bidentatus* was also collected. The number of specimens in each sample were counted (excepting bayberry fruits), wet weight determined, and the samples frozen. Collection consisted of 206 snap-traps randomly set. One hundred and fifty-two traps were baited with a mixture of oatmeal and peanut butter, and 50 with beef hotdogs. Traps were checked after 24 hrs, captured *P. leucopus* were sexed, weighted, homogenized, and frozen.

RESULTS

Sediment Findings

Sediment grain size characteristics were determined for the upper estuary (Table 1). The surface sediments were predominately silt and clay. Site 1 tidal creek substrates were 62 % clay/silt, with 7 % organic matter (peat). The creek sediments in Site 2 were coarser, with over 50% sand and 3% peat. These grain size differences are attributable to numerous factors (e. g. tidal current speed, wave exposure, and sediment origin). The proportion of peat was higher in the mud banks than the tidal creeks. At the mud banks in Site 2, peat composed 28% of the sediments, with 46% silty sand. On Site 1, the mud banks were characterized as 33% sand, with 16% peat.

The concentration of heavy metals (Cr, Cu, Pb, & Zn) and PCBs in the surface marsh sediments (15 cm) was highest at Sites 1 and 3. There was a trend for the lower elevations to have higher levels of contaminations and contaminant levels to decrease toward the harbor entrance. The reference Site 2 outside the harbor had the lowest levels. These data show a pattern of widespread elevated contaminant levels and may indicate a distribution related both to chronic disposal and to distribution from many localities throughout the region. Previous studies demonstrate a substantial PCB content in the estuary sediments (ACE,1986). Portions of this contaminant reservoir in the sediment may be potentially available for redistribution. The chemical and physical characteristic of the contaminants and the surrounding sediment may effect levels and state.

Vegetation Findings

Cover types: Site 1 (17.4 ha) is nearly 1.41 km. in length and 200 m wide at its widest point (Table 2). It is dominated by two near monotypic cover types, *S. patens* (> 48%) and *Iva frutescens* (> 32%) (Table 3). The tall form of *S. alterniflora* (>18% of the vegetation) grows in a narrow (< 50m) band along the entire marsh/river border. Site 3 (5.4 ha) has a variety of species, but the community size is limited by its narrow width and small size. Tall

S. alterniflora and *S. patens* high marsh communities and *Phragmites australis* stands are the dominant cover types, all occupying 30% of the vegetated wetland. Site 5 (1.4 ha) has steep banks supporting a narrow band of tall *S. alterniflora* (covering 68%), *S. patens* (covering 26%), and small patches of *Iva* sp. and *P. australis*. Site 4 (4.3 ha) has been altered considerably and as a result, *P.australis* covers over 80% of the area. A narrow band of tall *S. alterniflora* covering 9% lines the water edge. Site 9 (0.69 ha) is dominated (53%) by *S. patens* .

Site 2 (49.8 ha) has seasonally flooded freshwater habitats which are contiguous on the north and east sides, with the estuarine marsh comprising 28.7 ha of the area. The widespread distribution of tidal creeks and mosquito ditches has created zonation patterns that are complex, with cover types patchily distributed and high marsh communities co-dominated with a variety of species (Table 4). This site is dominated (55%) by *S. patens* cover type, with stands of tall *S. alterniflora* (coverage 3%) occurring along the water edge. Stands of *P. australis*, limited to the upland edge, dominate (over 23%) the area north of the floodgate structure.

Productivity: Sample-plot data for Site 1 (consisting of 63 plots distributed among 10 transects) correspond well with the data obtained from the cover type mapping (Figure 4). Analysis of these data reflects a wetland dominated by the high marsh grasses *S. patens*, which occurred in 50.8% of the plots, and *D. spicata* which occurred in 49.2% of the plots. For plots in which it occurred, the mean percent cover of *S. patens* was 77.6 and the mean stem density 259.1 stems/0.1m^2. The percent cover of *D. spicata*, with a mean of 54.4%, varied considerably; mean stem density for plots in which this species occurred was 72.8 stems/0.1m^2. High marsh communities were dominated by up to 5 species, a complex community composition that could not be delineated in the cover type mapping. *Juncus gerardi* occurred in 40% of the plots, with a mean cover of 66.7 % and a mean stem density of 22.7 stems/0.1m^2. *Solidago sempervirens* also occurred in 40% of the plots, but had an low percent cover (26%) with stem density (7 stems/0.1m^2). *Distichlis spicata* and *Iva frutescens* both occurred in 33.3% of the plots. *Spartina patens*, which occurred in 20% of the plots, had a high percent cover (75%) and stem density (274.5 stems/ 0.1m^2). Twelve (12) sample plots were distributed among 9 transects in Site 5. Tall *S. alterniflora* dominated this site occurring in 83.3% of the sample plots. The *S. alterniflora* at this site had the highest density (mean % cover = 96.5; mean stem density = 32.3 stems/0.1m^2) and tallest (mean height = 150cm) recorded in this study. Two (2) transects and 14 sample-plots established in Site 9 indicated a predominantly high marsh; the 3 most frequently encountered species were *D. spicata, S. patens, and J. gerardi*. *D. spicata* occurred in the greatest number of plots (50%), but had a low mean percent cover (40.7%) and stem density (76.1 stems/$0.1m^2$) when compared to *S. patens*, which occurred in 42.8% of the sample plots and had a mean percent cover of 66.7% and mean stem density of 237.8 stems/$0.1m^2$, and *Juncus gerardi*, which occurred in 21.4% of the plots and had the highest percent cover (86.7) and stem density (330 stems/$0.1m^2$) of all species encountered at this site.

Fifty-one (51) sample plots were distributed among 6 transects in Site 2. The 17 species encountered was the highest number of species recorded in this study. *S. patens* had the highest (51%) frequency of occurrence, with a mean cover of 63.9 % and a mean stem density of 244.4 stems/$0.1m^2$. *D. spicata* (47% occurrence) was often co-dominant in the high marsh communities with a mean stem density of 59.5 stems/$0.1m^2$. Five (5) species occurred in more than 20% of the plots making this community composition fairly complex. The short form of *S. alterniflora*, occurring in 43.1% of the plots, had the highest mean percent cover (79.5%) and a high stem density of 91.4 stems/$0.1m^2$. *Limmonium nashii* occurred in 23.5% of the plots and had a low percent cover of 17%. *Juncus gerardi* occurred in 21.6% of the plots with a mean cover of 62.8%; stem densities for this species varied considerably, the mean stem density for plots in which this species occurred was 264 stems/ $0.1m^2$. The tall form of *S. alterniflora* occurred in 7.8% of the plots, but had the highest mean cover (80%).

The estimates of above-ground primary productivity for this study compare well with values from other studies conducted in southern New England. Values for tall *S. alterniflora* correspond well with both data from Teal (1986) and with the indirect indices data collected here. In the Sites where samples of tall *S. alterniflora* were collected, above-ground primary productivity values ranged from 1023 g dry wt./m^2/yr (Site 1) to 1800 g dry wt/m^2/yr (Site 5). In comparison, Teal (1986) reports a value of 1320 g dry wt/m^2/yr for tall *S. alterniflora* communities. The high productivity value for tall *S. alterniflora* at Site 5 can be expected based on the height and density values obtained in the collection of indirect indices data. These values may be due to the high degree of tidal flushing this community receives (Teal 1986): tall *S. alterniflora* at Site 5 occurs in a very narrow (< 5m) band along steep banks which are completely flooded and exposed twice daily, thus facilitating constant nutrient exchange and oxidation of soils. Productivity values for *S. patens* communities on the high marsh ranged from 935 g dry wt/m^2/yr (Site 2) to 1040 g dry wt/m^2/yr (Site 9). In comparison, Nixon (1980) reports a value of 1100 g dry wt/m^2/yr for a Massachusetts salt marsh, and a value of 430 g dry wt/m^2/yr for a Rhode Island salt marsh. Using the ratios given by Teal (1986) for below-ground productivity of *S. alterniflora* communities, and that given by Nixon (1980) for below-ground productivity of high marsh communities, estimates of total marsh productivity for those communities ranged from 2557 g dry wt/m^2/yr (Site 1) to 4500 g dry wt/m^2/yr (Site 5) for tall *S. alterniflora* communities, and from 2874 g dry wt/m^2/yr (Site 2) to 4220 g dry wt/m^2/yr (Site 9) for high marsh communities (includes *S. patens*, short *S. alterniflora*, & high marsh mix communities).

Mammals Findings

The 206 trap night effort yielded (Table 5): *Mus musculus* (3), *Rattus norvegicus* (1) and *Peomyscus leucopus* (15) with a trapping success of 9.2 percent. Based on this study, the characteristics of these wetlands, and existing literature (e.g., DeGraaf and Rudis, 1986), small mammals are the most abundant resident vertebrates. Mammal use was observed in all the habitat types. Scat, tracks, small mammal nests and clippings, burrows and dens of medium sized mammals were the most frequently observed signs. Results of scent post sampling yielded 3 additional species: *Sylvilagus floridanus* scat (Site 1) in *S. patens* habitat, *Procyon lotor* tracks (Site 4) adjacent to *Phragmites* habitat, and *Vulpes fulva* and *S. floridanus* scat (Site 3) in *S. patens* habitat.

S. floridanus was the only mammal observed directly at Site 1, with scat found throughout the high marsh. Two (2) active *Marmota monax* burrows were found in the *I. frutescens* community; a *Microtus pensylvanicus* nest and system of runways were found in the *S. patens* habitat; *Ondatra zibethica* scat was found on the high marsh; and *Procyon lotor* tracks were observed in the non-vegetated portion of the wetland. Other observations recorded *Mephitis mephitis* and *Peromyscus leucopus.* At Site 3 *Ondatra zibethica* was observed swimming. A *Vulpes fulva* compound with10 burrows was found on an adjacent upland knoll. *S. floridanus* scat was found in the high marsh. At Site 5 *S. floridanus* scat was littered throughout the upland edge. *S. floridanus* were observed foraging in *Ammophila breviligulata* habitat and a *Marmota monax* was observed at the upland edge of Site 4. *Procyon lotor* tracks were present at a scent post placed adjacent to a stand of *Phragmites*. At Site 9 a *Sciurus catolinensis* was observed foraging on the high marsh and *S. floridanus* scat was found on the high marsh. *Procyon lotor* tracks and *Ondatra zibethica* scat were found in the regularly flooded areas; and *S. floridanus* scat was found on the high marsh of Site 2. *Sciurus caatolinensis* , *Didelphis virginiana*, and *Tamias striatus* utilize the wooded swamp in the northeast section of Site 2.

Avifauna Findings

Open Water Habitat: The size and exposure of Sites 1 and 2 differ, with Site 1 abutting relatively shallow upper estuary waters, and Site 2 abuting deeper open water habitat (Table 7). Intertidal flats are minimal at Site 2, but extensive at Site 1. Comparisons of use at these two sites required a combination of quantitative measures and site utilization knowledge. Thus avian densities, the total number of a species observed, and the frequency in which a species occurred were analyzed. A total of 16 species were observed Site 1, for a total density of 13.0 birds/405 ha, and 24 species at Site 2, for a total density of 12.8 birds/405 ha. Five species were common (observed >50% of the time) to both sites: Herring Gull, Double-crested Cormorant, Mallard Duck, Great Black-backed Gull and Rock Dove. Four species were unique to wetland 1: Mute Swan, Black-crowned Night Heron, Great Egret, and Least Tern. The Least Tern (a species of special concern of the Massachusetts Natural Heritage Program, MNHP) nests primarily on mainland beaches in variable sized colonies and forages on *Menidia menidia* in the waters adjacent to Site 1 throughout August and early September. Twelve species were unique to Site 2: Horned Grebe, Great Blue Heron, Green-backed Heron, Lesser Yellowlegs, Spotted Sandpiper, peep sp. (one or more of the small calidrid sandpipers including the Least and Semi-palmated Sandpipers), Laughing Gull, Common Tern, Common Grackle, Osprey, and American Kestrel. Osprey and Common Tern are species of special concern of the MNHP. Of the observed species, the Herring Gull was the most abundant and most frequently seen. The greater number of Herring Gulls observed at Site 2 reflects the greater size of the study area. Although this group was frequently observed, greater abundance may be expected at both sites in the fall/winter when post-breeding gulls come inshore.

Shorebird numbers were low and reflect trends observed throughout the region (Lloyd Center 1986) during this part of the year when the vast majority of shorebirds are on their breeding ground to the north. Except for the Killdeer and Spotted Sandpiper breeders at Site 2, the few shorebirds observed were recorded at Site 2 near the end of the census period and probably represented the first migrants of the fall. These early migrants included the Lesser Yellowlegs, Greater Yellowlegs, and peep sp. The Killdeer was the only shorebird observed at Site 1 during the study period. However, sightings throughout August and September of Yellowlegs, Spotted Sandpipers, and peep sp., suggest that the tidal open water habitat of the estuary receive increased use by shorebirds as fall migration progresses. Shorebirds observed at Site 2 (Killdeer and Spotted Sandpiper) were resident and suspected breeders. The Mallard Duck was common at Sites 1 and 2; and was a breeder at Site 2. The American Black Duck was less common at both sites, but was a breeder at Site 3. Sightings of up to 25 Black Ducks were recorded throughout August and September at Site 3. Although not abundant, herons and egrets were observed throughout the study period. The Snowy Egret was the most frequently observed wader at both Sites. The sightings at Site 1 throughout August and September show a much greater abundance of this group, especially immature birds, which foraged in the shallow water adjacent to Site 3 in the post-breeding season. The doves and passerines observed at both wetlands used the intertidal habitat for foraging. Least Bittern (listed as a threatened species by Massachusetts Natural Heritage Program) was observed foraging at the edge of a *P. australis* community adjacent to Site 3.

This study also censused the open water/mud flat habitats from Tarklin Hill Road to the estuary mouth during late winter/early spring of 1985 and late summer of 1986. Based on trends reported by the Lloyd Center (1986), the abundance of the various bird groups reported here were within the expected range for this region during the spring/summer. The Lloyd Center data showed a decrease in the numbers of bird species and densities as summer approaches. Heron, egret, and tern numbers at both sites were lower than those reported by the Lloyd Center (1986). However, this may be due to the proximity of this study area to the breeding grounds. Both the Common and Least Tern are known to breed in the Plymouth County region of Buzzards Bay (Lloyd Center 1986). Furthermore, the broad, shallow lagoon, along with the undeveloped and undisturbed shoreline characteristic of the Lloyd Center (1986) study site, offers favorable foraging and resting areas for long-legged waders and terns, and nesting habitat for the latter group. This accounts for the overall greater abundance of these groups reported by the Lloyd Center. Although species diversity was greater at Site 2, densities between Sites 1 and 2 were nearly equal. Differences between wetlands in the abundance of certain species may be expected based on their location. Site 2 is more centrally located with respect to nesting grounds of colonial nesters such as terns and long-legged waders. Greater use of Site 2 by these groups can be expected, as birds commuting to and from coastal foraging areas are more likely to encounter Site 2 than Site 1. Trends observed at Site 1 in August and September suggest that the tidal open water habitat at this site become more important during fledgling dispersion and migration, when terns and long-legged waders are not restricted in their foraging range, and when shorebirds pass through the region on their journey south.

Salt Marsh Habitat: Twelve (12) species for a total density of 276 birds/405 ha were recorded in the salt marsh habitat at Site 1. Eighteen species for a total density of 305.4 birds/405 ha were recorded in Site 2. These densities are within typically reported values for southern New England salt marshes (Reinert and Kilpatrick 1986; Reinert et al 1981). Of the seven species unique to Site 2, only the Clapper Rail and Spotted Sandpiper, had densities greater than 1.9

birds/405 ha. The Clapper Rail was a nesting species at Site 2 which was placed in a stand of short (< 40cm) *S. alterniflora* . The Spotted Sandpiper may be nesting at Site 2. Sites 1 and 2 received the greatest use by passerines species. Passerine densities were very similar (231 birds/40 ha, Site 1; 236.3 birds/40 ha, Site 2), but use of the salt marsh habitat between Sites differed. Use at Site 1 was dominated by birds nesting in the upland edge that use the marsh to forage. One salt marsh obligative (Sharp-tailed Sparrow) was recorded at this Site. The Sharp-tailed (nesting species) had a density of 22.6 birds/405 ha which was low compared to Site 2 of 143.0 birds/405 ha. The greater diversity and more highly interspersed nature of the cover types at Site 2 contributed to the higher densities. Site 2 use was dominated by the Sharp-tailed Sparrow, which was abundant and distributed throughout the marsh. Both Sites received irregular use by American Kestrels, and regular, similar use by Mourning Doves and aerial insectivores (e.g. Chimney Swifts, Barn Swallows, and Tree Swallows). The narrow width of Site 1 allows upland edge nesting species easy access to foraging areas in the *S. alterniflora* habitat and also provides suitable foraging areas for the Sharp-tailed Sparrow. The vegetation communities at Site 2 are much more heterogeneous and provide different habitats for foraging, nesting, and mating activities of marsh nesting birds.

Upland Edge Habitat: Shrub communities < 75 m wide form a broad transition zone between the salt marsh and forested upland habitat; this transition zone supported the highest density of birds (531.0 birds/405 ha). Twenty-seven (27) species were recorded at Site 1. Five (5) species were confirmed breeding with17 additional species suspected breeding. The 5 dominant species at this site (Red-winged Blackbird, European Starling, Northern Mockingbird, Song Sparrow, and American Robin) account for 66% of the total density of birds recorded in this habitat. At Site 2, the upland edge habitat is dominated by *P. australis* which occurs in narrow (< 50 m) strips. Shrub communities are sparsely distributed and the transition from salt marsh to oak-hickory forest is abrupt. The influence of forest associated species (e.g. Black-capped Chickadee, Tufted Titmouse, House Wren, and White-eyed Vireo) at this site contributed to the highest species diversity observed (32 species). These species were observed singing and foraging along the edge and made up 6% of the total density found in this habitat. The 5 dominant species (Red-winged Blackbird, Common Yellowthroat, Song Sparrow, and European Starling) made up 50% of the total species density; all, except the European Starling, are commonly found nesting in wetland or wetland edge habitat. Dominance by this group of primarily wetland associated species indicates a greater homogeneity of habitat at Site 2. Other wetland species including the Mallard Duck (confirmed nesting species) the Killdeer, a suspected nesting species, the American Black Duck and the Clapper Rail were recorded in this habitat.

A least bittern (listed as threatened by the MNHP) was observed foraging adjacent to Site 3. Least terns (listed as a species of special concern by MNHP) were observed throughout August and early September foraging in the waters adjacent to Sites 1 and 3. Both the osprey and common tern (listed as species of special concern MNHP) were observed at Site 2 in July and during July and August for the latter species. A peregrine falcon was observed in the vicinity of Site 1 in February 1985.

Benthic Infaunal Community Findings

Tidal Creeks: Tidal creek stations at Site 1 were dominated by oligochaetes and *Capitella* sp. during both sampling periods (Table 8). Abundances of the spionid *Streblospio benedicti* were also high during September. Three taxa were important numerically in the tidal creek stations of Site 2 as well. During both sampling periods, numerous additional taxa were apparent in moderate (< 102/m^2) to high densities (> 103/m^2) at Site 2, while the number of abundant taxa at Site 1 was limited. The most abundant taxa are typical estuarine species; primarily surface and subsurface deposit feeders. The bivalves collected from tidal creeks at Site 2 are filter feeders, with *Mya arenaria* being very abundant. The pattern of community structure was evidenced in the diversity and evenness indices for the tidal creeks. Diversity values varied between Sites, with Site 2 values higher than Site 1 values. Only one station x sampling period combination result had values over 1.0 (ranged from 0.883-3.098). From Site 1, only one station exceeded a value of 1.0 (September), and was close to 1.0 in June. The other stations on Site 1 had low diversity values ranging from 0.120 to 0.330. Site 2 supported 3 times as many taxa as Site 1. The greatest disparity between the 2 sites was the number of polychaete species. Evenness values were low, indicating that each station had only a few species with high abundances, while the remaining species had low abundances. Only at 2 stations was evenness moderately high (> 0.6). There was no strong difference between sampling periods, suggesting a similar distribution of species abundances in the 2 months. In June, skewness values for Site 2 were greater than for Site 1, indicating greater within-station (i.e. among replicates) variability in abundance in Site 2 than Site 1. A reverse trend was noted in September.

The tidal creek stations at Site 2 tend to support a greater variety of infaunal particularly polychaetes and bivalve species than those on Site 1, regardless of the month sampled. There were 3 to 4 times as many taxa with abundances greater than 100/m^2 at Site 2 than Site 1 during June and September. Site 2 stations were more likely to have several abundant co-dominant species than were Site 1 stations. Sample period was less of a contributing factor than location. The influence of sediment grain size is apparent at Site 2 in June, where sediments at station 2T1 (gravel) are much coarser than those at stations 2T2 and 2T3 (medium sand). Taxa such as *M. arenaria, Scoloplos* sp., *Scolecolepides* sp. and syllidae were much more abundant at station 2T1, while *S. benedicti* was more abundant at stations 2T2 and 2T3. The presence of herbivores (e.g. *L. littorea* and *G. inucronatus*) at station 2T1 was the result of the presence of algae rather than substrate differences. Wet-weight biomass measurements for major taxa showed that the stations containing mollusks had the highest biomass values, partially attributable to shell weight.

Mud Banks: The mud bank stations at Site 1 was dominated by Oligochaeta, *Fabricia sabella, Capitella* sp. and *S. benedicti* during both sampling periods. In June, amphipods, bivalves and gastropods were moderately abundant (102-103/m^2). Of these taxa, all but gastropods were moderately abundant in September. These species encompass several feeding: types; filter feeding, surface grazing/scraping, burrowing deposit feeding, and surface deposit feeding. Of the 30 taxa collected from Site 1, 10 were polychaetes and 7 were amphipods. Oligochaetes and *F. sabella* also predominated on Site 2 during June and September. The surface deposit feeder *P. ligni* was numerous also. Abundances of *M. arenaria, Nereis succinea* (June), *Capitella* sp., *Edotea triloba* and *Syllis typosyllis* sp. (September) exceeded 103/m^2. Moderately abundant (102-103/m^2) taxa represented several major taxonomic (polychaetes, bivalves, amphipods) and feeding (surface deposit feeders, burrowing deposit feeders, carnivores, filter feeders) groups. Sixty-one taxa were recorded from Site 2, predominantly polychaetes, amphipod, and bivalve species.

The diversity index varied more between the 2 sampling periods than Sites. For both Sites, all stations exhibited diversity indices above 1.0 (ranging from 1.025 to 1.357) in September. In June, with the exception of one station (H'= 1.285) values fell below 1.0 (ranging from 0.262 to 1.285). Evenness values were highest in September at most stations, although no value exceeded 0.5. There were no apparent differences between the Sites. This implies that all stations had only a few species with high abundances, while the remaining species had low abundances. Skewness was affected more by Site and station location than by sampling period. Highest values were in Site 2 indicating greatest within station variability. Species distributions appeared to be affected by the presence of mussel clusters (both Mytilidue & *G. demissa)* which were patchy in their distribution throughout the mud bank surface. These clumps provide habitat and refuge for other organisms, as seen in September at Site 2. The station with mussel clumps had more taxa (37) than stations without

(26 taxa) and (12 taxa), including infaunal (*Neresis succinea, Petricola pholadiformis*) as well as epifaunal taxa (*Edotea triloba, Hiatella* sp.).

<u>Habitat Comparisons</u>: The most abundant taxa (> 104) were similar in all wetland-habitat groups. These species are adapted to the stressful intertidal habitat by their burrowing or tube dwelling existence. Abundant (> 103) and moderately abundant (> 102) species were variable between habitats and between Sites. This may be due to the physical differences in the habitats. Mud bank stations provide a somewhat more complex substrate than tidal creeks due to the presence of *S. alterniflora* and large pieces of detritus. This provides a niche for grazers (e.g. *L. littorea, Llyanassa obsoleta*) and detritivores (e.g. *Hydrobia totteni, Corophium insidiosum* and *Gammarus* sp.). Tidal creek bed may be a less stressful habitat because the exposure duration during the tidal cycle is shorter. In addition, longer and earlier exposure to flooding may provide a slight advantage in terms of recruitment. Within a particular habitat, sediment grain size characteristics were sufficiently different to account for some of the among-station variability. In all cases, significant differences were observed among stations and among station x sampling period groups. Of the parameters tested statistically, differences between sampling periods were observed only for *P. ligni, M. arenaria* and biomass. Four (4) of the 6 stations at Site 2 exhibited a significantly greater number of taxa than all stations at Site 1. Tidal creek stations at Site 1 contained significantly fewer taxa than the mud bank stations. The significance test on station x season interaction exhibited no strong pattern as evidenced by large numbers of overlapping groups. Each Site tended to exhibit differences between the months. At Site 2, number of taxa was higher in June than in September. The opposite was true on Site 1. In addition, the Site 1, habitat seemed to affect the number of taxas, with mud banks higher than tidal creeks.

Total abundance and annelida abundance (including *F. sabella*) paralleled each other, indicating the dominance of this phylum in the marsh environment. Patterns among stations are not clear. There is much overlap among station groups and among station x sampling period groups. Generally, mud bank stations at Site 2 achieved higher abundances than the same habitat at Site 1. Tidal creek stations at Site 2 exhibited lowest abundances. Stations 2M4 and 2M5 attained highest abundances during both sampling periods, in part due to the abundance of *F. sabella* . Site stations sampled in September were next in abundance. Four (4) stations were consistently lower in abundance. Annelida abundance (excluding *F. sabella*) and oligochaeta abundance, exhibited very similar patterns. Site 1 tended to rank higher than Site 2. Neither habitat nor sampling period seemed to be a major factor influencing the results. Abundance of *P. ligni* was higher at Site 2 than Site 1. Within Site 2, abundances tended to be higher in June than September at each station. Abundances at Site 1 were low, therefore patterns between months or habitat were not apparent. Abundance of *M. arenaria* was greater in the June than the September. This species was present in cores from 6 of the 12 stations. Only at one station did *M. arenaria* occur during both sampling periods. The stations exhibiting the highest abundances were at Site 2 (during both months).

Biomass was higher in September than June, but station and station x sampling period patterns were indistinct (Figure 5). Significant differences were due to the presence of large organisms (particularly mollusks) in a few of the samples. An examination of mean annelid biomass suggests that the biomass of this group was higher at Site 2 stations. The greater abundances of such large species as *N. succinea*, as well as the extremely high abundances of *F. sabella*, may account for biomass differences. The relatively high annelid biomass observed at 1 Site 1 station during June was due to high abundances of *S. benedicti*, Oligochaeta and *Capitella* sp. Among the tidal creek stations annelid biomass showed no patterns. Although the mean values at 2 site 1 stations were relatively high in September, the high standard deviations indicated that the mean was strongly influenced by 1 or 2 replicates. Of the annelids at these stations, oligochaetes were the most abundant and exhibited variability among the replicates.

Shellfish: Twenty-three (23) species were collected in total, only 10 of which were mollusks. Non-molluscan species were not treated quantitatively. However, the presence of these other species is at least indicative of their distribution on the study marshes. The omnivorous burrowing polychaete *N. succinea* was collected from the banks of both marshes. Xanthid crabs, *Rhithropanopeus harrisii* and *Neopanope sayi* were collected from Site 2. The marsh crab *Sesarma reticulatum*, whose burrows generally occur in the *S. alterniflora* zone, (Daiber 1982) was collected at Site 1 as was the fiddler crab *Uca pugnax*. Absence of any of these species from the collections in a particular area may be an artifact of sampling. Sampling the tidal creek habitat at Site 1 revealed low abundances of bivalves represented by only 1 species, *G. demissa* . Only the mud snail *L. obsoleta*, a typical inhabitant of salt marsh creeks, (Daiber 1982) ever reached moderate densities. As this species feeds on benthic unicellular algae, its presence in September suggests that the sediment surface of Site 1 tidal creeks supports microfloral production. The tidal creeks on Site 2 supported populations of filter feeding bivalves (*M. arenaria* and *M. mercenaria*) as well as the deposit feeding *Macoma balthica*. *M. arenaria* and *M. balthica* are often associated with salt marsh creeks (MacDonald 1969 a,b). Sediment-grazing gastropods were in evidence during June. Three (3) bivalve and 2 gastropod species were collected from Site 2 tidal creeks. Sediment textural differences between the two Sites is one factor affecting their diversity. The 2 stations that contained the highest proportion of coarse sediments, also exhibited the highest number of bivalve species. *G. demissa* was the only bivalve collected at any of the other stations. The presence of *L. littorea* at station 2T1 may have been related to its exposed location and secondarily, to its coarse substrate since this species is generally associated with rocky intertidal areas. *L. obsoleta*, present in all sampling of Site 1 tidal creeks, occurred only occasionally at Site 2. In this case, the finer sediments occurring at Site 1 probably influenced the distribution. *G. demissa* was the predominant member of the molluscan assemblage in the mud bank habitat at both Sites. This species has been reported to have a mutual relationship with *S. alterniflora* (Bertness 1984). In addition, aggregations of the mussel help to stabilize the seaward edge of the marsh, reducing erosion from wave action. *M. arenaria* occurred in low numbers at both Sites. Other than *G. demissa* and *M. arenaria* no other bivalves were collected from Site 1. In addition to the 2 species occurring at Site 1, *M. balthica, M. edulis* , *M. mercenaria* and *Petricola pholadiformis* were found at Site 2. Differences in sediment grain size distribution between the two Sites contribute to the observed differences in species composition. Gastropods were present on mud bank stations at both Sites. *L. obsoleta* was abundant at Site 1 in June. *L. littorea* was abundant during both collection periods at Site 2. Its presence at Site 2 is influenced by higher energy there than at Site 1. *Bittium alternatum* occurred at Site 2 in September.

Habitat Comparisons: Analysis of variance was conducted to assess differences among stations, between sampling periods and among station sampling period groups on 4 parameters: number of bivalve taxa, total bivalve abundance, number of gastropod taxa, and total gastropod abundance. The number of bivalve taxa was significantly different among stations, but the groups of similar stations were not distinct from one another. Site 2 stations had the largest number of taxa, followed by the mud bank stations from Site 1. Tidal creek stations from Site 1 had the lowest number of taxa 1 (*G. demissa*) or 0. The 6 stations with the smaller numbers of taxa were also those with the lowest abundances. Site 1 mud bank stations had the highest bivalve abundances, since random sampling fell within patches of *G. demissa* . Only 4 gastropod species were collected in the shellfish quadrats. Tidal creek stations never contained more than 1 species in any collection. Three mud bank stations (2M4, 2M5, 1M5), however, were inhabited by 2 or more gastropod species in at least 1 sampling period. Gastropod abundance station groupings fell in roughly the same order as a number of taxa. Significant differences in station x sampling period groups were detected. Highest abundances occurred in September for Site 1 tidal creek stations and in June for mud bank samples (stations from both sites).

Population Size Structure: Shell length data were obtained for all bivalve individuals collected as part of the current study. Mean length and size class distribution for the dominant bivalve, *G. demissa* and the commercially valuable *M. arenaria* were determined. The mean size of *G. demissa* were not different among stations or Sites, since the means generally fall within one standard deviation of each other. Apparent differences might be attributable to a number of factors: the number of individuals varied widely among the samples; location within a patch of mussels can affect the size of the individuals; the random sampling did not evenly sample different locations in the patches; and there may be environmental differences affecting growth. Hampson and Moul (1978) observed that *G. demissa* was virtually the only species to recover within a few years from the effects of a spill of Bunker C oil. If *G. demissa* populations experienced mortalities from exposure to PCBs, a comparison of length data between Sites 1 and 2 suggests that the effects are no longer manifested in population structure, despite continued uptake of PCBs. Rough age groups can be ascribed only to small mussels: 1 year old (< 10 mm) ; 2 year old (< 40 mm) ; 3 - 4 year old (< 60 mm). Older mussels may grow more slowly, depending on environmental conditions, and may survive 10-20 years. Thus, stability of an aggregate or population is not dependent on frequent input of juveniles. Relatively low numbers of small *G. demissa* is attributable to several factors such as preferential predation on small individuals, low recruitment rates, or intraspecific competition. Few *M. arenaria* were collected, with most occurring at Site 2. Shell lengths ranged from 10-80 mm. Based on growth rates observed in this species (Brousseau 1978), recruitment has occurred over a number of years. The smallest clams (10-15 mm) are probably young-of-the-year clams. Few *M. arenaria* were collected from Site 1, none in the tidal creeks. Most were collected from Station 1M5, because of the relatively large proportion of sandy sediment. *M. arenaria* was found to be tolerant of moderate levels of PCB's (0.05-0.16 ppm) and metals in the ranges observed (Tsai, et al. 1979). However, the concentrations of PCBs observed in this study are much higher than Tsai, et al. tested and may reduce the success of recruitment of *M. arenaria* to Site 1. Collection of other bivalve species was sparse and was restricted to Site 2.

The gastropods *L. littorea* and *L. obsoleta* both distribute their larvae planktonically (Yamada 1987; Gooch et al. 1972). Thus, within an ecosystem such as the estuary, it is expected that population size class structures are similar throughout. This appeared not to be the case for *L. obsoleta* collected at Site 1 versus 2, although data from Site 2 may be less representative of the overall population due to the relatively low numbers of specimens collected. Sediment textural characteristics varied between the two Sites, potentially contributing to the disparity in occurrence. Other environmental factors affecting growth could include sediment-borne contaminants either directly ingested by the gastropods or which inhibit production of benthic microalgae or salinity. *L. littorea* occasionally occurred in moderate numbers, particularly at mud bank stations. Size class structure exhibited no differences between these stations or between sampling periods. The collection of *M. bidentatus* was incidental, since this species generally resides in the *S. patens* zone. Absence of larger specimens may indicate that the marsh environment provides unsuitable habitat for this species.

Fin Fisheries Findings

A total of 16 species of fin fish were collected. *P. americanus* were collected only at Site 2. A total of 13 *P. americanus* were examined for neoplasms and tumors. No neoplasms or tumors were observed on the livers of the examined fish. Neoplasms have been found in soft shell clams from the Harbor (Reinisch et al. 1984). Cell extracts from the tumors showed detectable levels of PCB congeners which suggest an association between the high prevalence of diseased tissue (10-90%) and the presence of contaminated sediment. In another study (Brown et al. 1977) soft shell clam neoplasms were common (12.5%) in New England sites with varying degrees of hydrocarbon contamination. Hydrocarbon levels in clam tissue were related to sediment hydrocarbon concentrations.

The beach seine efforts were characterized by large numbers of *Menidia menidia* (76.8% of the total catch). *M. menidia* were the most numerous fish caught in the estuary and marsh making up 97.7% and 88.6% of the catch in Sites 9 and 2, respectively. In the upper estuary (Sites 1, 3, & 5), *M. menidia* accounted for 74.7% of the fish caught. The second most numerous species, *F. heteroclitus*, was present in greater numbers in the upper estuary. In the upper estuary *F. heteroclitus* accounted for 24.4% of the fish caught, compared to 0.7% and 3.0% in lower estuary and Buzzards Bay, respectively. The *F. majalis* exhibited the reverse situation accounting for only 0.2% of the fish caught in the upper estuary compared to 1.4% and 7.5% in the lower estuary and Buzzards Bay, respectively. Of the other 8 species caught, each contributed < 1% of the total. There were 4 species caught in the minnow traps. *F. heteroclitus*, the most numerous, accounted for 95.5% of the total catch from all Sites. This species made up 98.9% of the catch in the upper estuary, 95.8% in the middle estuary and 87.0% in Buzzards Bay. *F. majalis*, the second most abundant species, accounted for 12.9% of the catch in Buzzards Bay and only 4.1% of the total number. The 2 remaining species combined contributed less than 1% of the total number and catch at any Site.

Length and Weights: Length and weight measurements were obtained from 1,781 specimens of 11 species from 5 Sites (beach seines). Lengths for *M. menidia* (the most numerous species caught) ranged from 22 - 132 mm, with 95.3% of them measuring < 80 mm. The larger specimens (89-132 mm) were only caught at Sites 2 & 9. Weights ranged from 0.1 - 13.6 gms, most of them measuring from 0.1 - 3.0 gms. *M. menidia* were caught at 5 Sites. *F. heteroclitus* lengths ranged from 22 - 100 mm, with 66.7% of the specimens measuring from 30 - 50 mm. Weights for *F. heteroclitus* ranged from 0.1 - 17.5 gms, with 68.5% < 1.5 gms. *F. heteroclitus* was caught at all Sites. *F. majalis* lengths ranged from 26 - 131 mm, with 98.1% < 60 mm. Weights ranged from 0.1 - 33.3 gms, with almost all < 3.0 gms. *F. majalis* was caught at all Sites. Length for *A. sapidissima* caught at all Sites, ranged from 33 - 57 mm, with all weights <= 2.5 gms. *Apeltes quadracus*, caught at Sites 1 & 2, had narrow lengths (27 - 39 mm) and weights (0.1 - 0.3 gms). The length range for *M. cephalus* was from 54 - 113 mm, with weight measurements from 1.1 - 17.7 gms. This species was caught at 3 Sites (1, 5, & 9). The last species present in any number, *Pomatomus saltatrix*, was caught at Sites 1 & 2, with lengths 107 - 139 mm and weights 12.0 - 21.3 gms. During this study only one specimen of *Tautoga onitis, Caranx hippos, Pseudopleur-onectes americanus*, and *Alosa pseudoharengus* were caught. A total of 1318 fish from 4 species were collected in minnow traps from 6 Sites. *F. heteroclitus* (91.7% individuals) had ranges of lengths 33 - 112 mm and weights 0.5 - 26.7 gms. This was the only species to be caught at all Sites. *F. majalis* (7.2% individuals) had lengths from 37 to 56 mm and weights from 0.5 to 2.3 gms. *M. menidia* (1% individuals) had lengths of 52 - 70 mm and weights of 0.9 - 2.3 gms. There was 1 specimen of *A. pseudoharengus* caught at Site 4. The length frequency distribution of *M. menidia* at Site 2 exhibited a bimodal pattern indicating two age classes. Site 9 had fish of the larger size group. In the upper estuary (Sites 1, 3, 5) the larger size group was not present, due to the physical make-up of this area. Percent composition of *F. heteroclitus* was the highest at Site 1 and exhibited a decrease further down the estuary. The length frequencies of *F. heteroclitus* exhibited a bimodal distribution indicating the presence of two size groups. However, unlike *M. menidia*, both size groups were present at all Sites. *F. majalis* had the highest percent composition at Site 1. Although only a few specimens of larger fish were caught, there are also indications of a bimodal distribution in the length frequencies of *F. majalis*.

Gut Contents: Seventeen specimens of *F. heteroclitus* were examined for gut contents, 10 of which contained food. All fish ranged from 70-75 mm in length. Gut contents included 7 major groups of organisms. Bivalve mollusks accounted for 53% of the total number of organisms found. Fish and fish eggs, decapod crustaceans, and polychaets accounted for

17.8%, 13.3%, and 11.1% respectively. Chordates and gastropods each accounted for 2.2%. Plant material, which was found in 3 of the 10 stomaches, was less than 1%. Biomass (blotted wet weight in gms) was measured for each prey category. Bivalves comprised 44% of the total biomass found in the guts. Fish and fish eggs and decapods accounted for 29% and 14%, respectively. Plant material accounted for 13% of the biomass. The remaining 3 groups (polycheats, chordates, & gastropods) each accounted for less than 1% of the biomass. Analysis of the gut contents were performed on 10 *P. americanus* individuals (from Site 2), with lengths between 50 - 60 mm. Two taxa (isopods & polychaetes) were found: isopods (63.8% of number of organisms) accounted for 21% of the biomass; polychaetes (31.9% of number of organisms) made up 73% of the biomass. The only other group present was amphipods, accounting for 4.3% of the total number of organisms and 6% of the biomass.

Bioaccumulation Findings

Biota within two food chains were sampled to help assess the potential for bio-concentration/ bioaccumulation of PCBs and selected heavy metals (Cu, Cr, Pb and Zn) in site organisms (Table 9). Ring-billed gulls were collected along with some of their food items (e.g. ribbed mussels, amphipods, and gastropods). Other major foods of the ring-billed gull include: fish, amphibians, insects, polychaets, grubs, and sometimes bird eggs and mice; they also scavenge (DeGraaf and Rudis 1986, Martin et al. 1951). Ring-billed gulls breed near open beaches, mud flats and harbors, and winter near salt water. *P. leucopus* along with some foods items were collected at Sites 1 and 2. *P. leucopus* diet is versatile, reflecting availability of food (eg. insects, snails, centipedes & small amounts of carrion). Plant foods include seeds, fruits, acorns, tender green plants, and roots or tubers (DeGraaf and Rudis 1986, Martin et al. 1951). *P. leucopus* are most abundant within the upland border of the salt marsh and areas of salt marsh shrub. In February and March the collection of Black ducks, *G. demissa* and *U. lactusa* occurred. Black ducks are a game bird. If contaminated, they may pose a potential risk to humans. Black ducks are known to breed in brackish marshes and winter exclusively in open marshes of the coast and interior. Their major foods include: mollusks, submerged aquatic plants, algae, acorns, seeds of marsh plants, salt marsh grasses, crustaceans, polychaets, amphibians and fishes (DeGraaf and Rudis 1986, Martin et al. 1951).

PCBs and selected metals (Cr, Cu, Pb, & Zn) were detected in tissue samples (Tables 10 & 11). These data indicate that PCBs are incorporated in the tissue of the sampled organisms. PCBs were detected in all of the *G demissa* (Figure 6), *O. grillus* and *M. bidentatus* tissues which comprise the lower trophic level of the Ring billed gull food chain;

and in selected fruit and composite animal food samples which comprise the lower trophic level of the *P. leucopus* food chain (Martin, Zim, & Nelson, 1951). Average PCB concentration in *G demissa* was 10.6 ug/g. The PCB concentration in *G demissa* was highest at locations closest to the area with the highest contaminated sediment . The PCBs concentration in *M. bidentatus* sample was 3.2 ppm and 29.0 ppm in the *O. grillus* sample. The average PCB concentration in Ring-billed gull muscles and fat samples were 13.99 ug/g and 153.67 ug/g, respectively. These data indicate that biomagnification may be taking place within this food chain. The average PCB concentration in all mouse foods was 4.31 ug/g. PCBs levels in *J. gerardi* and acorns were below detection levels. *P. leucopus* PCB concentrations averaged 22.33 ug/g. These data suggest that biomagnification of PCBs may be taking place within this food chain as well. Concentrations of metals appear to be comparable throughout the samples with some exceptions. Relatively high concentrations of copper and zinc were detected in the *O. grillus* (Cu = 36.0 ug/g; Zn = 140 ug/g) and *M. bidentatus* (Cu = 25.0 ug/g; Zn = 630 ug/g) samples. The *M. bidentatus* sample also contained relatively high concentrations of lead (9.0 ug/g). The levels of zinc detected in the muscle and fat portions of Ring-billed gull suggest that zinc may be concentrated in fat tissue. Although these data do indicate that certain metals may be selectively concentrated, they do not suggest transfer within the two food chains or a potential trend for biomagnification as do the PCB data.

Evaluation of the concentrations of metals and PCBs taken from samples of *Palaemonetes pugio* show a similar trend as demonstrated in the sediment samples. Metal concentrations from *P. pugio* taken in upper estuary Sites are more elevated than Site 9 or 2. *P. pugio* from Site 1 exhibited the highest levels for chromium, copper, and iron. The highest PCB values were found in *P. pugio* taken at Site 3 (25.3 mg/kg). The *P. pugio* PCB values were 7.63 mg/kg from Site 1. *P. pugio* taken near Site 2 has the lowest average concentrations for chromium, copper, PCB and iron. The most evident change was the two order of magnitude drop in PCBs between the *P. pugio* collected at Site 3 (25.3 mg/kg) and that from Site 2 (0.33 mg/kg). *G. demissa* were taken at Sites 2, 3, 4, 5, and 9. Metal and PCB concentrations from *G. demissa* tissue taken at Site 5 were generally higher than other stations, followed by decreasing concentrations from Sites 4 , 9 to 2. The total PCB and zinc concentrations were highest in tissue from Site 5. Copper and mercury concentrations were high from tissue from Site 2. The cadmium level was highest at Site 2. *F. heteroclitus* were taken from Sites 1, 2, and 4 and *P. americanus* from Site 2. With the exception of chromium and lead concentrations found in fish tissue from Site 1, there was little differences between contaminant values from the various wetland stations. Fish samples taken from Site 5 exhibited PCB values an order of magnitude higher (44 mg/kg) than all other stations. PCB concentrations at Sites 9 and 2 were 8.1 mg/kg and 3.0 mg/kg respectively. Concentrations of PCBs in the tissues of *F. heteroclitus* were 4 times higher in the middle estuary (Site 4) than in the fish caught at Site 2. The upper estuary (Site 1) had concentrations 5 times higher than the middle estuary. There was 20 times as much PCB contamination in the fish from the upper estuary than fish from Site 2. Concentrations of copper and lead were higher in upper estuary fish than in fish from Buzzards Bay. *F. heteroclitus* would be susceptible to PCB and heavy metal contamination from prey species. Analysis of tissue from *P. americanus* from Site 2 showed much lower concentrations of copper, lead, and zinc than the concentrations found in *F. heteroclitus* from Sites 1 & 4. Concentrations from *P. americanus* and *F. heteroclitus* caught at Site 2 were almost identical. The PCB concentrations for *F. heteroclitus* at Site 2 were 5% of the concentrations found in fish from Site 1. Analysis of tissue from *P. americanus* caught at Site 2 showed half the concentration of PCBs in *F. heteroclitus* caught at the same Site. If the high levels of PCBs and metals in *F. heteroclitus* in the upper estuary are a result of its diet, then *P. americanus* would also be expected to contain higher contaminant levels than in the fish sampled from Buzzards Bay.

DISCUSSION

Biological trends

Sediment: Salt marshes are known to be sinks for nutrients, organic material and toxins, although they also export large quantities of nutrients and detritus on a seasonal basis. These marshes have trapped large quantities of metals and PCBs. Most of this is associated with the sediment deposition within the accretion portions of the wetlands, as the metals and PCBs are adsorbed onto the particulates. Although there is debate in the scientific literature regarding the specifics of salt marsh import-export behavior (Nixon 1980), largely because of the difficulties in measuring these processes, a general understanding is possible. Import-export roles are affected by the structure, age, and hydrology of the marsh, and are parameter-specific. Odum et al. (1979) classification of salt marshes by flow and tidal exchange characteristics show that marshes with low currents have limited export. Age is also a factor. As the marsh fills its basin to the high tide level it only acts as a sediment sink primarily in relation to sea level rise. The lower metal and PCB concentrations in the high marsh portions of the study wetlands support the notion that sediment accretion rates within these older parts of the marsh is minimal at present. Younger marshes typically have greater accretion rates, and may actually show a net import of particulate organic carbon, while older marshes tend to export carbon through their creek systems.

The Sites in this study appear to be primarily older marshes and occur in a setting which is moderately constricted. This indicates that they likely have a net export of organic carbon within, or slightly below, the normal range determined for east coast marshes of 100-200 g $C/m^2/yr$ (Nixon 1980). The significance of this export in secondary production of adjacent waters is difficult to assess; Nixon (1980) notes that "the path from the emergent marsh to the open coastal water is not through a pipe, but through a complex chain of sub-systems, each of which is characterized by its own internal cycling as well as its own inputs, outputs, transformations and storages". Tidal flats adjacent to the wetlands may be important sites for trapping nutrients which leave the marsh on ebb tides, ultimately converting plant production into animal biomass (Whitlatch 1982).

<u>Benthos</u>: Sediment characteristics and other physical differences determines species distribution. A comparison of the benthic communities between Sites 1 and 2 is complicated by the physical differences. Based on the relationship of particle size and current speed (Hjulstrom 1939), sediment particles at Site 2 measuring less than 4.5 mm, over 90% of the surface sediments could be resuspended by the estimated 0.6 kt current speed. Current speeds at Site 1, estimated at 0.2 kt could potentially transport particles measuring less than 1.4 mm, or an average 90% of all surface sediments. Another difference is the contaminant levels. Site 1 is located adjacent to the highest polluted sediment, while Site 2 is located in much less polluted area. Site 1 exhibited a higher proportion of fine grained sediments, suggesting a greater potential for contaminant concentration, because fine grained sediments tend to have a higher affinity for contaminants. There were marked differences in infauna between tidal creeks on Sites 1 and 2. Dominant species on Site 1 were surface deposit feeders and shallow burrowing deposit feeders. The dominant taxa (Oligochaeta, *Capitella* sp., *Streblospio benedicti*) are generally considered to be opportunistic (Grassle and Grassle 1974). Diversity was low, indicative of a stressed environment, as estuaries generally are (Rhoads et al. 1978). The shellfish fauna (2 species) was depauperate in Site 1 tidal creeks. There were 3 times as many infaunal species in the creeks on Site 2 than at Site 1 (particular in polychaetes & bivalves).

A greater variety of mollusks species (most filter feeders) occurred at Site 2 than at Site 1. The same taxa dominating tidal creek fauna at Site 1 were also numerical dominants in the mud banks. Several amphipod species were also moderately abundant in the mud banks. These species generally have a strong association with the marsh grasses, either as detritivores or grazers of microorganisms associated with the plants (Daiber 1982). Species composition in Site 2 mud banks exhibited higher diversity, particularly among polychaetes, bivalves and amphipods than at Site 1. The higher proportion of organic material and fine grained sediments at Site 2 may offer an enhanced habitat value for deposit feeders and detritivores over Site 1. Mud banks on neither Site support a wide array of mollusks. The dominant bivalve, *G. demissa,* is especially adapted to existence in and near the *S. alterniflora* zone by its ability to "air gape" (Daiber 1982). There was no size difference in the *G. demissa* populations at the two Sites. The higher diversity at Site 2 suggests that this site provides a more conducive environment for benthic fauna.

Sites 1 and 2, both include a variety of intertidal habitats which contribute to the potential primary and secondary (invertebrate) production. Some of the biological differences found are due to physical differences (e.g. location in or out of the estuary, exposure to high energy environment, and/or sediment characteristics). The abundance and diversity of fauna at Site 2 indicates a high level of secondary production. Although diversity is greatly reduced at Site 1, the size (especially linear distance of marsh-open water interface) and elevated abundances of a few taxa suggest that this invertebrate production makes a substantial contribution to the system. Although Site 3 is large, it exhibited low invertebrate production and diversity, a combination which does not provide good feeding habitat. Sites 4 and 5 are both small fringing marshes associated with very soft mud flats. *G. demissa* are prominent features of both Sites. Site 5 has a greater variety of microhabitats (determine by grain size) than Site 4, and consequently supported a greater variety of shellfish. At Site 9 *G. demissa* and *L. littorea* are abundant, but the gravel substrate is not conducive for benthic infauna. This Site provides minimal feeding habitat for demersal fish and limited export of primary and secondary production.

Flora: Tidal marshes are among the most productive ecosystems in the world. Net primary productivity values reported for northeastern U.S. low marsh vegetation range from 507 - 840 g dry wt/m^2/yr; high marsh values are about 430 g dry wt/m^2/yr (Mitsch and Gosselink 1986). The mature salt marsh in this study was about 68% high and 17% low marsh vegetation. The average plant height for high marsh grasses was about 53 cm and for low marsh grass 143 cm. In general, plant heights were greater in the estuary Sites than the reference Site (Figure. The greater grass growth is probably due to the elevated nitrogen and phosphorous levels in the waters. Based on plant heights these Sites appear very productive for their age. Estimates of net marsh productivity (Figure 4) derived solely from above-ground plant harvesting are known to underestimate the total energy within a marsh system (Nixon 1980; Teal 1986). However, net above-ground productivity values for *S. alterniflora* have been correlated with below-ground production (Nixon 1980; Teal 1986). Teal (1986) reports ratios of above/below - ground productivity in Massachusetts of 2.5 for stands of tall *S. alterniflora* and 8.3 for stands of short *S. alterniflora.* Nixon (1980) reports a ratio of 4.0 for high marsh communities in a Massachusetts marsh. The values presented here are well above those expected for this region. The detritus, dead leaves and stems of the salt marsh grasses, are broken down by bacteria, fungi, protozoa, and nematodes which are in turn eaten by large deposit feeders (Weibe and Pomeroy 1972). Estuaries with a constricted opening such as this tend to trap and recirculate materials instead of exporting them.

The plant species composition of these marshes is representative of that found in this region for regularly flooded marshes (Teal 1986) and high salt marshes (Nixon 1980). One unusual feature is the relative abundance of *I. frutescens* at Site 1; this is related to the hydrologic regime which has developed. There were no indications of stress related to contamination in this study. There are no signs of abnormal rates of plant mortality or stress as might be reflected in chlorosis or other color or morphological aberrations. The above-ground standing crop data indicate vascular plant productivity is within the range of reported values for southern New England. The highest biomass of herbaceous vegetation was recorded for tall *S. alterniflora* at Site 5. This site is close to contamination sources, yet no indication of reductions in plant productivity were observed. There is little available data on what levels of contaminants such as heavy metals or PCBs are damaging to salt marshes (Teal 1986). Existing studies are limited (see Giblin, 1982, Hampson & Moul, 1978). Since PCBs are not known to accumulate in *S. alterniflora* tissues, no manifestion is visible relative to species composition or productivity

Fauna: *S. floridanus* were the most frequently observed mammals (Table 5). Medium-sized mammals (e. g. *M. monax*, *O. zibethica*, and *P. lotor*) were found at the larger Sites and *V. fulva* have inhabited these Sites for some time. Mammals were abundant on all of the Sites. Small mammal diversity and abundance was the lowest on the marsh proper where *M. pensylvanicus* and *P. leucopus* are known to nest. In the upland edge, a greater abundance and diversity of species, (including *S. cinereus*, *S. aquaticus*, *M. musculus*, & *Z. hudsonius*) were found. Differences in the size and compositional characteristics of these sites affects the mammal diversity and abundance among them because the majority of use is foraging by animals which live in marsh edge or upland habitats. Therefore Sites containing larger transition zones had the greatest diversity and abundance of small and medium sized mammals. Sites 1 and 3 provide suitable habitat for *M. pensylvanicus* , which builds its nest in *S. patens* (sometimes in *S. alterniflora)*, and feeds exclusively on salt marsh plants. Foraging areas are also found for larger mammals (e.g. *S. floridanus*, *O. zibethica* , *P. lotor*, *D. verginiana* , *M. mephitis* , *M. frenata*, and *V. fulva*, which live in upland areas, but feed in marshes. In addition, the extensive transition zones provide suitable habitat for burrowing mammals (e.g. *S. cinereus*, *M. monax*), and for seed eaters (eg. *P. leucopus* , *Z. hudsonius*) which build nests in old logs or tufts of grass.

There is little inhabitable area at Site 5, since it is dominated by the intertidal form of *S. alterniflora*. The mammal density and diversity is low. Site 4 is not inhabitated by mammals, rather it is used by mammals living in the adjacent stand of *P. australis* and upland areas (e.g. *P. leucopus*, *S. floridanus*, *P. lotor*, *D. virginiana*, & *M. mephitis*). The small size of Site 9 precludes extensive use of by mammals other than *M. pensylvanicus* and *P. leucopus*. Although Site 2 has less transitional marsh/upland edge habitat than Site 1, adjacent shrub and forested areas provide suitable habitat for small mammals (e.g. *S. cinereus* and *P. leucopus* , and larger mammals (e.g. *M. erminea*, *M. vison*, *M. mephitis* , *D. verginiana* , & *P. lotor*). The extensive area of salt marsh at this site and its high interspersion of cover types provides rich foraging areas for the species living in adjacent upland areas, as well as for wetland nesting species such as the *O. zibethica* and *M. pensylvanicus* .

Fish: Fish species composition (Table 6)in the study area was found to be comparable to that of other estuaries (Curley et. al. 1971, 1974; Nixon & Oviatt 1973). The dominant species (*M. menidia*, *F. heteroclitus*, & *F. majalis*) were also dominant in the other estuary studies of Massachusetts. *M. menidia*, which accounted for 76.8% of the total catch was also reported by Curley et al. (1974) for the Taunton River and Mount Hope Bay estuary where *M. menidia* made up 66.6% of the total catch. The dominant species caught at all 5 Sites, were consistent with McHugh's (1967) classification,which considers them to be general estuarine residents. *M. menidia* enter the shallows and tidal creeks of the upper estuary to feed and breed. *A. sapidissima* and *M. cephalus*, both migratory species, appeared to be more abundant in the upper estuary (Sites 1, 3, 5). These 2 species utilize the estuary as a nursery area. The specimens caught were all young-of-the-year. *A. quadracus* , categorized as an estuarine resident, was restricted almost entirely to Site 1. *P. saltatrix* was found at Sites 1 and 2, occurring in comparable numbers in those two areas. This species, a top predator, usually enters estuaries in pursuit of migratory planktivores such as *A. sapidissima* and *M. cephalus*. *C. hippos* and *P. americanus*, primarily marine species, were caught at Site 2. There were only 4 species of fish caught with minnow traps. Of these species *F. heteroclitus* and *F. majalis* were caught in large numbers. The *M. menidia* and *A. sapidissima* swim and feed in the middle to upper areas of the water column. In the beach seines, *F. heteroclitus* was present at all Sites and was more abundant in the estuary than at Site 2. Length frequencies from fish caught in minnow traps showed a bimodal distribution, though less distinctly than in the beach seine data. *F. majalis* was caught at 3 Sites (1, 2, and 9). The number of specimens increased further down the estuary; similar to observations in the beach seine collections. The average number of *F. heteroclitus* caught by minnow traps did not differ substantially among the 6 Sites, showing that comparable concentrations of this species are present in suitable habitat throughout the estuary. The higher the contamination in a Site, the greater the total amount of contamination is likely to be in the fish biomass in that area. *F. heteroclitus* would come into contact with contaminants associated with particulate matter in the water column as well as the sediments since they tend to burrow in the soft mud to over-winter (Chidester 1920). *F. heteroclitus* also tend to stay in the same general area throughout the year, moving very little within an estuary (Lotrich 1975). *F. majalis* would exhibit the same general behavior as *F. heteroclitus* , but *F. majalis* is a smaller component of the fish fauna in the areas of high contamination. The plankton feeding species *M. menidia* and *A. sapidissima* would come into contact with the contaminants bound to the particulate matter in the water column either through ingestion or physical contact. The diet of *F. heteroclitus* consists of: benthic organisms, decapods and other crustaceans, and plant material. Comparison of the diets of examined specimens with fish caught in other estuaries shows no variation in diet composition; however there is a difference in the percent occurrence of various groups in their diets. *F. heteroclitus* usually consume prey items in proportion to prey occurrence in the environment (Fraser,1973).

Functional attributes and values

Despite very heavy levels of contaminants, the project area Sites continue to function as effective systems and to have high values. The Wetland Evaluation Technique (WET) developed by the Corps of Engineers (1987) has been employed for the assessment of the relative wetland significance for 15 functions. The WET method assumes that wetland characteristics in combination contribute certain functions, and therefore rating those characteristics can provide a relative assessment of how well a particular wetland functions for certain purposes. This method was unable to distinguish differences in functional values between these sites. Larger size wetlands,with more diversity of vegetative types would be expected to have a greater potential to provide a wider array of functions to a degree which has more local significance than smaller, less diverse marshes. In considering the range of factors which, in combination, determine overall wetland value, the following ranking of these Sites (from highest to lowest) is suggested: 2, 1, 3, 5, 4, 9. The first three areas would be logically grouped together in a "higher value" assessment, versus the latter three in a "lower value" category.

Estuary resources are presumed to have functional values in the Massachusetts Wetlands Protection Act (M.G.L. Chapter 131, Section 40) and selected literature (Adamus 1983). These regulations contained in the Act (310 CMR 10.00), identify 7 resource categories that are present in this estuary:

- land under the ocean, banks of, or land under, the ocean, river, or creek that underline anadromous fish runs (ie. *A. pseudoharengus* & *A. aestivalis*);
- coastal beach (ie. tidal mud flats);
- salt marsh (all sites);
- land containing shellfish (ie. *M. arenaria* & *M. mercenaria*);
- coastal bank (ie. vegetative wetland edge);
- bordering vegetated wetland (ie. all sites);
- land subject to coastal storm flowage (ie. all sites within 100yr flood plain).

The Massachusetts Wetlands Protection Act identifies and protects 7 statutory interests. Coastal wetlands also have additional functioonal values that include: shoreline anchoring, dissipation of erosive forces, sediment trapping, wildlife habitat and socio-economic attributes (Adamus 1983). The wetlands also afford storm damage protection (wave erosion, etc.) to adjacent uplands. The marsh vegetation secures the substrate beneath the sediment-water interface and thus promotes the accumulation of clayey, cohesive sediments. Salt marsh cordgrass may reduce wave heights by as much as 71% and wave energy by 92% (Wayne 1976). Stems and leaves of salt marsh vegetation help trap suspended sediment and nutrients by impeding current flow. Salts extruded from the leaves of salt marsh grasses may increase salinity within the vicinity of the plants. This increased salinity may in turn promote clay flocculation (Pestrong, 1972). Wetlands are also presumed by the Act to aid in the removal of contaminants through uptake of nitrogen and phosphorous, removal of suspended particulates, immobilization of heavy metals, etc.

The Sites in this study contain abundant *G. demissa* beds along their banks. These gregarious bivalves increase substrate coherence by their network of byssal threads and their rigid framework structures (Davis, 1985). Suspension feeders, like *G. demissa* , extract organic and inorganic material from the water column and pellitize it. Average rates of biodeposition in the form of pseudofeces for *G. demissa* is 549 g feces/year (Davis 1985). Because much of the PCBs and metals in the water column is attached to fine organic particles, the deposition of pseudofeces by bivalves increases the levels of contaminants within the surface sediments of the marsh. Adjacent tidal flats in the upper estuary contain shellfish which are a food source for higher trophic level organisms. A number of fish species feed in the upper estuary and migrate through to spawn in the Acushnet River. In addition to the many fish and shellfish that feed along the marshes edges and on the marsh surface are crabs, snails, insects, birds and some small mammals that inhabit these marshes. The salt marshes of the Acushnet River estuary provide wildlife with open water, mud flat, herbaceous vegetation, low shrub habitat and a transition zone at the upland edge of the salt marsh which contains herbaceous, shrub and tree strata. The availability of food and protection are abundant in these wetlands. The estuary, because of its location amidst extensive development, is a habitat which provides valuable food, shelter and nesting sites for migratory waterfowl, herons and egrets, and year round residents such as, marsh sparrows. The wetland socio-economic attributes consist of observational, educational and scientific endeavors, and the amenities of open space located in the midst of heavy urban development. Sites 1 and 2 are located in the Sycamore Street wetland (Fairhaven conservation area) ,which make these wetlands important administratively.

Pollution trends: There is a trend of decreasing concentrations of metals and PCBs from the upper estuary wetlands south;' and a weak trend of stations close to mudflats or tidal waters having higher concentrations of metals and PCBs. This study has shown that metals and PCB contamination is tied to particulate matter. This estuary has been subjected to long term exposure to contaminated effluent from various activities. Although a previous study (Eisenriech, 1980) has indicated a net flow of contaminants south from the upper estuary to the lower portions, depending upon the mass of metals and PCBs released over time, a substantial residual mass of metals and PCBs exist in the sediments of the upper estuary. This large source of material makes potentially available a large mass of contaminants for redistribution within the estuary by both natural events (Eisenriech, 1980) (estuarine circulation, nutrient cycling) and anthropogenic events (dredging, filling, etc.). These events are similar to those described by Turk (1980) as being responsible for the redistribution of PCBs in the Hudson River. The distribution of PCB's within the entire estuary is influenced by estuarine circulation patterns. The highest concentrations of PCBs are found in low marsh which are subjected to daily tidal and circulation patterns and depositional processes. Periodic inundation of the high marsh areas, especially those close to open water, replenish these areas with contaminants during high water events. Sites 1 and 5 demonstrate similar levels of PCB. These are probably a reflection of their distance from contamination sources and the circulation effects. The low marsh station at Site 4 had elevated levels of PCBs, comparable to those in

Site 1 and 5. These levels are likely due to the Site 4 location relative to the harbor bridges and its intrusion into the central portion of the traditional channel. The physical structure of the bridge pilings and associated appurtances may also affect circulation patterns immediately downstream, which, when combined with the intrusion of the site, could result in depositional patterns leading to increased PCB concentrations. Low marsh PCB concentrations in Site 9, which is more physically remote from the center line of the traditional channel, are an order of magnitude less than those at Site 4. Though less than those at Site 4, the Site 9 PCB concentrations are yet an order of magnitude higher than at Site 2.

There is a weak upper to lower estuary trend in metals distribution; however there does not appear to be a quantitative difference between low and high marsh metal concentrations. The distribution patterns may result from both physical and biologically mediated processes which act both dependently or independently of each other. Metal contaminants may have been released from industrial activities into the estuary over a longer period of time, and in higher concentrations than PCBs. The sediment-metal reaction kinetics may be such that movement of metals from soluble aqueous forms in association with particulates differs from those for PCBs. Biologically mediated processes leading to the uptake of metals by the entire spectrum of biological systems may affect nutrient cycling rates in the water-mud-wetland system and the residence time within the various biological and physical resource sinks (Eisenreich, et. al. 1980). The pattern of chemical distribution is likely mediated by: the frequency, duration and concentrations of previous contaminant releases; depositional patterns created by the geographic, hydrologic, and circulatory processes specific to the confines of the estuary; and anthropogenic activities such as wetlands alteration, dredging and filling, construction within the estuary, and upland activities which can influence downstream physical, chemical and biological processes.

Bioaccumulation

PCBs enter the terrestrial environment primarily by attaching to fine particulate matter in the atmosphere. These fine particulates then deposit on vegetation and are available to the food chain through ingestion by herbivores. PCBs in the water are directly absorbed by organisms through gill membranes and other exposed tissue, or from the food chain via ingestion. The means of exposure to PCBs from an estuary would occur through ingestion, or contact with contaminated soil. Studies on the uptake and accumulation of heavy metals by marsh vegetation indicate that vegetation plays a major role in retention of various metals including cadmium, copper, lead, manganese, nickel, iron and zinc (Windom 1977, Gambrell et al. 1977, Chan and Hantzsche 1982, Simpson et al. 1983, Taylor and Crowder 1981).

Maximum uptake of metals in above ground tissues of marsh plants apparently occurs during the growing season, prior to the production of peak above ground biomass. During the dormant season, heavy metals are not translocated back to the roots and rhizomes, but remain in the stem and leaf parts. Studies have demonstrated correlations between metal contamination in the soil-sediment material and the uptake of various metals by marsh vegetation. Taylor and Crowder (1981) showed that the patterns of uptake of metals (Cu, Ni, Zn, Mn, and Mg) were similar. Roots showed higher concentrations than the rhizomes and above ground parts and young leaf tissue showed lower concentrations than the older tissue. Gambrell et al. (1977) determined that physiochemical parameters (e.g., Eh, pH, & salinity) play a major role in the availability of metals to salt marsh plants.

Fish and other aquatic organisms accumulate PCBs and metals by direct water intake, by absorption through gills, and by the ingestion of other aquatic organisms lower in their food chain. Because PCBs and some other chemicals are persistent in the body tissues of both the food source and the organisms, magnification occurs in organisms which are higher in the food chain. This phenomenon can result in contaminant concentrations one or several orders of magnitude higher than concentrations in the water or sediment. Larger fish, bottom feeders, and carnivores tend to accumulate (biomagnify) higher levels of contaminants (NUS, 1984). Many studies have documented the presence of contaminated materials in the estuary (NUS, 1984; Battelle, 1985; Reinisch et. al, 1984; Genest and Hatch, 1981). Many of the fish and shellfish living in the estuary exceed the FDA limit (2 ppm PCBs in the edible portion) while several others have concentrations near that limit (NUS, 1984). Species feeding in those areas of elevated contaminants can be expected to accumulate metals and PCBs. As massive volumes of sediment contaminated with PCB occur in the upper estuary, normal biological and abiotic forces (Eisenreich, 1980) will continue to make a portion of the PCBs and metals in the sediment sink available for bioaccumulation.

These data indicate that PCBs are incorporated into the tissue of the selected organisms from the estuary trophic levels. Concentrations of Aroclor 1254 exceeded FDA levels in the tissues of: *G. demissa*, Ring billed gull muscle tissue, *M. bidentatus*, and *P. leucopus* indicating that biomagnification may be taking place within this food chain. These data for *P. leucopus* system suggest that biomagnification of PCBs may be taking place within this food chain as well. Biomagnification of metals in the food chain(s) is less well defined. The inability to document metal biomagnification in this study may be due to a number of factors: the ubiquitous and chronic nature of metals contamination in the region leading to constant elevated levels of metals in water and sediment; differential metal uptake rates in the various biological systems sampled; lack of statistical power (number of replicate samples) to mathematically describe uptake trends between the various trophic levels. Bioaccumulation data indicate a trend of a gradual decrease in concentrations of PCBs from the upper to the lower harbor.

Other literature has discussed food chain implications resulting from contamination that relate to in this estuary (Genest and Hatch, 1981; NUS, 1984). Substantial literature exists about food chain impacts on other systems (Swartz and Lee, 1980; Goerke et al., 1979; Marinucci, 1981), including modeling efforts in the Hudson River (Turk, 1980) for PCB cycling and bioaccumulation (Battelle, 1988). At the study area elevated levels of PCBs were found in nearly all samples, indicating an uptake of this contaminant at all the trophic levels in the wetland system. In general, the data shows a gradual increase in the order of magnitude of the PCB concentration, from vegetative matter to herbivore/filter feeder to gulls. The data do not support a comparison between different wetland sites for different PCB uptake rates. Data from the metals analyses are less indicative of biomagnification, although elevated levels of metals were found in most samples. These data indicate a potential for bioaccumulation/biomagnification trend in the estuary. PCBs have been shown to bioaccumulate from sediment to *S. alterniflora* tissue (Marinucci, 1981). PCB concentrations were 3 to 4 times higher in decomposing cordgrass detritus than in the sediment. This has obvious implications for detritivore based food chains. Lobsters have been shown to accumulate PCBs from the ingestion of contaminated mussels, and hard shelled clams have been shown to accumulate amounts of PCBs from contaminated sediment (Battelle, 1984). Bioaccumulation of PCBs by sandworms, grass shrimp and hard clams was demonstrated in 4 sites in New York Harbor (Rubinstein, et al., 1983). Uptake was highest for the sediments and was affected by the organic content of the substrate. Other studies (Black et al 1987) have been conducted to determine if the accumulation of PCBs has an effect on the growth and survival of the *P. americanus*. Eggs of the *P. americanus* taken from the harbor contained significantly higher levels of PCBs than reference populations, and larvae hatched from these eggs were significantly smaller than reference larvae. Biologically mediated processes leading to the uptake of metals by the entire spectrum of biological systems may affect nutrient cycling rates in the water-mud-wetland system and the residence time within the variolus biological and physical resource sinks (Eisenreich et al. 1980). The patterns seen here may result from both physical and biologically mediated processes which act independently. The sediment-metal reaction kinetics may be such that movement of metals from soluble aqueous forms in association with particulates differs from those for PCBs.

The issue of whether there is net import or export of inorganic nutrients by salt marshes remains unresolved. Valiela, Teal and Sass (1974) found that salt marshes can act as nutrient sinks when high-nutrient waters pass through them. The waters of the Acushnet River estuary are enriched with nitrogen and phosphorous. Since salt marsh sediments are usually high in organic matter and sulfides they are presumed to retain heavy metals. However, factors which tend to reduce metal retention such as increased redox and low sediment pH's are often overlooked. Fifty to one hundred percent of the Zn, Cu, Cd, and Hg entering wetlands may subsequently be lost from the system. Fe, Mn, and Pb are retained to a higher degree. Their losses range from 0-50% (Kelly, Harwell and Giblin 1982). The retention of metals may decrease under higher loading rates as the sorptive abilities of the sediments become saturated. In addition, there is an interaction between nutrient levels and heavy metal retention. Under eutrophic conditions wetland sediments are more oxidized due to increased vegetative growth. The increased oxidation decreases sulfides in the sediment and increases the solubility of metals in the pore water (Kelly, Harwell and Giblin 1982). This estuary is somewhat eutrophied and has been exposed to high concentrations of metals for a number of years, therefore, it is likely that metal retention by these salt marshes is poor. Although PCBs are relatively stable with long half lives in the natural environment, there is some evidence to indicate that transformation of PCBs is promoted under anaerobic conditions (EPA 1983). However, transformation of PCBs may lead first to more toxic compounds (polychlorinated dibenzofurans) prior to degradation to innocuous chemicals.

Administrative Biological considerations

There are no visual signs of heavy metal or PCB toxicity in the floral community. PCBs in the marsh sediments were not readily taken up by wetland vegetation. The metals (Cr, Cu, Pb, & Zn) did accumulate in the salt marsh vegetation. Kelly, Harwell and Giblin (1982) found several times higher concentrations of Hg, Pb, Zn, Cu, Cd, and Cr in salt marsh vegetation growing in contaminated marshes compared to vegetation from nearby control areas. These contaminated salt marshes had no reduction in yield. Metals released from marsh sediments can enrich metal levels in salt marsh grass litter, an integral part of the detrital food web within salt marshes. *U. lactuca* and other algae found within the Acushnet River estuary also accumulate metals (U.S. EPA 1981). The most northern marsh (Site 3) had no sign of *G. demissa*, few *I. obsoleta* on adjacent tidal flats and no *U. pugnax*. *U. pugnax* populations are known to decline when exposed to polychlorinated hydrocarbons (Krebs et al. 1974). The macrobenthic population in the estuarine bottom sediment at the northern most end of the estuary was dominated by the opportunistic "pollution indicator," *Streblospio benedicti*. It is not known what factor(s) are regulating the distribution of these organisms within the estuary.

It may be a combination of stresses including possible exposure to low salinity water, nutrient enrichment, and sublethal, toxic or terratogenic effects of heavy metals or PCBs that has excluded/ eliminated certain organisms from the northern most reaches of wetland. Some organisms, such as birds do not show any decreased diversity or numbers at the estuary when compared to a "reference" site (for PCBs only) on Buzzards Bay. However, these birds are feeding on contaminated organisms within the estuary and accumulating PCBs. PCBs degrade Vitamin D and estrogen in birds which results in eggshell-thinning and reproductive failure (Weaver 1982). To ascertain whether animal populations are in decline due to the presence of contaminants or other biotic or abiotic factors within the estuary, transplant experiments and experiments which expose organisms to known quantities of existing contaminants need to be performed. The administratively important species are presented in Table 12.

Using the definitions of the Council on Environmental Quality (40 CFR 1508.20), wetland mitigation includes: avoiding adverse impacts by not taking a certain action; minimizing impacts by limiting the magnitude of action; rectifying the impact by repairing, rehabilitating, or restoring the affected wetland; reducing or eliminating the impact by preservation and maintenance operations; and compensating for losses by replacing or providing substitute resources or wetlands. The heavy metal and PCB contamination has done some harm to the wetlands in the study area; the actions to clean up these pollutants should not do more harm. The most contaminated portions of the wetlands are generally those where accretion continues to occur. The elevated levels in these sediments appears to be reflected in detritivores, which ingest the sediments and detrital matter. Similar trends are indicated for consumers of the detritivores. Biomagnification of PCBs may be occurring in the food chains invesitigated. These same studies suggest a trend of decreased levels away from the source of contaminants.

Despite very high levels of contaminants as well as evidence of bioaccumulation, these wetlands are functioning as effective systems and they have high resource values. These wetlands continue to support and produce biota representative of New England estuaries. Plant biomass and vegetative structure, benthic and fish community compostion and structure, and avian and mammal do not demonstrate PCB and heavy metal contamination effects. Most data for PCBs found in the literature are from tissue level studies. Without correlation with source of exposure concentrations, various physiological parameter studies and low solubility acutelly toxic static tests may result in erroneous interpurations. Natural environment impact evaluation is very complicated, because of several mixtures of PCBs were manufacatured and over 200 different chlorobiphenyls may have been produced. Each of these PCB components is different in its physical, chemical , and biological properties. The environment subjected to each component may be modified by, but may in turn also modify it. Therefore, more field ecological assessment studies are needed to accurately document changes in wetlands due to contamination.

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APPENDIX

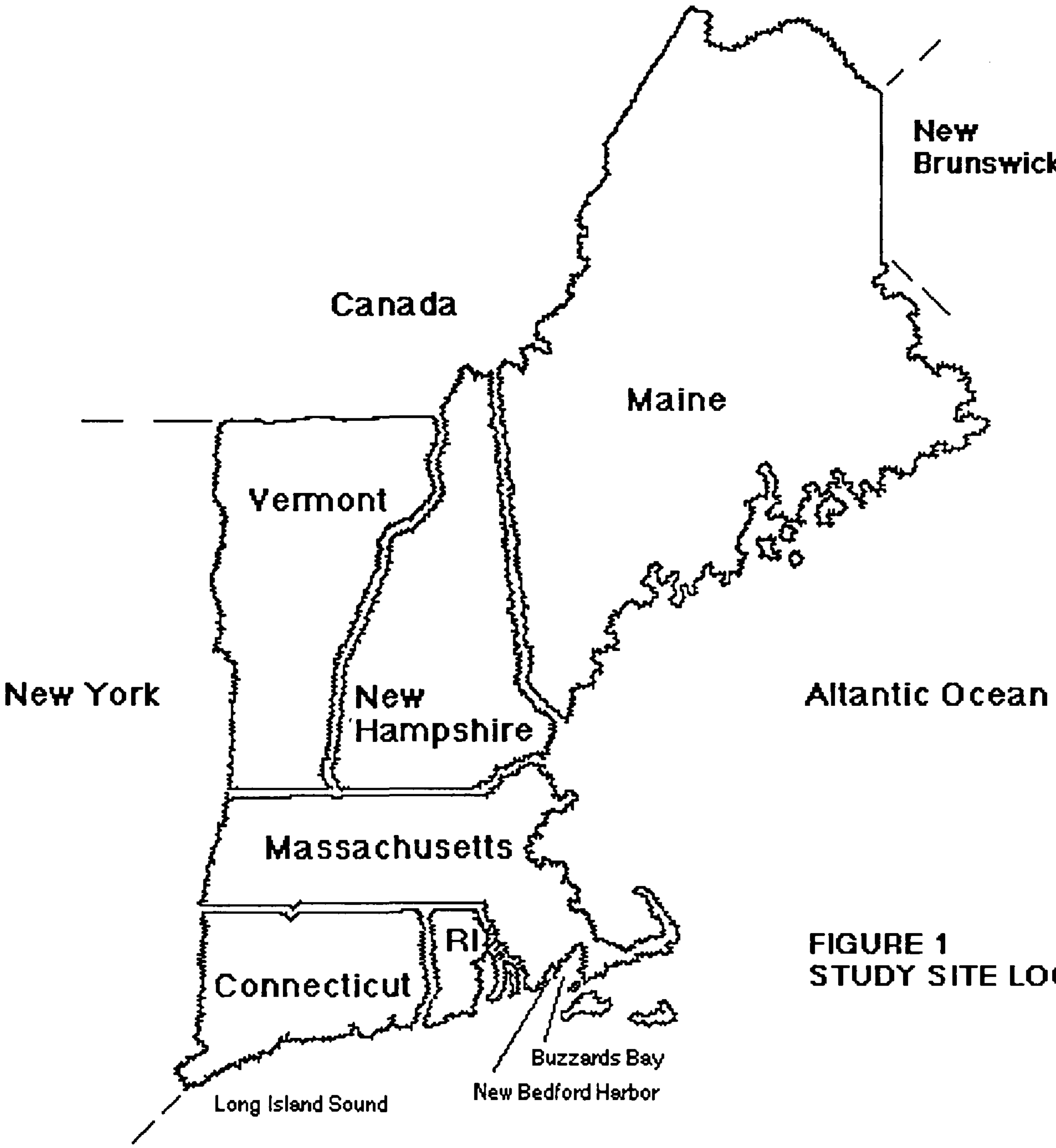

FIGURE 1
STUDY SITE LOCATION

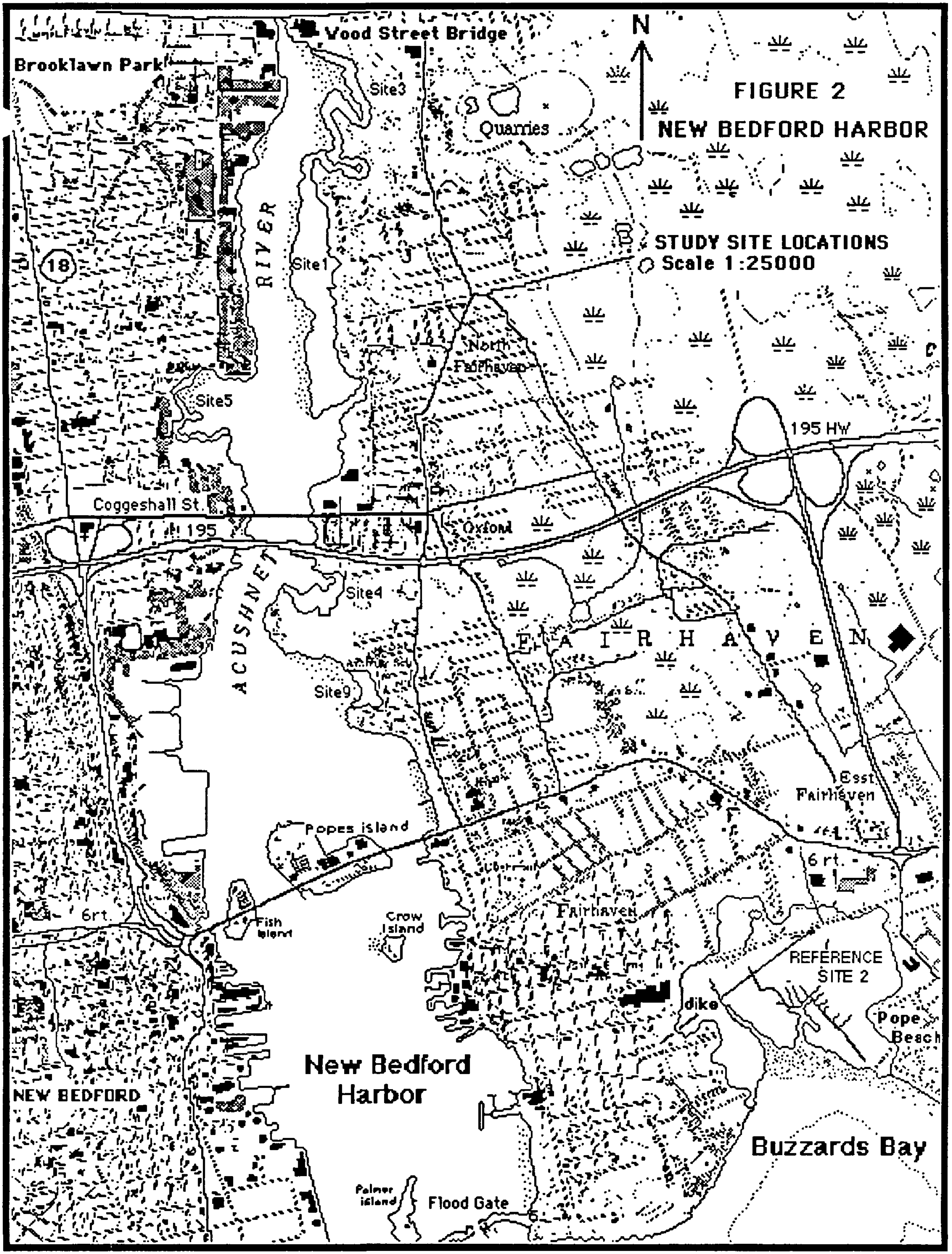
FIGURE 2
NEW BEDFORD HARBOR
STUDY SITE LOCATIONS
Scale 1:25000
N
Wood Street Bridge
Brooklawn Park
Site3
Quarries
Site1
RIVER
18
North Fairhaven
Site5
195 HW
Coggeshall St.
I 195
Oxford
ACUSHNET
Site4
FAIRHAVEN
Site9
East Fairhaven
Popes island
6 rt.
6rt.
Fish Island
Crow Island
Fairhaven
REFERENCE SITE 2
dike
Pope Beach
New Bedford Harbor
NEW BEDFORD
Buzzards Bay
Palmer island
Flood Gate

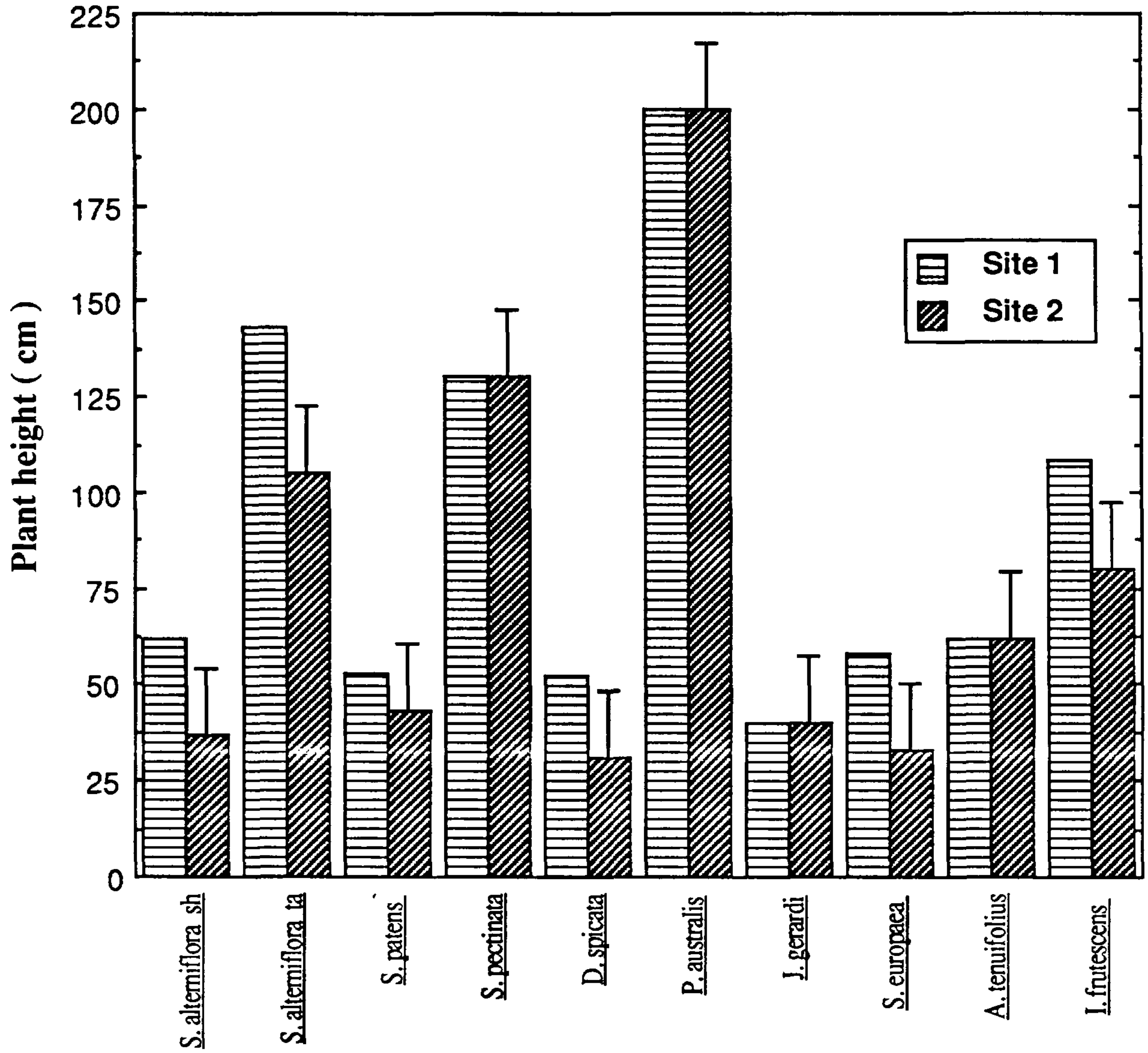

FIGURE 3 Selective Vegetation Heights for Sites 1 and 2

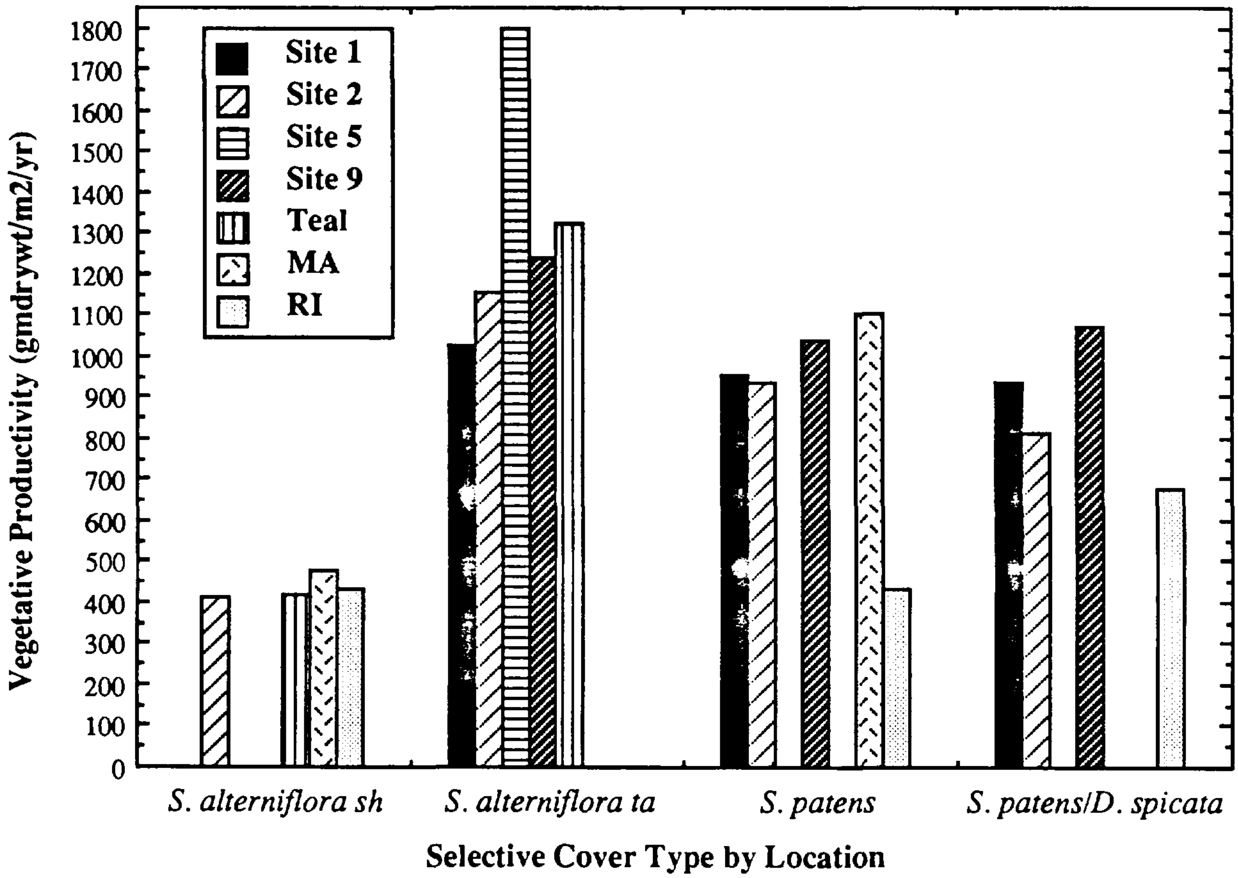

FIGURE 4 Productivity Comparisons Between Locations

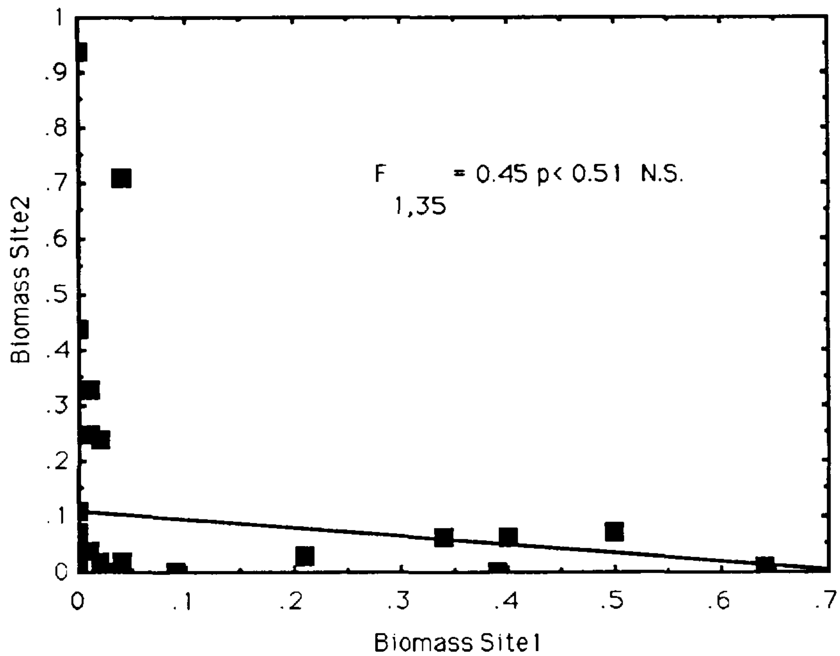

FIGURE 5 Biomass Analyses Sites 1 and 2

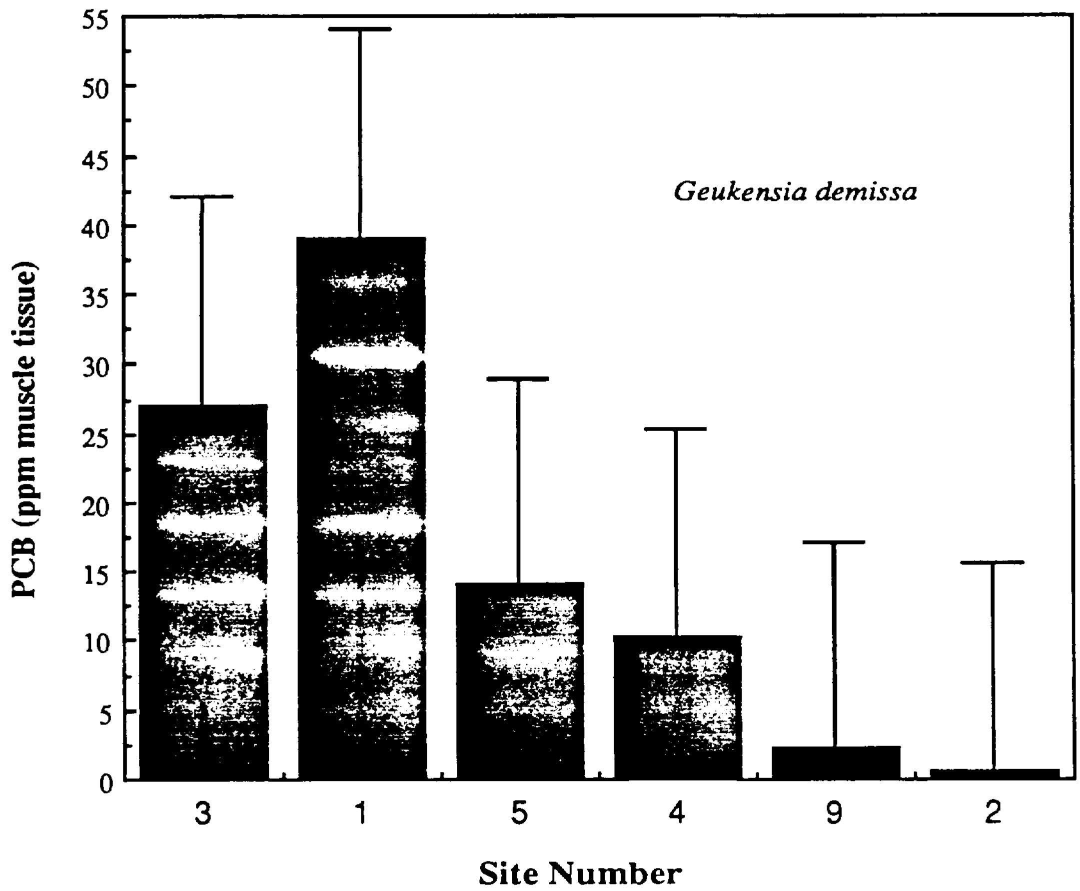

FIGURE 6 *Geukensia demissa* Tissue Levels of PCB for all Sites

TABLE 1 Sediment Characteristics

Pollutant	3	sd	1	sd	2	sd	5	sd	4	sd	9	sd
Cadmium	0		0		0		7.3	12.7	0.3	0.69	0.3	0.81
Chromium	44.6	35.19	53.7	62.6	58.4	58.0	188.0	247.6	86.8	70.91	188.0	247.6
Copper	186.9	122.96	186.9	189.17	335.1	482.02	364.9	407.6	195.3	145.5	275.0	185.77
Lead	202.9	93.21	131.8	127.37	172.1	160.62	275.0	185.77	135.3	111.96	375.3	367.26
Mercury	0	0	0		0		0.3	0.39	0.1	0.24	0.22	0.28
Zinc	354.7	434.83	145.9	168.5	229.0	262.1	1637.8	3501.4	131.0	79.48	172.6	139.31
PCB	225.9	256.1	135.9	456.49	2.0	1.29	94.0	156.44	72.9	111.88	20.3	19.38
Grain size	0.03	0.01	0.03	0.01	0.25	0.12	0.07	0.04	0.08	0.04	0.024	0.008

TABLE 2 Cover-type Hectares by Site Number

Covertypes	Site Number					
	1	2	3	4	5	9
Spartina alterniflora Shrt	0.2	2.6	0.1	-	-	-
Spartina alterniflora tall	2.8	0.8	0.9	0.4	1.0	-
S. alterniflora short / tall	-	1.9	-	-	-	-
Spartina patens	7.3	15.5	0.9	0.1	0.3	0.4
S. patens / Iva frutescens	-	-	0.2	-	-	-
Iva frutescens	4.8	0.4	0.2	-	0.1	0.1
Phragmites australis	0.1	6.3	0.9	3.2	0.1	0.1
Phragmites / S. patens	-	-	-	0.1	-	-
Shrub swamp (FW)	-	3.0	-	-	-	-
Wooded swamp (FW)	-	16.5	-	-	-	-
Wet Meadow (FW)	-	0.5	-	-	-	-
Mudflat	2.1	2.3	2.5	0.5	-	0.2
Total Hectares	17.3	49.8	5.7	4.3	1.5	0.8
# Covertypes	6	10	7	5	4	4

Note: FW freshwater wetlands.

TABLE 3 Occurrence, Distribution, and Species Characteristics[1] for Vegetation Site 1

	Percent Frequency of Occurrence	Relative Frequency Distribution	Mean Percent Cover	Mean Height (cm)	Mean Stem Density
Spartina patens	50.8	22.4	77.6 (6.2)	29.7 (3.1)	259.1 (39.3)
Distichlis spicata	49.2	21.7	54.4 (32.3)	31.5 (1.9)	72.8 (22.8)
Iva frutescens	28.6	12.6	64.4 (6.6)	87.8 (5.6)	28.6 (9.6)
Spartina alterniflora (shrt<1m)	19.0	8.4	74.5 (9.1)	73.4 (4.1)	33.4 (7.7)
Juncus gerardii	19.0	8.4	83.6 (8.0)	41.6 (4.0)	327.3 (72.5)
Spartina alterniflora (tall>1m)	14.3	6.3	89.4 (5.4)	133.1 (9.0)	27.5 (3.5)
Atriplex patula	12.7	5.6	5.0	47.0	5.0
Salicornia europaea	11.1	4.9	95.0	27.0	245.0
Suaeda linearis	4.8	2.1	5.0	17.0	1.0
Aster tenifolius	4.8	2.1	20.0	40.0	20.0
Spergularia marina	4.8	2.1	30.0	10.0	9.0
Elymus virginicus	1.6			0.7	
Solidago sempervirens	1.6	0.7	5.0	21.0	5.0

Note: Reported mean (standard error)
Total number of sample plots = 63
Percentage of plots in which species was found.
Measure of distribution, or chance of finding species in random selection.
Derived only from plots in which species occurred; measure of community characteristics.
Number of stems / 0.1m2.

TABLE 4 Occurrence, Distribution and Species Characteristics for Vegetation Site 2

	Percent Frequency of Occurrence	Relative Frequency Distribution	Mean Percent Cover	Mean Height (cm)	Mean Stem Density
Spartina patens	51.0	19.5	63.9 (7.1)	34.3 (1.5)	244.4 (33.2)
Distichlis spicata	49.0	18.8	53.1 (7.6)	34.8 (1.8)	59.5 (10.7)
Spartina alterniflora (shrt<1m)	43.1	16.5	79.5 (22.4)	43.2 (4.3)	91.4 (14.7)
Limonium nashii	23.5	9.0	17.1 (6.2)	30.4 (2.6)	40.0 (5.4)
Juncus gerardii	21.6	8.3	62.8 (10.8)	41.9 (3.4)	264.1 (80.0)
Salicornia europaea	5.7	6.0	5.0		9.0
Solidago sempervirens	9.8	3.8	7.5	40.0	
Spartina alterniflora (tall>1m)	7.8	3.0	80.0 (5.4)	105.5 (2.0)	30.0 (1.0)
Gerardia maritima	5.8	2.2	35.0	15.0	56.0
Iva frutescens	5.8	2.2	48.3 (13.6)	77.0 (4.4)	20.5 (7.7)
Ammophila breviligulata	3.9	1.5	52.5 (7.5)	50.0 (0.0)	45.5 (1.5)
Atriplex patula	3.9	1.5			
Elymus virginicus	3.9	1.5			
Triglochin maritima	3.9	1.5	10.0	57.0	
Suaeda maritima	2.0	0.8			
Convolvulus sp.	2.0	0.8	10.0		2.0
Plantago sp.	2.0	0.8	65.0	15.0	56.0

Note: Reported mean (standard error)
Total number of sample plots = 63
Percentage of plots in which species was found.
Measure of distribution, or chance of finding species in random selection.
Derived only from plots in which species occurred; measure of community characteristics.
Number of stems / 0.1m2.

TABLE 5 Mammals Utilizing Contaminated Sites (3,1,5,4,9)

Procyon lotor	Raccoon
Mephitis mephitis	Striped skunk
Vulpes fulva	Red Fox
Marmota monax	Woodchuck
Ondatra zibethica	Muskrat
Tamias striatus	Eastern Chipmunk
Sciurus carolinensis	Gray Squirrel
Peromyscus leucopus	White-footed Mouse
Microtus pennsylvanicus	Meadow Vole
Sylvilagus floridanus	Eastern Cottontail

TABLE 6 Dominant Fish Species Catch Comparisons

Species	Site 1	Site 3	Site 5	Site 9	Site 2
Menidia menidia	12800	389	1954	855	287
	378	208	52	316	654
	6078	2	65	718	318
	15				15
	1				0
	2				167
					55
					0
Fundus heterclitus	1070	137	4	6	0
	0	46	43	2	8
	33	47	160	6	0
	118				13
	189				1
	5329				0
					2
					34
F. majalis	48	1	0	17	1
	8	0	0	8	13
	1	0	6	3	0
	0				13
	1				1
	0				36
					5
					57
Alosa sapidissima	6	0	0	0	0
	0	29	3	1	0
	12	0	5	0	0
	1				1
	0				0
	1				1
					0
					0
Apeltes quadracus	5	0	0	0	0
	0	0	0	0	0
	69	0	0	0	0
	0				0
	0				0
	1				0
					0
					3

TABLE 7 Comparison of Avifauna Utilization of Sites 1 and 2

Survey	Site 1		Site 2	
	Species	Density	Species	Density
June / July 87 OW	16	13.0/40ha	24	12.8/40ha
June / July 87 SM	12	276.0/40ha	18	305.4/40ha
Spring 85 SM	13	12.2/40ha	15	12.9/40ha
June / July 87 M/UE	27	531.0/40ha	32	484.4/40ha
Spring 85 M/UE	28	281.4/40ha	26	211.6/40ha

Note: OW = open water
SM = salt marsh
M/UE = marsh upland edge

TABLE 8a Infaunal Species Numbers for Sites 1 and 2

	Site 1	Site2
Tidal Creeks (June)		
1	5.0	17.0
2	4.0	6.0
3	5.0	12.0
Mud Banks (June)		
1	8.0	16.0
2	7.0	11.0
3	11.0	16.0
Tidal Creeks (September)		
1	12.0	12.0
2	11.0	13.0
3	12.0	4.0
Mud Banks (September)		
1	16.0	32.0
2	16.0	17.0
3	11.0	7.0

TABLE 8b Infaunal Density for Sites 1 and 2 (numbers / m^2)

	Site 1	Site2
Tidal Creeks (June)		
1	19070.4	14796.0
2	40154.8	66617.1
3	15618.3	46606.9
Mud Banks (June)		
1	7809.0	8836.5
2	99914.0	8102.1
3	157207.7	49813.2
Tidal Creeks (September)		
1	42374.2	32551.5
2	43889.3	51621.3
3	153179.3	15289.6
Mud Banks (September)		
1	119313.1	251902.4
2	6521.9	76898.0
3	94570.3	14919.3

TABLE 9 PCB Tissue Levels from Different Food Chains

Biota	Muscle	sd	Fat	sd
Ring billed Gull	13.9	12.91	153.7	163.69
Geukensia demissa	39.1	24.06		
Amphipoda	46.0			
Gastropoda	5.6			
Peromyscus leucopus	22.3	22.95		
P. leucopus food	1.6	2.44		
Black duck	100.5	5042		
G. demissa	27.0	20.23		
Ulva lactuca	6.4	14.07		

Note: mean values; Amphipoda whole organism

TABLE 10 Metal Tissue Levels (mean and sd) (ppm)

Tissue	Cr	sd	Cu	sd	Pb	sd	Zn	sd
Ring billed gull muscle	2.23	0.72	5.48	0.651	1.59	1.396	41.2	26.046
Ring billed gull fat	2.9	1.1	2.933	0.603	1.767	0.987	100	36.056
Geukensia demissa meat	2.82	0.692	6.17	1.068	1.16	0.375	62.2	46.816
Amphipoda	2.8		36		1.3		140	
Gastropoda	2.5		25		9		630	
Peromyscus leucopus	2.975	0.525	7.275	1.367	2.55	1.136	57.25	24.473
P. leucopus food	2.7	0.7	6.233	2.597	2.667	1.71	39.667	25.17
Black Duck	0.2		5.7		0.9		10	
G. demissa meat	0.3	0.067	3.362	1.231	1.03	0.457	12.8	2.348
Ulva lactuca	3.418	1.007	17.909	7.727	12.791	5.061	52	28.125

TABLE 11 *Palemonetes pugio* Contaminant Tissue Levels (mean and sd)

Site	Cr		Cu		Pb		Zn		Fe		PCB	
3	0.35	0.30	40	1	0.82	0.08	20	0	41.3	2.08	25.33	6.80
1	0.97	0.13	44	2.64	0.89	0.02	20.33	0.57	72.33	1.15	7.63	1.35
5	0.81	0.01	36.33	0.88	1.16	0.05	20	0	76	2	3.6	0.17
4	0.16	0.28	35	1.15	0.22	0.38	15.33	0.57	50	1	2.4	0.44
9	0	0	38.66	1.20	0.62	0.01	17.33	0.57	43	2.64	1.66	0.41
2	0	0	33	1	0.85	0.35	20	1	41.33	4.16	0.35	0.11

TABLE 12 Species with Special Status

Administratively Important Species:

Fisheries:

- soft-shelled clam *Mya arenaria*
- hard shelled clam *Mercenaria mercanaria*
- American eel *Anguilla rostrata*
- winter flounder *Pseudopleuronectes americanus*
- summer flounder *Paralichthys dentatus*
- alewives *Alosa pseudoharengus*
- blue back herring *Alosa aestivalis*

Avifauna:

- American black duck, Mallard, Canvasback, Canada Goose
- Peregrine Falcon (Federal endangered species)
- Sharp-shinned Hawk (State species of special concern)
- Least tern (State species of special concern)

APPENDIX 8

Natural Heritage & Endangered Species Program
Massachusetts Division of Fisheries & Wildlife
Route 135, Westborough, MA 01581
telephone: 508-389-6360; fax: 508-389-7891
www.nhesp.org

COMMON TERN (*Sterna hirundo*)

State Status: **Special Concern**
Federal Status: None

B. Byrne, MDFW

The Common Tern is a small seabird that returns in the spring from warmer locales to enliven Massachusetts beaches with its raucous cries. It is a gregarious and charismatic creature, joining its neighbors to boldly mob, peck, and defecate on intruders to drive them away from their nests, which are situated on the ground. Probably numbering in the hundreds of thousands in the state before 1870, the Common Tern is considerably more scarce today. Protection, management, and restoration of nesting colonies have allowed populations to gradually increase, but the Common Tern remains a Species of Special Concern in Massachusetts.

Description. The Common Tern measures 31-35 cm in length and weighs 110-145 g. Breeding adults have light gray upperparts, paler gray underparts, a white rump, a black cap, orange legs and feet, and a black-tipped orange bill. The tail is deeply forked and mostly white, and does not extend past the tips of the folded wings. In non-breeding adults, the forehead, lores, and underparts become white, the bill becomes mostly or entirely black, legs turn a dark reddish-black, and a dark bar becomes evident on lesser wing coverts. Downy hatchlings are dark-spotted buff above and white below with a mostly pink bill and legs. Juveniles are variable: they have a pale forehead, dark brown crown and ear coverts, buff-tipped feathers on grayish upperparts resulting in a scaly appearance, white underparts, pinkish or orangish legs, and a dark bill. The voice has a sharp, "irritable" timber, and includes a *keeuri* advertising call and *kee-arrrr* alarm call.

Similar Species in Massachusetts. The Arctic Tern (*Sterna paradisaea*) is similar in size, but has a shorter, blood-red bill, very short red legs, much grayer underparts with contrasting white cheeks, a longer tail that extends past the tips of the folded wings, and a higher-pitched voice (although some calls are similar). The Roseate Tern (*Sterna dougallii*) is also similar in size, but has a mostly or entirely black bill during the breeding season, much paler gray upperparts, white or very pale pink underparts, a very long tail (longer than that of the Arctic Tern), and a distinctively different voice. The Least Tern (*Sterna antillarum*) is markedly smaller, with a yellow-orange bill, a white forehead, and a proportionately much shorter tail.

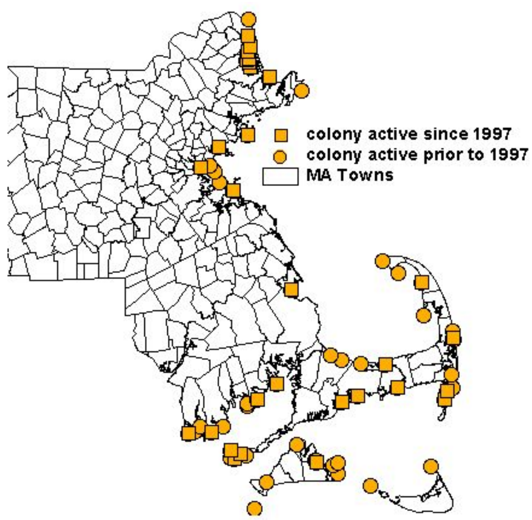

Figure 1. Distribution of present and historic Common Tern nesting colonies in Massachusetts.

Distribution and Migration. Outside the breeding season, the Common Tern is widely distributed primarily at temperate latitudes. It breeds in the northern hemisphere, principally in the temperate zones of Europe, Asia, and North America, and at scattered tropical and sub-tropical locations. In North America, it breeds along the Atlantic Coast from Labrador to South Carolina, and along lakes and rivers as far west as Montana and Alberta. Massachusetts birds arrive in April and May to nest at coastal locations statewide (Fig. 1). The largest populations occur on Cape Cod and in Buzzards Bay (see Status, below). Massachusetts birds depart from breeding colonies in July and August, and concentrate in "staging areas" around Cape Cod to feed before beginning their migratory journeys southward. Birds breeding on the Atlantic coast generally winter on the north and east coasts of South America as far south as northern Argentina.

Breeding and Foraging Habitat. In Massachusetts, the Common Tern generally nests on sandy or gravelly islands and barrier beaches, but also occurs on rocky or cobbly beaches and salt marshes. It prefers areas with scattered vegetation, which is used for cover by chicks. Along the Atlantic coast in the breeding area, it usually feeds within 1 km of shore, often in bays, tidal inlets, or between islands; it may forage as far as 20 km from the breeding colony.

Food Habits. The Common Tern feeds mainly on a wide variety of small fish; frequently it includes crustaceans and insects in its diet. The primary prey item in most Atlantic coast breeding colonies is the American sand lance. In Massachusetts, silversides, cunner, herring, pipefish, and hake are also important. Over water, it captures food by plunge-diving (diving from heights of 1-6 m and submerging to ≤ 50 cm), diving-to-surface, and contact-dipping; it catches flying insects on the wing. It often forages singly or in small groups, but it may congregate in feeding flocks of ≥ 1000 birds, especially over schools of predatory fish that drive smaller prey to the surface. It commonly feeds in association with Roseate and Arctic Terns, and sometimes gulls.

Breeding.

Phenology. Birds begin arriving in late-April or early-May. They select breeding sites and begin courting. Egg dates are 4 May – 15 August. Incubation lasts about 3 wk, and the nestling period about 3-4 wk. Most birds have departed for winter quarters by mid-October.

Colony. The Common Tern is gregarious, nesting in colonies of a few to thousands of pairs. It often breeds in colonies with Roseate and Arctic Terns, Black Skimmers (*Rynchops niger*) and, rarely, with the Least Tern. Pairs vigorously defend their nesting territory and sometimes also maintain a linear near-shore feeding territory. (See also Predation, below).

Pair bond and parental care. Courtship involves both aerial and ground displays, including High Flights (in which a pair spirals to 30-100 m above ground and then glides down), Low Flights (in which a fish-carrying male is chased by a female), Parading (circling on ground), and Scraping. Males feed females during courtship and early incubation. The Common Tern is socially monogamous, but sometimes seeks extra-pair copulations. While both parents incubate eggs and attend chicks, females do more incubating and brooding (especially at night), and males generally do more feeding. Birds of similar age tend to pair. Mate fidelity is high; data from Germany showed that two-thirds of pair bonds were retained from year-to-year; the rest were broken by death or divorce in approximately equal frequencies. Pair-bond durations of up to 14 years have been documented.

Nests. Nests are depressions or "scrapes" in the substrate, to which nesting material, usually dead vegetation or tide wrack, is added throughout incubation. Nest density is highly variable, but usually in the range of 0.06-0.5 nests/m^2.

Eggs. Eggs are cream, buff, or medium brown (sometimes greenish or olivish) with dark spots or streaks. Markings are often evenly distributed on the egg, but may be concentrated at the blunt end -- especially for the third egg of the clutch, which also may be paler than the first two. Eggs measure approximately 40 x 30 mm, and are subelliptical in shape. Clutch size is usually 2-3 eggs, occasionally 1 or 4. Incubation is sporadic until the clutch is complete. The period between laying and hatching is about 23 d for the first egg and about 22 d for the second and third eggs. Incubation shifts last anywhere from <1 min. to several hours.

Young. Chicks are semi-precocial. At hatching, they are downy and eyes are open. They are able to stand and take food within hours after hatching. They wander away from the nest to seek cover, but still remain in the territory, at 2-3 d. Chicks are brooded/attended most of the day and night for the first few days of life. Parental attendance drops off after that, except for cold, wet, or hot weather. Parents carry prey to chicks in their bills. Feeding rates vary by location, but are usually on the order of 1-2 feedings per chick per hour. Chicks fledge at 22 to > 29 d, but they remain at first within the colony and are still dependent on parents for food. After about a week, they venture out with parents to the feeding grounds, but are unable to catch fish for themselves until 3-4 wk post-fledging. Families leave the colony 10-20 d after chicks fledge and remain together during the staging period. Little is known of family cohesion during migration.

Predation.

Predators. In North America, predators of Common Tern eggs, young, and adults include a wide variety of birds and mammals, snakes, ants, and land crabs. Nocturnal mammals (especially fox, mink, and rat; sometimes skunk, raccoon, feral cat, weasel, and coyote) are the most important predators in mainland or near-shore colonies. Mammalian predation often causes birds to abandon the site. A local example of this is Plymouth Beach: in 1999, a family of foxes hunting on the beach displaced a thriving colony of about 5,000 pairs of mostly Common Terns. At islands further from the mainland, Great Horned Owl and Black-crowned Night-Heron are important predators. Herring and Great Black-backed Gulls, Short-eared Owl, American Crow, Ruddy Turnstone, Great Blue Heron, and Peregrine Falcon can also be significant predators.

Responses to predators and intruders. The Common Tern prefers to nest on islands lacking predatory mammals or reptiles. Eggs and chicks are cryptically colored. Hatched eggshells are removed from the nest site and feces are dispersed (the white of the feces and of the inner shell is obvious).

Behavioral response to diurnal predators is very variable, and depends on predator species and behavior, stage in nesting cycle, and degree of habituation to threat. Hunting Peregrine Falcons cause “panics”, during which terns rapidly flee the nesting area and fly over the water; Peregrines may delay colony occupation. Many other diurnal predators (including crows, Herring and Great Black-backed Gulls, Northern Harriers, and Bald Eagles) are “mobbed” (chased and attacked) by terns. Common Terns distinguish between hunting and non-hunting gulls and falcons, and respond to them differently. Common Terns attack human intruders by diving at them, pecking exposed body parts, and defecating on them. Inexperienced birds may merely circle overhead and give alarm calls, whereas more experienced birds may launch intense attacks -- to which many researchers will attest. Common Terns also distinguish between individual humans, and familiar humans are attacked more vigorously. Attacks intensify as chicks begin to hatch, but diminish as chicks mature and become less vulnerable. Adults’ alarm calls cause very young chicks (≤3 d) to crouch motionless, while older, more mobile chicks seek cover.

There is little information on how the Common Tern responds to nocturnal mammalian predators; however, nocturnal predation by owls and night-herons causes terns to abandon the colony at night. This has several consequences: prolonged incubation periods for eggs; chick deaths due to exposure; increased predation on eggs and chicks, particularly by night-herons and ants; and sometimes inattentiveness to eggs by day, which increases egg vulnerability to diurnal predators.

Life History Parameters. In Massachusetts, most Common Terns breed annually starting at 3 yr, some at 2 or 4 yr. As birds age, they nest progressively earlier in the season. Only one brood per season is raised, but birds renest 8-12 d after losing eggs or chicks. Productivity is highly variable, and may range from zero to > 2.5 chicks fledged per pair, depending on food availability, degree of flooding, and predation. Productivity increases with age through the lifetime of the bird. Survival from fledging to 4 yr was estimated at about 10% for Massachusetts birds. Annual survival of adults in Massachusetts was estimated about 90%. The oldest documented Common Terns are two individuals that bred at age 26 yr.

Status. The Common Tern is listed as a Species of Special Concern in Massachusetts. Populations are well below levels reported pre-1870, when hundreds of thousands are reported to have bred. Egging probably limited populations throughout the 1700s and 1800s. More seriously, hundreds of thousands were killed along the Atlantic coast by plume-hunters in the 1870s and 1880s, reducing the population to a few thousand at fewer than ten known sites by the 1890s. In Massachusetts, only 5,000 to 10,000 pairs survived, almost exclusively at Penikese and Muskeget Is. The state’s population grew to 30,000 pairs by 1920, following protection of the birds in the early part of the century. Populations subsequently declined through the 1970s, reaching a low of perhaps 7,000 pairs, largely as a result of displacement of terns from nesting colonies by Herring Gulls and, later, by Great Black-backed Gulls. Since then, numbers have edged upwards (Figure 2). In 2005, 15,447 pairs nested at 34 sites in the state. About 90% of these birds were concentrated at just three sites: Monomoy National Wildlife Refuge (S. Monomoy and Minimoy Is)., Chatham (9,747 pairs); Bird I., Marion (1,857 pairs); and Ram I., Mattapoisett (2,278 pairs). While populations in the state are relatively well-protected during the breeding season, trapping of birds for food on the wintering grounds may be a source of mortality for Common Terns.

Conservation and Management. Populations in Massachusetts continue to be threatened by predators and displacement by gulls. Also, should established nesting colonies be disrupted, lack of suitable (*i.e.*, predator-free) alternative nesting sites is a serious concern in the state. Most colonies are protected by posting of signs, by presence of wardens, and/or by exclusion of visitors. Lethal gull control (initially), continual gull harassment, and predator control at S. Monomoy and Ram Is. have resulted in thriving tern colonies at these restored sites (see Status, above). Two other tern restoration projects are currently underway, both involving clearing gulls from small portions of islands. At Penikese I., in Buzzards Bay, after a pilot project in 1995, aggressive discouragement of gulls (using harassment by trained dogs and human site occupation) was initiated in 1998. The colony increased from 137 pairs of Common Terns in 1998 to 756 pairs in 2006. Non-lethal gull control at Muskeget I., in Nantucket Sound, began in 2000; however, the budding tern colony is struggling against predators. Tern restoration is a long-term commitment that requires annual monitoring and management to track progress, identify threats, manage vegetation, prevent gulls from encroaching on colonies, and remove predators.

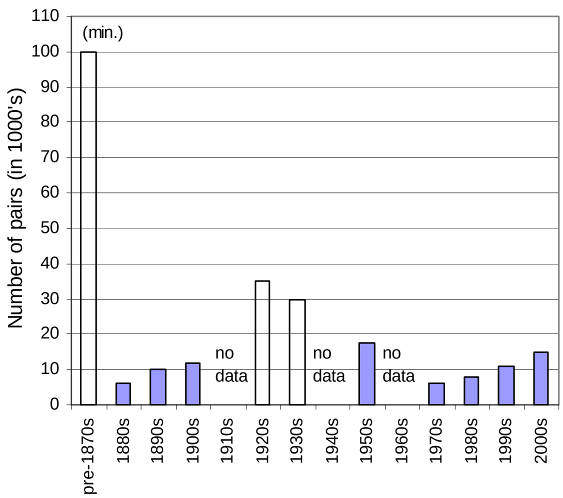

Figure 2. Common Tern population trends in Massachusetts, pre-1870s to 2005 (modified from Blodget and Melvin 1996).

References.

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Veit, R. R. and W. R. Petersen. 1993. Birds of Massachusetts. Massachusetts Audubon Society. Lincoln, MA.

C. S. Mostello, 2007

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Natural Heritage & Endangered Species Program
Massachusetts Division of Fisheries & Wildlife
Route 135, Westborough, MA 01581
telephone: 508-389-6360; fax: 508-389-7891
www.nhesp.org

ROSEATE TERN (*Sterna dougallii*)

State Status: **Endangered**
Federal Status: **Endangered**

B. Byrne, MDFW

The elegant Roseate Tern, with its long, white tail-streamers and rapid flight, alights on Massachusetts beaches in the spring. It tunnels under vegetation to nest within colonies of its more rough-and-tumble relative, the Common Tern, from which it derives protection from intruders. The Roseate Tern is a plunge-diver that feeds mainly on the sand lance, and availability of this fish may influence the timing of breeding. Depredations of plume hunters in the 19th century and displacement from breeding sites by gulls and increased predation in the 20th century contributed to a decline in numbers and loss of major breeding sites in the northeast. In a sense, the Roseate Tern is emblematic of the Commonwealth, because for the past century, about half the northeastern population has nested in Buzzards Bay and outer Cape Cod. The Roseate is now considered an Endangered Species. The population, which increased from the 1980s through 2000, is now in decline. Several projects are in progress to restore the Roseate to historical breeding locations in Massachusetts.

Description. The Roseate Tern measures 33-41 cm in length and weighs 95-130 g. Breeding adults have pale gray upperparts, white underparts (flushed with pale pink early in the breeding season), a black cap, orange legs and feet, and a black bill (which becomes more red at the base as the season progresses). The tail is mostly white, and is deeply forked with two very long outer streamers, which extend well past the tips of the folded wings. In non-breeding adults, the forehead becomes white and the crown becomes white marked with black, merging with a black patch that extends from the eyes back to the nape. The down of hatchlings is distinctive: it is grizzled buff/black or gray/black, and is spiky-looking because the down filaments are gathered at the tips. Juveniles are buff or gray above, barred with black chevrons, and have a mottled forehead and crown, black eye-to-nape patch, and black bill and legs. The Roseate's vocal array includes a high-pitched *chi-vik* advertising call, and musical *kliu* and raspy *aaach* alarm calls, the latter sometimes likened to the sound of tearing cloth.

Similar Species in Massachusetts. The Common Tern (*Sterna hirundo*) is similar in size, but has a black-tipped orange bill, darker gray upperparts, pale gray underparts, a shorter tail that does not extend beyond the folded wingtips, and an "irritable" voice. The Arctic Tern (*Sterna paradisaea*) is also similar in size, but has a shorter, blood-red bill, very short red legs, gray underparts with contrasting white cheeks, a shorter tail (which still extends past the folded wingtips), and a very different, high-pitched voice. The Least Tern (*Sterna antillarum*) is markedly smaller, with a yellow-orange bill, a white forehead, and a short tail.

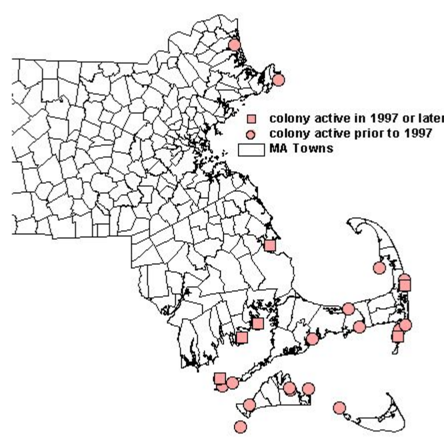

Figure 1. Distribution of present and historic Roseate Tern nesting colonies in Massachusetts.

Distribution and Migration. The Roseate Tern has a scattered breeding distribution primarily in the tropical and sub-tropical Atlantic, Indian, and Pacific Oceans. In North America, it breeds in two discrete populations: from Nova Scotia south to New York and in the Caribbean. The northeast population, at about 40-45° N, is among the most northernmost nesting groups of this mostly tropical species. Roseates arrive in Massachusetts from late-April to mid-May to nest at just a handful of coastal locations (Fig. 1). The largest colonies occur in Buzzards Bay (see Status, below). Massachusetts birds depart from breeding colonies in late-July and August and concentrate in "staging areas" around Cape Cod and the Islands, before departure for wintering grounds in September. Roseates appear to feed offshore and return to the staging areas to rest and roost. Most have departed staging areas and have begun migrating southward by mid- to late-September. The Roseate's wintering range remains poorly known, but increasing evidence indicates that Northeastern birds winter along the north and east coasts of South America southward along the coast of Brazil to approximately 18° S.

Breeding and Foraging Habitat. In Massachusetts, the Roseate Tern generally nests on sandy, gravelly, or rocky islands and, less commonly, in small numbers at the ends of long barrier beaches. Compared to the Common Tern, it selects nest sites with denser vegetation, such as seaside goldenrod and beach pea, which is also used for cover by chicks. Large boulders are used for cover at other locations in the northeast. It feeds in highly specialized situations over shallow sandbars, shoals, inlets or schools of predatory fish, which drive smaller prey to the surface. The Roseate is known to forage up to 30 km from the breeding colony.

Food Habits. The Roseate Tern feeds almost exclusively on small fish; occasionally it includes crustaceans in its diet. It is fairly specialized, consuming primarily sand lance (about 70% of diet in Massachusetts). Other prey species of importance in Massachusetts are herrings, bluefish, mackerel, silversides, and anchovies. In the northeast, it often forages with Common Terns. The Roseate captures food mainly by plunge-diving (diving from heights of 1-12 m and often submerging to ≥ 50 cm), but also by surface-dipping and contact-dipping. Some individuals specialize in stealing fish from Common Terns.

Breeding.

Phenology. Roseates usually begin to arrive in Massachusetts in late-April or the first week of May. Egg dates are 12 May to 18 August, and laying usually begins about 8 d later than that of Common Terns in the host colony. Incubation lasts about 3 wk, and the nestling period about 4 wk.

Colony. The Roseate Tern is gregarious. In the northeast it nests in colonies of a few to about 1,700 pairs, and the largest colony in Massachusetts numbers about 1,100 pairs (see Status, below). In this portion of its range, the Roseate invariably nests with the Common Tern, forming clusters or sub-colonies within larger Common Tern colonies. Pairs defend their nest site. (See also Predation below).

Pair-bond. Courtship involves both aerial and ground displays, including spectacular High Flights (in which ≥ 2 birds spiral up to 30-300 m above ground and then descend in a zig-zag glide), and Low Flights (in which a fish-carrying male is chased by up to 12 other birds). Males feed females before and during the egg-laying period. The Roseate Tern is socially monogamous, but extra-pair copulations occur. Both parents spend roughly equal amounts of time incubating, and incubation shifts last about 26 min. Males and females also contribute approximately equally to brooding and feeding chicks. The average length of pair bonds in Connecticut was 2.5 yr. The sex ratio in Massachusetts (and probably other northeast colonies) is skewed towards females (1.27 females:1 male). This results in multi-female associations (≥ 2 females), and often ≥ 3-egg clutches, at nests.

Nests. Nests (usually beneath vegetation or debris, or in special nest boxes) are depressions or "scrapes" in the substrate, to which nesting material may or may not be added throughout incubation. In the northeast, nests are usually 50-250 cm apart, depending on the distribution of vegetation and rocks.

Eggs. Eggs are various shades of brown with dark spots and streaks. The second egg may be paler than the first. Eggs measure approximately 43 x 30 mm, and are subelliptical in shape. The eggs are difficult to distinguish from those of the Common Tern, but Roseate eggs are generally longer, more conical, less rounded, darker, and more uniformly and finely spotted. Clutch size is usually 1-2 eggs; older females generally lay 2 eggs (laid about 3 d apart), and younger females, 1. Nests with ≥ 3 eggs are often attended by more than one female. Incubation, which begins after laying of the first egg, may be sporadic until the second egg is laid. The period between laying and hatching is about 23 d for both eggs.

Young. Chicks are semi-precocial. They are downy at hatching. Eyes open after a couple hours, and chicks are able to waddle and take food within hours after hatching. In 2-chick broods, there is often a substantial size difference between the young that persists throughout the growth period; this is because the first chick (*A*-chick) is usually 3 d older. Chicks are brooded/attended most of the day and night for the first few days of life. Parental attendance ceases after about a week, except for cold, rainy days. Parents carry prey to chicks in their bills one fish at a time. Feeding rates at sites in Massachusetts and Connecticut are about 1 fish/h. At sheltered nests, undisturbed chicks may remain at the nest site until they are nearly fledged. Where there is more disturbance, chicks may move more than 60 m away to new hiding spots. In 2-chick broods, the younger chick (*B*-chick) is less likely to survive than the *A*-chick. Most losses of *B*-chicks appear to be due to starvation. The peak of fledging is at 27-30 d. Four to 10 d after fledging, young birds accompany parents to fishing grounds. They begin to catch fish after 3 wk, but remain dependent on parents for food at least 6 wk, or until migration in September. This notably long period of dependence reflects the highly specialized fishing techniques that the young must master. At Bird I., MA, family units depart the nesting colony 5-15 d post-fledging to congregate at staging locations. When two chicks are raised, the male leaves first with the older chick and the female leaves up to 7 d later with the younger chick. Nothing is known of family cohesion during migration.

Predation.

Predators. In North America, predators of Roseate Tern eggs, young, and adults include birds and mammals, snakes, ants, and land crabs. In the northeast, the Great Horned Owl is the primary predator on adults, and predation on adults by the Peregrine Falcon has also been documented. Other significant avian predators (on eggs or chicks) include: Black-crowned Night-Heron, Herring and Great Black-backed Gulls, American Crow, and Red-winged Blackbird.

Responses to predators and intruders. The Roseate Tern prefers to nest on islands lacking mammalian predators. Eggs and chicks are cryptically colored and well-concealed under vegetation, debris, or rocks. Roseates are less aggressive birds than Common Terns, and rely on Commons for defense in the nesting colony. Attack rate peaks at hatching. Roseates dive at, and sometimes strike, various avian predators. Roseates circle above humans and dive at them, but do not make physical contact or defecate on them. Roseates in the Caribbean have been shown to respond more vigorously to familiar *versus* unfamiliar humans. As is the case for Common Terns, Roseates desert colonies at night when subject to nocturnal predation. This prolongs incubation periods for eggs, and exposes eggs and chicks to the elements and predation. Roseate nests and chicks, however, are better concealed, and thus less vulnerable, than those of Common Terns. Roseate adults, in contrast, are often disproportionately preyed upon in comparison to Common Terns from the same colony. Perhaps for this reason Roseates are quicker to abandon a site when predators are active.

Life History Parameters. In Massachusetts, most Roseate Terns breed annually starting at 3 yr, some at ≥ 4 yr. Only one brood per season is raised, but birds renest after losing eggs or chicks. Estimating productivity is challenging due to inaccessible nest sites and chicks' hiding behavior, but productivity usually exceeds 1 chick fledged per pair (range: 0-1.6 chicks fledged per pair); older birds are more productive than younger ones. Survival from fledging to first breeding was estimated at about 20% for Connecticut birds. Annual survival of adults in the northeast was estimated to be about 80%. The oldest Roseate Tern documented was 25.6 yr old; it was originally banded as a chick in Massachusetts.

Status. The northeastern population of the Roseate Tern is listed as Endangered federally and in Massachusetts principally because of its range contraction and secondarily because of its declining numbers. Prior to 1870, its status was somewhat obscure, but the Roseate was considered to be an abundant breeder within Common Tern colonies on Nantucket and Muskeget Is., MA. Prior to the 20th century, egging was a problem in northeast colonies, but it was persecution of terns for the plume industry that greatly reduced numbers in the northeast to perhaps 2,000 pairs, mostly at Muskeget and Penikese Is., MA, by the 1880s. Following protection, numbers rose to the 8,500 pair level in 1930. From the 1930s through the 1970s, Roseates were displaced from nesting colonies by Herring and Great Black-backed Gulls, and had declined to 2,500 pairs by 1979. Following two decades of fairly steady increase, the Northeast U.S. population peaked at 4,310 pairs in 2000. Since then, however, the population has declined rapidly to 3,320 pairs (Roseate Tern Recovery Team, unpubl. 2006 data). The cause of this has not been identified, but data suggest that it may be related to mortality on the wintering grounds. Approximately 85% of the population is dangerously concentrated at just 3 colonies: Great Gull Island, NY (1,227 pairs); Bird I., Marion, MA (1,111); and Ram I., Mattapoisett, MA (463). The only other nesting colonies in Massachusetts in 2006 were at Penikese I. (48 pairs) and Monomoy National Wildlife Refuge (NWR) (S. Monomoy and Minimoy Is)., Chatham (26 pairs).

Desertion of ≥ 30 major breeding sites over the past 80 years in most cases has been related to occupation of sites by gulls, and secondarily, to predation in the colonies (which may have intensified as terns were displaced by gulls to sites closer to the mainland). While populations in the state receive protection during the breeding season, the species is unprotected by South American governmental entities and while in international waters. Prior to the 1980s, persecution by humans (trapping for food) on the wintering grounds may have affected Roseates nesting in the northeast. Major wintering areas for this population have not been identified; this, along with investigation of current threats on the wintering grounds, is badly needed.

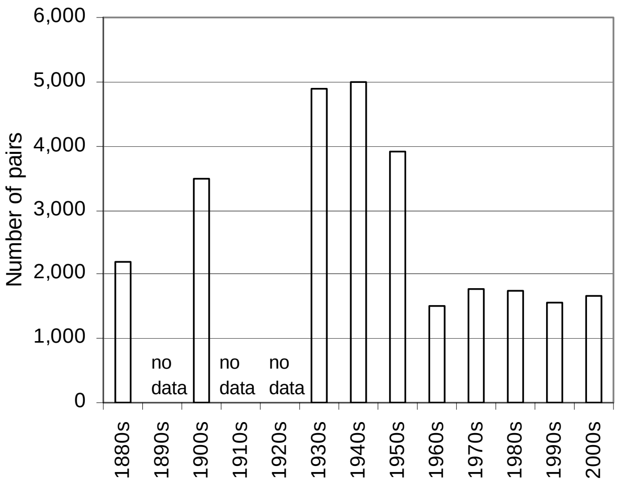

Figure 2. Roseate Tern population trends in Massachusetts, 1880s to 2006 (modified from Blodget and Melvin 1996).

Conservation and Management. Colonies are protected by posting of signs, by presence of wardens, and/or by exclusion of visitors. Wooden nest boxes and boards, partially buried tires, and other structures enhance the number of potential nest sites. Vegetation control is sometimes necessary when plant growth is dense enough to actually impede adults' ability to access nesting sites. The gradual loss of breeding sites in the Northeast, coupled with the Roseate's reluctance to colonize new sites, is a serious obstacle to recovery of the northeast population. The current overwhelming concentration of Roseates in Massachusetts in just two colonies in Buzzards Bay (Bird and Ram Is.), despite suitable conditions elsewhere, does not bode well for the population should one of these sites become unsuitable. Because of the regional importance of Massachusetts for Roseate recovery, several restoration projects have been initiated in the state. Restoring Common Terns to nesting sites is a necessary first step in restoring Roseates because of the Roseate's close association with the Common Tern at breeding colonies. Roseates were successfully restored to Ram I. after a gull control program in 1990-1991. A similar program at Monomoy NWR, begun in 1996, encouraged the expansion of a huge colony of Common Terns (9,747 pairs in 2005), but only a handful of Roseates nest there. Two other tern restoration projects -- at Penikese I., in Buzzards Bay, and at Muskeget I., in Nantucket Sound -- are currently underway, both involving aggressive discouragement of gulls from small portions of the islands; Roseates returned to Penikese in 2003, but numbers have fluctuated widely since then. Tern restoration is a long-term commitment that requires annual monitoring and management to track progress, identify threats, manage vegetation, prevent gulls from encroaching on colonies, and remove predators.

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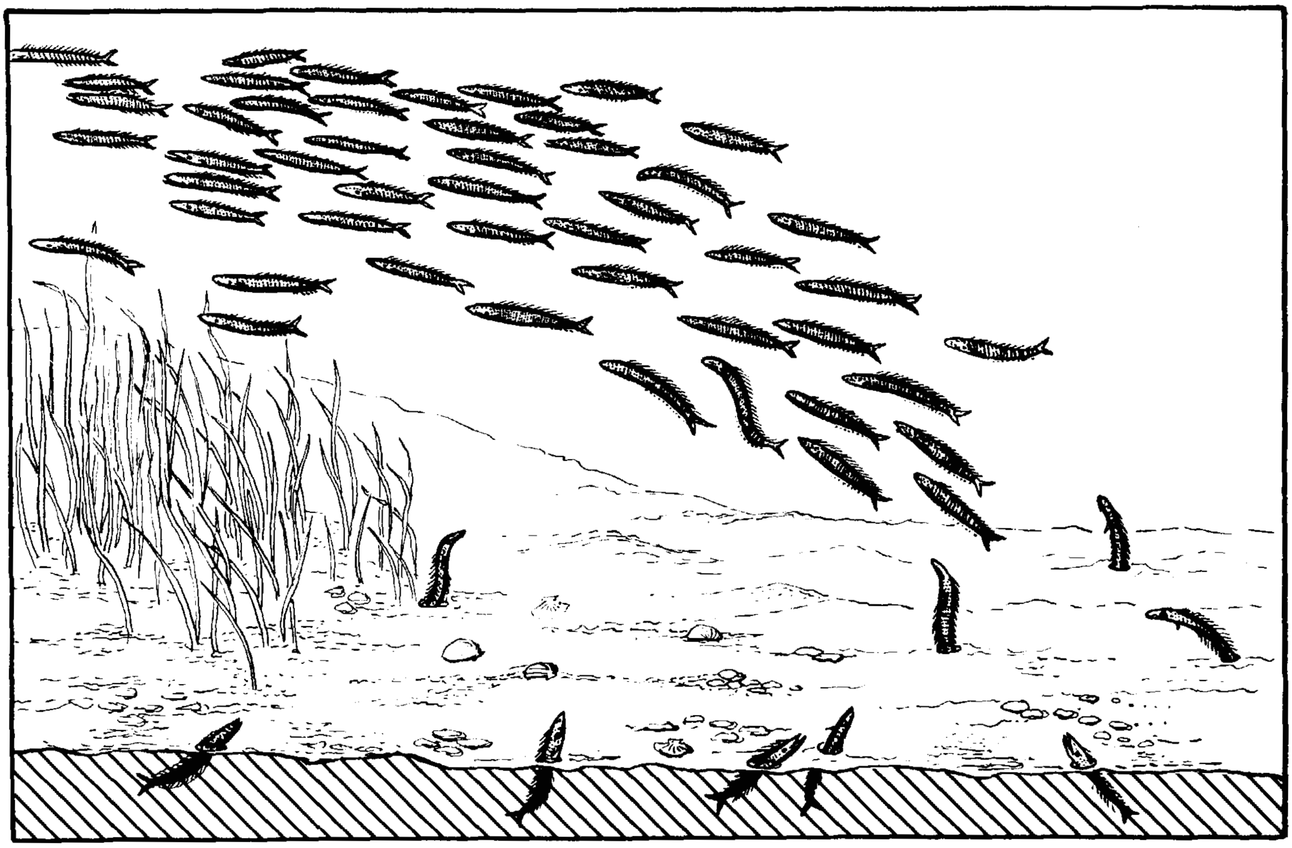
Biological Report 82 (11.66)
June 1986

TR EL-82-4

Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (North Atlantic)

SAND LANCE



Fish and Wildlife Service
U.S. Department of the Interior

Coastal Ecology Group
Waterways Experiment Station
U.S. Army Corps of Engineers

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Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (North Atlantic)

SAND LANCE

by

Peter J. Auster and Lance L. Stewart
NOAA's National Undersea Research Program
The University of Connecticut at Avery Point
Groton, CT 06340

Project Manager
Carroll Cordes
Project Officer
David Moran
National Coastal Ecosystems Team
U.S. Fish and Wildlife Service
1010 Gause Boulevard
Slidell, LA 70458

Performed for
Coastal Ecology Group
U.S. Army Corps of Engineers
Waterways Experiment Station
Vicksburg, MS 39180

and

National Coastal Ecosystems Team
Research and Development
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U.S. Department of the Interior
Washington, D.C. 20240

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This profile may be cited as follows:

Auster, P. J., and L. L. Stewart. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic)--sand lance. U.S. Fish Wildl. Serv. Biol. Rep. 82 (11.66). U.S. Army Corps of Engineers, TR EL-82-4. 11 pp.

PREFACE

This species profile is one of a series on coastal aquatic organisms, principally fish, of sport, commercial, or ecological importance. The profiles are designed to provide coastal managers, engineers, and biologists with a brief comprehensive sketch of the biological characteristics and environmental requirements of the species and to describe how populations of the species may be expected to react to environmental changes caused by coastal development. Each profile has sections on taxonomy, life history, ecological role, environmental requirements, and economic importance, if applicable. A three-ring binder is used for this series so that new profiles can be added as they are prepared. This project is jointly planned and financed by the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service.

Suggestions or questions regarding this report should be directed to one of the following addresses.

Information Transfer Specialist
National Coastal Ecosystems Team
U.S. Fish and Wildlife Service
NASA-Slidell Computer Complex
1010 Gause Boulevard
Slidell, LA 70458

or

U.S. Army Engineer Waterways Experiment Station
Attention: WESER-C
Post Office Box 631
Vicksburg, MS 39180

CONVERSION TABLE

Metric to U.S. Customary

Multiply	By	To Obtain
millimeters (mm)	0.03937	inches
centimeters (cm)	0.3937	inches
meters (m)	3.281	feet
kilometers (km)	0.6214	miles
square meters (m^2)	10.76	square feet
square kilometers (km^2)	0.3861	square miles
hectares (ha)	2.471	acres
liters (l)	0.2642	gallons
cubic meters (m^3)	35.31	cubic feet
cubic meters	0.0008110	acre-feet
milligrams (mg)	0.00003527	ounces
grams (g)	0.03527	ounces
kilograms (kg)	2.205	pounds
metric tons (t)	2205.0	pounds
metric tons	1.102	short tons
kilocalories (kcal)	3.968	British thermal units
Celsius degrees	1.8(°C) + 32	Fahrenheit degrees

U.S. Customary to Metric

Multiply	By	To Obtain
inches	25.40	millimeters
inches	2.54	centimeters
feet (ft)	0.3048	meters
fathoms	1.829	meters
miles (mi)	1.609	kilometers
nautical miles (nmi)	1.852	kilometers
square feet (ft^2)	0.0929	square meters
acres	0.4047	hectares
square miles (mi^2)	2.590	square kilometers
gallons (gal)	3.785	liters
cubic feet (ft^3)	0.02831	cubic meters
acre-feet	1233.0	cubic meters
ounces (oz)	28.35	grams
pounds (lb)	0.4536	kilograms
short tons (ton)	0.9072	metric tons
British thermal units (Btu)	0.2520	kilocalories
Fahrenheit degrees	0.5556(°F - 32)	Celsius degrees

CONTENTS

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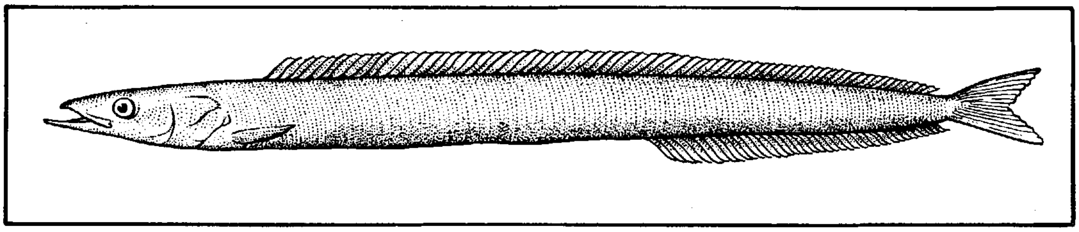

Figure 1. Sand lance.

SAND LANCE

NOMENCLATURE/TAXONOMY/RANGE

Scientific name.............. Ammodytes spp.
Preferred common name...........Sand lance (Figure 1)
Other common names......... Sand eel, sand launce, lant, lance, equille, northern sand lance (A. dubius), American sand lance (A. americanus)
Class.................... Osteichthyes
Order..................... Perciformes
Family.................... Ammodytidae

Geographic range: From northern Labrador and Hudson Bay south to Cape Hatteras (Bigelow and Schroeder 1953; Richards et al. 1963; Liem and Scott 1966) and from upper estuaries (Norcross et al. 1961) to the edge of the Continental Shelf (Richards and Kendall 1973)(Figure 2). This genus is most abundant, however, along the inner half of the Continental Shelf and is most commonly associated with sandy substrates (Bigelow and Schroeder 1953; Grosslein and Azarovitz 1982).

MORPHOLOGY/IDENTIFICATION AIDS

Meristic values of sand lance vary greatly with latitude as well as with distance from shore at the same latitude (Backus 1957; Richards et al. 1963; Winters 1970; Scott 1972; Pellegrini 1976). Richards et al. (1963) demonstrated various types of spatial changes in the genus Ammodytes from the northwest Atlantic and distinguished groups with high, intermediate, and low meristic counts. The intermediate group was split, and fish with high to intermediate counts were named A. dubius and those with low to intermediate counts were named A. hexapterus (= A. americanus). The range of meristic characteristics and overlap between species of this genus over a wide geographic area were significant (Table 1). As a result of this variation, sand lance in the North Atlantic area off the coast of the U.S. (Ammodytes spp.) will be covered as a combined group in this profile.

The body of the sand lance is small, elongate, and slender. Body depth is uniform from the opercular region to the beginning of the anal fin. Body depth then begins to taper towards the caudal peduncle. The tail is forked. The anal fin originates under the 29th or 30th dorsal fin ray. The lateral line is straight. The mouth is terminal with lower jaw projecting forward and no teeth (Liem and Scott 1966). Fin ray counts vary as in Table 1.

Color of individual fish is variable. The dorsal surface can be olive, brown, or bluish green. Lower sides are silver with a dull white ventral region. Some individuals have a steel-blue iridescent longitudinal stripe.

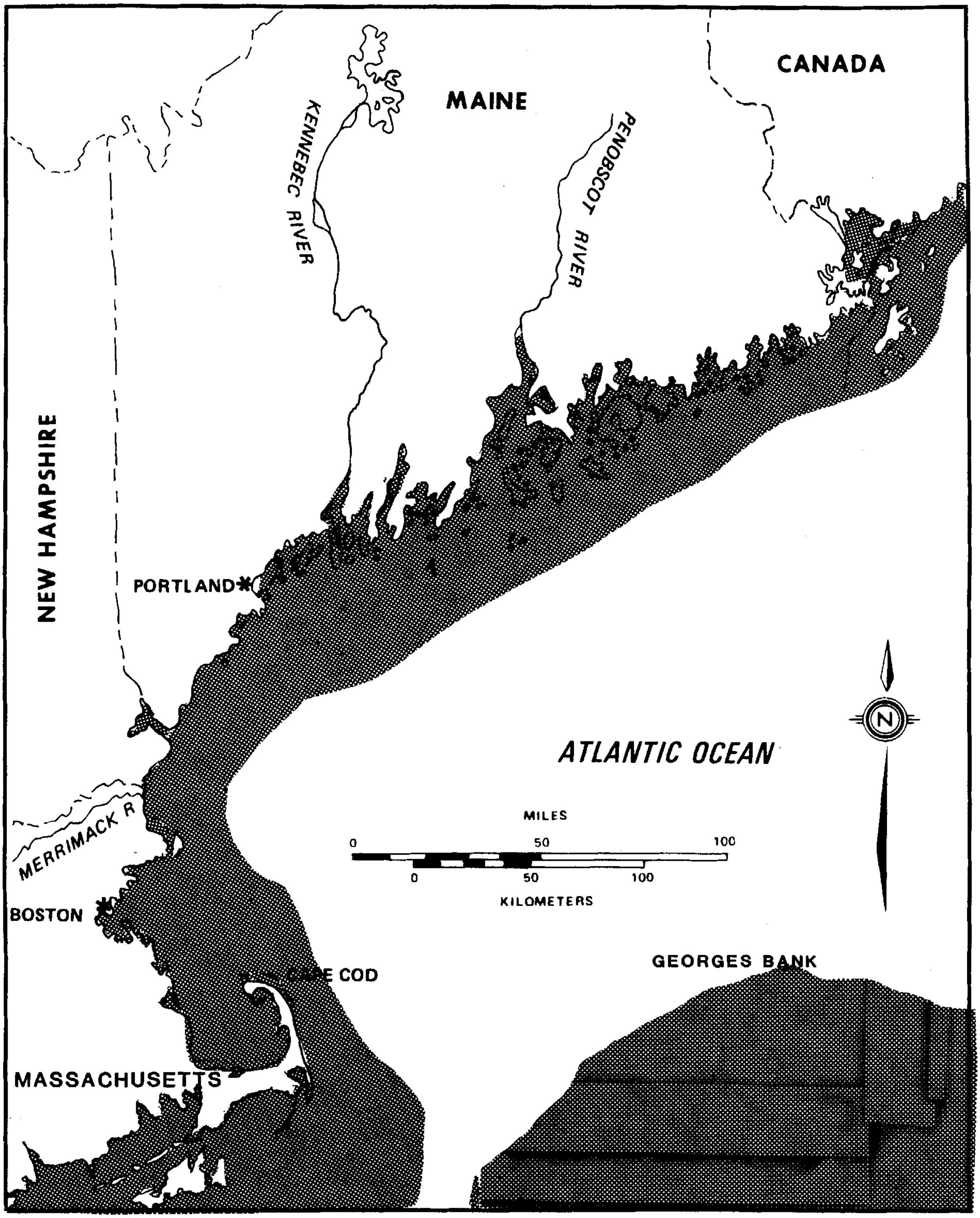

Figure 2. Distribution of sand lances along the North Atlantic coast.

Table 1. Meristic values of Northwest Atlantic species of *Ammodytes* (adapted from Pellegrini 1979).

Species	No. in sample	Vertebrae		Dorsal fin rays		Anal fin rays	
		Range	Mean	Range	Mean	Range	Mean
Ammodytes hexapterus (Richards et al. 1963) East coast of North America	1020	61-73		51-62		23-33	
A. hexapterus (Scott 1972) Newburyport, Massachusetts	73	64-71	68.1	55-61	57.6	27-32	29.4
A. americanus (Backus 1957) Labrador	12	62-69	67.2	56-60	58.5	28-31	29.6
A. americanus adults (Pellegrini 1976)	700	63-73	67.9	52-62	57.4	26-32	29.4
A. americanus juveniles (Pellegrini 1976)	610	64-73	68.0	53-62	57.8	27-33	29.7
A. dubius (Richards et al. 1963) East coast of North America	—	65-78		56-68		27-35	
A. dubius (Leim and Scott 1966) East coast of Canada	—	71-75		62-68		30-35	
A. hexapterus (Winters 1970) Offshore Newfoundland	—	70-78		60-69		30-37	
A. hexapterus (Winters 1970) Inshore Newfoundland	—	63-72		52-60		25-33	

Sand lance eggs, larvae, and postlarvae were described by Norcross et al. (1961), Williams et al. (1964), Richards (1965), and Smigielski et al. (1984), and can be distinguished from those of other species on the basis of morphology.

REASON FOR INCLUSION IN SERIES

Sand lance are widespread along the northeast coast of the U.S. (Sherman et al. 1981; Morse 1982). They are abundant and are an important prey species for many predatory fishes important to commercial and recreational fisheries and are also important prey for marine mammals. Sand lance occur in estuarine, open coastal, and offshore habitats. Contiguous overlapping populations provide linkages between these habitat types and coastal regions.

LIFE HISTORY

Spawning

Sand lance mature during their first or second year (Westin et al. 1979), and males reach maturity several months before females (Scott 1968). Spawning occurs principally from November to March (Bigelow and Schroeder 1953; Norcross et al. 1961). Larval fish survey data indicate that spawning occurs principally inshore although evidence exists of some offshore spawning activity (Richards and Kendall 1973; Sherman et al. 1981; Sherman et al. 1984). Sand lance lay demersal eggs that are deposited on or in sand substrates or on gravel surfaces (Ehrenbaum 1904; Williams et al. 1964). Sand lance larvae are distributed over a wide area of the shelf in winter (Sherman et al. 1984).

Fecundity and Eggs

Westin et al. (1979) showed that sand lance in the Merrimack River exhibited size specific fecundity. The model which describes this relationship is: $f = 0.328\ l^{3.857}$ where f is fecundity (number of eggs) and l is fork length (cm). Estimates of weight loss during spawning of females range from 30% to 45% (Scott 1972; Westin et al. 1979; Smigielski et al. 1984).

Sand lance eggs range in diameter from 0.67 to 1.03 mm and have a single bright yellow oil globule (Williams et al. 1964; Smigielski et al. 1984). Eggs hatch from November to May when water temperatures drop below 9 °C (Wheatland 1956; Norcross et al. 1961; Richards and Kendall 1973). Incubation times of eggs spawned in the laboratory ranged from 30 days at 10 °C to 82 days at 2 °C (Smigielski et al. 1984).

Larvae

Larvae are approximately 3 to 4 mm in length at hatching. After a planktonic stage of 2 to 3 months (Grosslein and Azarovitz 1982), during which they grow to about 35 mm (Scott 1973a), they become semidemersal. Larvae reared in captivity at 7 °C exhibited schooling behavior at a size of 35 to 40 mm 90 days after hatching, and first burrowed into the sand at 133 days after attaining a size of 35 to 40 mm (Smigielski et al. 1984).

Larvae are most abundant off the mouths of major estuaries but are common out to the edge of the Continental Shelf (Norcross et al. 1961; Richards and Kendall 1973). Major concentrations of larvae have consistently occurred in the Georges Bank and the Nantucket Shoals to Long Island, New York, regions since 1976 (Sherman et al. 1981; Morse 1982). Norcross et al. (1961) found that larvae increased in size in samples taken along nearshore to offshore transects, suggesting that the larvae may be able to undertake directed migrations away from the shore.

Richards (1976) reported the occurrence of heterotypic schools of sand lance and herring (*Clupea harengus harengus*) postlarvae. The ubiquity of this behavior is unknown. Heterotypic schooling has been reported in several diverse species groups (Nursall and Pinsent 1969; Ogden and Erlich 1977; Frank and Leggett 1983; Auster 1984). This behavior is believed to be an adaptive response to predation: increased school size reduces the probability of predation on any individual.

Sand lance larvae feed diurnally. Their diet consists of phytoplankton, invertebrate eggs, and copepod nauplii. As the fish increases in size, phytoplankton such as peridinians decrease in importance and copepod nauplii increase. When larvae become about 21 mm long, their diet consists mostly of adult copepods (Covill 1959).

Juveniles and Adults

Juvenile and adult sand lance have generally been found in schools during the day. Meyer et al. (1979) observed school sizes ranging from about 100 to tens of thousands of fish. We have observed schools of about 20 to 100 individuals along the coast. This observation is consistent with those reported for *Hyperoplos lanceolatus* and *A. tobianus* off Europe by Kuhlmann and Karst (1967), who observed school sizes of 30 to 300. In general, school size seems to be smaller in shoaler water, increasing as water depth increases. However, schools may occur at any depth in the water column (Meyer et al. 1979).

The shape of sand lance schools is generally compressed vertically and lengthwise. In shallow water, schools tend to be more compressed vertically and longer than in deeper water (Kuhlmann and Karst 1967; Meyer et al. 1979).

Sand lance are generally found over sandy substrates. Sand is used as a refuge. Individual fish have been observed to burrow into the sand and remain either partly buried (with either anterior or posterior body parts exposed) or totally buried after emerging headfirst and then backing up (Meyer et al. 1979). European sand lance species are reported to school diurnally and seek refuge in sand substrates at night. Schools reform at dawn (Kuhlmann and Karst 1967).

Copepods are the major prey of juvenile and adult sand lance (Reay 1970; Scott 1973b; Meyer et al. 1979). The inclusion of less important prey items such as crustacean larvae (Scott 1973b) and chaetognaths (Meyer et al. 1979) in the sand lance diet probably reflects the utilization of locally abundant prey.

GROWTH CHARACTERISTICS

Reay (1970) reported that 1- to 3-year-old fish dominate sand lance populations but individuals can live to 9 years of age and grow to a total length of 37 cm (Scott 1968). Comparison of length-at-age data suggests that growth rate increases from the New York Bight to the Nova Scotia banks (Grosslein and Azarovitz 1982).

Pellegrini (1976) found that sand lance from the Merrimack River, Massachusetts, had a weight-length relationship described by the model:

$$\log W\ (g) = -2.718 + 3.098\ \log L\ (mm)$$

This model agrees with weight-length relationships found by Scott (1972) for sand lance on the Newfoundland Grand Banks and Emerald Bank.

Growth is fastest during the first year of life and slows with increasing age. The Von Bertalanffy growth model for sand lance from the

Merrimack River, generated from the Ford-Walford relationship, is

$$l_t = 24.08 \quad (1-e^{-0.2508(t+0.5970)}).$$

This model includes both males and females because their growth rates did not differ significantly (Pellegrini 1976).

FISHERY

The use of sand lance in the U.S., limited to occasional use in the baitfish industry, has not been extensive. Annual landings between 1965 and 1973 ranged from 0 to 75 metric tons (Grosslein and Azarovitz 1982). Historically, Bigelow and Schroeder (1953) reported that more than 30 metric tons (67,800 pounds) were landed in 1919 and over 9 metric tons (20,000 pounds) in 1946, from traps in Massachusetts. National Marine Fisheries Service survey data indicate that the sand lance population in the northwest Atlantic increased greatly after 1974 (Grosslein et al. 1980; Sherman et al. 1981). No plans now exist for the management of sand lance in U.S. waters of the northwest Atlantic.

ECOLOGICAL ROLE

Sand lance are a major link between zooplankton production and fishes of commericial importance. They have been found in the stomachs of a wide variety of species, including Atlantic cod, *Gadus morhua*; haddock, *Melanogrammus aeglefinus*; silver hake, *Merluccius bilinearis*; white hake, *Urophycis tenuis*; yellowtail flounder, *Limanda ferruginea*; and longhorn sculpin, *Myoxocephalus octodecemspinosus* (Scott 1968, 1973b; Bowman et al. 1976; Bowman and Langton 1978). They are also important prey of whales and porpoises (Bigelow and Schroeder 1953; Overholtz and Nicolas 1979; Hain et al. 1982). The importance of sand lance as prey of cod increases from south to north (Grosslein and Azarovitz 1982).

Although no specific data exist on diséases of sand lance in the North Atlantic, other studies in the literature suggest that certain trends have been discerned in pollution-related diseases. Sand lance in coastal waters of northeastern United States are associated with surficial sediments through their burrowing behavior. In fishes other than sand lance, fin necrosis has been associated with high coliform counts in coastal waters (Mahoney et al. 1973) and with high concentrations of heavy metals in sediments (Carmody et al. 1973). The frequency of skin tumors in geographically separated populations of flatfishes has been correlated with environmental rather than with genetic factors (Stich et al. 1976). The relationships discerned in these studies may apply to sand lance populations as well.

ENVIRONMENTAL REQUIREMENTS

Temperature

Sand lance occur along the North American coast from 35°N to 69°N. Temperatures within this latitudinal range vary widely. During the time of egg development, bottom water temperatures can be near 0 °C (Richards et al. 1963; Richards and Kendall 1973). Scott (1968) reported that sand lance were taken from the Nova Scotia banks at temperatures ranging from -2 to 11 °C, but they were most abundant between 3 and 6 °C. No records of an upper temperature limit have been published. Reay (1970) reported that *A. tobianus* along the south coast of England is active at temperatures as high as 18 °C.

Salinity

Tolerance of fluctuations in salinity apparently decreases with increasing age. Sand lance larvae have been found in waters with salinities less than 1.8 ppt although only a small percentage were taken in samples at salinities less than 30 ppt (Norcross et al. 1961). Richards et al. (1963) reported that sand lance juveniles and adults occur in salinities ranging from 26 to 36 ppt.

Habitat

Sand lance occur throughout the water column over sandy substrates into which they burrow (Bigelow and Schroeder 1953; Reay 1970; Meyer et al. 1979). The sand lance burrows for rest and escape from predators; hence much time may be spent within the substrate, isolated from the water column. Relatively high bottom current velocities must therefore be present to maintain aeration of the interstitial water. The interaction of current velocity with substrate type in keeping interstitial water oxygenated is more critical in defining proper habitat than is the range of substrate particle sizes (Reay 1970).

Other Environmental Factors

European studies have reported on the light-mediated diel cycle of activity in other sand lance species. Direct underwater observations by Kuhlmann and Karst (1967) showed that sand lance (*H. lanceolatus* and *A. tobianus*) are diurnal schoolers, resting in the sand in groups at night. At dawn, schools re-form and begin feeding. In laboratory studies of *A. marinus*, swimming activity was high at light levels of 1000 and 100 lux but was greatly reduced at levels below 10 lux (Winslade 1974). In the same study, it was found that the threshold light intensity for swimming activity in the field was approximately 100 lux, and that buried sand lance may be able to detect light, via the pineal gland, to respond to changes in light intensity.

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P. J. Auster and L. L. Stewart

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National Undersea Research Program
University of Connecticut at Avery Point
Groton, CT 06340

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National Coastal Ecosystems Team
Fish and Wildlife Service
U.S. Department of the Interior
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U.S. Army Corps of Engineers
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P.O. Box 631
Vicksburg, MS 39180

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16. Abstract (Limit: 200 words)

Species profiles are literature summaries on taxonomy, morphology, range, life history, and environmental requirements of coastal finfishes and shellfishes. They are designed to assist in environmental impact assessment. The systematic classification of the sand lances *Ammodytes americanus* and *Ammodytes dubius* is confusing because of overlapping meristic values. In this report, all sand lances in the North Atlantic area off the coast of the United States are treated as a combined group (*Ammodytes* spp.). Sand lances occur in estuarine, open coast, and offshore habitats. They are important prey to many commercially and recreationally valuable fish and marine mammals. Spawning occurs principally inshore between November and March. Larvae are found along the coasts to the edge of the Continental Shelf. Sand lances occur in schools of from tens to tens of thousands of individuals. They are planktivorous predators; copepods are their major prey item. To rest and to take refuge from predators, sand lances burrow into sand substrates. One to three-year-old fish dominate populations. Growth rate probably increases from the New York Bight to the Nova Scotia banks. Exploitation of sand lances off the Northeast coast of the United States is presently only for baitfish.

17. Document Analysis a. Descriptors

Estuaries	Life cycles	Food chains
Marine fishes	Growth	Temperature
Salinity	Contaminants	Feeding habits

b. Identifiers/Open-Ended Terms
Sand lance
Ammodytes
Spawning

c. COSATI Field/Group

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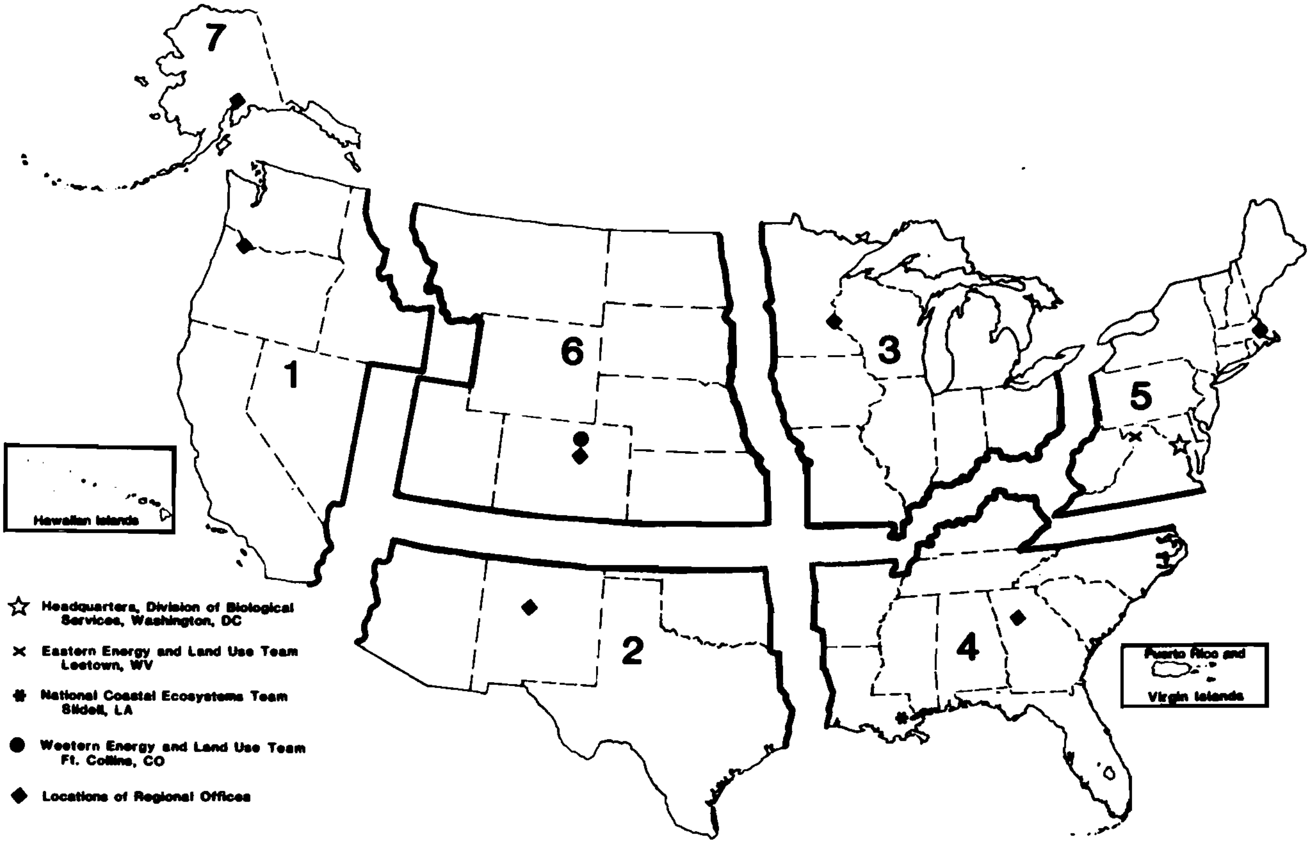

REGION 1
Regional Director
U.S. Fish and Wildlife Service
Lloyd Five Hundred Building, Suite 1692
500 N.E. Multnomah Street
Portland, Oregon 97232

REGION 2
Regional Director
U.S. Fish and Wildlife Service
P.O. Box 1306
Albuquerque, New Mexico 87103

REGION 3
Regional Director
U.S. Fish and Wildlife Service
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

REGION 4
Regional Director
U.S. Fish and Wildlife Service
Richard B. Russell Building
75 Spring Street, S.W.
Atlanta, Georgia 30303

REGION 5
Regional Director
U.S. Fish and Wildlife Service
One Gateway Center
Newton Corner, Massachusetts 02158

REGION 6
Regional Director
U.S. Fish and Wildlife Service
P.O. Box 25486
Denver Federal Center
Denver, Colorado 80225

REGION 7
Regional Director
U.S. Fish and Wildlife Service
1011 E. Tudor Road
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DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

APPENDIX 9

Commonwealth of Massachusetts

Division of Fisheries & Wildlife

Wayne F. MacCallum, *Director*

August 3, 2010

Chet H Myers, PE, LSP
Apex Companies, LLC
184 High Street, Suite 502
Boston, MA 02110

RE: South Terminal Extension
NHESP Tracking No. 10-28430

Dear Mr. Myers:

Thank you for contacting the Natural Heritage and Endangered Species Program ("NHESP") of the Massachusetts Division of Fisheries & Wildlife regarding state-listed rare species associated with the above referenced site. Based on the information provided, it appears that a portion of the project site is located within *Priority & Estimated Habitat* (PH 926/EH 755) as indicated in the *Massachusetts Natural Heritage Atlas* (13th Edition). Our database indicates that this area is mapped as foraging habitat for the Roseate Tern and Common Tern, state-listed as "Endangered" and "Special Concern," respectively. As acknowledged in your letter, the Roseate Tern is also Federally listed as "Endangered." These species are protected under the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) and its implementing regulations (321 CMR 10.00). State-listed wildlife are also protected under the state's Wetlands Protection Act (WPA) (M.G.L. c. 131, s. 40) and its implementing regulations (310 CMR 10.00). Fact sheets for most state-listed rare species can be found on our website (www.nhesp.org).

However, I understand that projects falling under the jurisdiction of the Comprehensive Environmental Response Compensation, and Liability Act (CERCLA) [42 u.s.c. sec. 9601 et seq. (1980)] are exempt from state review and permitting requirements although the EPA still applies the substantive standards of certain federal and state laws in its review of projects authorized under CERCLA. The NHESP cannot say with certainty whether this project would, or would not cause harm to foraging state and federally listed terns without seeing detailed project plans, but in your letter you requested preliminary comments from this office.

Based on a preliminary review of the information that has been provided and information that is currently contained in our database, it appears that the proposed dredging and terminal extension would only impact a small acreage of shallow-water feeding habitat for terns. Given the relatively small project footprint within mapped tern habitat, it does not appear that the project will result in any measurable harm to state-listed species, and our office would not require a "take" permit for the activity were the proposal to be in our permitting jurisdiction. However, an effort should be made to avoid the suspension of sediments and any potential sediment plume during dredging operations. Finally, given that this project will result in some unavoidable impacts to aquatic habitat, we encourage the project proponent to consider the implementation of a tern mitigation plan. For example, targeted tern foraging surveys and/or support for habitat management efforts would aid the conservation of state and federally listed terns in the Commonwealth. If you are interested in exploring mitigation options, please feel free to contact Carolyn Mostello, our Tern Project Leader, at (508) 389-6372.

This evaluation is based on the most recent information available in the Natural Heritage database, which is constantly being expanded and updated through ongoing research and inventory. If you have any questions regarding this letter please contact Emily Holt, Endangered Species Review Assistant, at (508) 389-6361.

Sincerely,

Thomas W. French

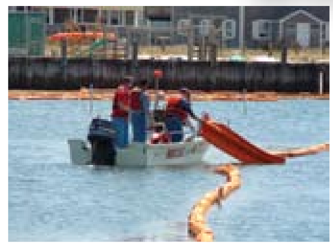
Thomas W. French, Ph.D.
Assistant Director

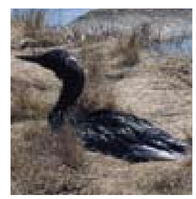
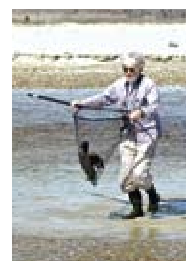
cc: Michael Amaral, USFWS

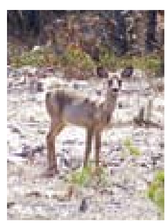
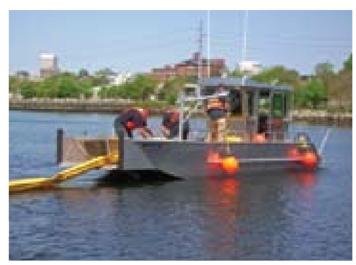
APPENDIX 10

Evaluation of Marine Oil Spill Threat to Massachusetts Coastal Communities

For the COMMONWEALTH of MASSACHUSETTS

Prepared for: Massachusetts Department of Environmental Protection

December 2009

July 2008

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]

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[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

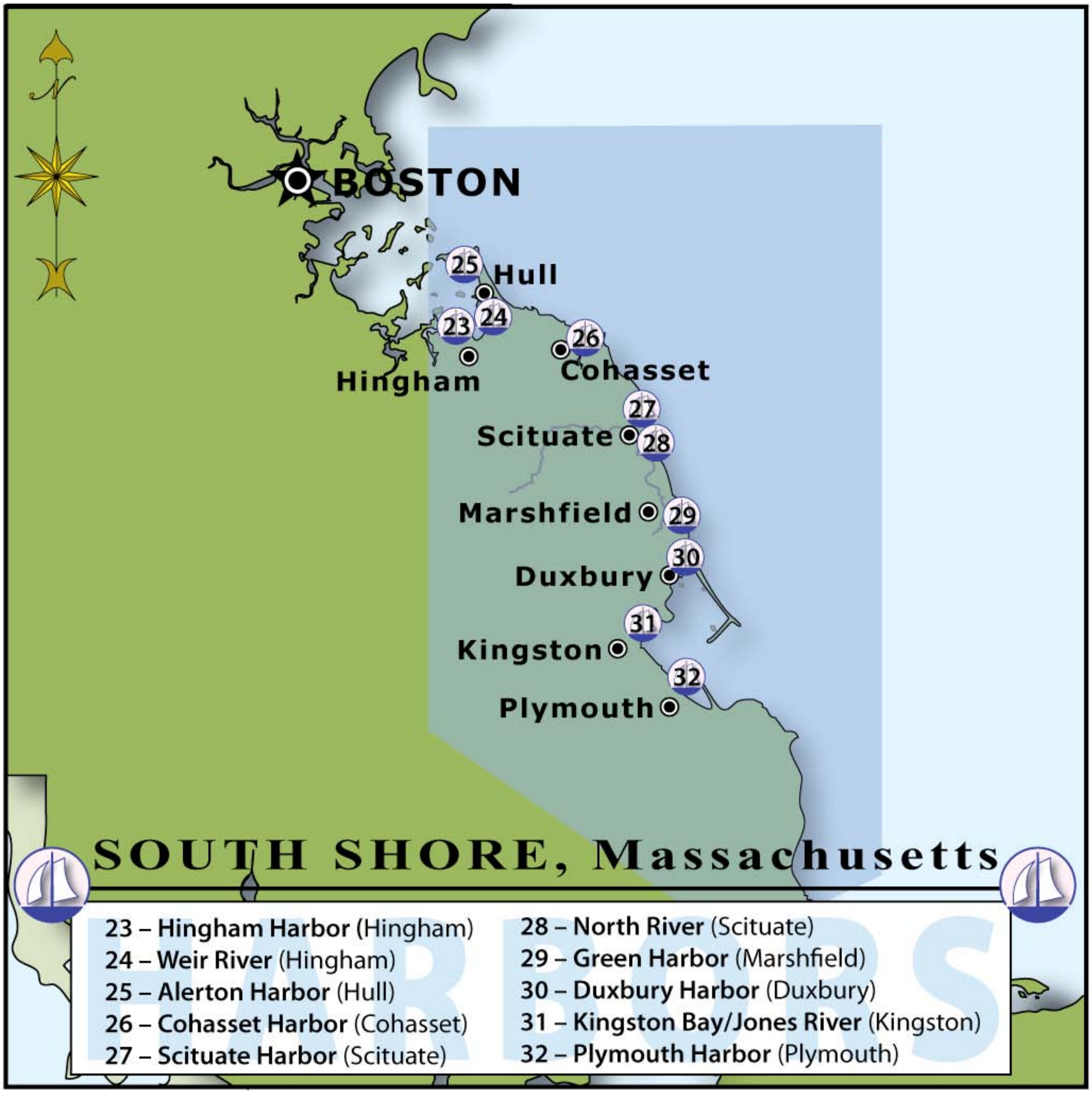


Figure 1.2.4 Harbors Located in the Cape and Islands Region

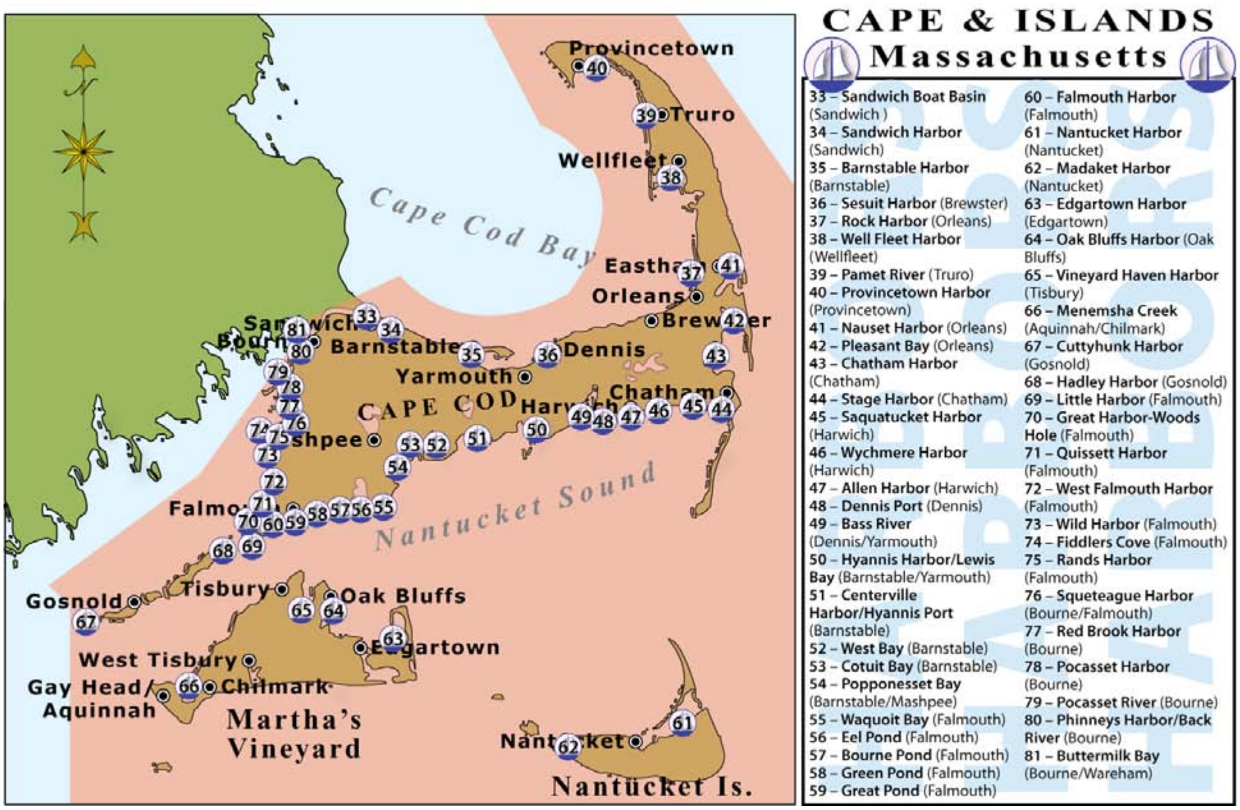
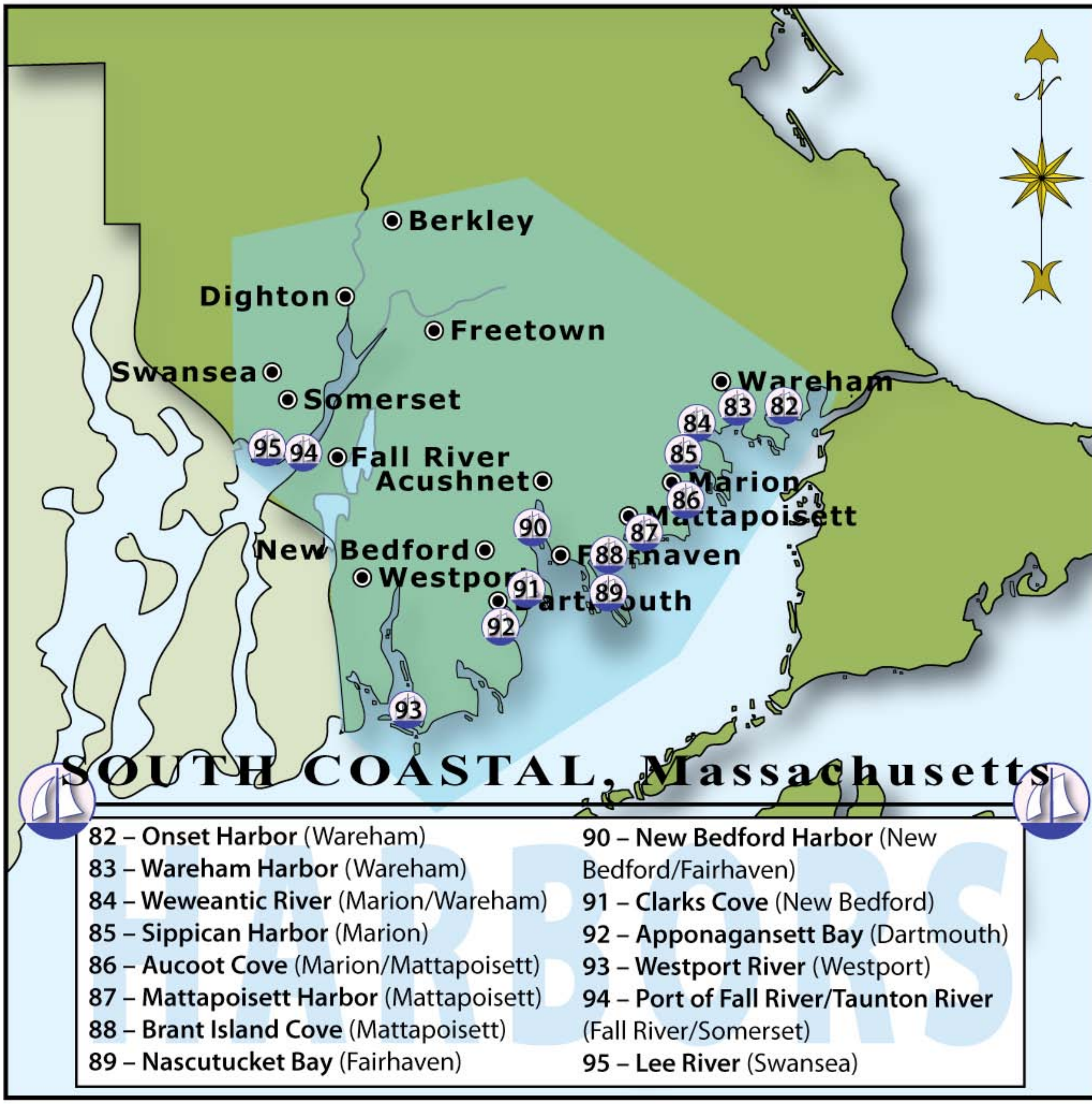


Figure 1.2.5 Harbors Located in the South Coastal Region



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

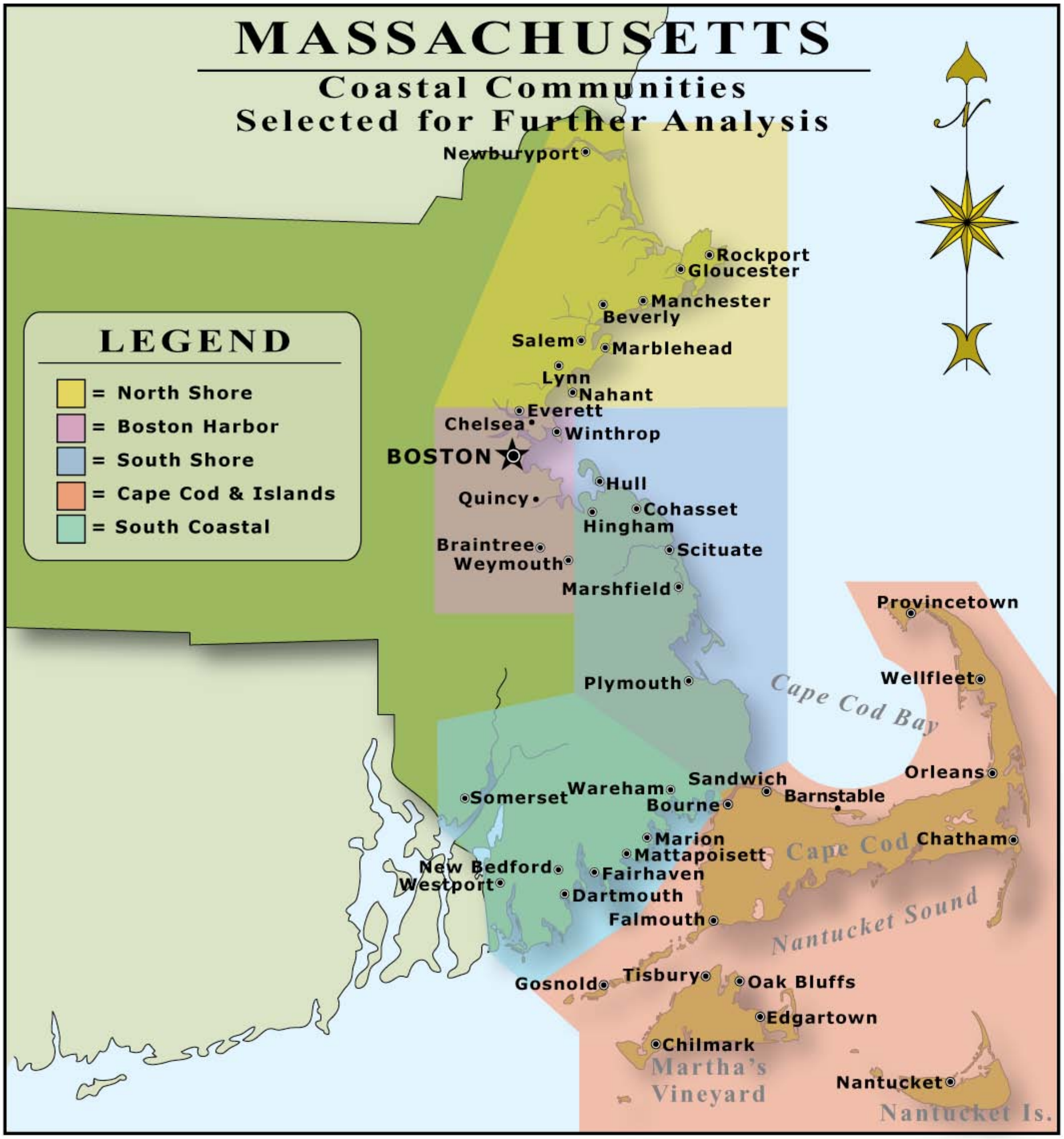
Municipality	Tank Vessel	NTV	Vessel Transit	Rec. and Charter	Fishing Vessels	Ferry	Other Large Vessel	Ship-yard	Reg. Tank
Boston/ Chelsea/ Everett	✓	✓	✓	✓	✓	✓	✓	✓	✓
New Bedford/ Fairhaven	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fall River/ Somerset	✓	✓	✓	✓	✓		✓	✓	✓
Sandwich	✓	✓	✓	✓	✓		✓		✓
Tisbury	✓	✓		✓	✓	✓	✓		✓
Gloucester	✓	✓		✓	✓		✓	✓	
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



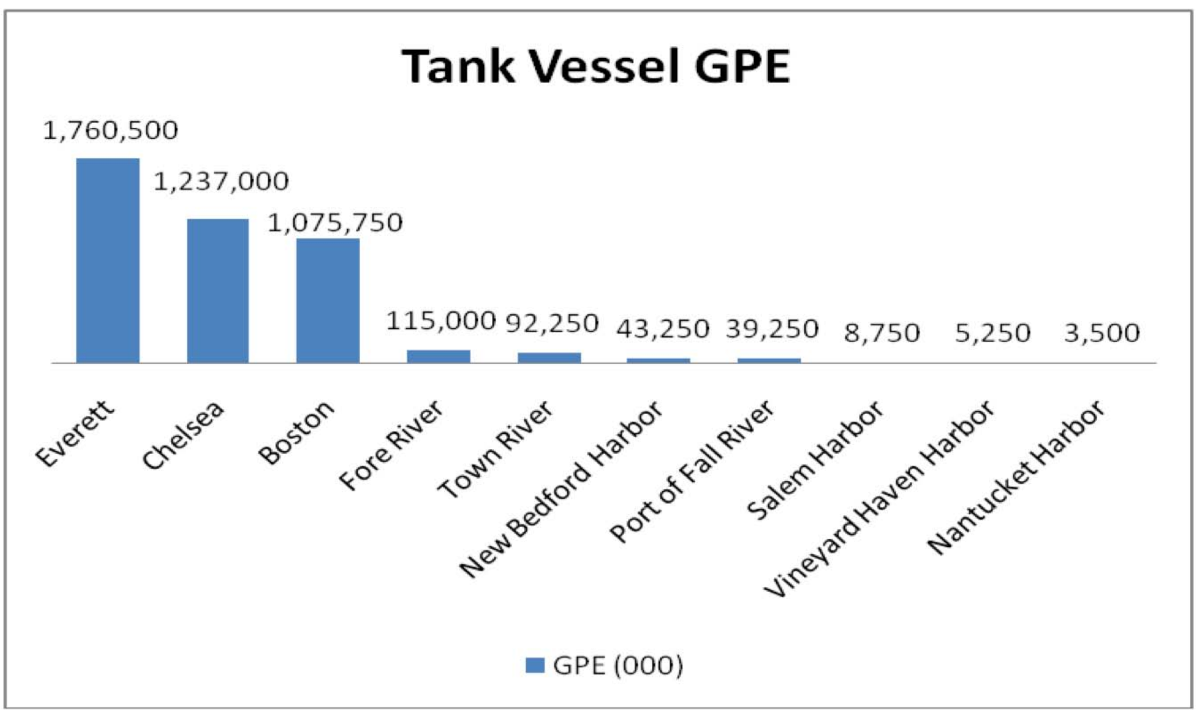
4.2.1 Oil Tanker or Tank Barge Activity in Ports and Harbors

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.

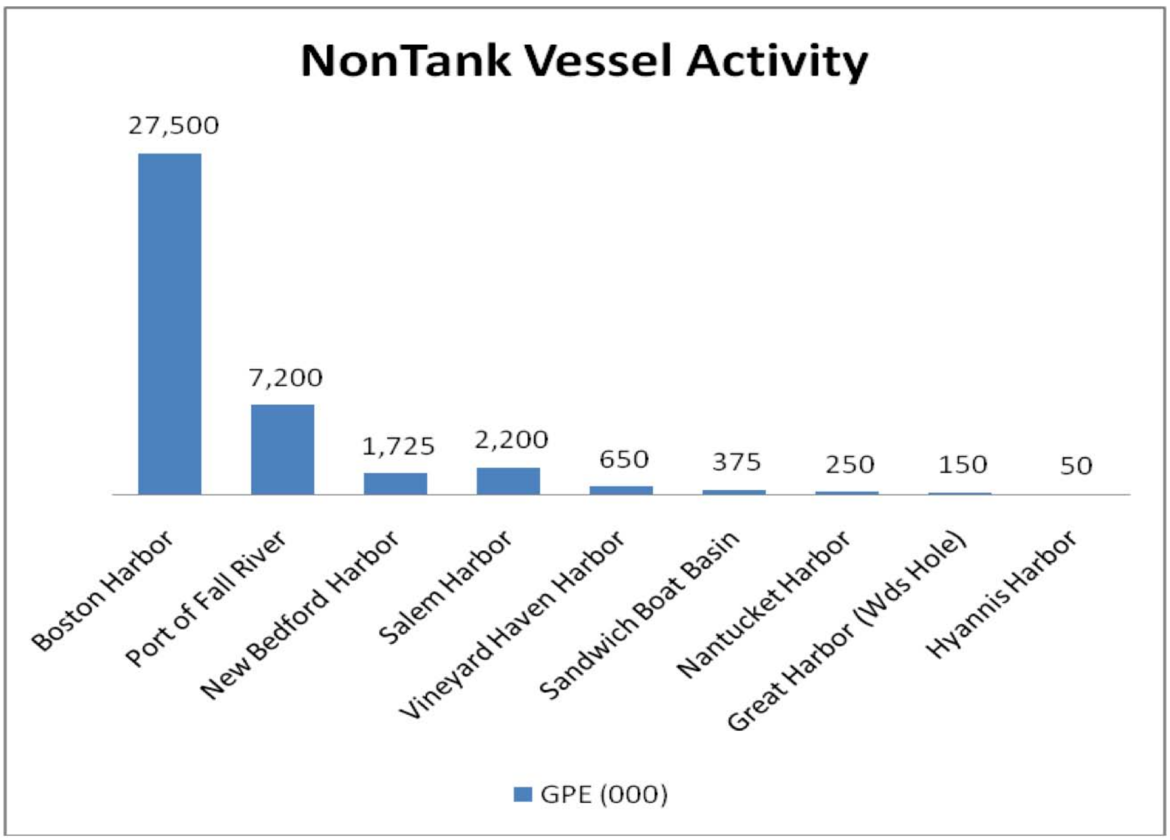
Finally, the data used in this analysis was taken from 2006 activity as presented in the ACOE and USCG reports. This one-year data set provides a snap shot of vessel activity but does not necessarily reflect trends or changes in traffic levels, which might be better captured in a multi-year data set. 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.

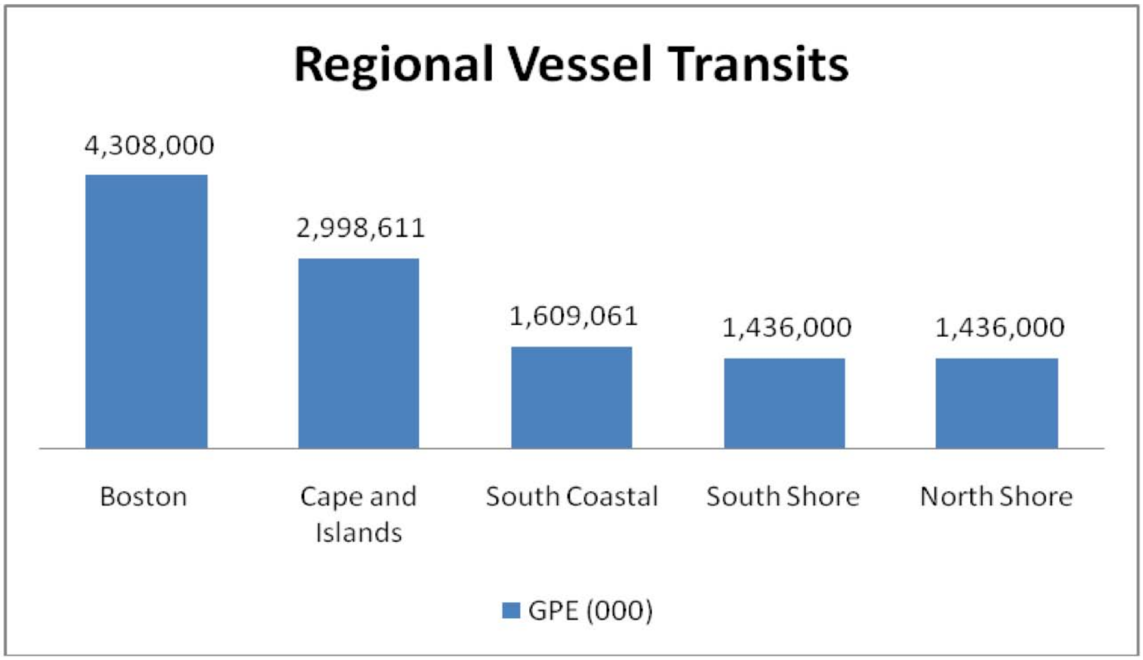
Figure 4.5 shows total estimate gallons of petroleum exposure from vessel activity in shipping lanes for each region.

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.

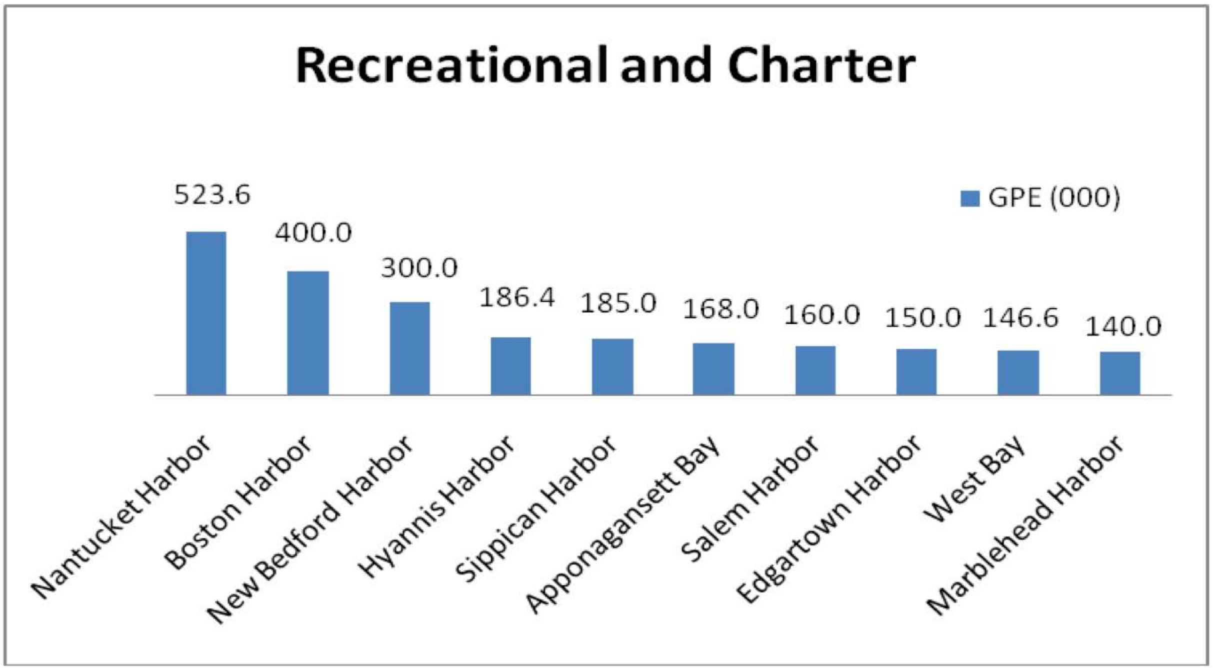
To estimate the petroleum exposure for each harbor, the average fuel capacities identified in Table 4.2 were multiplied by the number of moorings and slips. Boston, Nantucket, New Bedford and Hyannis all reported having recreational vessels up to 200 feet in length. Each also had a high number of moorings 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

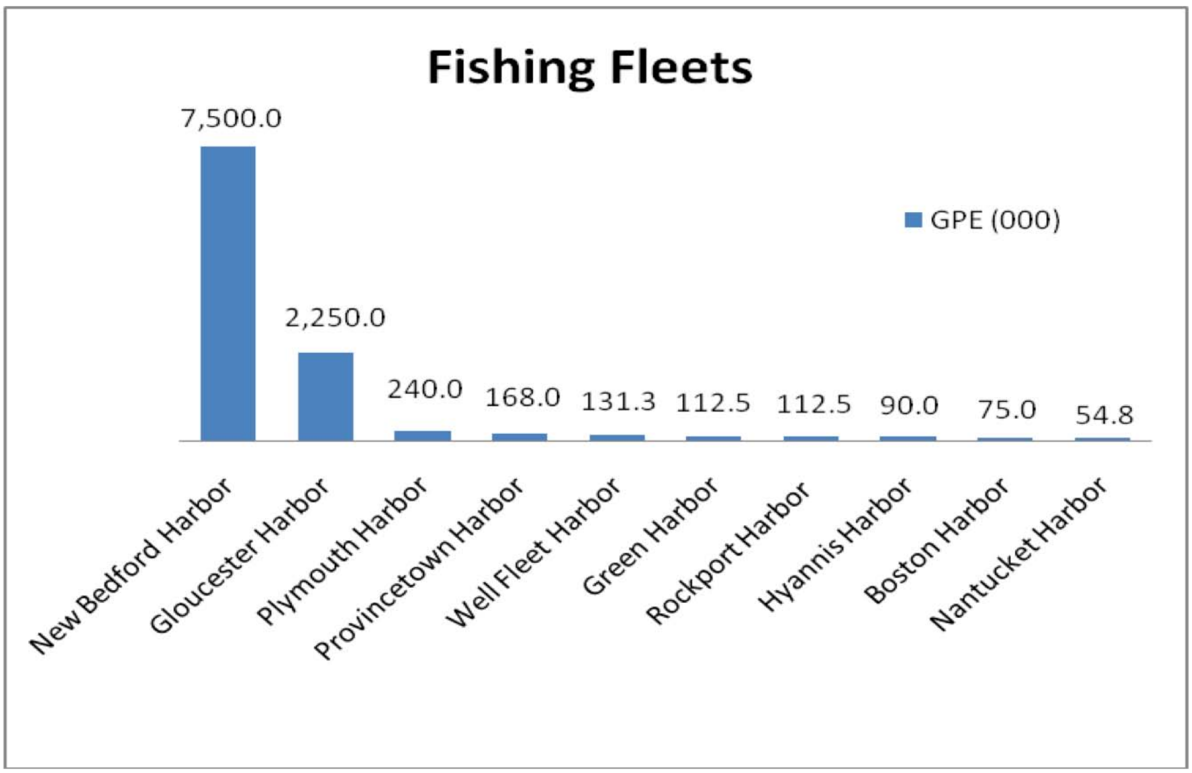


[17] All values in table should be multiplied by a factor of 1,000.

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

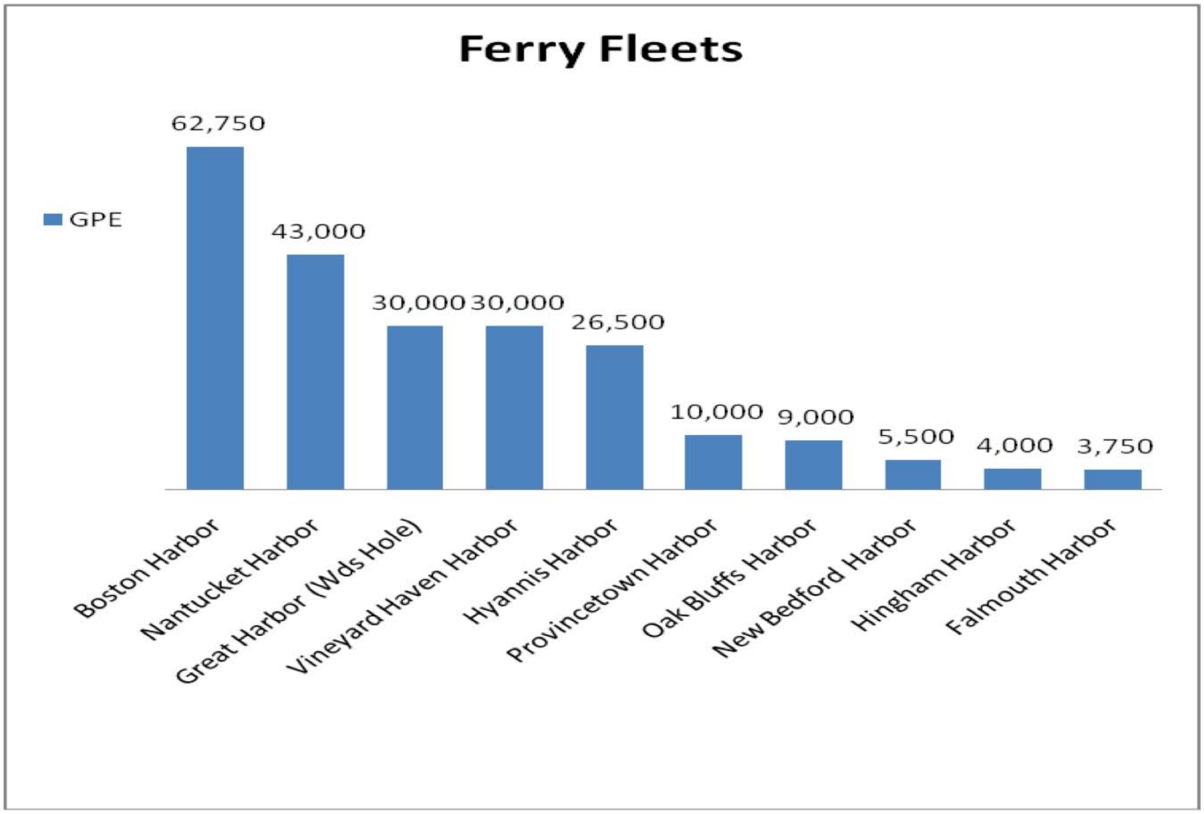
4.2.6 Ferry Terminals

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



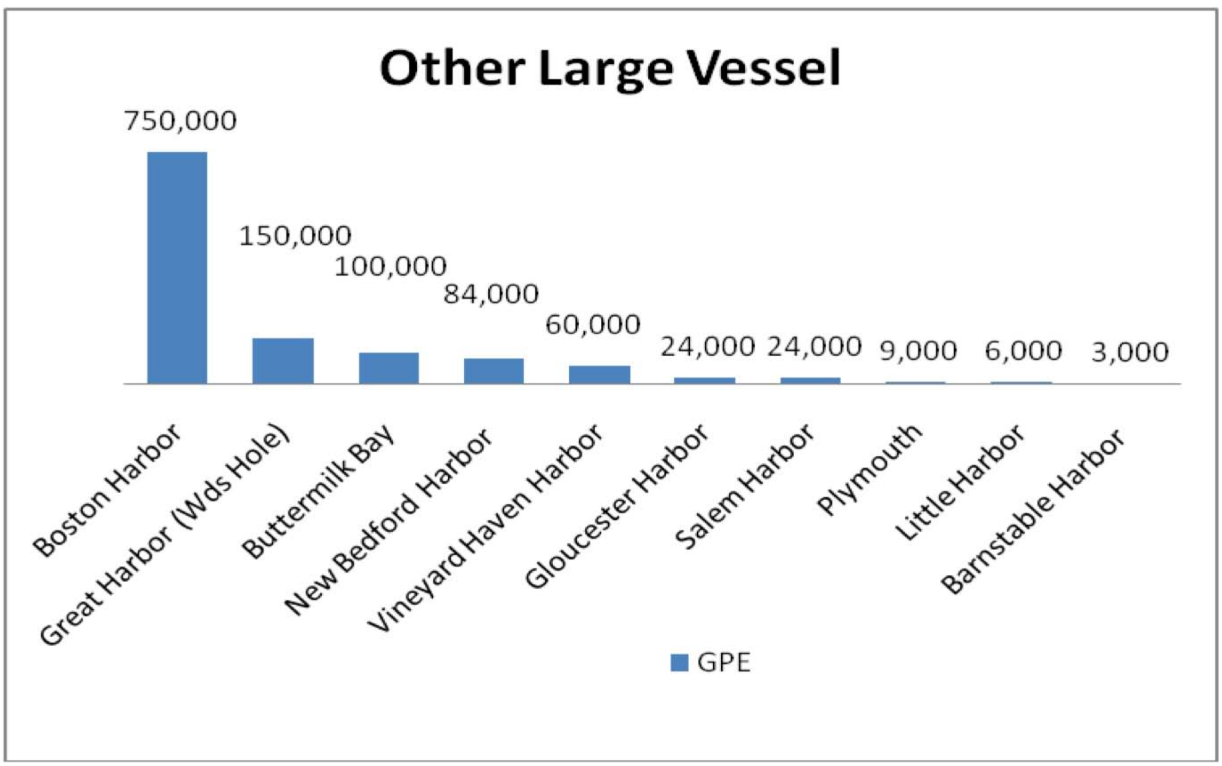
4.2.7 Other Large Vessel Activity

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



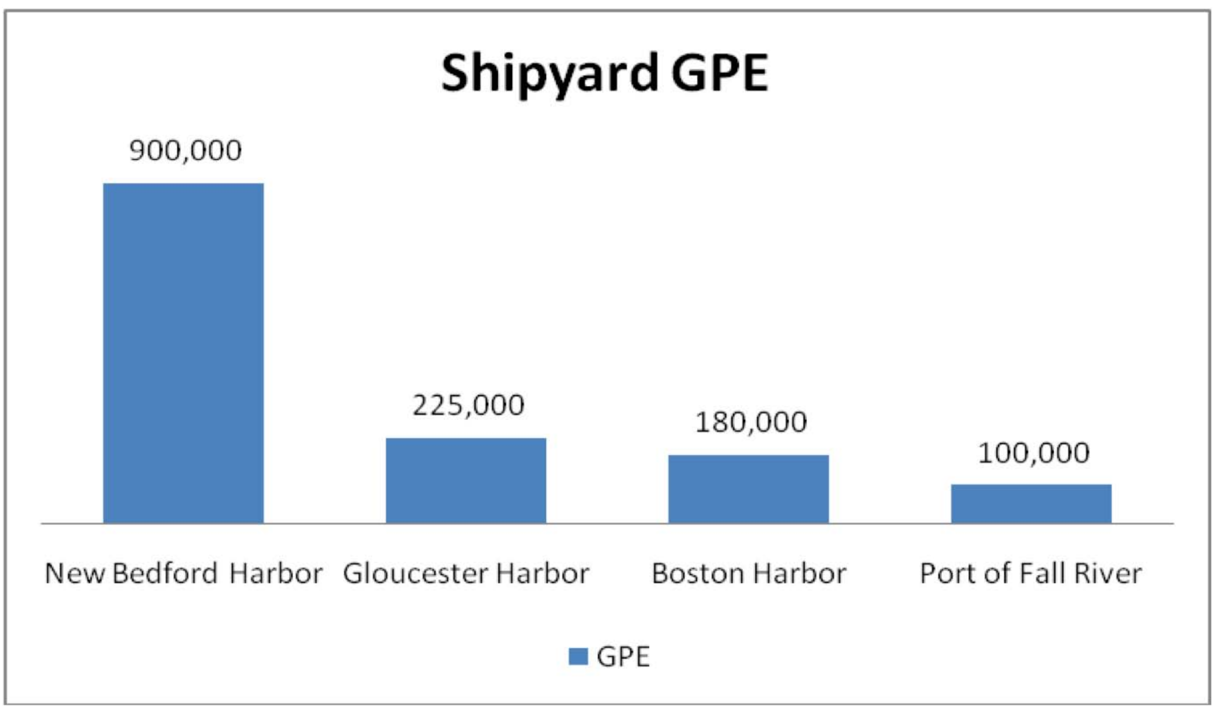
4.2.8 Shipyards

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.

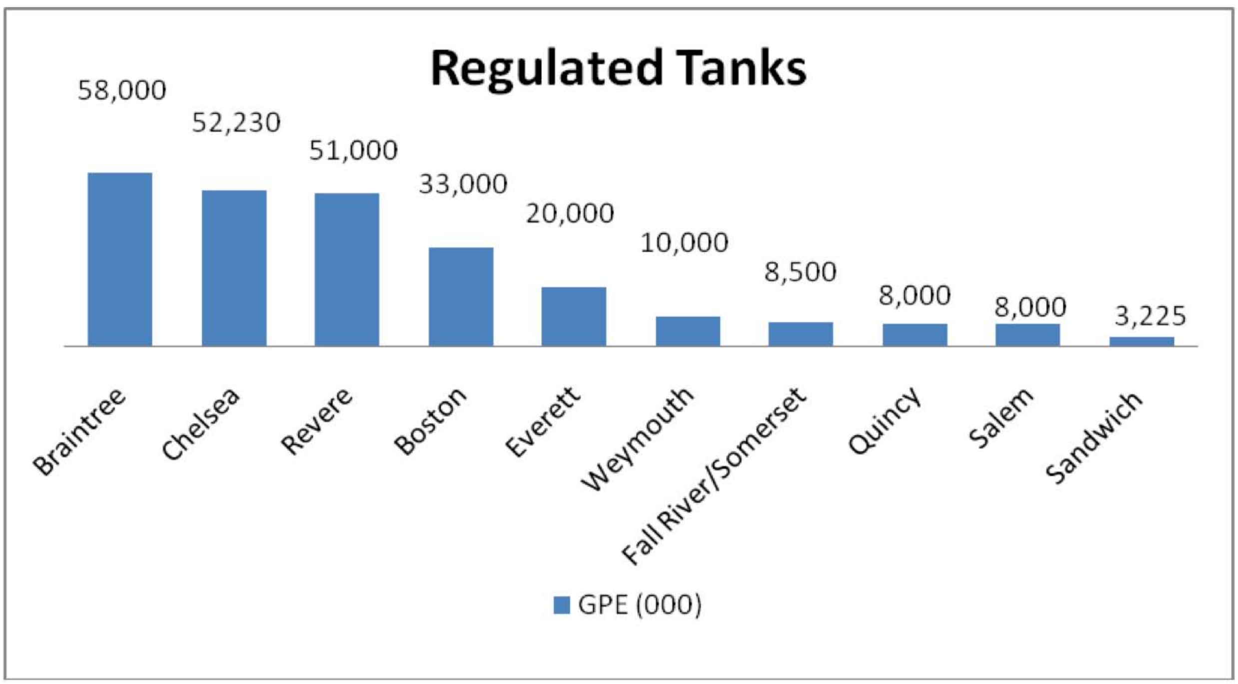
For the facilities with FRPs in Beverly, Lynn, and Peabody, it was not possible to estimate the number or size of storage tanks with available aerial photographs. Therefore, the total storage quantity for each of these three is assumed to be 42,000 gallons, which is the minimum regulated quantity. This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

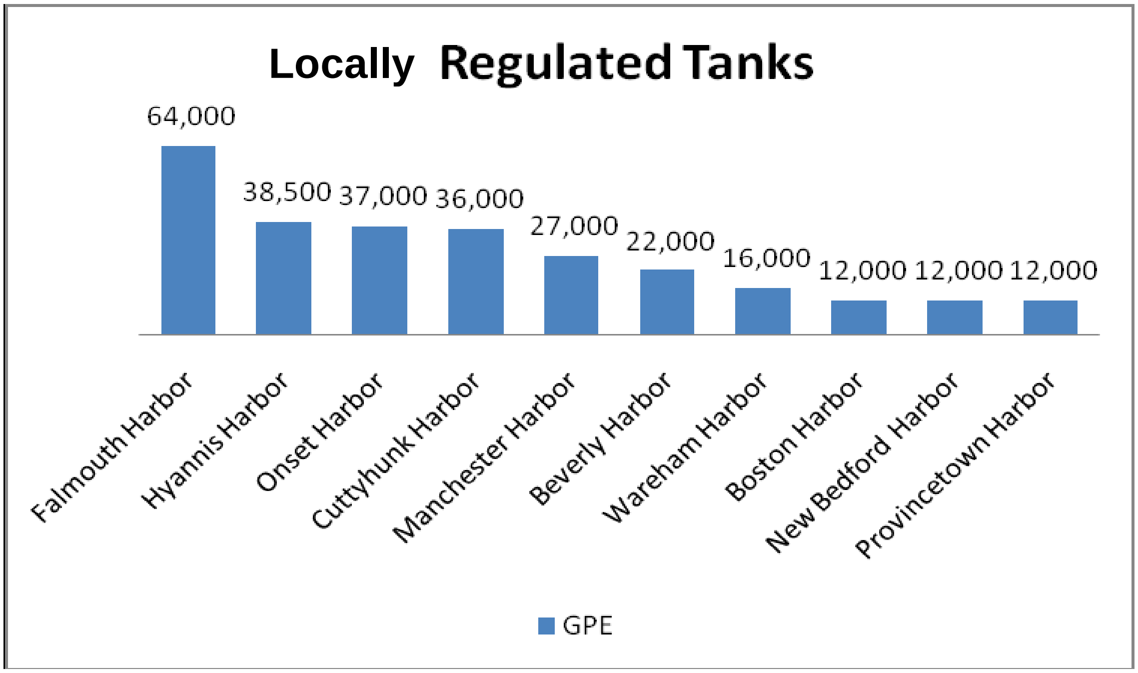
4.2.10 Locally Regulated Bulk Fuel Storage at Harbor or Marina

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.

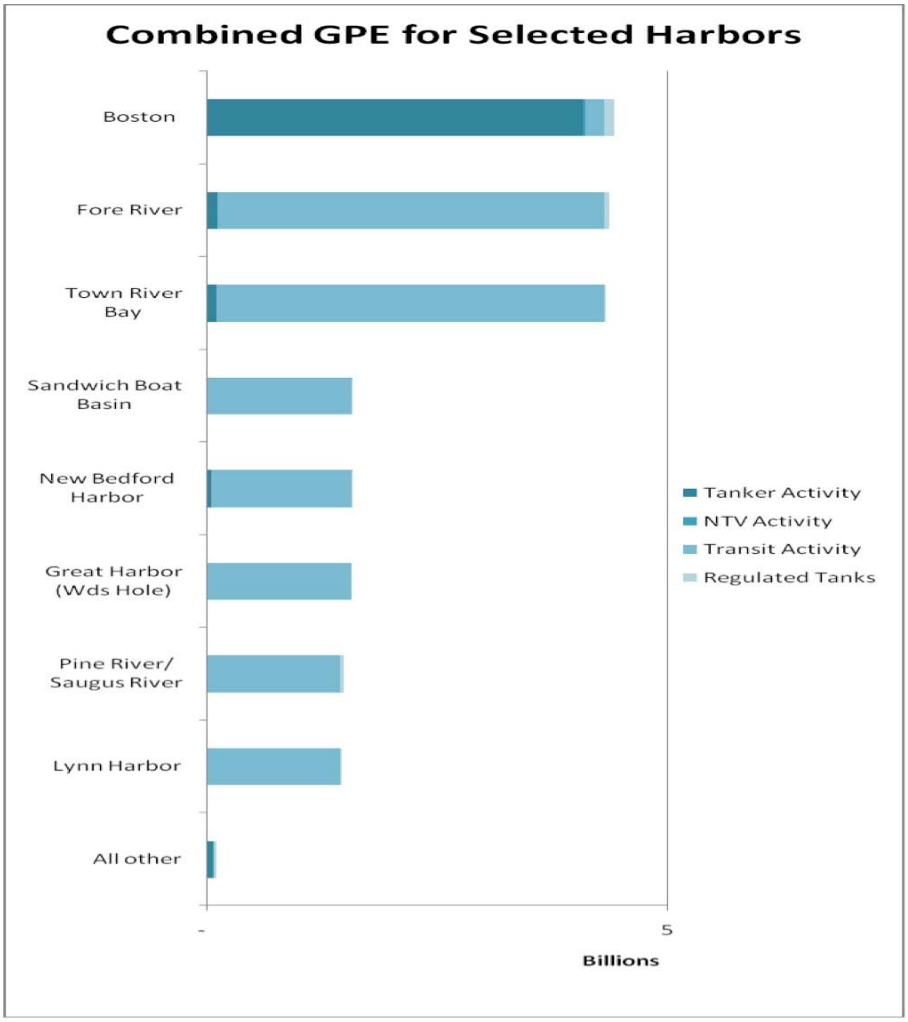
Figure 4.12 shows the GPE estimates for harbors that have exposure to "high magnitude" threat activities. The harbors with less than 100 million GPE are combined in the "all other" column.

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.

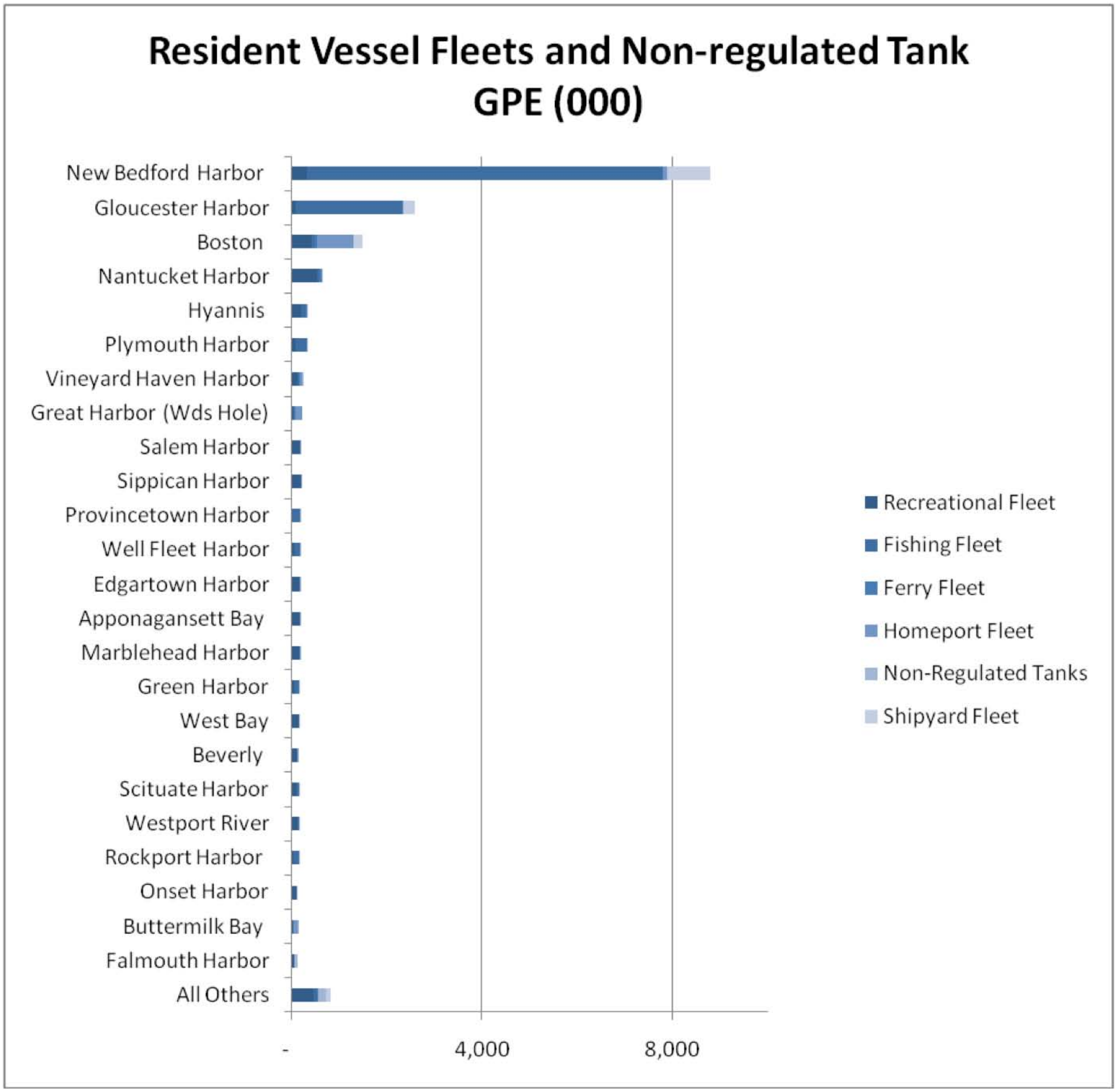
Nantucket follows in fourth place with a combined GPE of 629,350 gallons, mostly due to having the highest estimated recreational and charter fleet GPE of 523,600 gallons. Plymouth and Provincetown harbors have relatively large fishing vessel fleets at 240,000 and 168,000 gallons respectfully. Great 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.

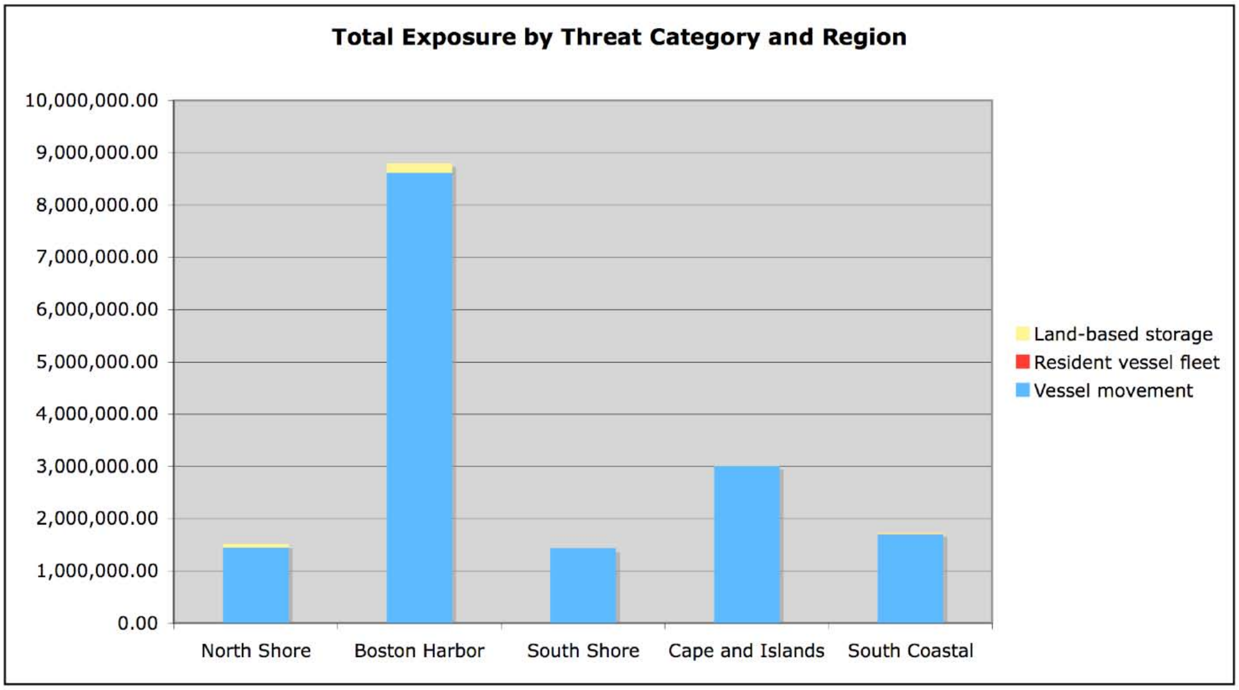
Figure 5.1 shows the total threat exposure for each coastal region of Massachusetts, and also shows the proportional contribution of the three categories of threats – vessel movements, residential vessel fleets, and land-based storage – to the total threat level in each region. Figure 5.2 shows the proportionate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

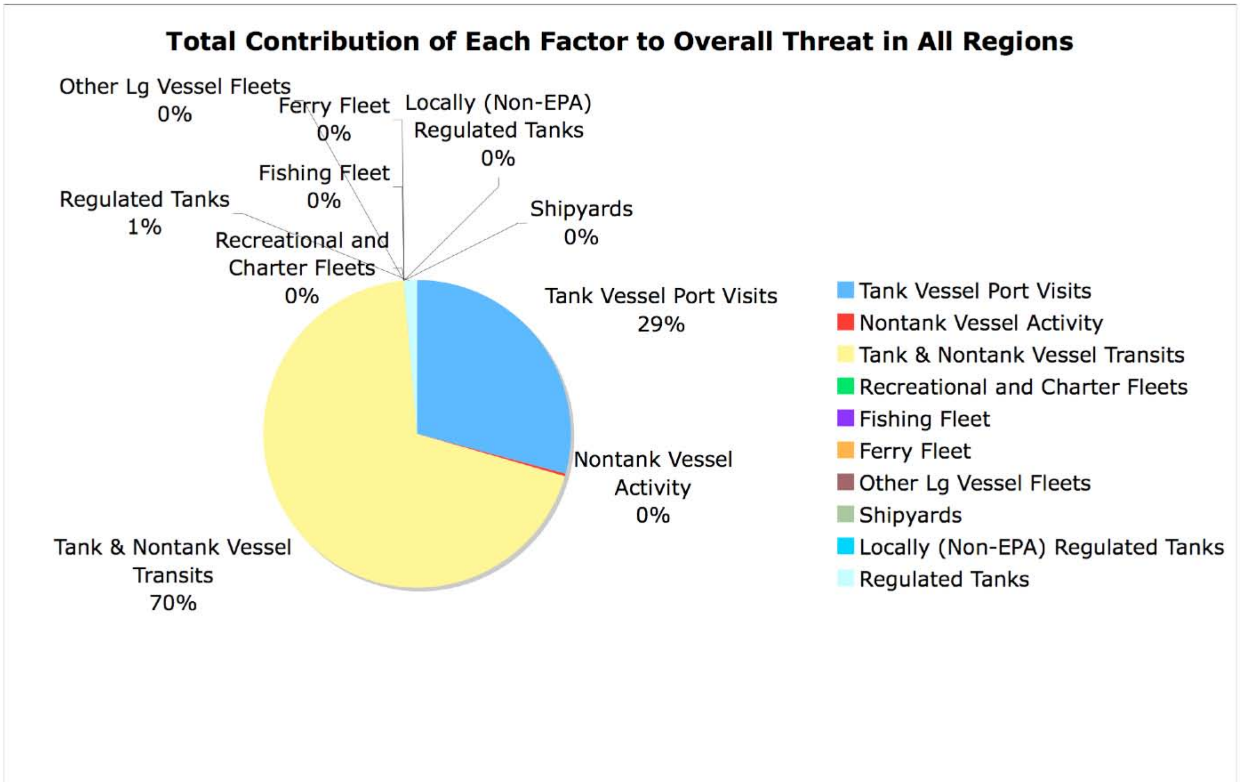
The overall threat from residential vessel fleets does not register for any of the regions, and contributes less than 1% to the total threat for all regions, because the total GPE from residential vessel fleets is an order of magnitude less than the total from vessel movement and land-based storage.

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]

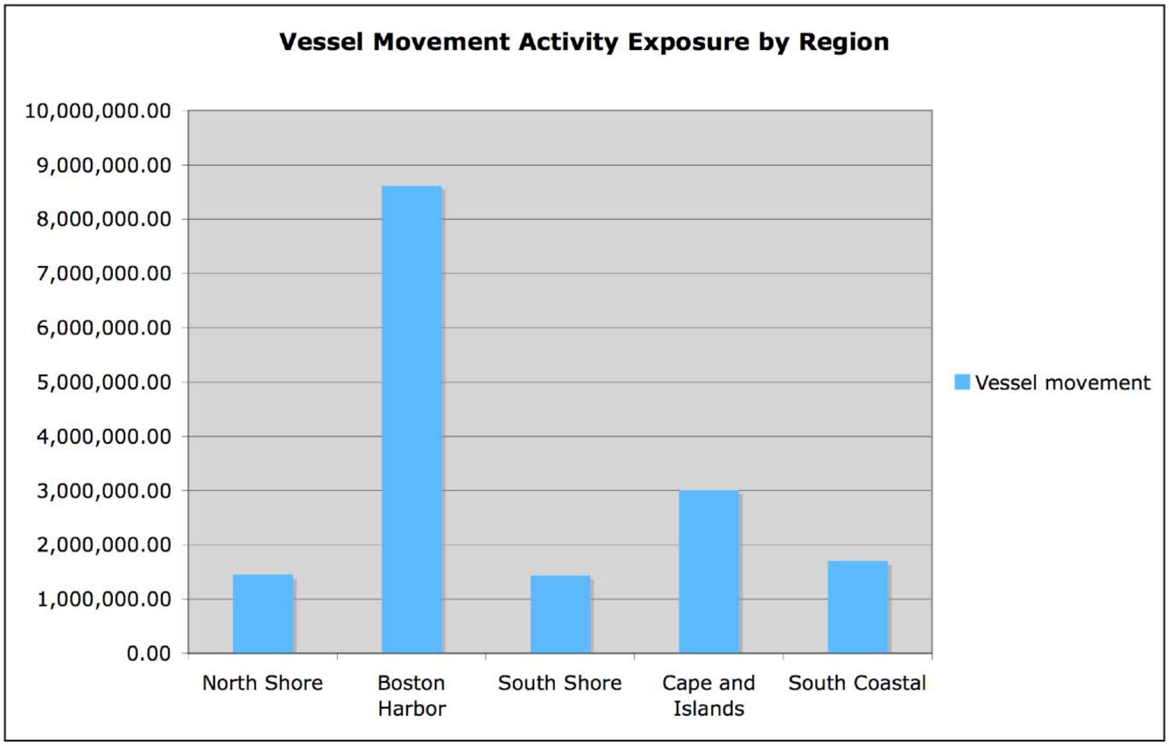
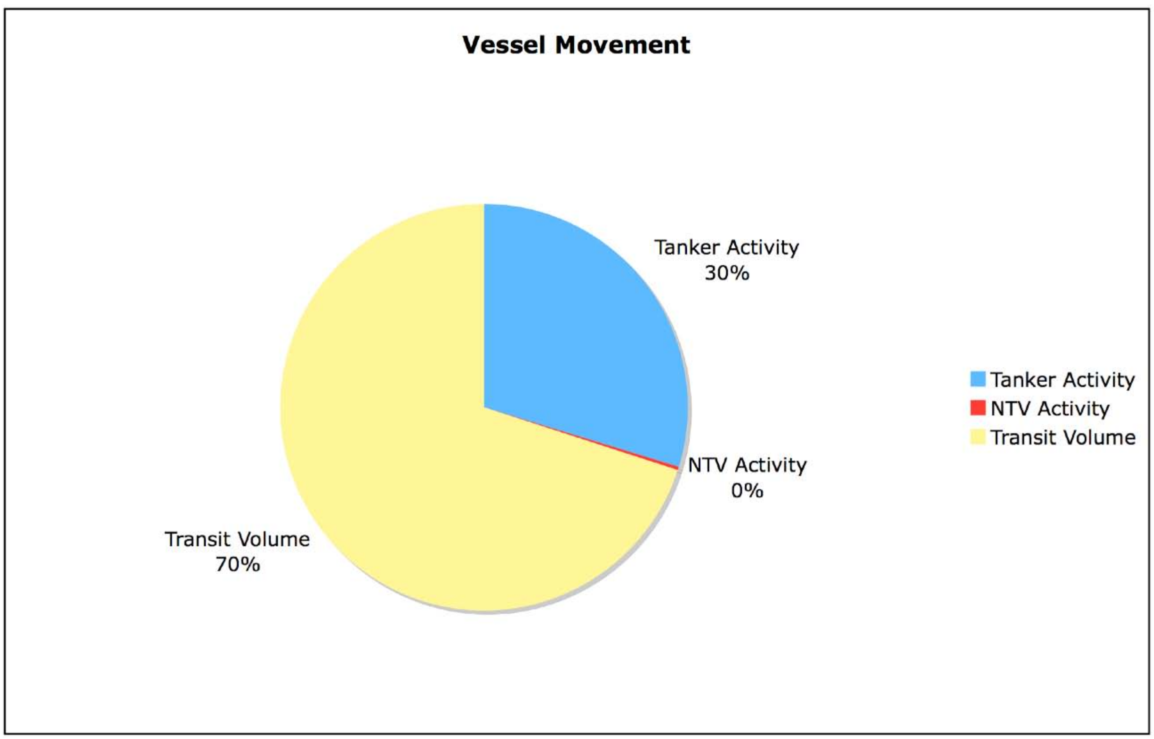


Figure 5.4 Contribution of Threat Factors to total Vessel Movement Threat and Comparison of Threat Factors by Region – Vessel Movement



[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

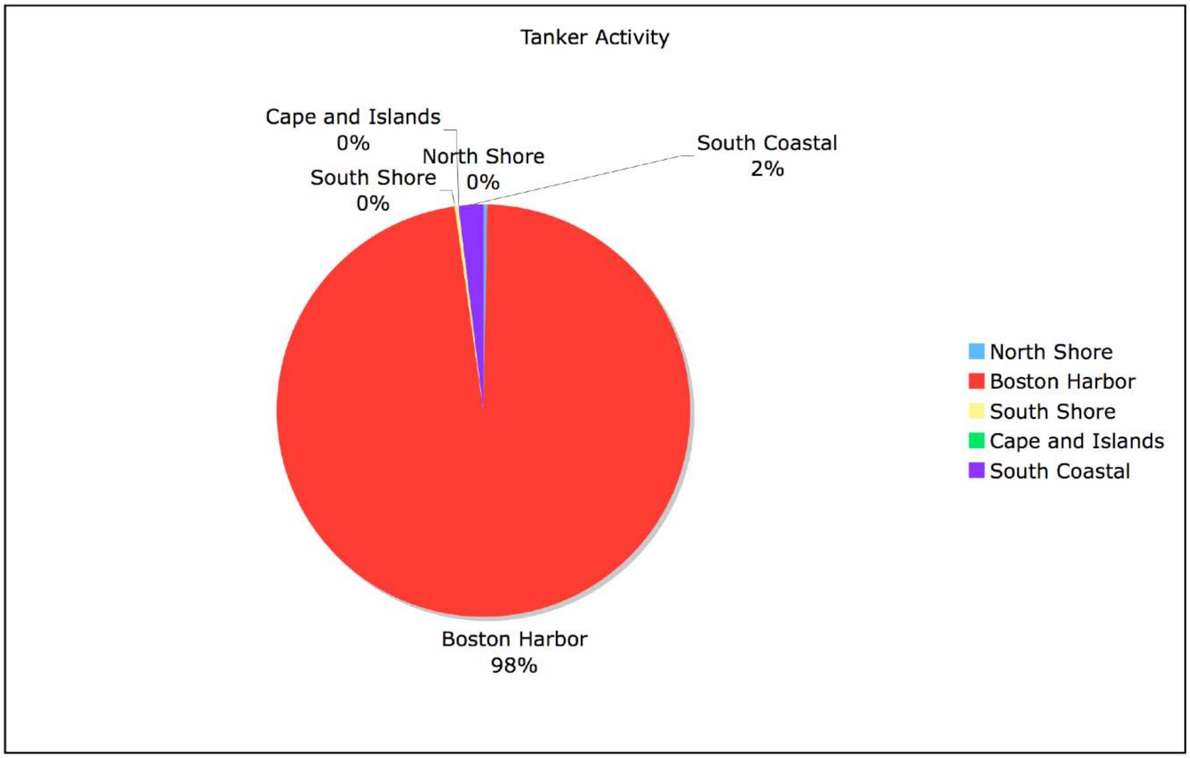


Figure 5.6 Contribution of Threat Factors to total Vessel Movement Threat and Comparison of Threat Factors by Region – Nontank Vessel Activity

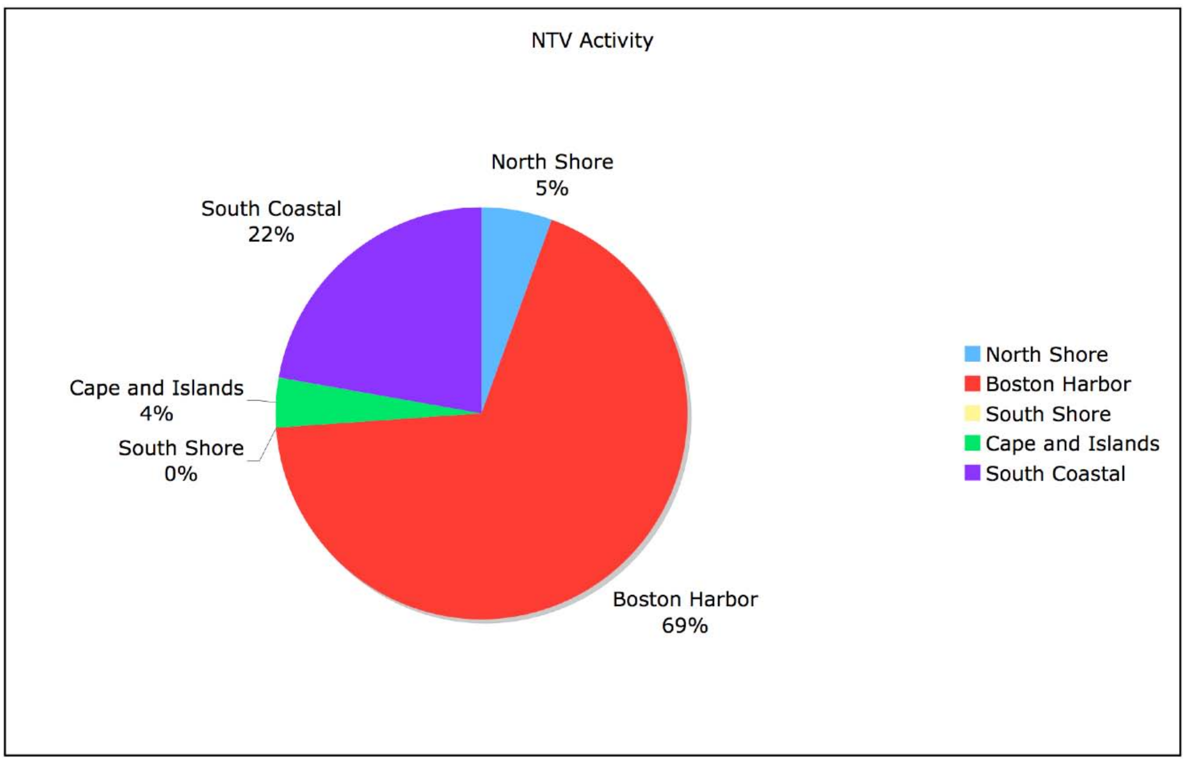
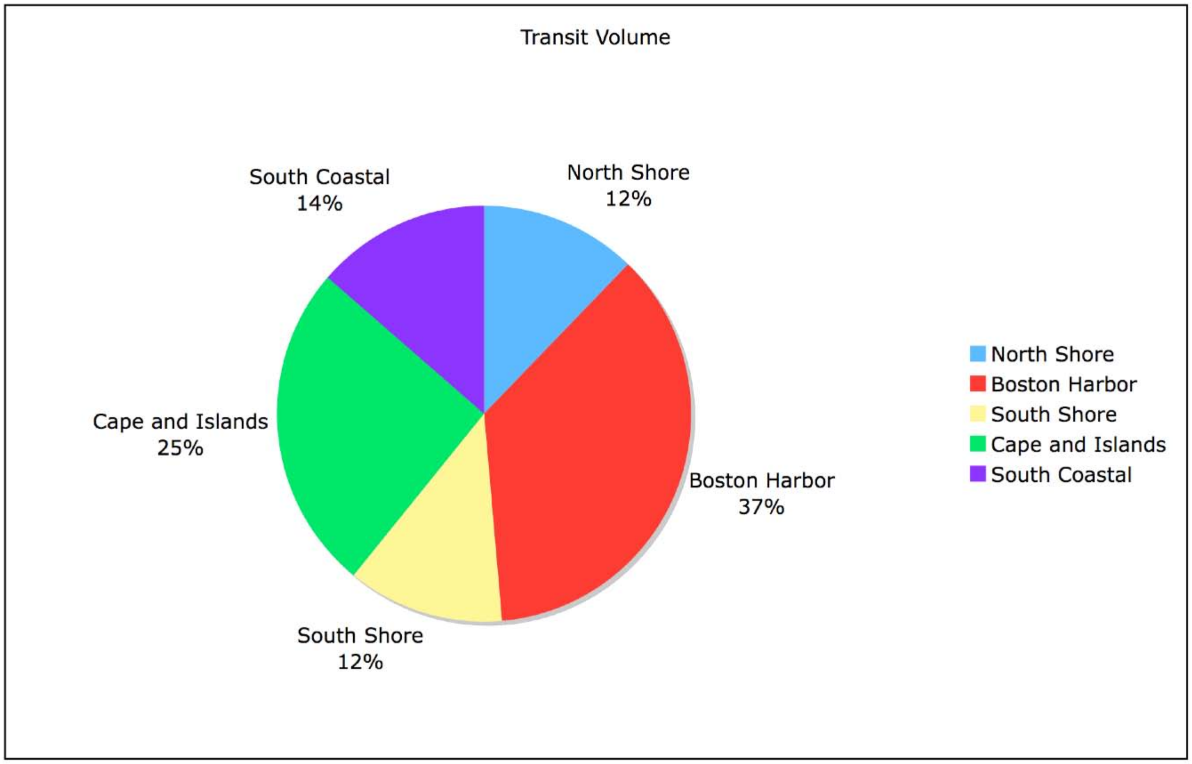


Figure 5.7 Contribution of Threat Factors to total Vessel Movement Threat and Comparison of Threat Factors by Region – Transit Volume



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]

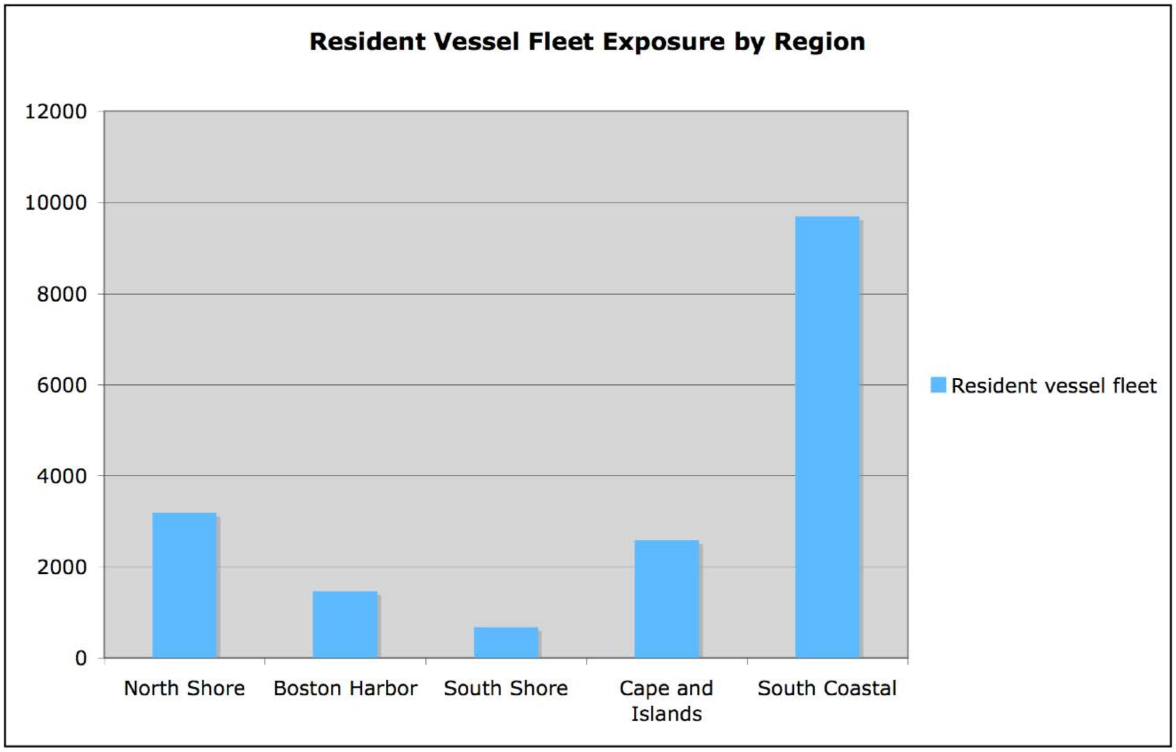
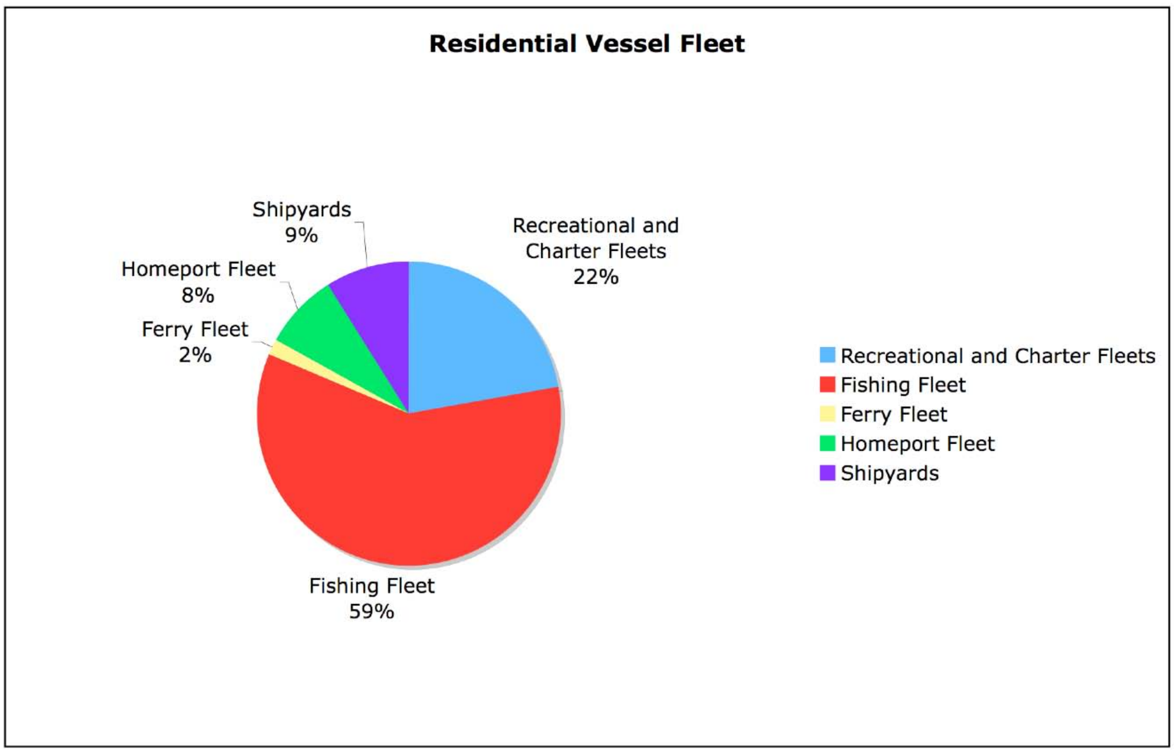


Figure 5.9 Contribution of Threat Factors to total Residential Vessel Fleet Threat



[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

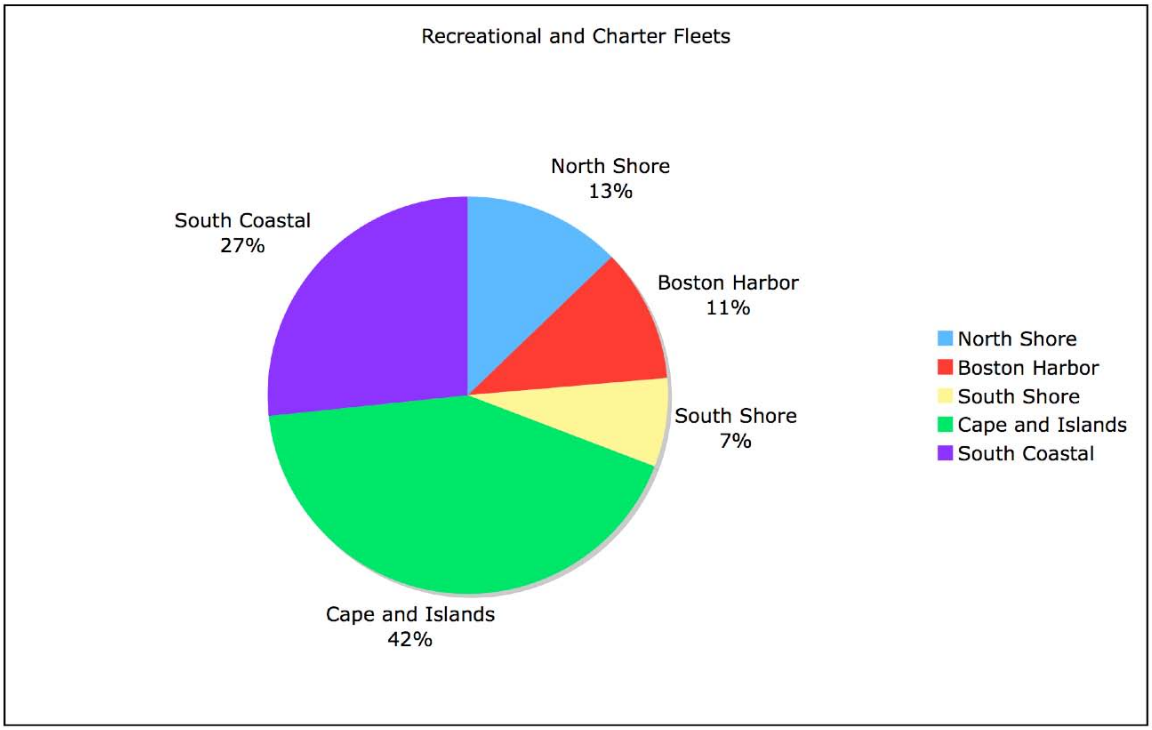


Figure 5.11 Comparison of Threat Factors by Region – Fishing Fleet

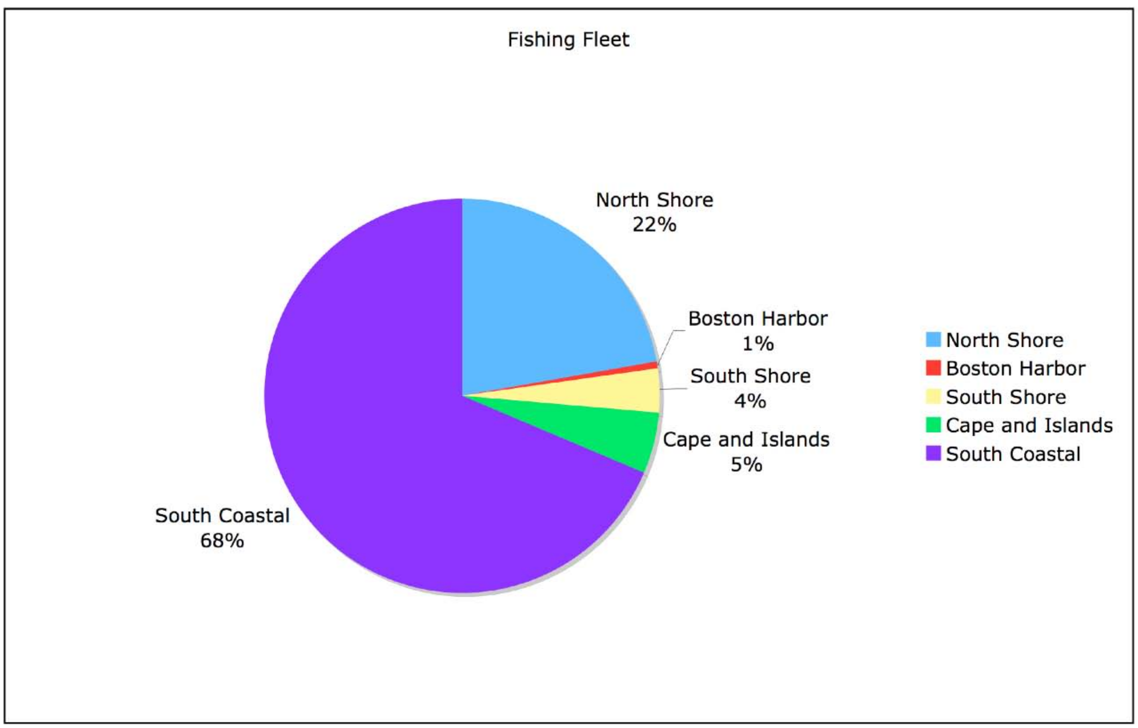


Figure 5.12 Comparison of Threat Factors by Region – Ferry Fleet

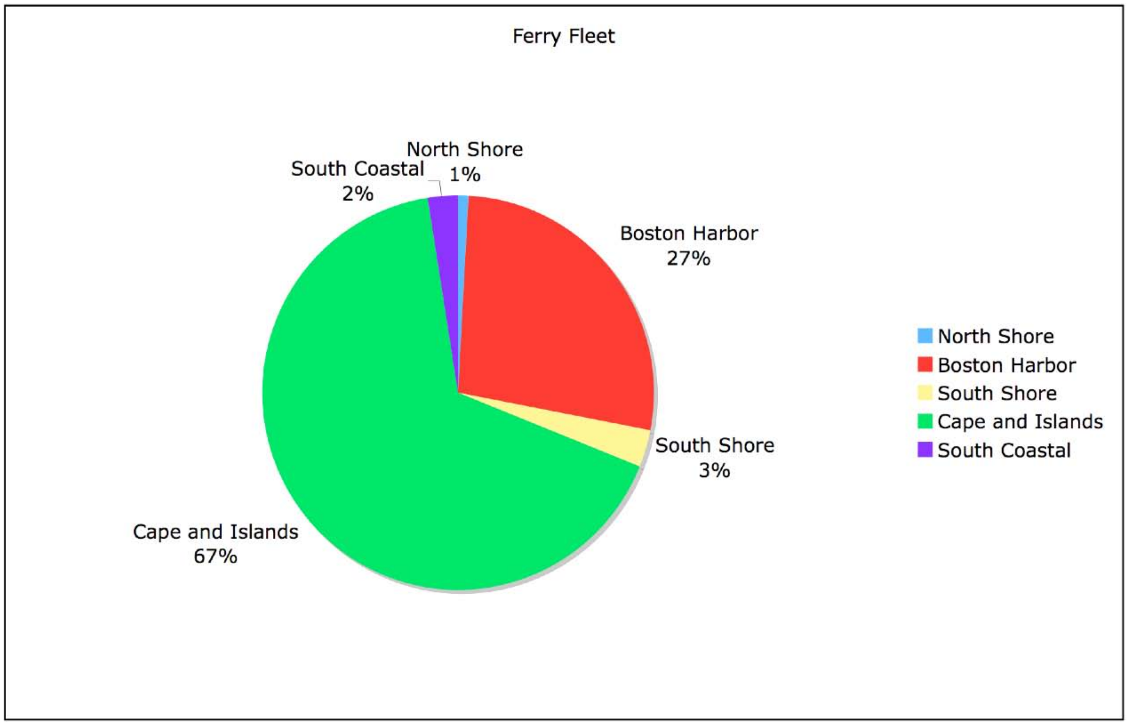


Figure 5.13 Comparison of Threat Factors by Region – Homeport Fleet

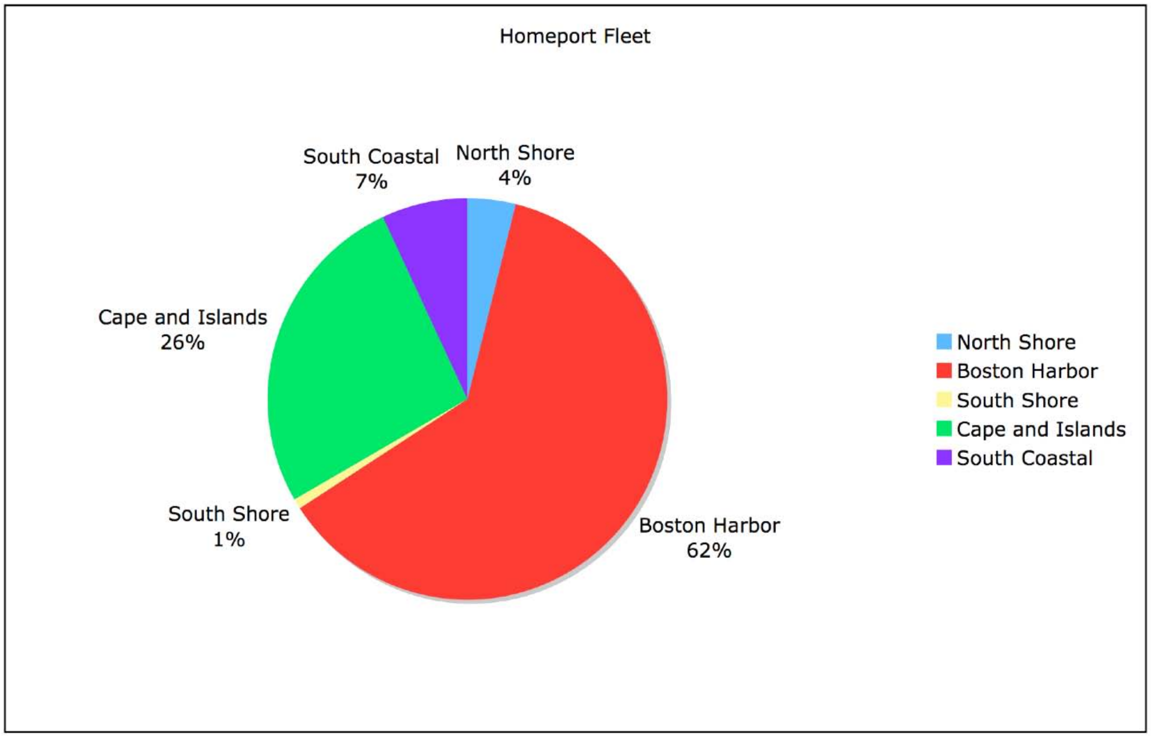
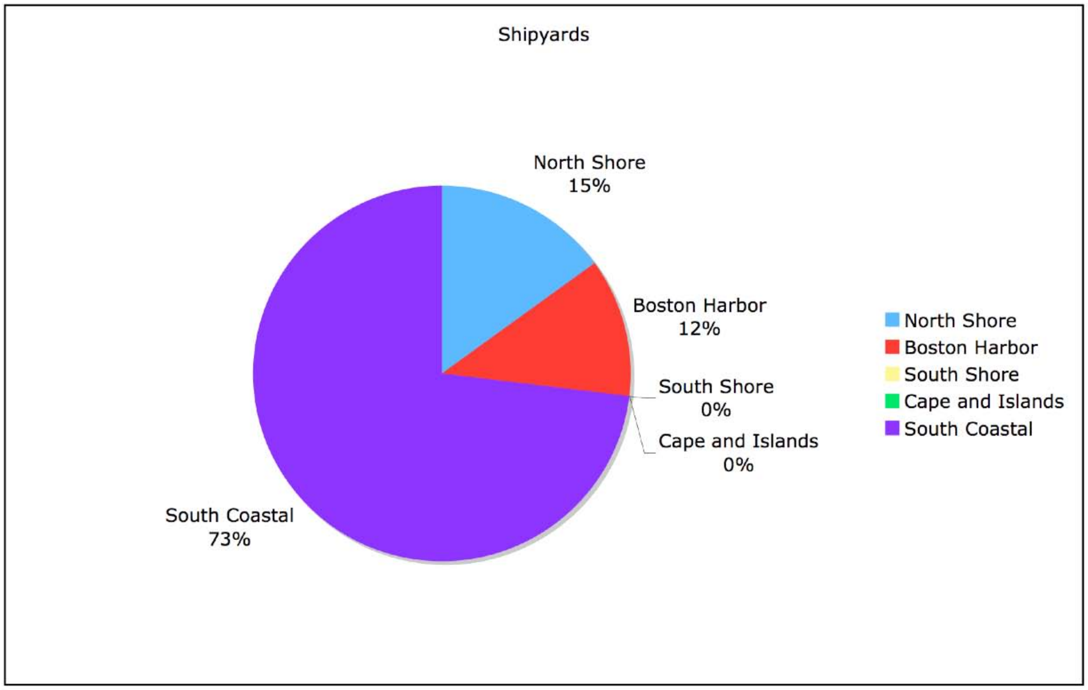


Figure 5.14 Comparison of Threat Factors by Region – Shipyards



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.

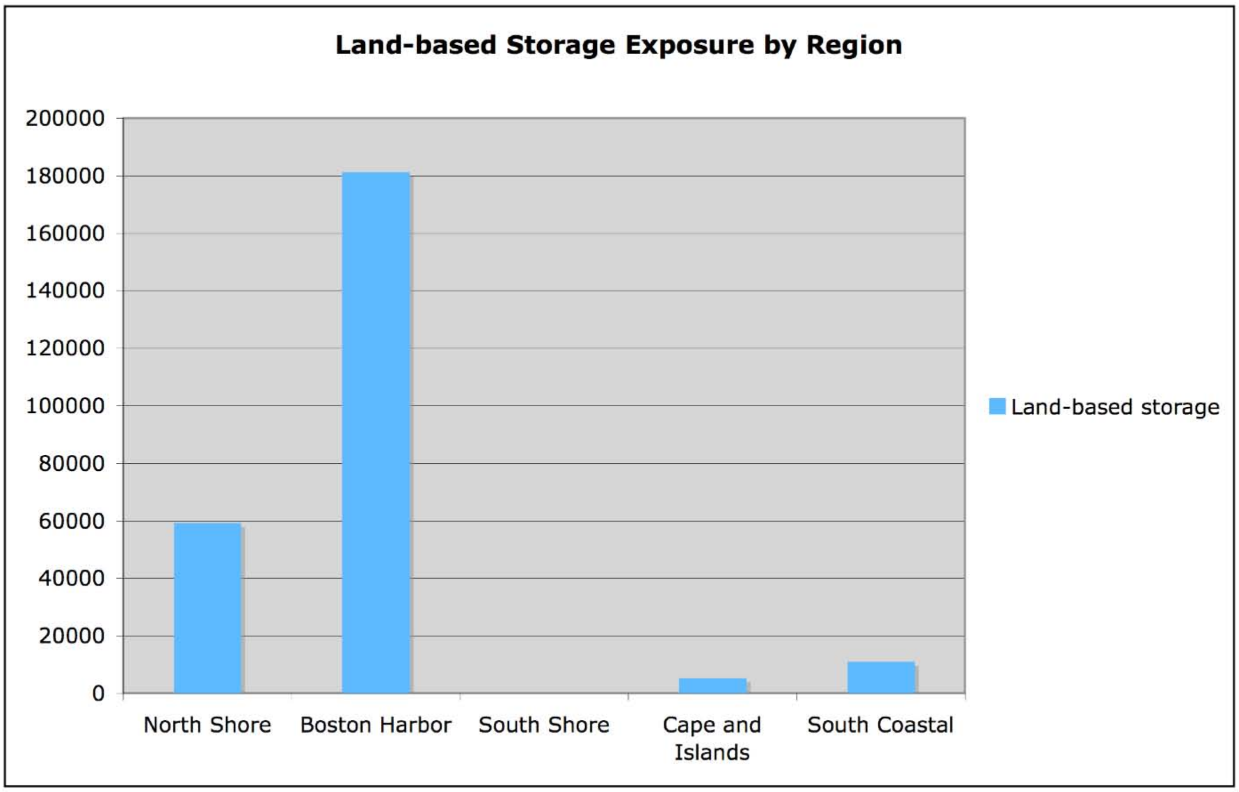
Figure 5.16 shows the proportionate contribution of the two threat factors that comprise the land-based storage estimate – EPA regulated and locally regulated tanks – to the overall threat for all regions. This chart shows that virtually all of the threat exposure from land-based storage is attributable 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

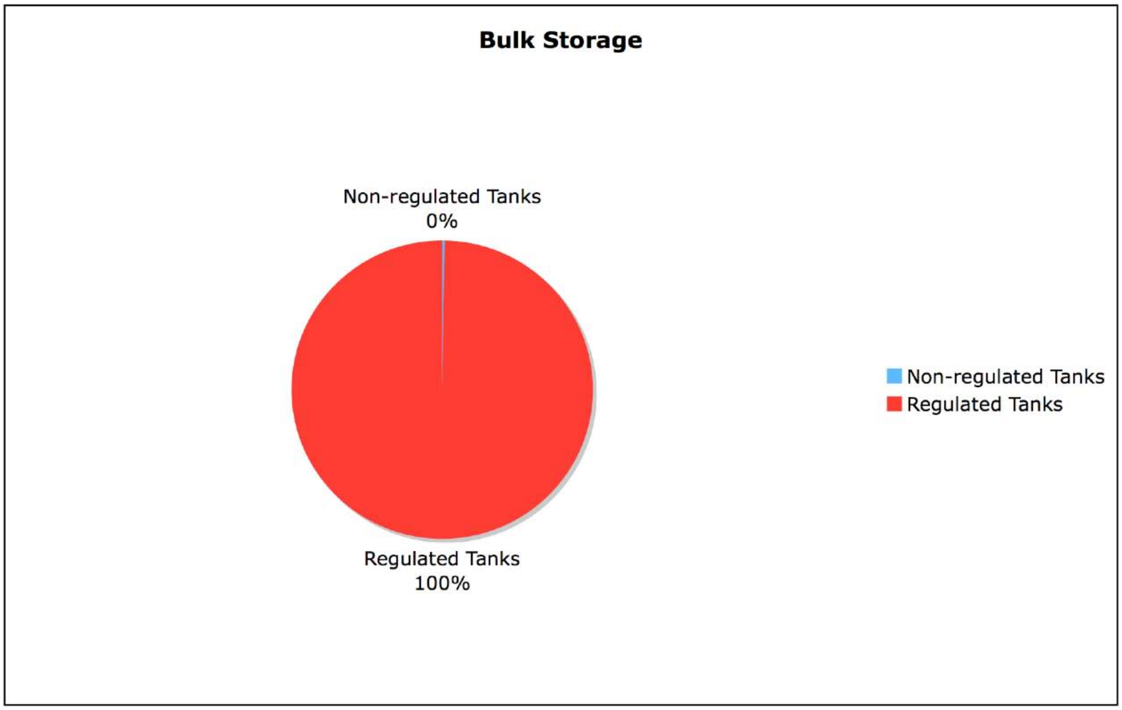


Figure 5.17 Comparison of Threat Factors by Region – Locally Regulated Tanks

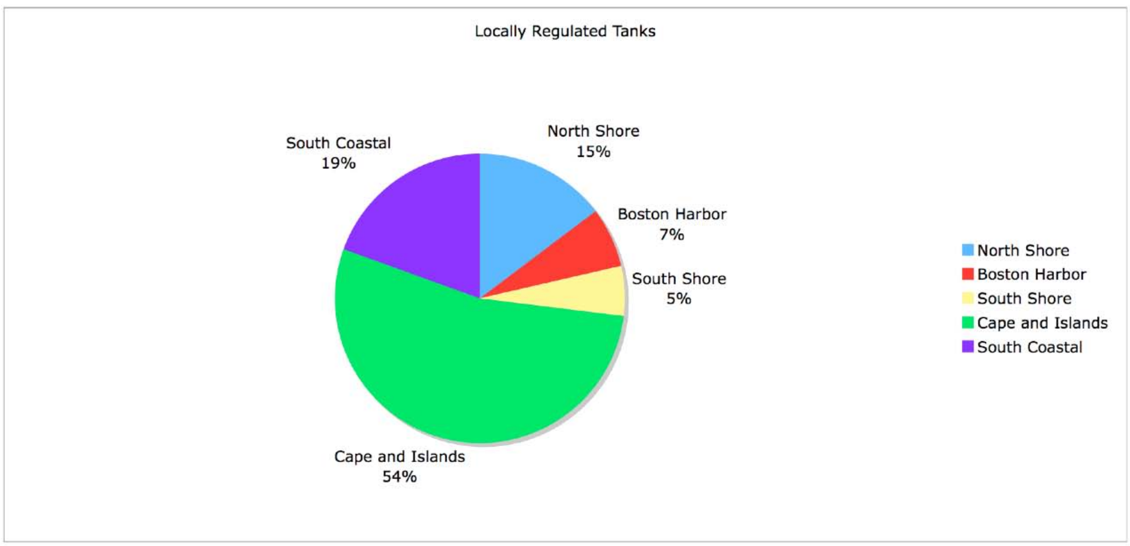
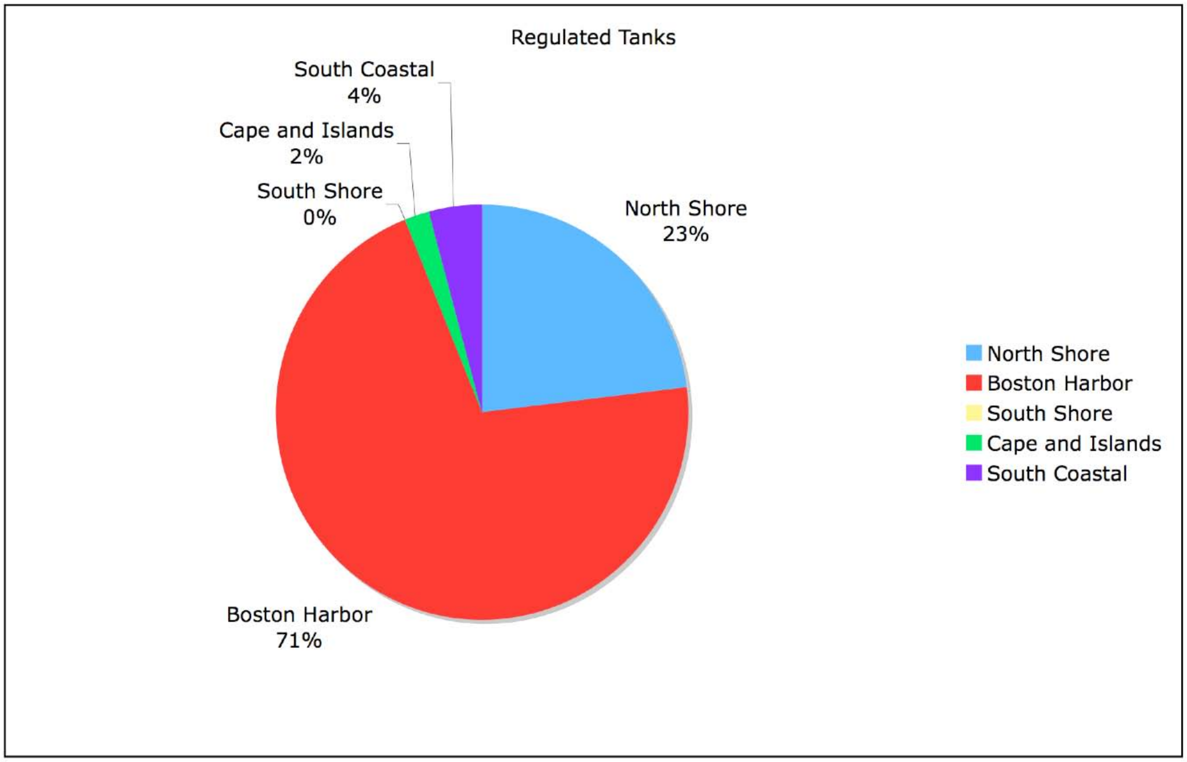


Figure 5.18 Comparison of Threat Factors by Region –EPA Regulated Tanks



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

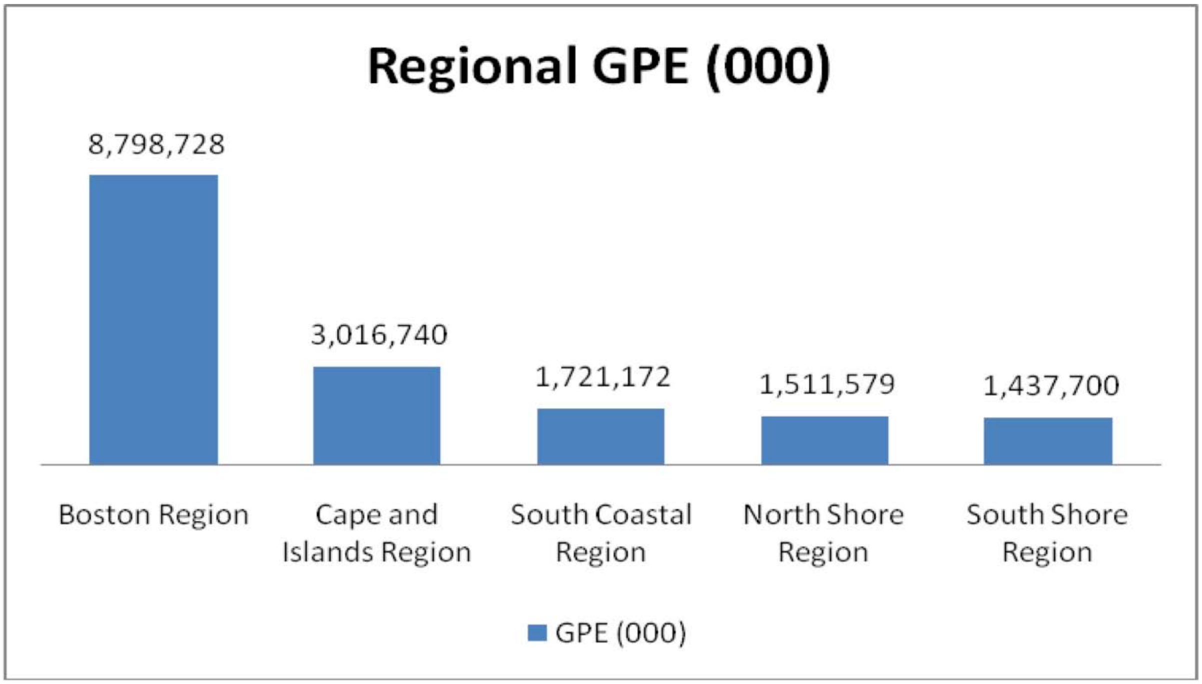


Table 5.1 Regional Summary of Oil Spill Threats in Estimated Gallons of Petroleum Exposure (000)[27]

	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.

[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]

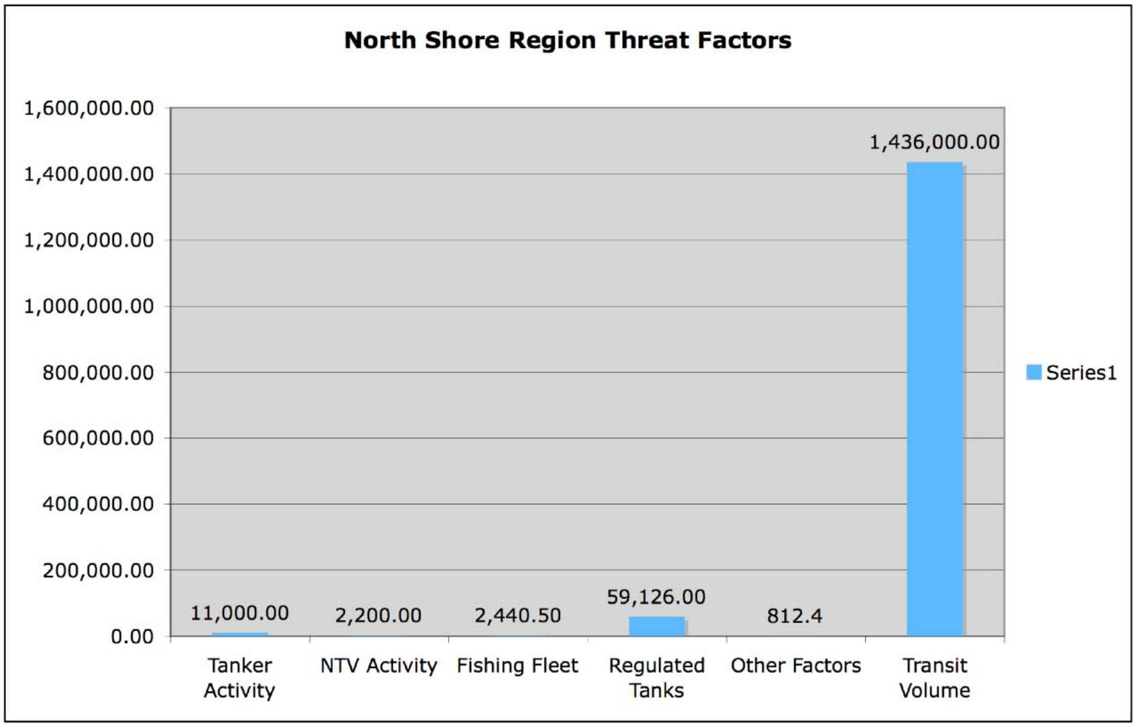
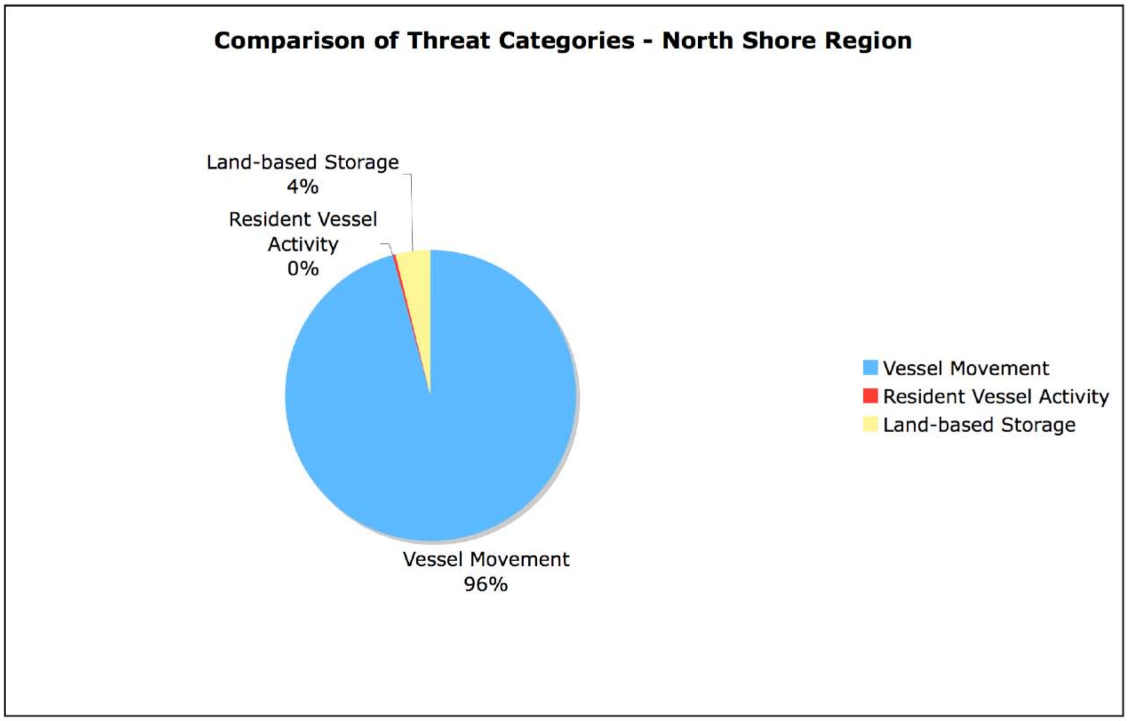


Figure 5.21 Comparative Oil Spill Threat Levels within North Shore Region by Threat Category



[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]

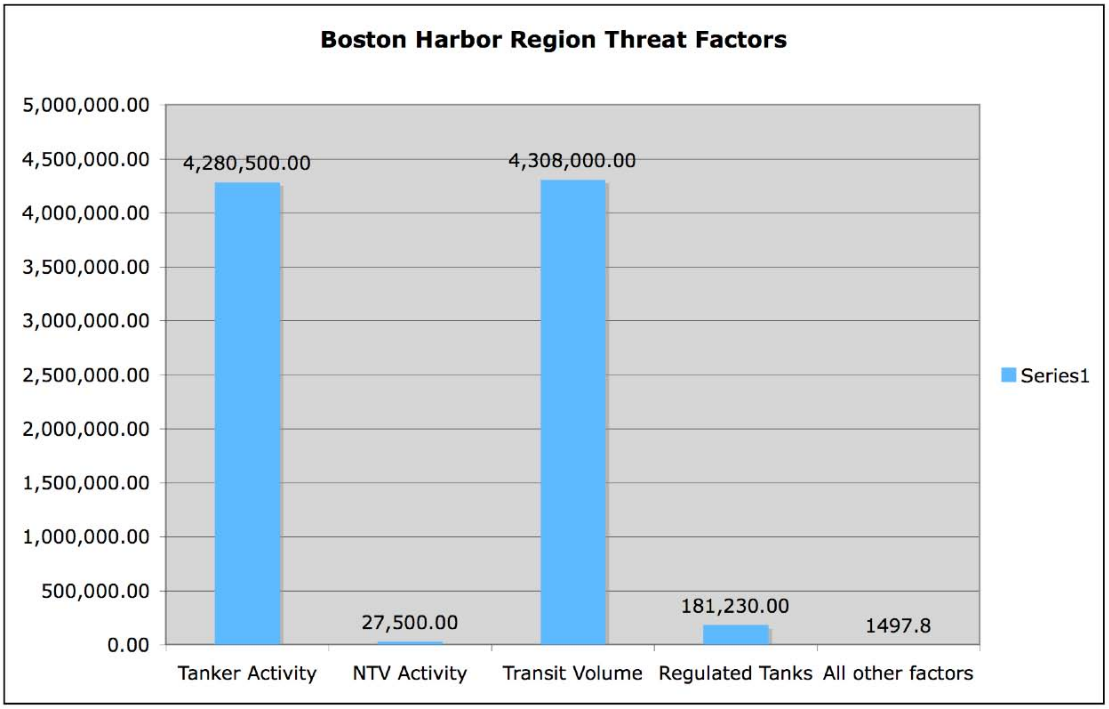
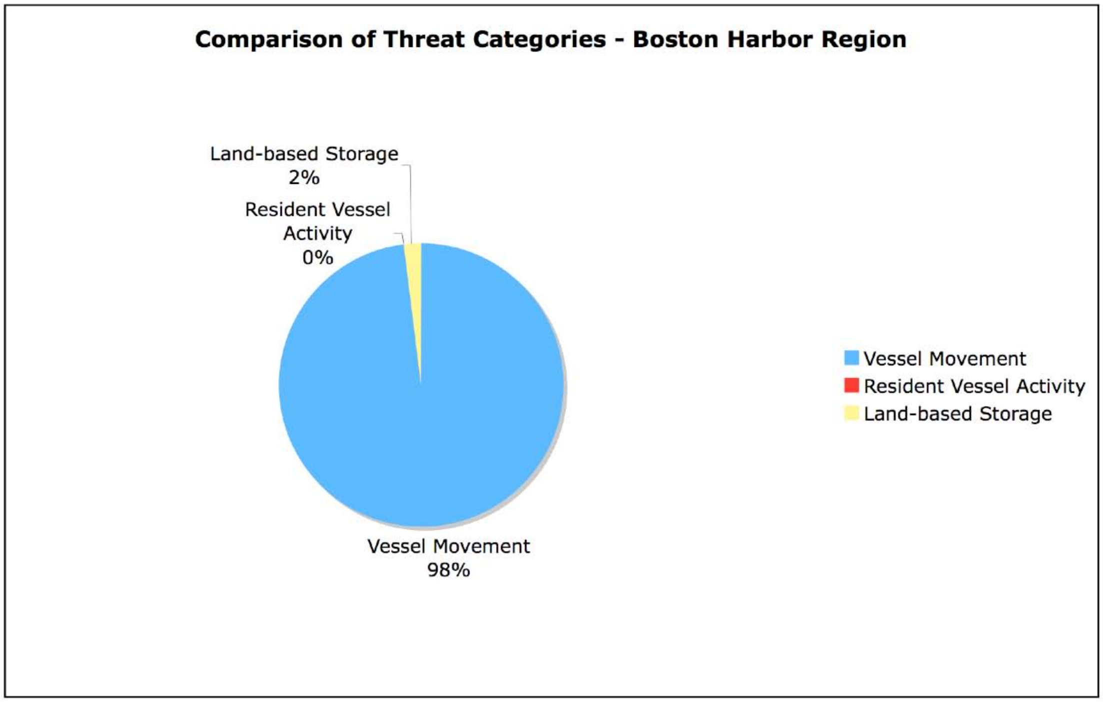


Figure 5.23 Comparative Oil Spill Threat Levels within Boston Harbor Region by Threat Category



[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]

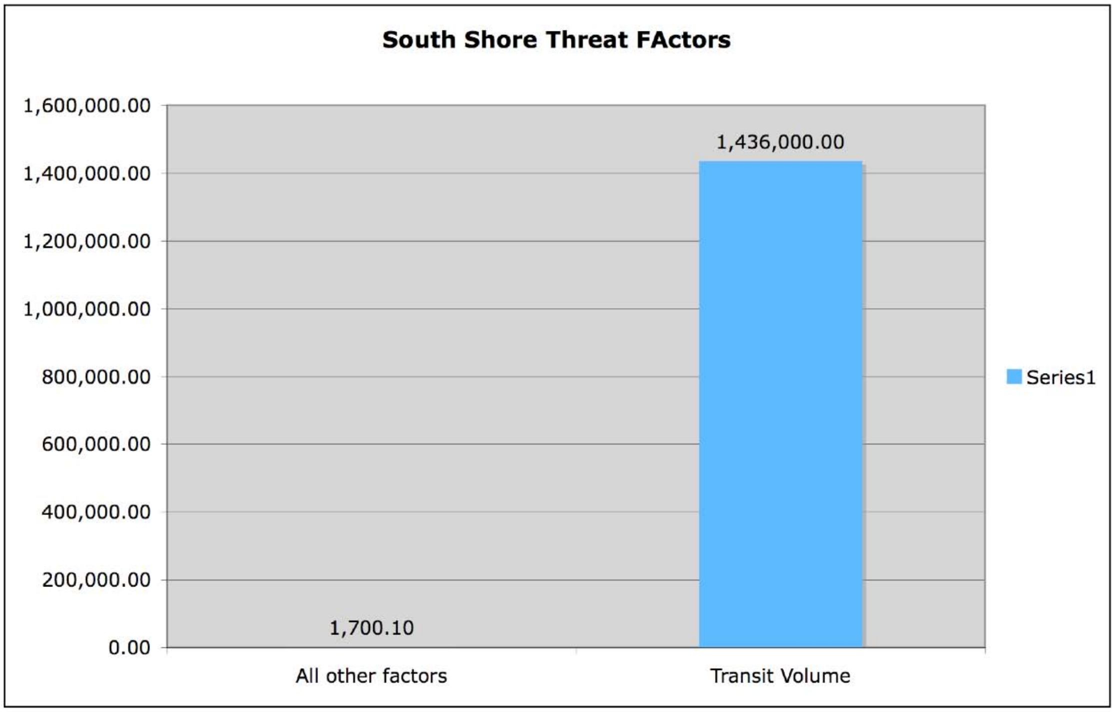
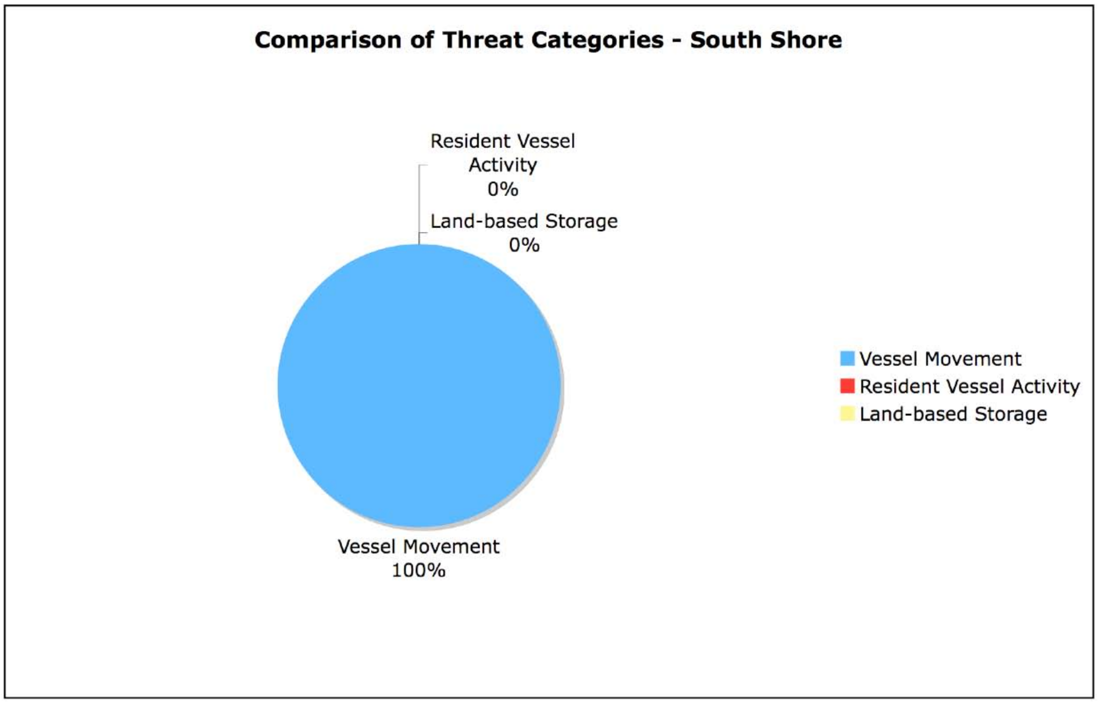


Figure 5.25 Comparative Oil Spill Threat Levels within South Shore Region by Threat Category



[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]

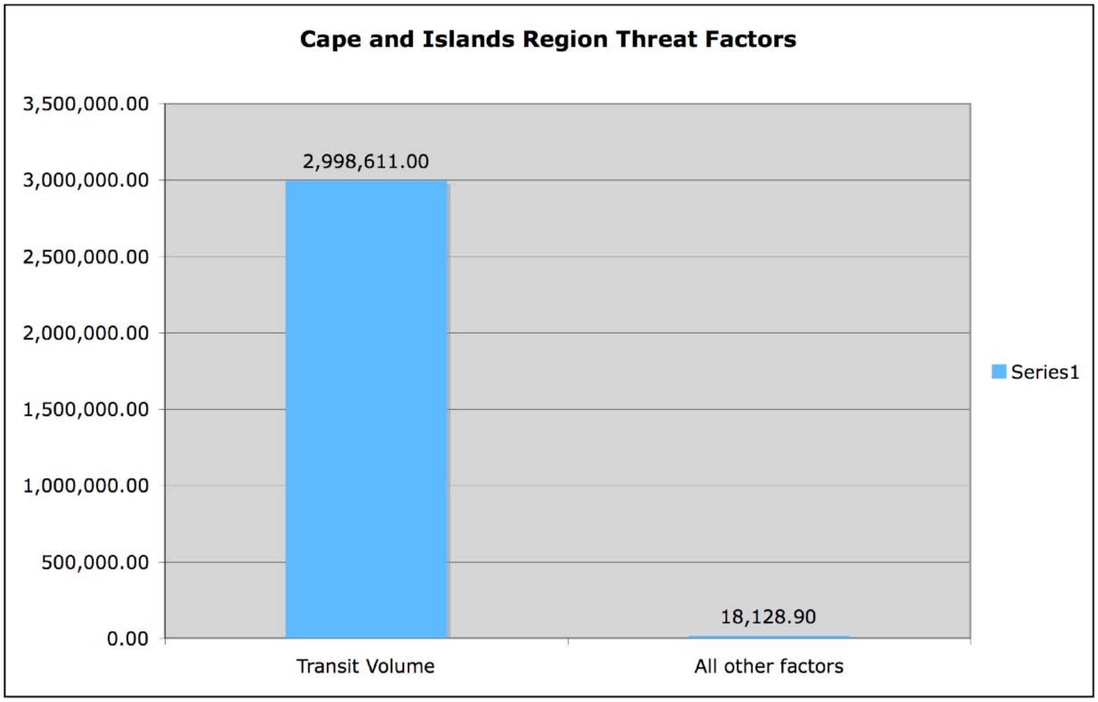
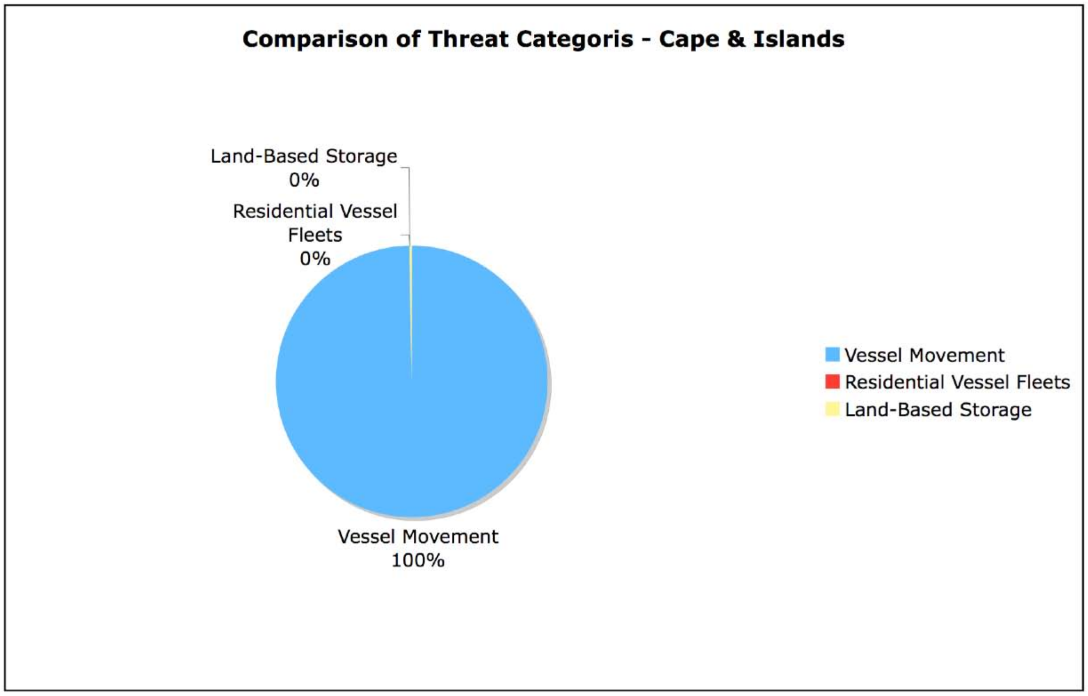


Figure 5.27 Comparative Oil Spill Threat Levels within Cape and Islands Region by Threat Category



[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]

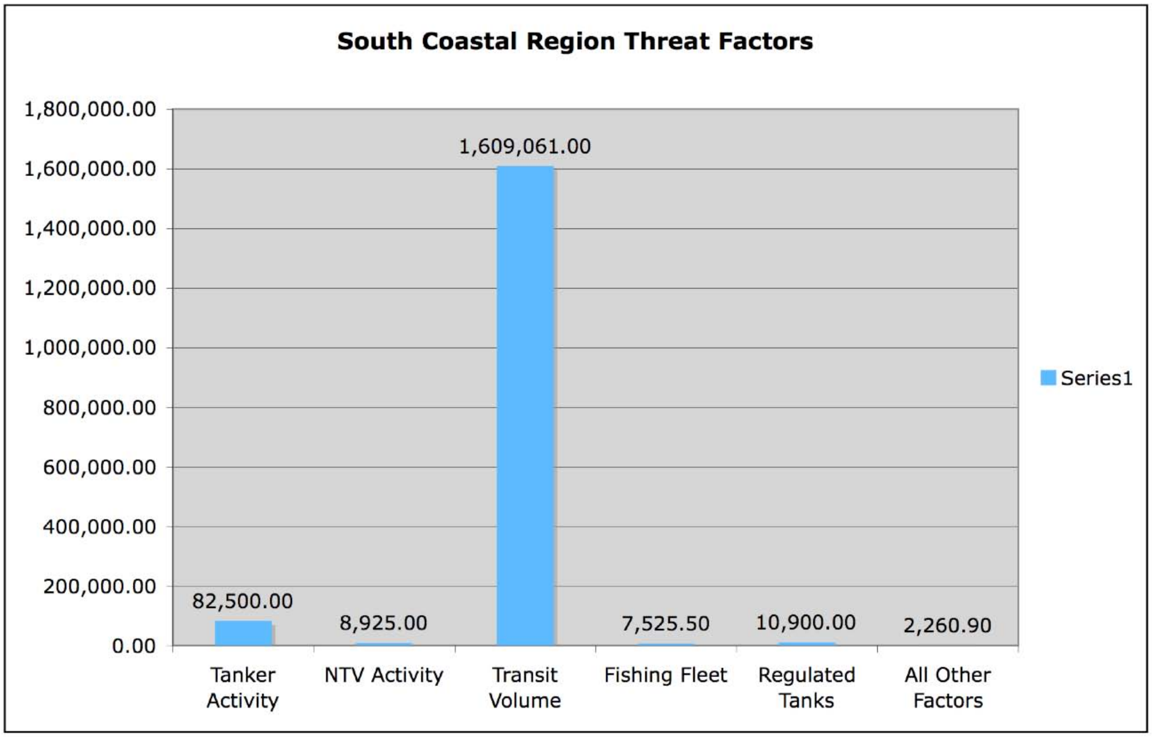
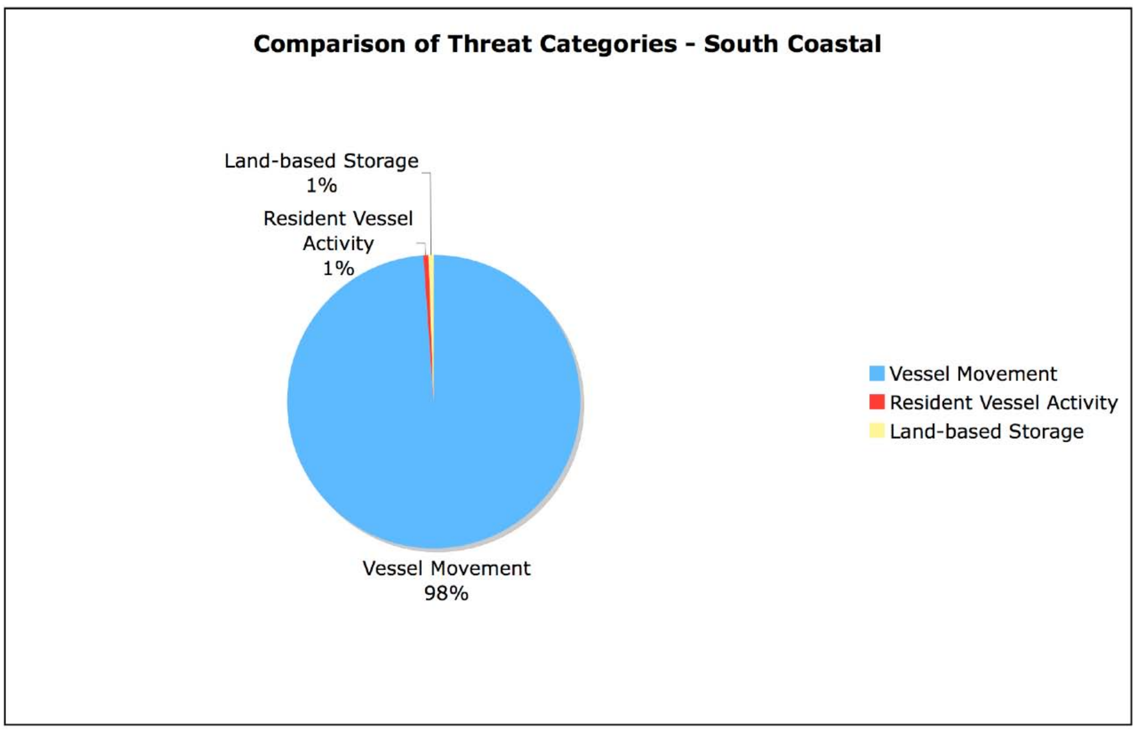


Figure 5.29 Comparative Oil Spill Threat Levels within South Coastal Region by Threat Category



[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

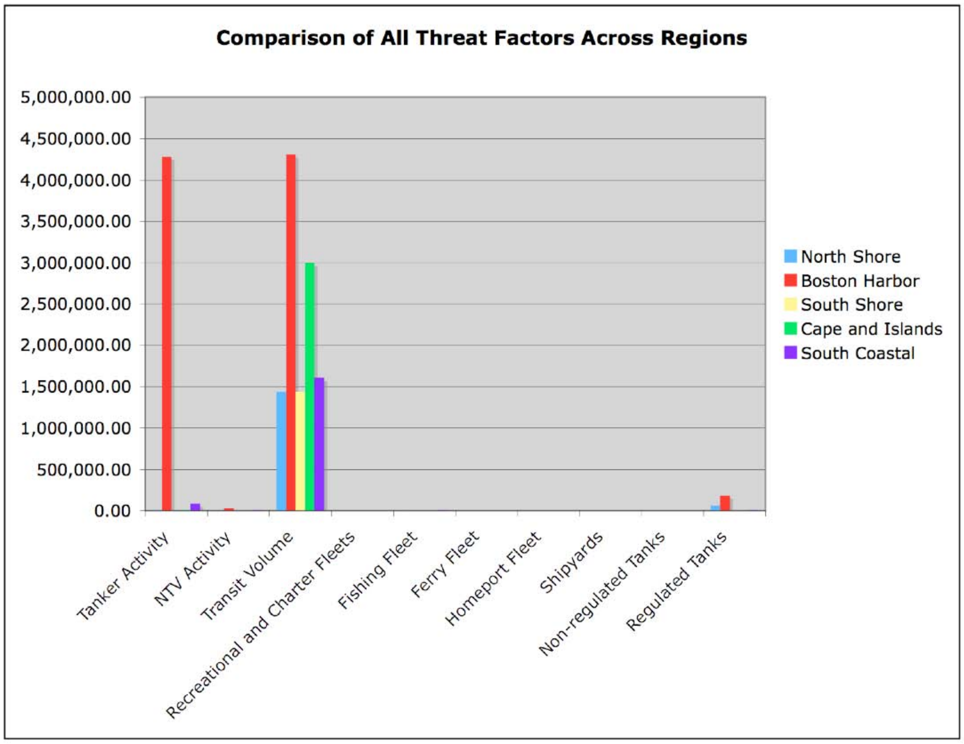
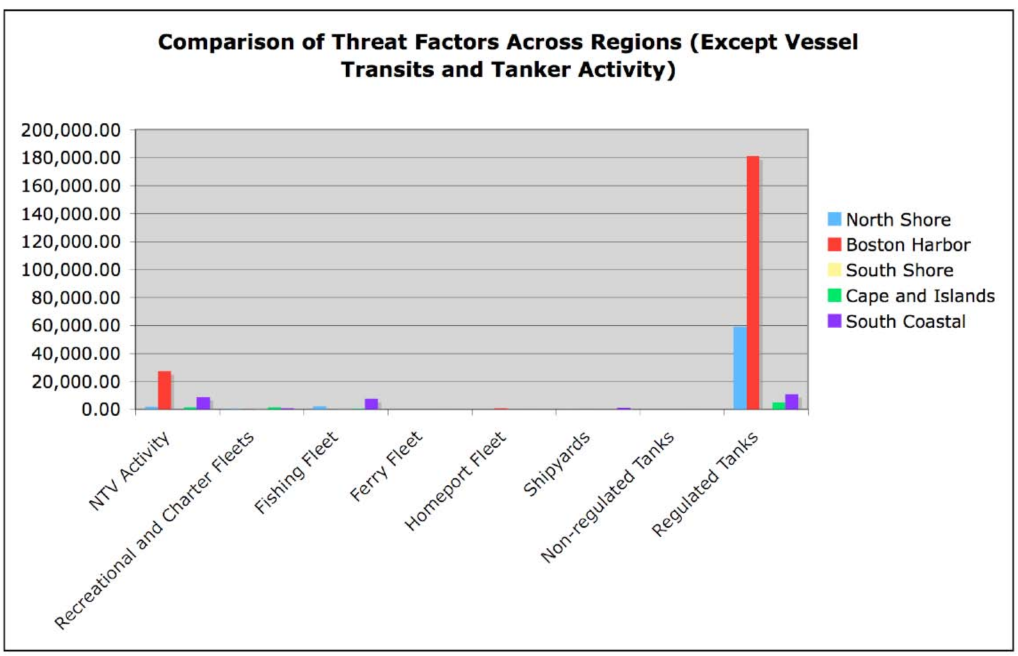


Figure 5.31 Comparison of Estimated Gallons of Petroleum Exposure (000)[37] for all Threat Factors Across Regions, Excluding Transit Volume and Tanker Activity



[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

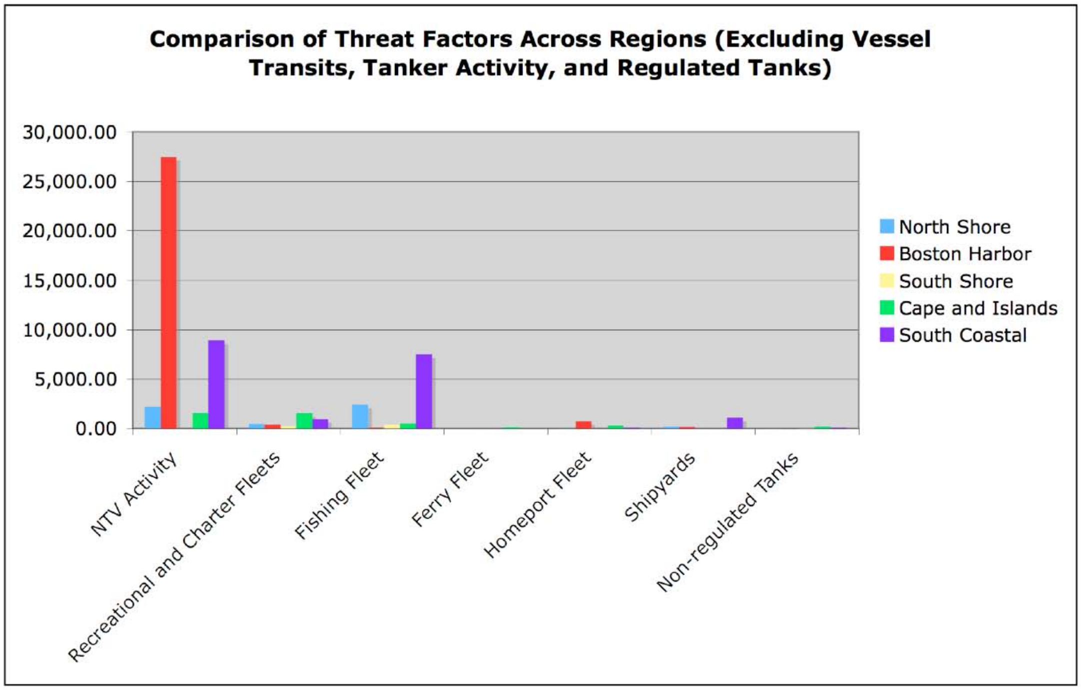
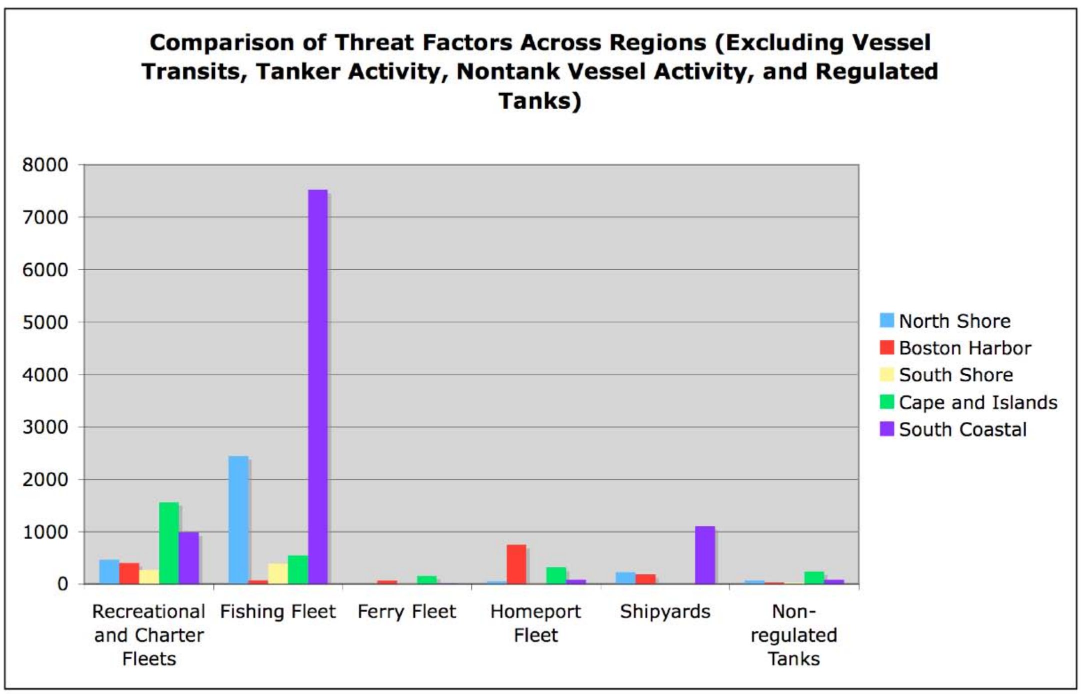
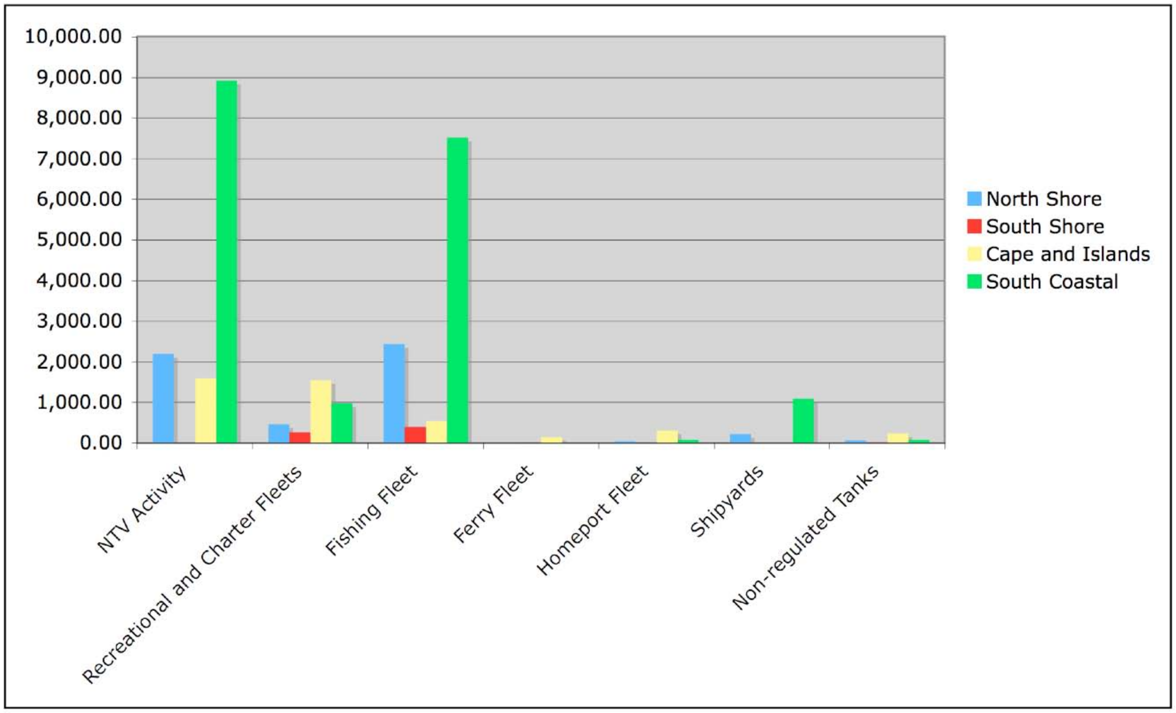


Figure 5.33 Comparison of Estimated Gallons of Petroleum Exposure (000)[39] for all Threat Factors Across Regions, Excluding Transit Volume, Tanker Activity, Nontank Vessel Activity, and Regulated Tanks



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

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

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.

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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?	

1 of 3

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?	

APPENDIX 11

New Bedford Harbor
Navigational Dredge – Phase III, Part A

State Enhanced Remedy – Performance Standards

I MADEP 401 Water Quality Program Standards:

1. Anti-degradation provisions of the Massachusetts Surface Water Quality Standards protect all waters, including wetlands. The Contractor shall take all steps necessary to assure that the proposed activities will be conducted in a manner, which will avoid violations of said standards.

2. Prior to the start of in-water work, the SER Project Manager (SER PM) shall be notified of any proposed change(s) in plans that may affect waters or wetlands.

3. As proposed, silt-curtains and absorbent booms shall be deployed to enclose the area being dredged. The contractor's plan for deployment of the silt curtains/absorbent booms shall be submitted to the SER PM for review prior to the start of in-water work. Should the deployment of silt-curtains prove not feasible or be unsuccessful, the SER PM will be notified prior to any dredging without silt curtains.

4. Water Quality Monitoring:

   a. **When the dredging operation is contained within a silt-curtained area,** the following water-quality monitoring program shall be carried out daily for the first three days of dredging and once a week thereafter:
      i. A reference location shall be established outside of and approximately 200-feet from the silt-curtained area and a monitoring location shall be established outside of and within 15-feet of the silt-curtain.
      ii. Turbidity shall be measured, using an optical backscatter sensor, at both the reference and monitoring locations, at established depths: near the water's surface, at the mid-point of the water column and near the bottom. The three values obtained shall be averaged, such that a single, representative turbidity value is calculated for the monitoring site and a single, representative value is calculated for the reference site.
      iii. Turbidity shall be measured at both the monitoring and reference site prior to the start of dredging, and once every two hours during dredging.
      iv. An exceedance of the project turbidity standard shall be attributed to project activities when the average turbidity at the monitoring site exceeds the average reference site turbidity plus the permissible turbidity increase, as outlined in the following table:

Reference Site Turbidity (NTUs)	Permissible Turbidity Increase
<10	Reference plus 20 NTUs
11-20	Reference plus 15 NTUs
>21	Reference plus 30% of reference

v. If, in two consecutive monitoring events, the average turbidity at the monitoring site exceeds the average turbidity at the reference site by more than the permissible turbidity increase, then water samples, composited over the entire water column, from both the monitoring and reference sites shall be collected and submitted for analysis of Total Suspended Solids, dissolved PCBs, arsenic, cadmium, copper, chromium, lead, mercury, nickel, and zinc. When samples are submitted to the laboratory, a 36-hour turn-round time shall be requested. Additionally, the Proponent, or their contractor, shall take operational action(s) designed to limit such exceedences, such as increasing the dredge cycle time, inspection and any necessary repair, of the silt curtains, deployment of an additional row of silt curtains or other mitigation measures. Turbidity monitoring shall continue on the schedule outlined in Section 6.a.iii, until compliance is reestablished.

vi. If compliance can not be reestablished within 48 hours, dredging shall cease and Department and any other interested local, state, or federal agency staff, in consultation with the Proponent, their contractors and/or consultants shall review the operational actions undertaken, the results of the analyses of the water samples and evaluate the biological significance of the available data and determine the requirements for additional mitigation, if any.

b. **Should the deployment of silt-curtains prove not possible or be unsuccessful,** the following water-quality monitoring program shall be carried out daily for the first three days of dredging and twice a week thereafter:

i. A reference location shall be established approximately 200-feet up-current from the dredge and a monitoring location shall be established 200-feet down-current from the dredge.

ii. Turbidity shall be measured, using an optical backscatter sensor, at both the reference location and the monitoring location, at established depths: near the water's surface, at the mid-point of the water column and near the bottom. The three depth values obtained shall be averaged, such that a single, representative turbidity value is calculated for the reference location and a single, representative turbidity value is calculated for the monitoring location.

iii. Turbidity shall be measured at both the reference location and at the edge of the mixing zone prior to the start of dredging, and once every two hours of dredging.

iv. An exceedance of the project turbidity standard shall be attributed to project activities when the average turbidity at the edge of the mixing zone exceeds the reference site turbidity plus the permissible turbidity increase, as outlined in the following table:

Reference Site Turbidity (NTUs)	Permissible Turbidity Increase
<10	Reference plus 20 NTUs
11-20	Reference plus 15 NTUs
21-30	Reference plus 10 NTUs
>31	Reference plus 30% of reference

v. If, in two consecutive monitoring events, the average turbidity at the edge of the mixing zone exceeds the average turbidity at the reference site plus the permissible turbidity increase, then water samples, composited over the entire water column, from both the reference location and the edge of the mixing zone shall be collected and submitted for analysis of Total Suspended Solids, dissolved PCBs, arsenic, cadmium, copper, chromium, lead, mercury, nickel, and zinc. When samples are submitted to the laboratory, a 36-hour turn-round time shall be requested. Additionally, the Proponent, or their contractor, shall take operational action(s) designed to limit such exceedences, such as increasing the dredge cycle time, inspection and any necessary repair, of the silt curtains, deployment of an additional row of silt curtains or other mitigation measures. Turbidity monitoring shall continue on the schedule outlined in Section 6.b.iii, until compliance is reestablished.

vi. If compliance cannot be reestablished within 48 hours, dredging shall cease and the Department and any other interested local, state or federal agency staff, in consultation with the Proponent, their contracts and/or consultants shall review the operational actions undertaken, the results of the analyses of the water samples and evaluate the biological significance of the available data and determine the requirements for additional mitigation, if any.

5. As proposed, dredging of contaminated, silty sediment shall be done using a closed, environmental, clamshell bucket. Where pilings or other debris are found to interfere with environmental bucket closure or equipment operation, a conventional clamshell bucket may be used to extract the pilings/debris. Sediment removal during such activity shall be minimized to the greatest extent practicable. Should dredging with the environmental bucket become unfeasible or unsuccessful, the SER PM must be notified prior to any contaminated sediment dredging not using the environmental bucket, and the contractor must also continue to meet the project water quality standard performance standards.

6. Water discharged from the barge shall be appreciably free of suspended sediment and meet the water quality criteria established in Section 4 (above). Any free liquid

flowing from the barge in the harbor shall be passed through a sand media filter or equivalent filtration system (which must be approved by the project Resident Engineer) prior to discharge.

7. Diesel-powered equipment shall be fitted with after-engine emissions controls such as oxidation catalysts or particulate filters.

8. Within 30 days of the completion of the initial dredging, a bathymetric, survey of the dredge footprint, depicting post-dredge conditions, shall be sent to the MADEP SER Project Manager.

9. Disposal of any volume of dredged material at any location in tidal waters is subject to approval by the Department and the Massachusetts Coastal Zone Management office.

II MADEP Chapter 91 Waterways Standards:

1. Acceptance of these Waterways Conditions shall constitute an agreement by the Proponent to conform to all terms and conditions herein.

2. All subsequent maintenance dredging and transportation and disposal of this dredge material, during the term of this Project shall conform to all standards and conditions applied to the original dredging operation performed under this Project.

3. After completion of the work authorized, the Proponent shall furnish to the Department a suitable plan showing the depths at mean low water over the area dredged. Dredging under this Project shall be conducted so as to cause no unnecessary obstruction of the free passage of vessels, and care shall be taken to cause no shoaling. If, however, any shoaling is caused, the Proponent shall at his/her expense, remove the shoal areas. The Proponent shall pay all costs of supervision, and if at any time the Department deems necessary a survey or surveys of the area dredged, the Proponent shall pay all costs associated with such work.

4. The Proponent shall assume and pay all claims and demands arising in any manner from the work authorized herein, and shall save harmless and indemnify the Commonwealth of Massachusetts, its officers, employees, and agents from all claims, audits, damages, costs, and expenses incurred by reason thereof.

5. The Proponent shall, at least three days prior to the commencement of any dredging in tide water, give written notice to the Department of the time, location, and amount of the proposed work.

Special Waterways Conditions

1. Dredge material shall be transported to suitable disposal facilities; unregulated dumping of dredge materials is not permitted.

2. The Proponent shall develop and implement a Navigation Plan to address and mitigate temporary impacts to navigation during dredging activities.

3. The Proponent shall provide and maintain in good working order appropriate United States Coast Guard (USCG) approved navigation aids to assist mariners in avoiding work areas as required by the USCG.

4. The Proponent shall maintain vehicular access to water-dependent users throughout construction activities.

5. The Proponent shall remove and properly dispose of all temporary structures no later than three (3) months after completion of the dewatering and amendment of the sediments. Temporary structures are defined as berms and dikes; lime silo; dewatering tanks, erosion and sediment control systems, pipes, and siltation curtains.

6. Modification to this Project: the SER PM, may review on an individual basis, modifications to construction activities and/or temporary structures which represent and insignificant deviation from original specifications, in terms of configuration, materials or other relevant design or fabrication parameters as determined by DEP within all areas of construction. Such review shall be in accordance with the following procedure:
    a. The Proponent shall submit a written request describing the proposed modifications to the work accompanied by plans, for prior review of the DEP. The DEP will consider comments submitted within ten (10) days of the DEP's receipt of the request. The DEP will send any significant modifications to the Resource Agencies for review and comment and to identify any future Performance Standards, if necessary. EPA will also have the opportunity to make a consistency determination if the change is significant, as necessary. The DEP will notify the Resource Agencies of any minor modifications.

7. After completion of the work authorized the Proponent shall furnish the Department a suitable plan showing the depths at mean low water over the areas dredged within 90 days of completion if each phase of the dredging.