# Summary of marine mammal observations during 2012 surveys

Massachusetts Water Resources Authority
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# SUMMARY OF MARINE MAMMAL OBSERVATIONS DURING 2012 SURVEYS

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## 1.0 Introduction

At least five endangered species of whales are known to visit or inhabit the Massachusetts and Cape Cod Bay area (Environmental Protection Agency [EPA] 1993): the right whale, humpback whale, finback whale, and the rarely observed sei and blue whales. Several non-endangered marine mammal species are also found: minke whales, pilot whales, harbor porpoises, Atlantic white-sided dolphins, white beaked dolphins, hooded seals, harp seals, gray seals, and harbor seals.

Since 1995, Massachusetts Water Resources Authority (MWRA) has included marine mammal observers on monitoring surveys. The MWRA surveys are conducted as part of the long-term Harbor and Outfall Monitoring Project, designed to verify compliance with the discharge permit and to assess the potential environmental impact of treated sewage effluent discharge into Massachusetts Bay. These observers were included in response to a National Marine Fisheries Service (NMFS) request that MWRA provide observational data and set a positive example by using observers to minimize the chances of collision with a right whale. In addition to looking for right whales, observers noted other marine mammals. On surveys where observers were not present, the chief scientist and field crew documented any incidental sightings of marine mammals.

Marine mammal observers were present on all effluent outfall water quality surveys in Massachusetts Bay during 2012. Observers were not present on Boston Harbor surveys, floatable debris surveys, and bacteria surveys for shellfish water quality monitoring.

## 2.0 Background

A brief description of when marine mammals are expected to be found in Massachusetts and Cape Cod Bays follows.

The right whale (*Eubalaena glacialis*) is critically endangered. Based on historical sightings, right whales can be expected to visit Massachusetts and Cape Cod Bays throughout the year (Brown *et al.* 2002), with peak abundance in February, March and early April (Hamilton and Mayo 1990). Approximately 70% of the catalogued population of right whales have been reported to visit Cape Cod Bay and Massachusetts Bay (Brown *et al.* 2002), and NMFS has designated the Bays as an "area of high use" (NMFS 2013a). The use of the eastern portion of Stellwagen Bank/Wildcat Knoll by right whales has been noted during extended surveys by the Provincetown Center for Coastal Studies (PCCS) (Brown *et al.* 2002). The total population of right whales in the western Atlantic Ocean is estimated to be about 400 individuals (NMFS 2013a).

The humpback whale (*Megaptera novaeangliae*) is an endangered species of whale known to feed within the Gulf of Maine in the spring, summer and fall (Waring *et al.* 1999). In the winter, some, but not all, humpbacks will migrate to mating and calving grounds in the West Indies (NMFS 2013a). Historic records indicate that humpbacks have been documented on Stellwagen Bank from April through December (CeTap 1982; Geraci et al. 1989; NMFS 1991). However, distribution appears to correlate with prey densities (Waring *et al.* 1999). The amount of humpback whale use of the Stellwagen area varies periodically most likely based on the availability of sand lance as prey (Payne *et al.* 1986; Payne *et al.* 1990; Weinrich *et al.* 1997). The best available estimate of the humpback population in the western Atlantic is about 11,500 individuals (NMFS 2013a).

The finback (or fin) whale (*Balaenoptera physalus*) is considered to be an endangered species and is the most abundant and frequently sighted of the endangered whales that visit Massachusetts and Cape Cod Bays (EPA 1993). Finbacks are sighted year round in the Stellwagen Bank area with a peak abundance occurring between the spring and fall (Pett and McKay 1990). Finbacks do also migrate, potentially from

the North Atlantic to the West Indies, but migratory routes are unknown. Insufficient data exists to determine population trends of the western North Atlantic population, but the minimum number of individuals is estimated at 1,678 whales (NMFS 2013a).

The sei whale (*Balaenoptera borealis*) and blue whale (*Balaenoptera musculus*) are both endangered species (EPA 1993). The sei whale is uncommon but is regularly sighted (Schilling *et al.*1992), while the blue whale is rarely sighted in Massachusetts and Cape Cod Bays (EPA 1993). For blue whales, Massachusetts and Cape Cod Bays may represent the southern limit of their feeding area (NMFS 2013a). Both blue and sei whales typically remain in deeper water (more than 100 meters) and further offshore (CeTap 1982). However, sightings of these species in coastal areas may correspond to changes in prey distribution (Payne *et al.* 1990, Wenzel *et al.* 1988). In general, though, the large-scale distribution and movement patterns of sei whales are not well known. There are no current population estimates for sei whales, although the North Atlantic population seems to be "relatively abundant" (NMFS 2013a) after intensive whaling in the 19$^{th}$ and 20$^{th}$ centuries. An estimated 400-600 blue whales reside in all of the North Atlantic (NMFS 2013a).

The minke whale (*Balaenoptera acutorostrata*) is a non-endangered species typically seen in the Stellwagen Bank area during the spring, summer and fall (CeTap 1982; Pett and McKay 1990). During the winter, minke whale sightings in New England appear to decline dramatically (Waring *et al.* 1999). For management purposes, New England minke whales are known as the Canadian Eastern Coastal Stock, with an estimated 2,500-3,000 individuals. Insufficient data exists for analysis of population trends (NMFS 2013a).

The Atlantic white-sided dolphin (*Lagenorhynchus acutus*) is a species of dolphin found from central west Greenland to North Carolina (Waring *et al.* 1999). The Gulf of Maine stock of Atlantic white-sided dolphins is classified as strategic by the National Marine Fisheries Service (Waring *et al.* 1999). Sightings of these dolphins in the Stellwagen Bank and Cape Cod Bay areas are common in the spring, summer (Weinrich *et al.* 2001), and, to a lesser extent, the fall (Pett and McKay 1990). The western Atlantic population is estimated at 63,000 individuals, with insufficient information to determine population trends (NMFS 2013a).

The Atlantic pilot whale or long-finned pilot whale (*Globicephala melas)* is the largest species of dolphin found in cool temperate waters off Labrador, Newfoundland, and in the St. Lawrence River with sporadic sightings as far south as Maryland and Virginia (Bulloch 1993). Pilot whales form schools of a few to many hundreds of individuals and are mainly found relatively close to shore. Pilot whale distribution and abundance appear to be linked to sea floor topography and the abundance of squid, their primary food source (Harrison and Bryden 1989). Population estimates of the long-finned pilot whale in the western North Atlantic range from 25,000 to 31,000 individuals. Note that this estimate includes short-finned pilot whales (*Globicephala macrorhynchus*), a different species that is almost visually indistinguishable from long-finned pilot whales in the field (NMFS 2013a).

The gray seal (*Halichoerus grypus*) is a non-endangered species of pinniped found from Maine to Long Island Sound (Rough 1995). A small, year round breeding population is known to occur on outer Cape Cod and Nantucket Island (Waring *et al.* 1999). The majority of gray seal sightings in Cape Cod Bay and the Stellwagen Bank area occur during the winter and spring, although periodic sightings have been recorded in the summer (PCCS unpublished data). Current population in the western North Atlantic is estimated at about 250,000 individuals. Most recent surveys seem to indicate that population is increasing after a long period of decline due to hunting for both subsistence and fur (NMFS 2013a).

Harbor porpoises (*Phocoena phocoena*) of the Gulf of Maine/Bay of Fundy stock are classified as strategic by the National Marine Fisheries Service (Waring *et al.* 1999). Historic data indicate that harbor

porpoises can be found in the Stellwagen Bank area and Cape Cod Bay from December through June (Pett and McKay 1990). A 2006 aerial survey of the Gulf of Maine/Bay of Fundy stock estimated 89,054 individuals. No population trend analysis has been performed (NMFS 2012).

The harbor seal (*Phoca vitulina*) is a non-endangered species of pinniped commonly found in the near shore waters around New England (Katona *et al*. 1993). Harbor seals are most frequently seen in the Stellwagen Bank and Cape Cod Bay areas in the winter and early spring with sightings beginning in late September (Pett and McKay 1990). No surveys of population have been conducted since 2001 but between the passage of the Marine Mammal Protection Act in 1972 and the 2001 survey populations in New England waters have increased (NMFS 2013b).

## 3.0 Methods

Figure 1 shows MWRA effluent outfall ambient monitoring water column sampling stations. The year 2012 was the second year the second revision of the ambient monitoring plan design was implemented (MWRA 2010). The revised design focuses more on stations likely to be impacted by the outfall; there are fewer distant reference stations. The total number of outfall monitoring stations was reduced from 33 to 14. Also, the number of annual surveys was changed from 12 nearfield and six farfield to nine surveys of all 14 stations. These changes have meant that the surveys are generally completed in a single day while previously multiple days were needed to accomplish the farfield surveys. Thus, there is less time to observe marine mammals than under the previous survey plan. In addition, except for the *Alexandrium* surveys, MWRA's marine mammal observations no longer include the areas where whales are most frequently found (Stellwagen Bank National Marine Sanctuary and Cape Cod Bay). Those areas are monitored specifically for marine mammals under separate non-MWRA research programs.

Marine mammal observations were performed during all daylight hours while transiting between stations during water column surveys, and while the vessel was on-station for sampling operations. During vessel transits, the observer continuously scanned the sea surface from directly ahead to 90 degrees abeam on either side of the vessel. Initial sightings were made by eye with confirmation and identification aided by binoculars. While on-station, the observer scanned 360 degrees around the vessel. The observer was typically positioned at the highest secure vantage point of the survey vessel. Weather conditions, safety of the observer, and limiting interference with the operation of the vessel and sampling team were all factors that influenced the position of the observer on board the vessel.

Multiple survey vessels were used as observation platforms during the course of the year. The observer's eye-height above the sea surface was approximately 4 meters on the R/V *Tioga* and R/V *Andy Lynn VI* and 2.5 meters aboard the R/V *Aquamonitor*. Observations were conducted 40 minutes out of every hour and were suspended when visibility was reduced to zero or when darkness occurred. The vessels R/V *Auk* and R/V *Tioga* were also used for surveys with onboard marine mammal observers.

For some surveys, dedicated marine mammal observers were not present. The scientific crew on board the R/V *Merganser* and R/V *Aquamonitor* observed marine mammals while on these surveys. These vessels were used to conduct MWRA Boston Harbor surveys and some other nearfield, farfield, and *Alexandrium* rapid response surveys (Figures 2 and 3). Similar to previous years, data from those surveys are included in this report.

Vessel track, station sequence, and number of stations varied among cruises, due to the constraints of weather, special survey requirements, or both.

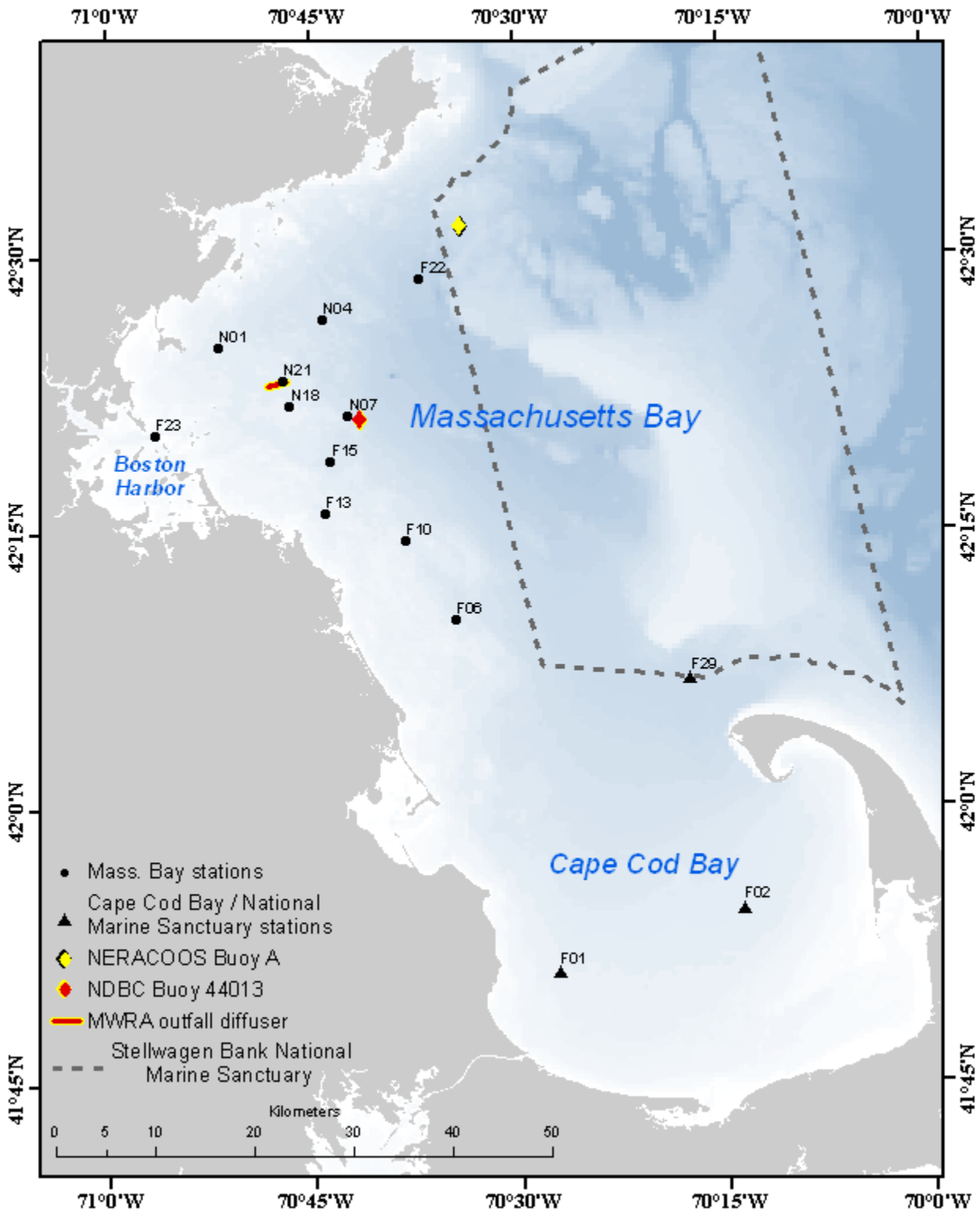


**Figure 1. MWRA effluent outfall water column monitoring stations.**

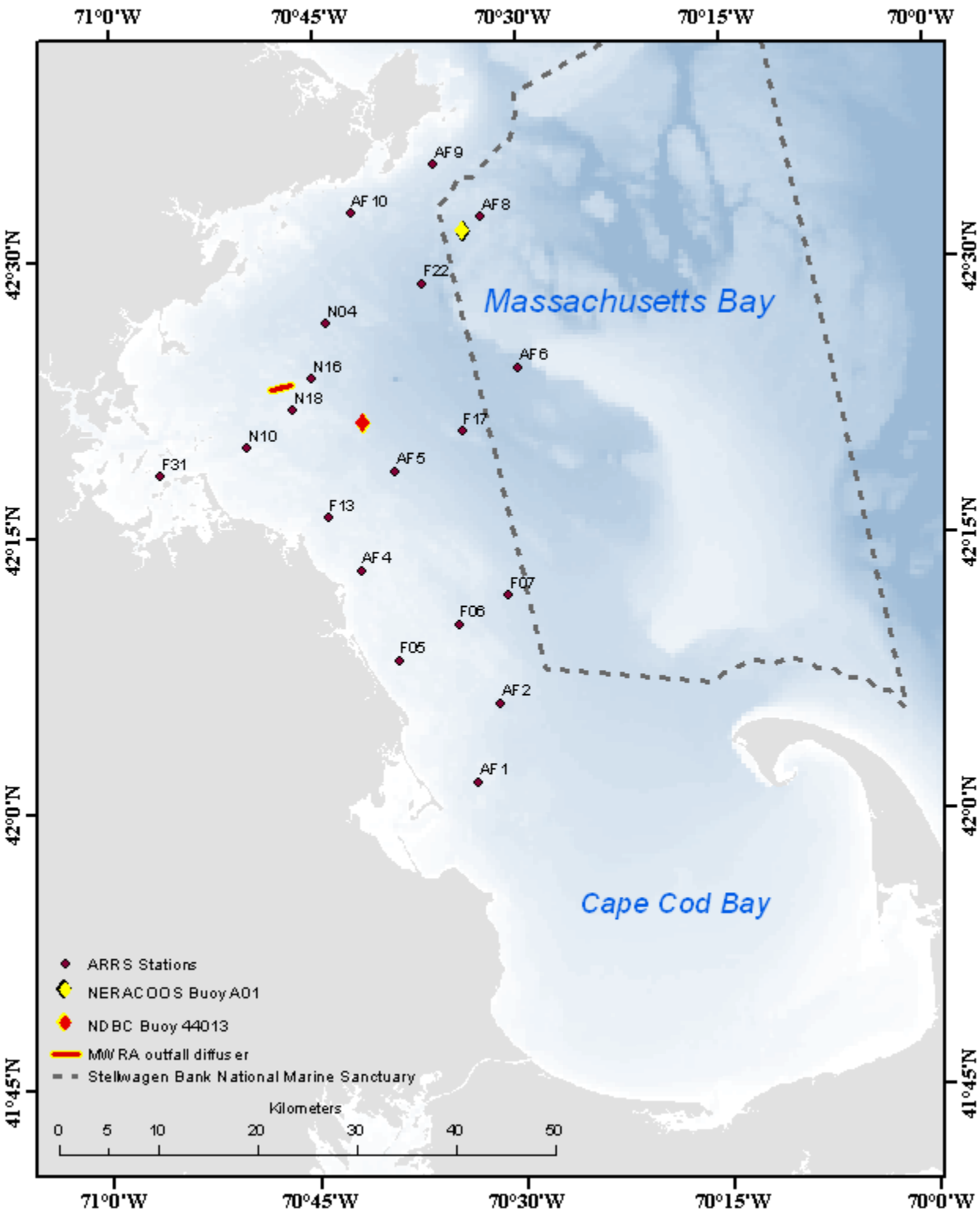


**Figure 2. MWRA *Alexandrium* monitoring stations**

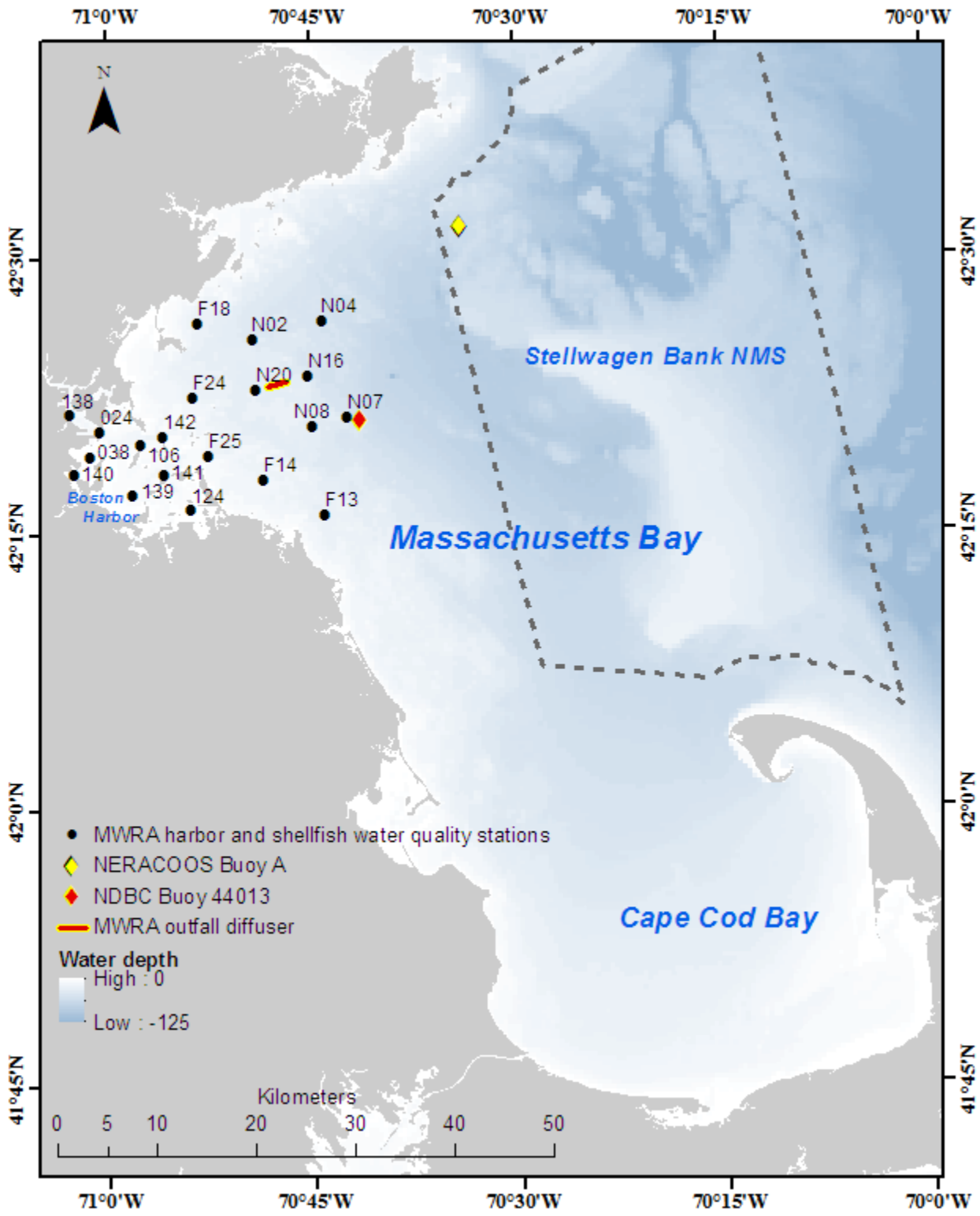


**Figure 3. MWRA Boston Harbor and shellfish-growing water quality monitoring stations**

## 4.0 Results

Observation of marine mammals on surveys designed and operated for the collection of water quality data places limitations and constraints on the method of observation and on the conclusions that may be drawn from the data. Standard line transect methodology is not possible on such surveys, and different vessels (which vary the characteristics of the survey platform) were used during the year. Therefore, it is not appropriate to use these opportunistic sightings to estimate animal abundance. The data provide useful qualitative information concerning seasonal patterns and relative abundance within the same study area.

During the 2012 monitoring year, there were nine effluent outfall ambient monitoring surveys (WN) and three *Alexandrium* surveys (AF), two floatables surveys (MD), 138 Boston Harbor water quality surveys, and thirteen Massachusetts Bay shellfish water quality monitoring surveys. Observers were present on the nine effluent outfall ambient monitoring surveys. Survey team members counted six individual whales including one North Atlantic right whale, one humpback whale, one minke whale, and three unidentified whales. Also counted were approximately 14+ Atlantic white-sided dolphins, 6 harbor porpoises, and 69 harbor seals. Tables 1 and 2 summarize the locations and dates of all MWRA's sightings of whales, pinnipeds and dolphins in 2012. The locations of whale sightings are shown in Figure 4.

**Table 1. Year 2012 effluent outfall ambient monitoring surveys and *Alexandrium* surveys when marine mammals were sighted.**

| Survey ID | Date/Time | Number | Mammal | Location | Sighting Comments | Observer Present |
|---|---|---|---|---|---|---|
| WN121 *R/V Tioga* | 2/6/12 1525 | 1 | Harbor seal | 42.3473, -70.9378 | On rock NE of Lovell Island | Yes |
| WN122 *R/V Aquamonitor* | 3/20/12 0615 | 1 | Harbor seal | 42.2473, -70.9613 | Between blue fin dock and F23 | Yes |
| | 3/20/12 0634 | 1 | Harbor seal | 42.2842, -70.9298 | Between blue fin dock and F23 | Yes |
| | 3/20/12 0705 | 1 | Harbor seal | 42.3388, -70.943 | Between F23 and N01 | Yes |
| | 3/20/12 0726 | 1 | Harbor seal | 42.368, -70.909 | Between F23 and N01 | Yes |
| | 3/20/12 0814 | 1 | Harbor porpoise | 42.4235, -70.8433 | Between N01 and N04 | Yes |
| | 3/20/12 0836 | 1 | North Atlantic right whale | 42.4413, -70.7578 | Between N01 and N04 | Yes |
| | 3/20/12 0836 | 1 | Humpback whale | 42.4413, -70.7578 | Between N01 and N04 | Yes |
| | 3/20/12 0840 | 1 | North Atlantic right whale | 42.4425, -70.7367 | Same as 8:36 animal | Yes |
| | 3/20/12 0840 | 1 | Humpback whale | 42.4425, -70.7367 | Same as 8:36 animal | Yes |
| | 3/20/12 0935 | 10+ | Atlantic white-sided dolphin | 42.4711, -70.6467 | Between F22 and N21 | Yes |
| | 3/20/12 0935 | 2 | Atlantic white-sided dolphin | 42.4793, -70.626 | Between F22 and N21 | Yes |
| | 3/20/12 1010 | 2+ | Atlantic white-sided dolphin | 42.4443, -70.6725 | Small group | Yes |
| | 3/20/12 1026 | 1 | Harbor porpoise | 42.4071, -70.7415 | Between F22 and N21 | Yes |
| | 3/20/12 1522 | 17 | Harbor seal | 42.313, -70.9143 | On Toddy Rock, N side of Hull | Yes |
| | 3/20/12 1522 | 3 | Harbor seal | 42.313, -70.9143 | On rocks, SE side of George's Island | Yes |
| WN123 *R/V Aquamonitor* | 4/10/12 0650 | 4 | Harbor seal | 42.3402, -70.9383 | At F23 | Yes |
| | 4/10/12 1520 | 1 | Harbor seal | 42.2567, -70.9495 | In water swimming | Yes |
| AF122 *R/V Aquamonitor* | 5/30/12 1223 | 1 | Minke whale | 42.3221, -70.6187 | In transit from F17 to AF5 | No |
| WN127 *R/V Aquamonitor* | 8/21/12 0928 | 1 | Harbor porpoise | 42.4522, -70.6613 | In transit from N04 to F22 | Yes |
| WN128 *R/V Aquamonitor* | 9/6/12 1048 | 1 | Harbor seal | 42.3558, -70.7155 | In transit from N07 to N18 | Yes |

**Table 2. Year 2012 Boston Harbor and Massachusetts Bay shellfish water quality monitoring surveys when marine mammals were sighted.**

| Survey ID | Date/Time | Number | Mammal | Location | Sighting Comments | Observer Present |
|---|---|---|---|---|---|---|
| WQM2012 *R/V Merganser* | 1/5/12 1130 | 1 | Unidentified whale | 42.3705, -71.0515 | Station 014 | No |
| | 1/5/12 1200 | 1 | Harbor seal | 42.3845, -71.0483 | Under Tobin Bridge | No |
| CSO2012 *R/V Merganser* | 1/27/12 0926 | 1 | Harbor seal | 42.384, -71.0298 | Station 027 | No |
| WQM2012 *R/V Merganser* | 2/16/12 0830 | 1 | Harbor seal | 42.3868, -71.0628 | Station 137 | No |
| | 2/16/12 0944 | 1 | Harbor seal | 42.3557, -71.0359 | Off the Fish Pier | No |
| WQM2012 *R/V Merganser* | 3/7/12 1246 | 1 | Harbor seal | 42.3349, -70.9596 | Between station 106 and Deer Island | No |
| CSO2012 *R/V Merganser* | 3/14/12 0727 | 1 | Harbor seal | 42.2861, -71.0372 | Near station 042 | No |
| WQM2012 *R/V Merganser* | 3/19/12 0710 | 1 | Harbor seal | 42.3512, -71.0229 | Inner Harbor | No |
| | 3/19/12 0720 | 1 | Harbor seal | 42.3617, -71.0395 | Inner Harbor | No |
| PC124 *R/V Merganser* | 4/17/12 0800 | 3 | Harbor porpoises | 42.2734, -70.729 | Near station F13 | No |
| | 4/17/12 0840 | 2 | Unidentified whale | 42.3420, -70.6950 | Suspect humpback. Near station N07 | No |
| PC128 *R/V Merganser* | 8/20/12 1052 | 1 | Harbor seal | 42.4144, -70.8890 | Near Nahant | No |
| CSO2012 *R/V Merganser* | 9/4/12 0645 | 1 | Harbor seal | 42.3510, -71.0262 | Inner Harbor | No |
| CSO2012 *R/V Merganser* | 9/20/12 1024 | 1 | Harbor seal | 42.2762, -71.0458 | Neponset River | No |
| CSO2012 *R/V Merganser* | 9/25/12 0907 | 1 | Harbor seal | 42.3866, -71.0546 | Near mouth of Island End River | No |
| CSO2012 *R/V Merganser* | 10/4/12 0649 | 1 | Harbor seal | 42.3427, -71.0287 | Station 022 | No |
| WQM2012 *R/V Merganser* | 10/18/12 0639 | 1 | Harbor seal | 42.3665, -71.0449 | Inner Harbor | No |
| | 10/18/12 0757 | 1 | Harbor seal | 42.3357, -71.0033 | Near station 044 | No |
| WQM2012 *R/V Merganser* | 10/25/12 0821 | 1 | Harbor seal | 42.3194, -71.0171 | 100 yards from station 038 | No |
| | 10/25/12 0918 | 2 | Harbor seal | 42.2937, -70.9180 | Near Hull | No |
| | 10/25/12 0942 | 1 | Harbor seal | 42.3391, -70.9320 | 20 yards off station 142 | No |
| WQM2012 *R/V Merganser* | 11/20/12 0937 | 1 | Harbor seal | 42.3058, -71.0405 | Station 140 | No |
| | 11/20/12 1015 | 1 | Harbor seal | 42.359, -71.0448 | Off station 019 | No |
| PC12B *R/V Merganser* | 11/27/12 0756 | 1 | Harbor seal | 42.3, -70.8083 | Station F14 | No |
| | 11/27/12 0953 | 2 | Harbor seal | 42.4332, -70.7508 | Between station N04 and N20 | No |
| WQM2012 *R/V Merganser* | 12/3/12 0757 | 2 | Harbor seal | 42.3643, -71.0431 | Inner Harbor | No |
| | 12/3/12 0801 | 1 | Harbor seal | 42.369, -71.0464 | Inner Harbor | No |
| | 12/3/12 0927 | 1 | Harbor seal | 42.3443, -71.0088 | Near station 024 and Logan Airport | No |
| PC12C *R/V Merganser* | 12/4/12 1140 | 1 | Harbor seal | 42.3817, -70.8172 | Station N20 | No |
| WQM2012 *R/V Merganser* | 12/20/12 0941 | 2 | Harbor seal | 42.348, -71.0223 | Near mouth of Reserved Channel | No |
| | 12/20/12 0947 | 2 | Harbor seal | 42.3560, -71.0380 | Inner Harbor | No |
| | 12/20/12 1043 | 5 | Harbor seal | 42.3799, -71.0460 | Inner Harbor | No |

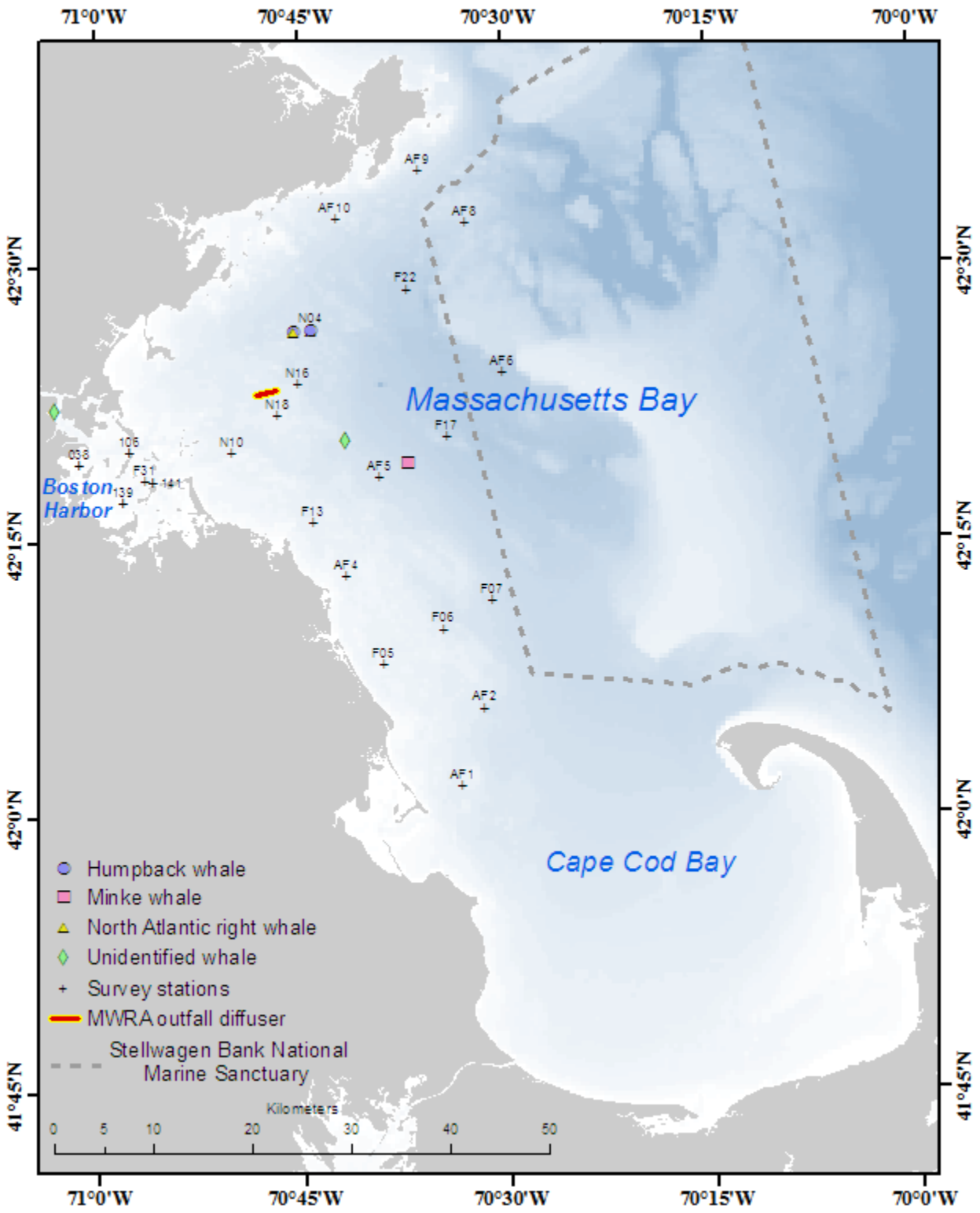


**Figure 4. Locations of whale sightings during 2012 surveys**

Note: The data displayed in this figure come from Tables 1 and 2 of this report.

## 5.0 Discussion

Unlike statistically-based programs or programs that are specifically designed to search for whales, the MWRA sightings are opportunistic and do not follow dedicated and systematic line transect methodology. Therefore, observations are descriptive and not a statistically robust population census. As noted above, the hours spent on the water have been substantially reduced since 2011 compared to previous years, and the prime whale habitats of Stellwagen Bank and Cape Cod Bay are no longer included in MWRA's marine mammal observations.

MWRA's previous marine mammal reports compared the sightings of species of whales across areas surveyed and years (e.g., Wu 2011, Table 3). Although not identical, the best historical comparisons for 2012 whale observations would be with the past nearfield (NF) observations. From 1998-2010 the 13-year NF observations were: right whales total = 0; humpback whales total = 3, range 0-2/year; finback whales total = 7, range 0-3/year; minke whales total = 24, range 0-4/year; unidentified whales total = 14, range = 0-5/year. In 2012, MWRA observed one each of North Atlantic right, humpback, and minke whales, and three unidentified whales, which with the exception of the right whale sighting, is in the range of previous NF observations. The right whale sighting in 2012 is the first in the nearfield. Table 3 summarizes the observations of 2012, 2011, and the historical period 1998-2010. Figure 5 displays the same information in graphical form.

**Table 3. Comparison of whale sightings in the nearfield from 1998 to 2012**

| Whale species | Total number of sightings (1998-2010) | Range of sightings per year (1998-2010) | 2011 | 2012 |
|---|---|---|---|---|
| Finback | 7 | 0-3 | 1 | 0 |
| Humpback | 3 | 0-2 | 0 | 1 |
| Minke | 24 | 0-4 | 5 | 1 |
| North Atlantic Right | 0 | 0-0 | 0 | 1 |
| Unidentified | 14 | 0-5 | 0 | 3 |

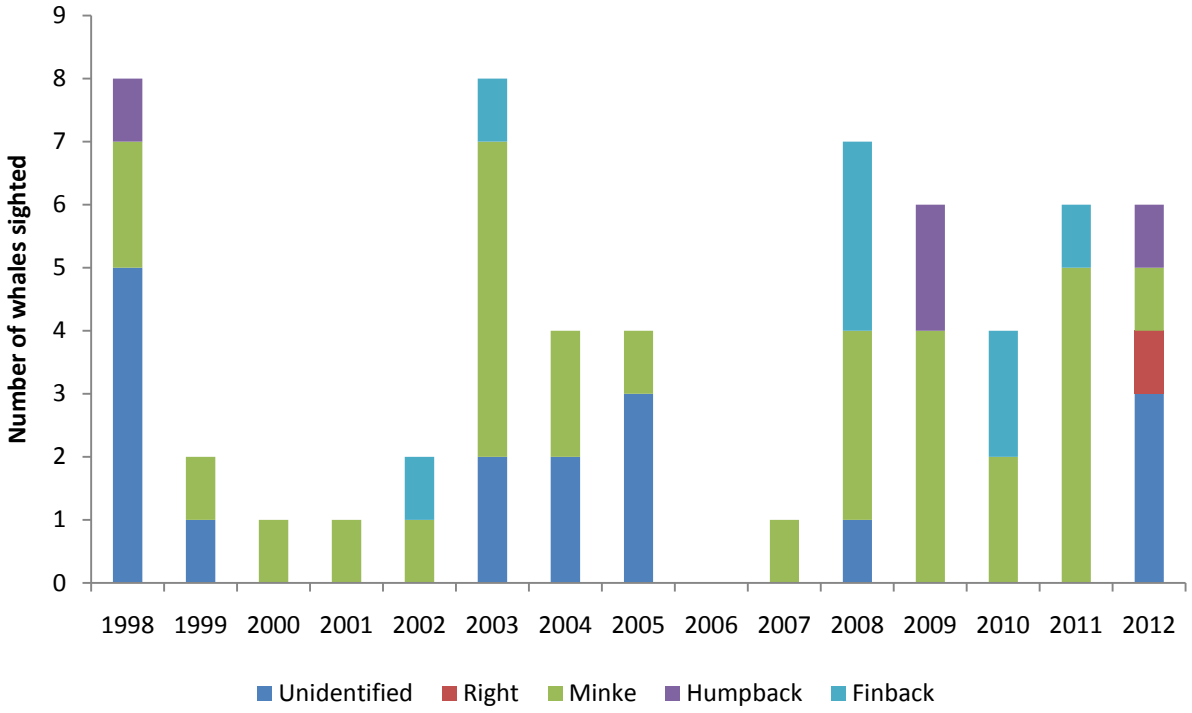


**Figure 5. Whale sightings in the nearfield (1998-2012)**

Most observations of seals are when the vessels are transiting to and from the outfall monitoring area or during Boston Harbor surveys. The seals were typically resting upon rocks. During 2012, 69 pinnipeds were sighted. All were harbor seals. These sightings were an increase from 2011 when 31 pinnipeds were reported. For comparison, the numbers for 2001 to 2010 ranged from 76 to 303/year. Before 2001, 20 to 60 pinniped sightings were made throughout the survey area.

Approximately 14+ Atlantic white-sided dolphins were sighted in 2012, in addition to six harbor porpoises.

MWRA no longer tabulates whale observations in Cape Cod Bay. Beginning in 2011, MWRA's Cape Cod Bay water quality monitoring is carried out by the PCCS, which has a long-standing scientific monitoring program for whales in Cape Cod Bay. Since 1998, PCCS has conducted systematic surveys of Cape Cod Bay and adjacent waters from January through mid-May. In 2010 PCCS (Stamieszkin *et al*. 2010) counted 163 different right whales identified using photographs. This number is comparable to sightings in 2007, 2008, and 2009. Half the individuals sighted in 2007 were seen again in the 2008 surveys, and 61% of the individuals seen in 2008 were spotted in 2009. From 2007 to 2010 at least 45% of the known right whale population has been sighted annually in the Cape Cod Bay, making it an important habitat for right whales (Stamieszkin *et al*. 2010, Leeney *et al*., 2008, 2009).

## 6.0 References

Brown MW, O Nichols, MK Marx, and JN Ciano. 2002. Surveillance monitoring and management of North Atlantic right whales (*Eubalaena glacialis*) in Cape Cod Bay, Massachusetts: 2002. Final report to Division of Marine Fisheries, Commonwealth of Massachusetts, and Massachusetts Environmental Trust, September, 2002. 28 pp.

Bulloch DK. 1993. The Whale-Watcher's Handbook: A Field Guide to the Whales, Dolphins, and Porpoises of North America. Lyons & Burford, New York, NY. 114 pp.

CeTAP. 1982. A Characterization of Marine Mammals and Turtles in the Mid- and North Atlantic Areas of the U.S. Outer Continental Shelf. Final Report of the Cetacean and Turtle Assessment Program, University of Rhode Island, Kingston, RI. U.S. Dept. of the Interior, Bureau of Land Management, Washington, DC. Contract AA551-CT-48. 450 pp.

Environmental Protection Agency. 1993. Assessment of Potential Impact of the MWRA Outfall on Endangered Species. Boston, MA: U.S. Environmental Protection Agency.

Geraci, J.R., Anderson, D.M., Timperi, R.J., Early, G.A., Prescott, J.H., and Mayo, C.A. 1989. Humpback whales (Megaptera novaeangliae) fatally poisoned by dinoflagellate toxin. J. Fish. Res. Bd. Canada 46: 1895-1898.

Hamilton PK, CA Mayo. 1990. Population characteristics of right whales (*Eubalaena glacialis*) observed in Cape Cod and Massachusetts Bays, 1978-1986. Reports of the International Whaling Commission (special issue) 12: 203-208.

Harrison R, MM Bryden. 1989. Whales, Dolphins and Porpoises. Weldon Owen Pty Limited, McMahons Point, Australia. 240 pp.

Katona SK, V Rough, DT Richardson. 1993. A Field Guide to Whales, Porpoises, and Seals from Cape Cod to Newfoundland. Smithsonian Institution Press. Washington, DC. 316 pp.

Leeney RH, K Stamieszkin, N Jaquet, CA Mayo, D Osterberg, and MK Marx. 2008. Surveillance, Monitoring and Management of North Atlantic Right Whales in Cape Cod Bay and Adjacent Waters – 2008. October 2008; 186pp, retrieved from http://www.coastalstudies.org/what-we-do/right-whales/rwreports.htm

Leeney RH, K Stamieszkin, CA Mayo, and MK Marx. 2009. Surveillance, Monitoring and Management of North Atlantic Right Whales in Cape Cod Bay and Adjacent Waters – 2009. November 2009; 324pp, retrieved from http://www.coastalstudies.org/what-we-do/right-whales/rwreports.htm

NMFS (National Marine Fisheries Service). 1991. Recovery Plan for the Humpback Whale (*Megaptera novaeangliae*). Report prepared by the Humpback Whale Recovery Team for the National Marine Fisheries Service, Silver Springs, MD. 105 pp.

NMFS. 2012. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2011. NOAA Technical Memorandum NMFS-NE-221. 330 pp. Retrieved from http://www.nmfs.noaa.gov/pr/sars/region.htm.

NMFS. 2013a. Website – "Marine Mammals – Office of Protected Resources" at http://www.nmfs.noaa.gov/pr/species/mammals/. Last accessed May 17, 2013.

NMFS. 2013b. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2012, volume 1. 425 pp. Retrieved from http://www.nmfs.noaa.gov/pr/sars/region.htm.

MWRA. 2010. Ambient monitoring plan for the Massachusetts Water Resources Authority effluent outfall revision 2. July 2010. Boston: Massachusetts Water Resources Authority. Report 2010-04.

Payne, PM, Nicolas, J.R., O'Brien, L., and Powers, K.D. 1986. The distribution of the humpback whale, *Megaptera novaeangliae*, on Georges Bank and in the Gulf of Maine in relation to densities of the sand eel, *Ammodytes americanus*. Fish. Bull. U.S.: 271-277.

Payne PM, DN Wiley, SB Young, S Pittman, PJ Clapham, JW Jossi. 1990. Recent fluctuations in the abundance of baleen whales in the southern Gulf of Maine in relation to changes in selected prey. Fishery Bulletin 88:687-696.

Pett, S, CJ McKay. 1990. Technical report on the resources and uses of Stellwagen Bank. In: The Resources and Uses of Stellwagen Bank. J.H. Archer (ed.). Urban Harbors Institute, University of Massachusetts, Boston. 66pp.

Rough V. 1995. Gray seals in Nantucket Sound, Massachusetts, winter and spring, 1994. Final report prepared for the U.S. Marine Mammal Commission. Contract No. T10155615. NTIS No. PB95-191391.

Schilling, M.R., Seipt, I., Weinrich, M.T., Frohock, S.E., Kuhlberg, A.K., and Clapham, P.J. 1992. Behavior of individually identified sei whales (*Balaenoptera borealis*) during an episodic influx into the southern Gulf of Maine in 1986. Fishery Bulletin 90: 749-755.

Stamieszkin K, L Ganley, CA Mayo, RH Leeney, and MK Marx. 2010. Surveillance, Monitoring and Management of North Atlantic Right Whales in Cape Cod Bay and Adjacent Waters – 2010. November 2010; 31pp, retrieved from http://www.coastalstudies.org/what-we-do/right-whales/rwreports.htm

Waring GT, DJ Lalka, PJ Clapham, S Swartz, MC Rossman, TVN Cole, KD Bisack , LJ Hansen. 1999. U.S. Atlantic marine mammal stock assessments-1998. NOAA Technical memorandum NMFS-NE-116.

Wenzel, F, DK Matilla, PJ Clapham. 1988. *Balaenoptera musculus* in the Gulf of Maine. Mar. Mamm. Sci. 4(2):172-175.

Weinrich, M., M. Martin, R. Griffiths, J. Bove, and M. Schilling. 1997. A shift in distribution of humpback whales, (*Megaptera novaeangliae*) in response to prey in the southern Gulf of Maine. Fishery Bulletin 95: 826-836.

Weinrich, M.T., C.R. Belt, and D. Morin. 2001. Behavior and ecology of the Atlantic white-sided dolphin (*Lagenorhynchus acutus*) in coastal New England waters. Marine Mammal Science 17: 231-248.

Wu D. 2011. Summary of marine mammal observations during 2010 surveys. Boston: Massachusetts Water Resources Authority. Report 2011-08. 16 p.


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