# Summary of marine mammal observations during 2003 surveys

Massachusetts Water Resources Authority

Environmental Quality Department
Report ENQUAD 2004-01

**Citation**

Short LM, Gagnon C, and Inglin DC. 2004. **Summary of marine mammal observations during 2003 surveys.** Boston: Massachusetts Water Resources Authority. Report ENQUAD 2004-01. 20 p.

# SUMMARY OF MARINE MAMMAL OBSERVATIONS DURING 2003 SURVEYS

*for*

**MWRA Harbor and Outfall Monitoring Project**

*submitted to*

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**April 30, 2004**

**Report No: 2004-01**

**Acknowledgements**

Marine mammal observers were individually contracted to assist Battelle in collecting the data contained in this report. The dedication and professionalism of David Silvia is appreciated.

Special thanks are extended to Mason Weinrich, Director of the Whale Center of New England and Moira Brown from the Center for Coastal Studies for their review and input of general whale sighting information in this report.

Thanks and appreciation are also extended to the captains, crews, and scientific personnel of the R/V *Aquamonitor,* F/V *Isabel*, F/V *Shanna Rose*, and F/V *Christopher Andrew* who assisted in the surveys.

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## 1.0 Introduction

At least five endangered species are known to visit or inhabit the Massachusetts and Cape Cod Bay area (EPA 1993): the right whale, humpback whale, finback whale, sei whale (rarely observed) and blue whale (rarely observed). Several non-endangered species are also found: minke whales, harbor porpoise, several dolphin species, gray seals, and harbor seals.

Since 1995, Massachusetts Water Resources Authority (MWRA) has included marine mammal observers on monitoring surveys. The MWRA surveys are being 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 conducted observations for 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 26 water quality surveys during 2003. Throughout the year, observers were present on all of the Nearfield water column surveys (n=17) to document the sightings of right whales in the Nearfield. Observers were also placed on the vessel during other water quality surveys conducted between January to mid-May and in December. Included in these additional surveys were three (WF031, WF032, and WF034) of the six Farfield water column surveys, and six (PC031, PC032, PC033, PC034, PC035, and PC03C) of the twelve fecal coliform surveys.

## 2.0 Background

A brief description of when marine mammals are expected to be found in Massachusetts and Cape Cod Bays is presented and discussed below.

The right whale (*Eubalaena glacialis*) is critically endangered. Based on historical sightings made, 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). Over the past four decades, 72% of the catalogued population of right whales has visited Cape Cod Bay and Massachusetts Bay (Brown *et al.* 2002). Although sightings of right whales by Kraus *et al*. (1987) for the years 1975-1986, and by Hamilton and Mayo (1990) for the year 1986 show general distribution patterns along Stellwagen Bank, Race Point, Provincetown, and central Cape Cod Bay, the presence of a right whale was documented near Boston Harbor on April 5, 1996 (Wennemer *et al.* 1998). Within the last five years, the use of the eastern portion of Stellwagen Bank/Wildcat Knoll by right whales has been noted during extended surveys by the Center for Coastal Studies (Brown *et al.* 2002).

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). Historic records indicate that humpbacks have been documented on Stellwagen Bank from mid-April through November, with a peak abundance in May and June (CeTap 1982; NMFS 1991). However, distribution appears to correlate with prey densities (Waring *et al.* 1999). In 1992-1993, humpbacks were most abundant in offshore waters of Cultivator Shoals and the Northeast Peak of Georges Bank and less abundant in the nearshore areas (Langton *et al*. 1994). In 1996-1997, an increase in humpback whale sightings correlated with an abundance of sandlance (*Ammodytes dubius*) in the Stellwagen Bank area (Waring *et al.* 1999).

The sei whale (*Balaenoptera borealis*) and blue whale (*Balaenoptera musculus*) are endangered species rarely sighted in Massachusetts and Cape Cod Bays (EPA 1993). 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).

The finback 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).

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).

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 and, to a lesser extent, the fall (Pett and McKay 1990).

The Atlantic pilot whale or long-finned pilot whale (*Globicephala melaena)* 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 the topography of the sea floor and the abundance of their primary food source, squid (Harrison and Bryden 1989).

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).

Harbor porpoises (*Phocoena phocoena*) in 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).

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).

## 3.0 Methods

Marine mammals observations were performed during all daylight hours while transiting Nearfield water column surveys (Figure 1), and while the vessel was on-station for sampling operations. Additionally, marine mammal observers were present during three winter/spring Farfield surveys (Figure 1), and six Fecal Coliform surveys (Figure 2) during the 2003 survey year. 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 and most 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. Four survey vessels were used as observation platforms during the course of the year. The observer's eye-height above the sea surface was approximately 5 meters on the F/V *Isabel S* and 2.5 meters aboard the R/V *Aquamonitor,* F/V *Shanna Rose, and* F/V *Christopher Andrew.* Observations were conducted 40 minutes out of every hour and were suspended when visibility was reduced to zero or when darkness occurred.

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

## 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 four different vessels, which vary the characteristics of the survey platform were used during the year. Based on these factors, the ability to extrapolate from observation data to abundance estimates is severely limited and is not advisable. The utility of this data set is thus limited to documentation of the time, location and particulars for each individual occurrence of a sighting and provides useful qualitative information concerning seasonal patterns and relative abundance within the same study area.

During the 2003 monitoring year, 16 individual whales, six harbor porpoise, and 112+ Atlantic white-sided dolphins were directly observed by the marine mammal observers or Battelle survey team members. Included in these sightings were three humpback whales, one finback whale, six minke whales, and six instances of unidentifiable whale(s). MWRA whale sightings in 2003 were concentrated mainly in Massachusetts Bay with other sightings noted in Cape Cod Bay (Figure 3). Nine whales were sighted in the vicinity of the Nearfield. The total number of whales sighted during 2003 was smaller than during the previous year (2002, 16 to 19 sightings: 2001, 20 sightings), and considerably less than sightings during prior years (2000, 53+ sightings: 1999, 59 sightings) (McLeod *et al.* 2000, McLeod 2001, McLeod 2002). Unlike during 2001 and 2002, right whales were not observed during 2003 water column surveys. In addition to the whales, marine mammal observers on the surveys sighted 105 harbor seals during the year.

All sightings recorded by a dedicated marine mammal observer are summarized in Table 1. Incidental sightings of marine mammals by other survey personnel are summarized in Table 2. Whale sighting distribution is presented in Figure 4.

**Table 1. Marine Mammal Observer Sightings During MWRA 2003 Water Quality Monitoring Program[1]**

| Survey ID | Date\Time | Number | Mammal | Location | Sighting Comments |
|---|---|---|---|---|---|
| PC031 F/V *Shanna Rose* | 01/29/03 1330 | 1 | Harbor seal | 42º22.01'N/070º55.20'W | |
| WF031/WN031 F/V *Isabelle S.* | 02/05/03 | | No sightings | | |
| | 02/06/03 | | No sightings | | |
| | 02/07/03 1610 | 2 | Harbor seals | 42º36.53'N/70º39.57'W | Seals sighted 0.10 miles from main pier in Gloucester Harbor |
| | 02/08/03 | | No sightings | | |
| PC032 F/V *Shanna Rose* | 02/20/03 0740 | 1 | Harbor seal | 42º16.50'N/070º55.86'W | |
| | 02/20/03 0750 | 3 | Harbor seals | 42º18.92'N/070º54.26'W | |
| | 02/20/03 0750 | 8 | Harbor seals | 42º18.92'N/070º54.26'W | |
| WF032/WN032 F/V *Isabelle S.* | 02/25/03 | | No sightings | | |
| | 02/26/03 1235 | 1 | Harbor seal | 42º56.07'N/070º31.44'W | Seals on rocks along coast at Stage Point. |
| | 03/01/03 | | No sightings | | |
| | 03/02/03 | | No sightings | | |
| | 03/03/03 | | No sightings | | |
| | 03/04/03 0630 | 1 | Harbor seal | 42º20.43'N/070º56.46'W | |
| | 03/04/03 0640 | 1 | Harbor seal | 42º20.43'N/070º56.46'W | |
| | 03/04/03 0650 | 1 | Harbor seal | 42º20.41'N/070º56.50'W | |
| | 03/04/03 0710 | 1 | Harbor seal | 42º20.81'N/070º56.20'W | |
| WN033 F/V *Christopher Andrew* | 03/20/03 | | No sightings | | |
| WN034/WF034/ PC033 R/V *Aquamonitor* | 04/01/03 0830 | 1 | Harbor seal l | 41º55.92'N/070º31.68'W | |
| | 04/01/03 1110 | 1 | Unidentified Baleen whale | 41º54.53'N/070º13.71'W | |
| | 04/01/03 1120 | 1 | Unidentified Baleen whale | 41º54.91'N/070º13.78'W | |
| | 04/01/03 1130 | 2 | Humpback whales | 41º54.34'N/070º13.56'W | Sighting determined to be the same two humpback whales. |
| | 04/01/03 1140 | 1 | Humpback whale | 41º57.17'N/070º14.98'W | |
| | 04/02/03 0715 | 2 | Harbor seals | 42º16.35'N/070º55.79'W | |
| | 04/02/03 0730 | 1 | Harbor seal | 42º18.75'N/070º53.93'W | |
| | 04/02/03 0730 | 8 | Harbor seals | 42º18.75'N/070º53.93'W | |
| | 04/02/03 1135 | 1 | Harbor porpoise | 42º23.85'N/070º37.23'W | |
| | 04/02/03 1710 | 6 | Harbor seals | 42º15.95'N/070º54.44'W | |
| | 04/03/03 0720 | 4 | Harbor seals | 42º16.72'N/070º55.80'W | |
| | 04/03/03 0730 | 10 | Harbor seals | 42º19.02'N/070º54.84'W | |
| | 04/03/03 0735 | 11 | Harbor seals | 42º19.43'N/070º55.55'W | |
| | 04/03/03 0740 | 2 | Harbor seals | 42º20.65'N/070º56.34'W | |
| | 04/03/03 0740 | 3 | Harbor seals | 42º20.65'N/070º56.34'W | |
| | 04/03/03 0750 | 2 | Harbor seals | 42º20.37'N/070º56.44'W | |
| | 04/03/03 0810 | 2 | Harbor seals | 42º20.38'N/070º56.48'W | |
| | 04/03/03 0820 | 2 | Harbor seals | 42º20.49'N/070º55.64'W | |
| | 04/03/03 1210 | 1 | Harbor porpoise | 42º21.05'N/070º44.06'W | |
| | 04/03/03 1440 | 2 | Harbor porpoise | 42º25.16'N/070º51.85'W | |
| | 04/03/03 1540 | 2 | Harbor seals | 42º15.98'N/070º55.63'W | |
| | 04/07/03 0830 | 1 | Unidentified Baleen whale | 42º23.23'N/070º53.20'W | |

**Table 1. Marine Mammal Observer Sightings During MWRA 2003 Water Quality Monitoring Program[1]**

| Survey ID | Date\Time | Number | Mammal | Location | Sighting Comments |
|---|---|---|---|---|---|
| | 04/07/03 0845 | 1 | Harbor porpoise | 42º26.02'N/070º46.19'W | |
| | 04/07/03 1025 | 1 | Harbor porpoise | 42º34.74'N/070º30.90'W | |
| | 04/07/03 1515 | 1 | Harbor seal | 42º00.18'N/070º38.64'W | |
| PC034 R/V *Aquamonitor* | 04/22/03 0715 | 1 | Harbor seal | 42º16.21'N/070º53.89'W | |
| | 04/22/03 0730 | 1 | Harbor seal | 42º19.01'N/070º54.36'W | |
| | 04/22/03 0830 | 1 | Minke whale | 42º18.01'N/070º48.48'W | |
| | 04/22/03 1305 | Small Group | Atlantic white-sided dolphins | 42º26.50'N/070º53.21'W | |
| | 04/22/03 1320 | 2 | Atlantic white-sided dolphins | 42º25.46'N/070º53.30'W | |
| WN035 R/V *Aquamonitor* | 04/23/03 1305 | 2 | Atlantic white-sided dolphins | 42º21.23'N/070º42.83'W | |
| | 04/23/03 1335 | 1 | Harbor seal | 42º23.15'N/070º42.97'W | |
| | 04/23/03 1535 | 5-6 | Atlantic white-sided dolphins | 42º22.89'N/070º49.04'W | |
| PC035 R/V *Aquamonitor* | 05/14/03 1255 | 100+ | Atlantic white-sided dolphins | 42º25.64'N/070º49.25'W | |
| WN036 R/V *Aquamonitor* | 05/15/03 1010 | 1 | Minke whale | 42º25.23'N/070º45.48'W | Possibly the same animal. |
| | 05/15/03 1020 | 1 | Minke whale | 42º25.00'N/070º45.62'W | |
| | 05/15/03 1030 | 1 | Minke whale | 42º24.97'N/070º45.86'W | |
| | 05/15/03 1040 | 1 | Minke whale | 42º24.11'N/070º46.47'W | |
| | 05/15/03 1220 | Small Group | Atlantic white-sided dolphins | 42º21.89'N/070º44.89'W | |
| | 05/15/03 1240 | Large Group | Atlantic white-sided dolphins | 42º21.18'N/070º43.55'W | |
| | 05/15/03 1240 | 1 | Minke whale | 42º21.18'N/070º43.55'W | |
| WN037 R/V *Aquamonitor* | 06/18/03 | | No sightings | | |
| WN038 R/V *Aquamonitor* | 07/09/03 | | No sightings | | |
| WN039 R/V *Aquamonitor* | 07/21/03 0915 | 1 | Harbor seal | 42º25.54'N/070º49.66'W | Juvenile seal |
| WN03A R/V *Aquamonitor* | 08/04/03 1325 | 1 | Finback whale | 42º23.21'N/070º43.17'W | |
| | 08/04/03 1355 | 1 | Unidentified Baleen whale | 42º24.44'N/070º47.23'W | |
| WN03B R/V *Aquamonitor* | 08/20/03 | | No sightings | | |
| WN03C R/V *Aquamonitor* | 09/10/03 | | No sightings | | |
| WN03D R/V *Aquamonitor* | 09/25/03 0610 | 3 | Harbor seals | 42º16.48'N/070º55.80'W | |
| | 09/25/03 0620 | 2 | Harbor seals | 42º18.66'N/070º55.88'W | |
| | 09/25/03 0630 | 8 | Harbor seals | 42º20.05'N/070º56.27'W | |
| WF03E/WN03E/ PC03A/SW032 R/V *Aquamonitor* | 10/08/03 1555 | 1 | Harbor seal | 42º18.94'N/070º54.03'W | Seals observed in the water. |
| | 10/08/03 1555 | 2 | Harbor seals | 42º18.94'N/070º54.03'W | Seals observed hauled out on the rocks. |
| WN03F R/V *Aquamonitor* | 10/31/03 1020 | Small Group | Atlantic white-sided dolphins | 42º23.27'N/070º47.09'W | |
| WN03G R/V *Aquamonitor* | 11/18/03 0720 | 1 | Harbor seal | 42º16.00'N/070º55.82'W | |
| | 11/18/03 0725 | 1 | Harbor seal | 42º17.06'N/070º55.76'W | |
| | 11/18/03 0725 | 1 | Harbor seal | 42º17.06'N/070º55.76'W | |
| PC03C R/V *Aquamonitor* | 12/16/03 1120 | 1 | Harbor seal | 42º19.03'N/070º54.39'W | |

**Table 1. Marine Mammal Observer Sightings During MWRA 2003 Water Quality Monitoring Program[1]**

| Survey ID | Date\Time | Number | Mammal | Location | Sighting Comments |
|---|---|---|---|---|---|
| WN03H R/V *Aquamonitor* | 12/19/03 1530 | 1 | Harbor seal | 42°18.45'N/070°55.70'W | |

[1] - A dedicated marine mammal observer was present during these surveys. "No sightings" means that the marine mammal observer did not see any animals on that day.

**Table 2. Incidental Sightings During MWRA 2003 Water Quality Monitoring Program[a]**

| Survey ID | Date\Time | Number | Mammal | Location | Sighting Comments |
|---|---|---|---|---|---|
| WF037/WN037/PC036 R/V *Aquamonitor* | 06/19/03 | | No sightings | | |
| | 06/20/03 | | No sightings | | |
| | 06/21/03 | | No sightings | | |
| PC037 R/V *Aquamonitor* | 07/17/03 | | No sightings | | |
| WF03B/WN03B/PC038/ SW031 R/V *Aquamonitor* | 08/18/03 | 2 | Unidentified Odontocete | 42°18.3'N/070°23.1'W | |
| | 08/19/03 | | No sightings | | |
| | 08/21/03 | | No sightings | | |
| PC039 R/V *Aquamonitor* | 09/24/03 | | No sightings | | |
| WF03E/WN03E/ PC03A/SW032 R/V *Aquamonitor* | 10/06/03 | | No sightings | | |
| | 10/07/03 | | No sightings | | |
| | 10/9/03 | | No sightings | | |
| PC03B R/V *Aquamonitor* | 11/17/03 | | No sightings | | |

a – Dedicated marine mammal observers were not present on these surveys. Sightings were incidental observations by field staff. Therefore, all marine mammals may not have been sighted during the survey.

## 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. However, some generalizations can be made.

Dedicated observer sightings of large baleen whales in 2003 (n=13) were considerably greater than in 2002 (n=6) but sightings were less than the previous four years (1998 – 2001, n between 16 and 31). During 2003, more than 105 pinnipeds were sighted, a slight decrease in number compared to sightings in 2001 and 2002, when 138 pinnipeds were noted each year. However, in years prior to 2001, only 20 to 60 pinniped sightings were made throughout the survey area.

Dolphin sightings in 2003 totaled approximately 112+, an increase in number from the previous year (2002, 10-13: lowest number of sightings since 1998). Over the past four years, 50 to 100 dolphins were noted each year during surveys (McLeod 2001).

In general, Whale Center of New England sighting records throughout the southern Gulf of Maine region show that 2003 was characterized by increased humpback whale sightings in comparison with the previous year, primarily on the southeast portion of Stellwagen Bank. Surface feeding was consistent, with sand lance as the apparent prey. Minke whale use was also very high around the same area. As in the past three years, during fall a substantial number of juvenile humpback whales and adult fin whales

were often sighted feeding unusually close to shore from Cape Ann to Cape Cod. These whales were seen subsurface feeding, filtering water through their baleen upon surfacing. The prey species (likely planktivorous) is unknown during this period. Many adult humpback whales were found off the east coast of Chatham for most of the summer, and there was clear movement between this area and Stellwagen. There was consistent presence of several right whales throughout the summer in the waters of Stellwagen Basin. While many individuals were sighted from whale watch boats and could not be approached for identification photos, we were able to obtain photos of at least two distinct mother-calf pairs during late July. Sei whales were also sighted sporadically throughout the summer, most often in the first half of July (Mason Weinrich, Director of the Whale Center of New England, January 2004).

Over the last six years, the Center for Coastal Studies has conducted systematic surveys of Cape Cod Bay from January through mid-May (Brown *et al*. 2003). In 2003, right whales were present in the Cape Cod Bay Critical Habitat area for at least 102 days between January 18, 2003 and April 30, 2003, although recording of right whale calls from bottom mounted passive acoustic hydrophones suggest that the season of right whale occupancy may have been from late November through to early May (Brown *et al*. 2003). At least 27 different right whales were observed within the Cape Cod Bay Critical Habitat area and 54 individuals on the Stellwagen Bank/Wildcat Knoll area and the Great South Channel, these area totals include nine right whales seen in both areas (Brown *et al*. 2003). The number of right whales identified in Cape Cod Bay and adjacent waters in 2003 is a minimum estimate because about 46% of the sightings are not yet matched to an individual in the catalogue. For the second year in a row there was a decrease in the number of right whales seen in the Cape Cod Bay Critical Habitat area relative to the previous four years and the number of sightings on the Stellwagen Bank/Wildcat Knoll area and Great South Channel increased. We documented an uncharacteristic mid season departure of right whales from Cape Cod Bay for at least 46 days between February 10 and March 28, 2003 (Brown *et al.* 2003). This apparent absence from the Bay coincided with the lowest plankton concentrations of the season determined from net tows during habitat sampling (S. Mayo per comm.). Right whales were seen again in Cape Cod Bay on 7 April through 30 April. In addition there were right whales seen in Massachusetts Bay from whale watch vessels from early April through at least July, but there was little photo documentation of this somewhat unusual event (Brown et al 2003).

## 6.0 Summary of Whale Sightings 1998 through 2003

For the past 9 years, MWRA has collected and reported on the yearly sightings of whales made during program surveys. This reporting has had a yearly focus but a comparison among years has not been made. The same methods have been used to collect whale sighting data over the years, but other factors such as platforms used, areas surveyed and time at each site prevent the data from being used for quantitative statements regarding whale populations in Massachusetts and Cape Cod Bays. The most consistent aspect of the program is that stations were surveyed around the same time of the year for approximately the same number of days. Because the outfall has been on-line for three years, a comparison of the observations before and after diversion is possible. The following text provides a summary and comparison of the MWRA whale sighting data over the last six years (1998 through 2003). Data prior to 1998 have not been included in this report due to possible differences in data collection methods, changes in survey teams, and variations in time spent in each area.

For this comparison, the whale sightings were grouped into four areas:

- Nearfield (NF; all nearfield stations),
- Stellwagen Bank National Marine Sanctuary (SBNMS; stations F12, F27, F28, and F29),
- Cape Cod Bay (CCB; stations F01, F02, F03, F32, and F33), and

- Farfield (FF; all stations not in other areas).

A minimum of 61 survey days is spent in Massachusetts and Cape Cod Bays throughout the year. The Nearfield area is visited at least 17 times each year normally for one day. The remaining areas are visited during 6 or more surveys covering 1 to 3 days in an area, depending on the planned vessel track and weather.

During these MWRA surveys, more than 190 whales of at least four identified species were seen over the past 6 years (Table 3). In most years (1998, 2001, 2002, and 2003), approximately 16-30 whales were sighted during the surveys. The highest number of whales (59) was sighted in 1999, due in part to 27 fin whales being observed on Stellwagen Bank. In the following year (2000), more than 29 humpback whales were noted on Stellwagen Bank bringing the total number of whales sighted in the year to more than 53.

**Table 3. Sightings by Area, Species, and Year**

| Area\Species | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | Total Sightings |
|---|---|---|---|---|---|---|---|
| **Stellwagen Bank National Marine Sanctuary** | | | | | | | |
| Unidentified | 5 | 7 | 5-6 | 1 | 1 | 2 | 19-20 |
| Right | 2 | 1 | 0 | 0 | 2 | 0 | 5 |
| Minke | 3 | 0 | 1 | 0 | 0 | 0 | 4 |
| Humpback | 4 | 12 | 29+ | 1 | 2-5 | 0 | 48+ |
| Fin | 0 | 27 | 4 | 0 | 1 | 0 | 32 |
| Stellwagen Totals | 14 | 47 | 39+ | 2 | 6-9 | 2 | 110+ |
| **Farfield** | | | | | | | |
| Unidentified | 1 | 2 | 1 | 1 | 2 | 0 | 7 |
| Right | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| Minke | 1 | 3 | 0 | 3 | 0 | 1 | 8 |
| Humpback | 0 | 0 | 0 | 3 | 4 | 0 | 7 |
| Fin | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Farfield Totals | 3 | 5 | 1 | 7 | 7 | 1 | 24 |
| **Cape Cod Bay** | | | | | | | |
| Unidentified | 1 | 4 | 11 | 3 | 0 | 2 | 21 |
| Right | 1 | 1 | 0 | 7 | 0 | 0 | 9 |
| Minke | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Humpback | 0 | 0 | 0 | 0 | 1 | 2 | 3 |
| Fin | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cape Cod Bay Totals | 2 | 5 | 12 | 10 | 1 | 4 | 34 |
| **Nearfield** | | | | | | | |
| Unidentified | 5+ | 1 | 0 | 0 | 0 | 2 | 8+ |
| Right | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Minke | 2 | 1 | 1 | 1 | 1 | 5 | 11 |
| Humpback | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| Fin | 0 | 0 | 0 | 0 | 1 | 1 | 2 |
| Nearfield Totals | 8+ | 2 | 1 | 1 | 2 | 8 | 22+ |
| Year Totals | 27+ | 59 | 53+ | 20 | 16-19 | 15 | 190+ |

Over half of the overall sightings (56% of the 190) were made within the boundary of Stellwagen Bank (Figure 5). An additional 13% were sighted just outside its western boundary (listed as Farfield). The

area with the second highest whale sightings from 1998 to 2003 was Cape Cod Bay (19% of the 190), which was dominated by right whale sightings. The lowest number of sightings was recorded in the Nearfield area, which lies over and around the outfall. Only 12% of the total whale sightings were noted in this area, with minke whales being the dominant species. An interesting caveat of the Nearfield sightings is that this area receives the most concentrated effort towards sighting whales relative to the other 3 areas. The Nearfield is visited at least 17 days a year with vessel time exceeding eight hours per day (approximately 136 hours/year). The other areas are visited at least six times a year for 6-8 hours each (approximately 48 hours/year/area).

The most abundant identified whale species noted during the surveys was the humpback whale. This observation is modified by the assumption that the ratio of unidentified whales, which makes up 30% of the sightings, has the same ratio as identified whales (Figure 6). The second most abundant identified whale was the fin whale with 18% of the sightings. The total humpback (46) and fin whale (32) sightings on Stellwagen Bank represent 85% of the sightings for these whales and 50% of the sightings of all whales throughout all of the areas over the years.

Cape Cod Bay had the highest number of right whale sightings (9 out of 15) (Figure 7), with the highest concentration of sightings occurring in February 2001 when 7 were noted in Cape Cod Bay. Minke whales were sighted in all four areas each year, but in low numbers. With the exception of the humpback and fin whales noted on Stellwagen Bank, the minke whale in the Nearfield area was the only other whale species consistently sighted in an area each year under the MWRA program.

## 7.0 Comparison of Pre-discharge vs. Discharge Whale Sightings

The question of whether the outfall has had an effect on whale populations in Massachusetts Bay is often asked. While the observations from MWRA were not designed to rigorously test this question, the data are qualitatively useful for comparison of abundance before and after the outfall went on-line. Figure 7 shows the number of sightings noted over the two years prior to the outfall coming on line (9/98 – 8/00) and the three years after the outfall was brought on-line (9/00 – 8/03). The number of whales sighted was similar in the Farfield, Nearfield, and Cape Cod Bays for the two-years prior and three-years after the start of the outfall. Slight increases in sightings were noted in the Farfield (28%) and Nearfield (25%), areas closest to the outfall, and a decrease was noted in the Cape Cod Bay area (35%). Unlike in the farfield and nearfield areas, sightings on Stellwagen Bank have been noticeably lower since the divergence of the outfall.

The 2003 surveys conducted by the Center for Coastal Studies indicated that the abundance of right whales in 2003 was lower and of shorter duration in Cape Cod Bay than in recent years, although abundance was not as low as during 2002 [Note: the lowest year for numbers of right whales is 2002, see Figure 8 on page 17 of the 2002 report] (Brown *et al.* 2002). Research by Dr. Charles (Stormy) Mayo found evidence that strongly suggests that low densities of the primary food sources of the whales in Cape Cod Bay resulted in short periods of residency and low absolute numbers of animals through most of the season. The decrease in zooplankton concentration, similar to that found in recent years, appears to have had a profound impact on the patterns of habitat use by right whales and is believed to underlie many of the changes in whale occurrence observed by the Center for Coastal Studies during the period 2001-2003. Reduced total zooplankton density in Cape Cod Bay in 2002 contributed to the early departure (Attachment 1, Brown *et al.* 2002). At this time the causes of the zooplankton decline are unknown and additional studies will need to be conducted (Brown *et al.* 2002).

The largest before and after count difference was in the Stellwagen Bank area (89 whales sighted prior to and 9 whales sighted after outfall diversion). The difference may have been caused by a change in pattern of site sampling (tracklines), but investigation shows that most of the difference is due to the sighting of large groups of fin whales and humpback whales in August 1999 and April 2000, respectively. During 2003, when only 2 whales were sighted on Stellwagen Bank during MWRA surveys, the Center for Coastal Studies actually noted an increased abundance of right whales within the Stellwagen Bank/Wildcat Knoll area in the winter and spring months in 2002 and in the winter through summer months in 2003 (Brown *et al.* 2002, 2003). Sightings records from the Whale Center of New England indicated that there was an increase in humpback whales, mostly in the southeast portion of Stellwagen Bank. Both minke and right whales were noted on Stellwagen Bank during the year (email discussion with Mason Weinrich, Director of the Whale Center of New England, January 2003)

Whale sightings made as part of the MWRA program do not indicate a change in whale populations in the area directly above and immediately surrounding the outfall in since the outfall was brought on line.

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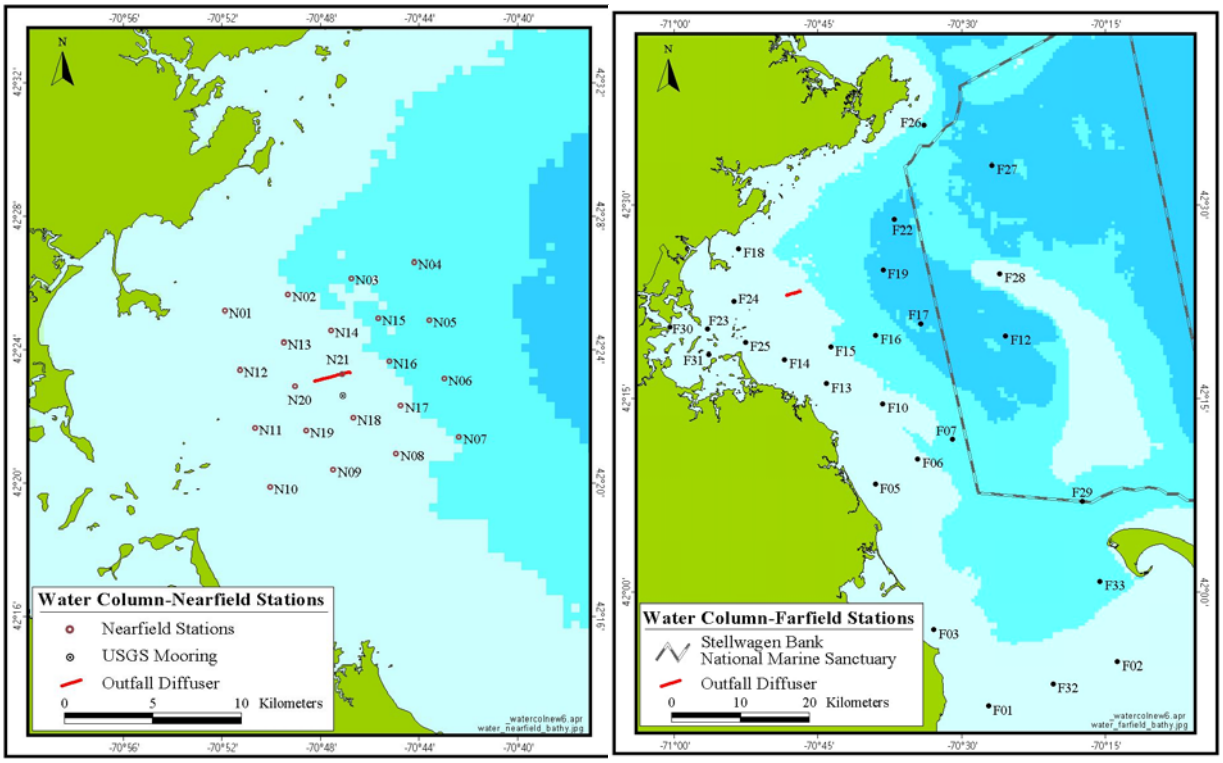


**Figure 1. Location of Nearfield (Left) and Farfield Stations (Right)**

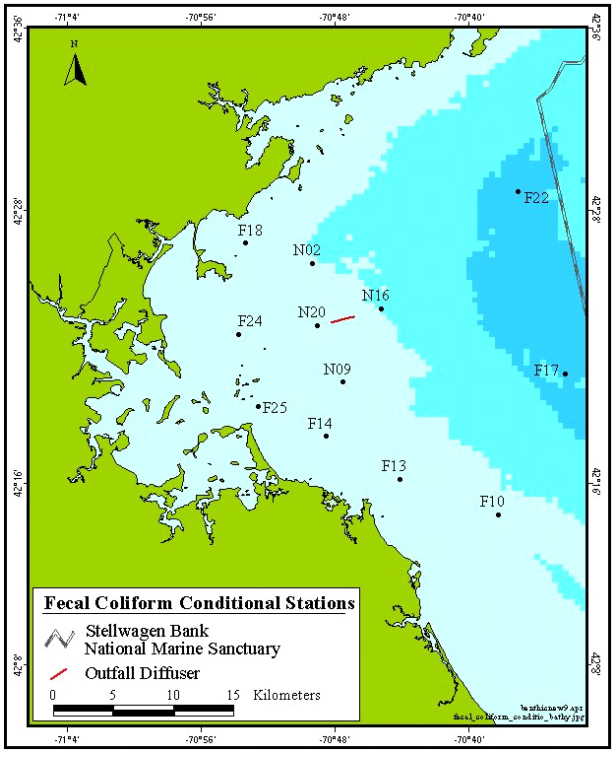


**Figure 2. Location of Fecal Coliform Conditional Stations**

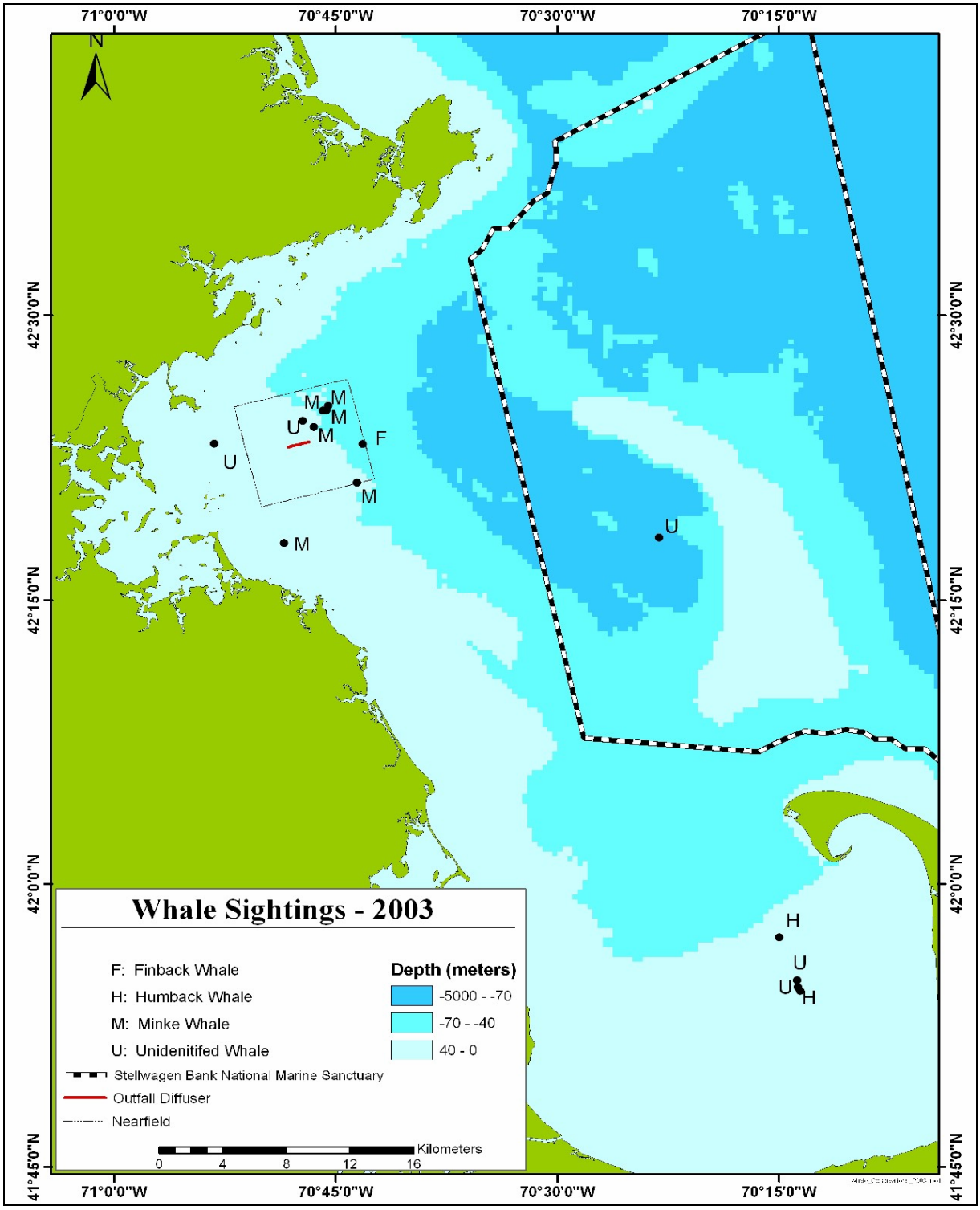


**Figure 3. Approximate Locations of Whale Sightings during 2003 MWRA Water Quality Surveys**

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

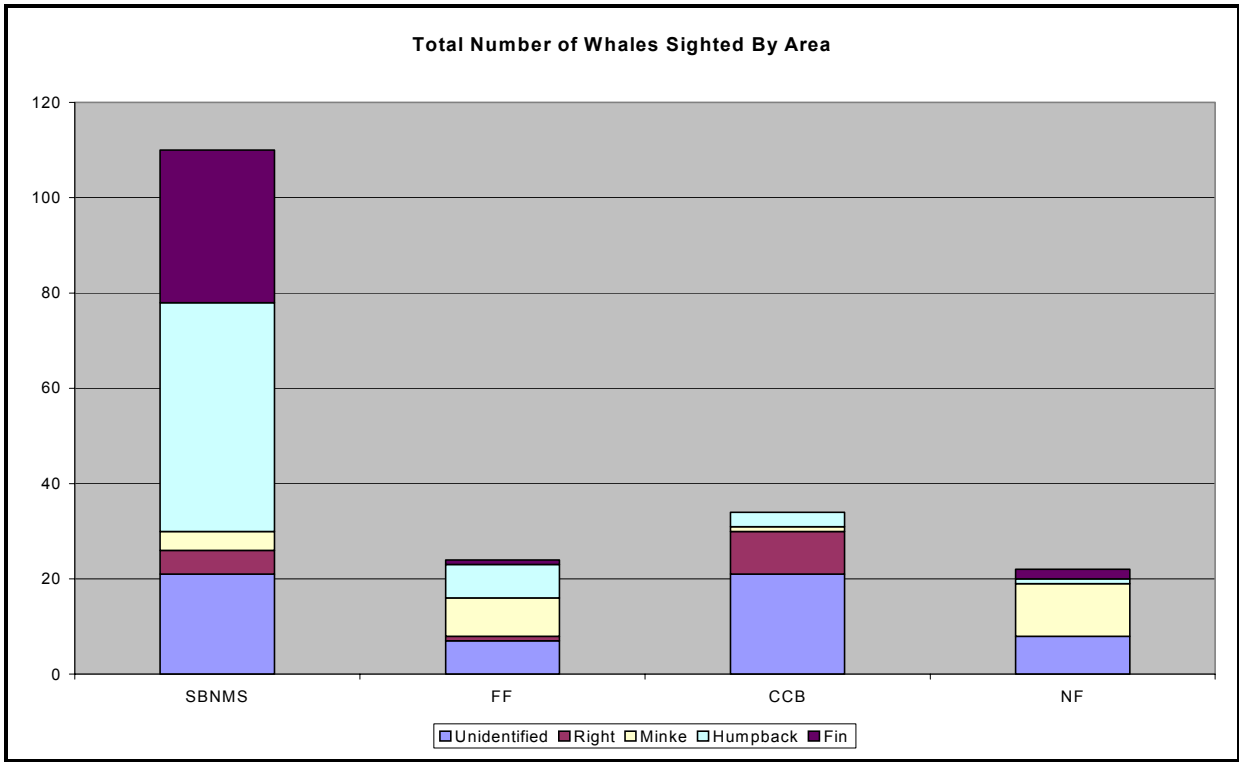


**Figure 4. Distribution of Sightings by Species and Area, 1998-2003**

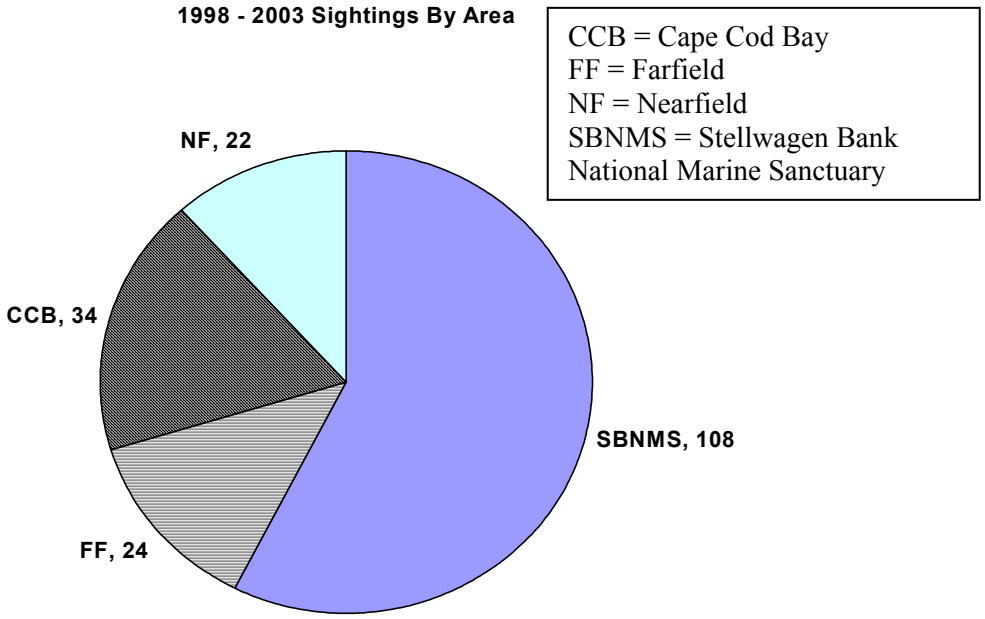


**Figure 5. Total Sightings of Whales per Area over 6 years**

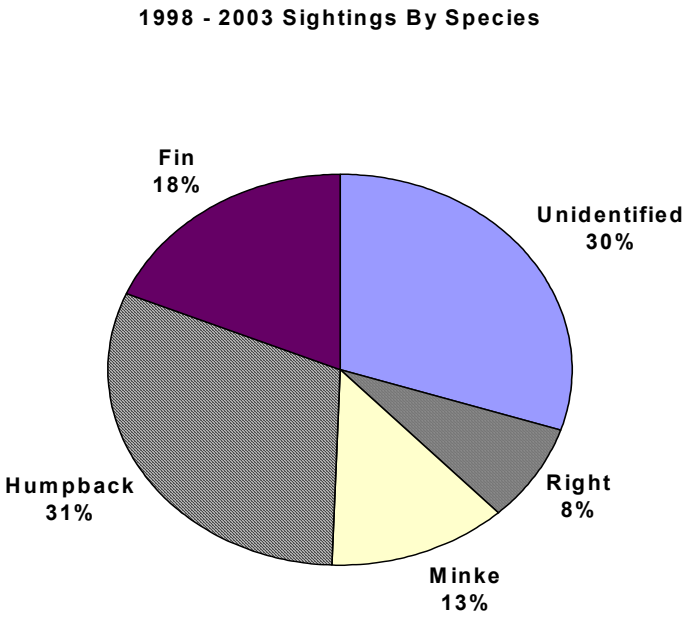


**Figure 6. Distribution of Sightings within the Four Identified and Unidentified Species Categories**

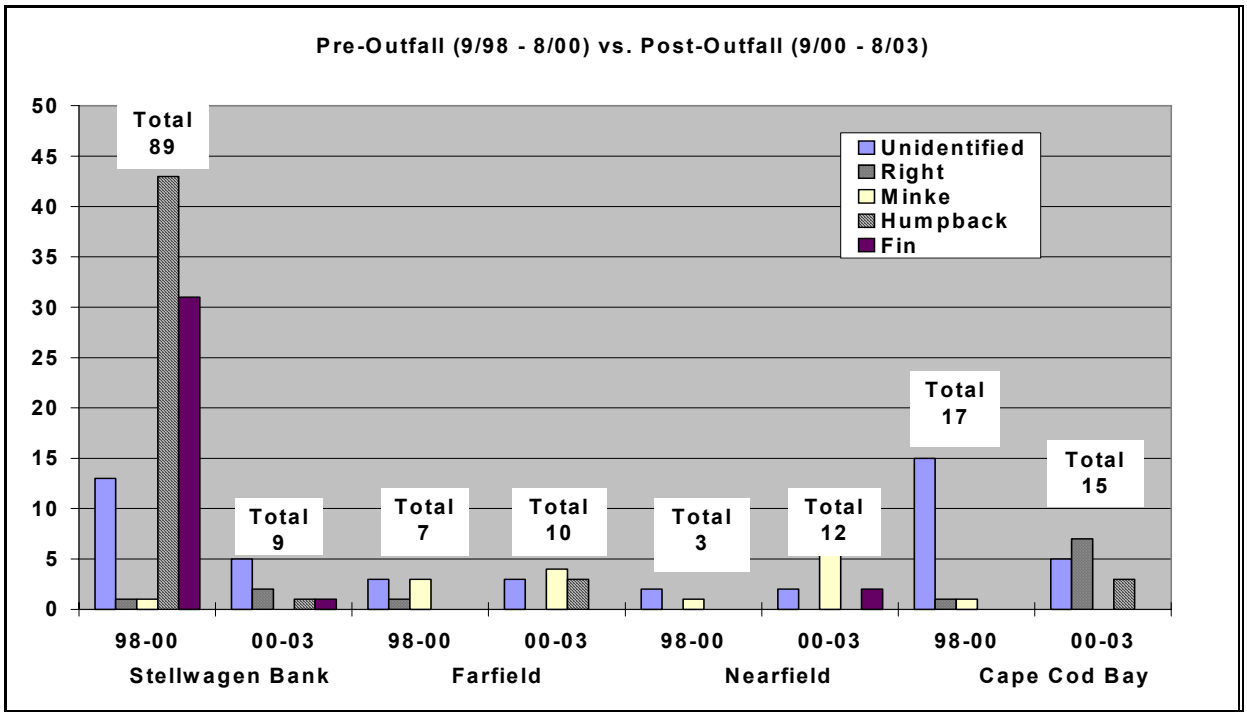


**Figure 7. Comparison of Pre-discharge vs. Discharge Whale Sightings by Area**


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