

Summary of marine mammal observations during 2002 surveys

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**SUMMARY OF MARINE MAMMAL OBSERVATIONS
DURING 2002 SURVEYS**

for

MWRA Harbor and Outfall Monitoring Project

submitted to

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1.0 Introduction

Several endangered and threatened species of whales are known to visit or inhabit the Massachusetts and Cape Cod Bay area (EPA 1993). The whales include the right whale, humpback whale, finback whale, sei whale (rarely observed) and blue whale (rarely observed). Although not presently on the endangered or threatened species list, minke whales, harbor porpoise, several dolphin species, gray seals, and harbor seals are also found in Massachusetts and Cape Cod Bays.

Since 1995, Massachusetts Water Resources Authority (MWRA) has included marine mammal observers on monitoring surveys to verify the presence and absence of right whales in the vicinity of the outfall. 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 29 water quality surveys and one benthic survey conducted during 2002. Observers were present on all of the Nearfield water column surveys (n=17) to document throughout the year the occasional presence as well as the general absence 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 (WF021, WF022, and WF024) of the six Farfield water column surveys, three (AV021, AV022, and AV026) of the six Anthropogenic Virus surveys, and five (PC021, PC022, PC023, PC024, and PC02C) of the twelve fecal coliform surveys, and one (BC021) of the two Nearfield Contaminant Special Study 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.

Right whales (*Eubalaena glacialis*) are critically endangered. Based on sightings made over the last two decades, 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 two decades, 72% of the catalogued population of right whales have 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).

Humpback Whales (*Megaptera novaeangliae*) are 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).

Sei whales (*Balaenoptera borealis*) and blue whales (*Balaenoptera musculus*) are endangered species which are 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).

Finback whales (*Balaenoptera physalus*) are considered to be an endangered species and are the most abundant and frequently sighted of the endangered whales that visit Massachusetts and Cape Cod Bays (EPA 1993). They are sighted year round in the Stellwagen Bank area with a peak abundance occurring between the spring and fall (Pett and McKay 1990).

Minke whales (*Balaenoptera acutorostrata*) are a non-endangered species of whale that are 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).

Atlantic White-sided dolphins (*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). They 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).

Gray seals (*Halichoerus grypus*) are 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 Main/Bay of Fundy stock are classified as strategic by the National Marine Fisheries Service (Waring *et al.* 1999). Historic data indicate that harbor porpoise can be found in the Stellwagen Bank area and Cape Cod Bay from December through June (Pett and McKay 1990).

Harbor seals (*Phoca vitulina*) are a non-endangered species of pinniped commonly found in the near shore waters around New England (Katona *et al.* 1993). They 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

Observations were performed for marine mammals during all day light hours while transiting Nearfield water column surveys (Figure 1), and while the vessel was on-station for sampling operations. Additionally, NMFS requested additional information be collected on surveys between December and May 15th of each year when right whales usually visit Massachusetts Bay. In response, marine mammal observers were present during three winter/spring Farfield surveys (Figure 1), three Anthropogenic Virus surveys (Figure 2), five Fecal Coliform surveys (Figure 3), and one Nearfield Contaminant Special Study survey (Figure 4) during the 2002 survey year. Observations were also performed as above for these additional surveys. 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 are 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 which influenced the position of the observer on board the vessel. Two survey vessels were used as observation platforms during the course of the year. The *F/V Isabel S* was used on surveys WN021, WF021, WN022, WF022, AV021, and PC022. The *R/V Aquamonitor* was used for surveys WN023, WN024, WF024, WN025, WN026, WN027, WF027, WN028, WN029, WN02A, WN02B, WF02B, WN02C, WN02D, WN02E, WF02E, WN02F, WN02G, WN02H, PC021, PC023, PC024, PC02C, AV022 and AV026. 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*. 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 two different vessels were used during the year which vary the characteristics of the survey platform. 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 2002 monitoring year, 16-19 individual whales, 4 Harbor porpoise, and 10-13 Atlantic White-sided dolphins were directly observed by the marine mammal observers or Battelle survey team members. Included in these sightings were 2 right whales, 7-10 humpback whales, 3 finback whales, 1 minke whale, and 3 instances of unidentifiable whale(s). MWRA whale sightings in 2002 were concentrated mainly in Massachusetts Bay with other sightings noted in Cape Cod Bay (Figure 5). Two of the sightings were within the boundary of the Stellwagen Bank National Marine Sanctuary and two whales were sighted in the vicinity of the Nearfield. The total number of whales sighted during 2002 (16-19 individuals) is similar to the previous year (2001– 20 sightings), but is considerably less than sightings during prior years (2000 – 55 sightings; 1999 – 49 sightings) (McLeod *et al.* 2000, McLeod 2001, McLeod 2002). In 2002, one minke whale was sighted in the Nearfield area. Similar sightings also occurred in previous years. As in 2001, right whales were observed in Cape Cod Bay during the February 2002 water column survey. The sightings of

theses two right whales were in the general vicinity of sightings made during previous years, but were much earlier within the year (February rather than April).

In addition to the whales, marine mammal observers on the surveys observed 138+ harbor seals throughout the entire 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 5.

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. It is expected that MWRA whale sightings will fluctuate between years as whale distributions change in response to prey density and distribution (Payne *et al.* 1990). However, some generalizations can be made.

Dedicated observer sightings of large baleen whales were considerably less in 2002 (n=6) than noted during the previous four years 1998 – 2001 (n between 16 and 31). During 2002, more than 138 pinnipeds were sighted, comparable to 2001 when 138 pinnipeds were also noted. However, in years prior to 2001, only 20 to 60 pinniped sightings were made throughout the survey area.

Dolphin sightings in 2002 totaled only 10-13, the lowest number of sightings since 1998. Over the past four years, 50 to 100 dolphins were noted each year during surveys (McLeod 2001). Observations of large baleen whales (10-13) by the survey staff were made mainly during the July to October surveys along the western perimeter of and within Stellwagen Bank National Marine Sanctuary.

In general, Whale Center of New England sighting records show that 2002 was characterized by low humpback and minke whale use for much of the season. Fin whale and Atlantic white-sided dolphin abundance was more regular, although sightings were generally more frequent to the east and to the west of their usual sighting location on or immediately around the shallow water of Stellwagen Bank. During the late summer and early fall, a substantial number of juvenile humpback whales and adult fin whales appeared, often feeding unusually close to shore from Boston to Cape Ann. These whales were seen subsurface feeding, filtering water through their baleen upon surfacing. Prey species remains unknown during this period. In general, many of the adult humpback whales were found off the Great South Channel and in other habitats outside of Massachusetts Bay for most of the summer (personal communication, Mason Weinrich, Director of the Whale Center of New England, January 2003).

Over the last five years, the Center for Coastal Studies has conducted systematic surveys of Cape Cod Bay from January through mid-May (Brown *et al.* 2002). In 2002, right whales were present in the Cape Cod Bay Critical Habitat area, state waters west of the critical habitat, and along the outer coast of Cape Cod between Chatham and Race Point for 37 days between February 7, 2002 and March 15, 2002 (Brown *et al.* 2002). This is the shortest residency period of right whales in Cape Cod Bay since aerial surveys began in 1998. Twenty-four right whales were observed within the Cape Cod Bay Critical Habitat area, 29 right whales were observed in the Stellwagen Bank/Wildcat Knoll area, and 51 right whales were observed during two surveys of the Great South Channel (Brown *et al.* 2002). Although there was a decrease in both the number of right whales and period of occupancy in the Cape Cod Bay Critical Habitat area relative to the last five years, the number of sightings in the Stellwagen Bank/Wildcat Knoll

area increased. The Stellwagen Bank/Wildcat Knoll sightings also coincided with the departure of right whales from Cape Cod Bay (Brown *et al.* 2002).

6.0 Summary of Whale Sightings 1998 through 2002

For the past 8 years, MWRA has collected and reported on the yearly sightings of whales made during program surveys. This reporting has had a yearly focus but comparisons 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 prevents 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 two 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 five years (1998 through 2002). 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 are 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 1-3 days in an area depending on the planned vessel track and weather.

During these MWRA surveys, more than 175 whales of at least four identified species (Table 3) were seen over the past 5 years. Most years (1998, 2001, and 2002), approximately 16-30 whales were sighted during the surveys. In 1999, the highest number of whales was sighted (59) due in part to 27 fin whales observed in Stellwagen Bank (Table 3). The following year (2000), more than 29 humpback whales were noted in Stellwagen Bank bringing the total number of whales sighted in the year to more than 53 (Table 3).

Over half of the overall sightings (62% of the 175) were made within the boundary of Stellwagen Bank (Figure 6). An additional 13% were sighted just outside its western boundary (listed as Farfield). The area with the second highest whale sightings from 1998 to 2002 was Cape Cod Bay (17% of the 175) which was dominated by right whale sightings. The lowest number of sightings were recorded in the Nearfield area which lies over and around the outfall. Only 8% 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) (Figure 1). The other areas are visited at least six times a year with 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 caveated by the assumption that the ratio of unidentified whales, which makes up 30% of the sightings, has the same ratio as identified whales (Figure 8). The second most abundant identified

whale was the fin whale with 19% of the sightings. The total humpback (48+) and fin whale (32) sightings in Stellwagen Bank represent 88% of the sightings for these whales and 52% 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 and during each year, but in low numbers (Figure 7). With the exception of the humpback and fin whales noted in Stellwagen Bank, the sighting of a minke whale in the Nearfield area is 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 is qualitatively useful for comparison of before and after abundances. Figure 9 shows the number of sightings noted over the two years prior to the outfall coming on line (9/98 – 8/00) and the two years after the outfall was brought on-line (9/00 – 8/02). The number of whales sighted were similar in the Farfield, Nearfield, and Cape Cod Bays for the two-years prior and two-years after the start of the outfall. Slight increases in sightings were noted in the Farfield (22%) and Nearfield (25%), areas closest to the outfall, and a slight decrease was noted in the Cape Cod Bay area (35%). Unlike the other areas, sightings in Stellwagen Bank have been noticeably lower since the divergence of the outfall.

The 2002 surveys conducted by the Center for Coastal Studies indicated that the abundance of right whales in 2002 was lower and of shorter duration in Cape Cod Bay than in recent years, although abundance was not as low as during 1999 (a pre-discharge year) (Brown *et al.* 2002). Research by Dr. Charles (Stormy) Mayo found evidence that strongly suggests a combination of factors led to right whales leaving the Cape Cod Bay area early for other areas richer in zooplankton resources. 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 7 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 2002, when only 2 whales were sighted in 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 (Brown *et al.* 2002). Sightings records from the Whale Center of New England indicated that a number of whales were noted unusually close to shore between Boston and Cape Ann and off the Great South Channel rather than in Stellwagen Bank (personal communication, Mason Weinrich, Director of the Whale Center of New England, January 2003)

Whale sightings made as part of the MWRA programs have shown that the area directly above and immediately surrounding the outfall has not experienced a change in whale populations since the outfall was brought on line. Sightings in Cape Cod Bay and western Stellwagen Bank during MWRA surveys seem to correlate well with observations made by other groups as whales move throughout the region to areas rich with food.

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Table 1. Marine Mammal Observer Sightings During MWRA 2002 Water Quality Monitoring Program¹

Survey ID	Date\Time	Number	Mammal	Location	Sighting Comments
PC021 <i>R/V Aquamonitor</i>	01/29/02 1545	1	Harbor Seal	42°16.92'N/070°55.82'W	
WF021/WN021 <i>F/V Isabelle S.</i>	02/05/02		No Sightings		
	02/06/02 1035	2	Atlantic White-Sided Dolphins	42°20.83'N/070°34.29'W	
	02/06/02 1045	1	Unidentified Baleen Whale	42°22.50'N/070°36.06'W	
	02/07/02		No Sightings		
	02/08/02		No Sightings		
	02/09/02		No Sightings		
BC021 <i>R/V Aquamonitor</i>	02/20/02 0700	1	Harbor Seal	42°16.42'N/070°55.86'W	
	02/20/02 0755	1	Harbor Porpoise	42°24.83'N/070°52.70'W	
	02/20/02 0840	4	Harbor Seals	42°19.75'N/070°56.10'W	
	02/20/02 0845	1	Harbor Seal	42°19.24'N/070°55.26'W	
	02/20/02 0850	1	Harbor Seal	Not given	
	02/20/02 0920	1	Harbor Seal	42°17.35'N/070°55.42'W	
	02/20/02 0925	3	Harbor Seals	42°17.87'N/070°55.41'W	
	02/20/02 0935	3	Harbor Seals	42°19.76'N/070°56.10'W	
WF022/WN022/ AV021/PC022 <i>F/V Isabelle S.</i>	02/26/02 1040	1	Harbor Porpoise	41°51.86'N/070°24.86'W	
	02/26/02 1120	2	North Atlantic Right Whales	41°53.54'N/070°18.63'W	Right whale sightings were reported to Tim Cole at the Northeast Science Center for the Sighting Advisory System
	02/27/02 1150	2	Harbor Porpoises	42°17.93'N/070°48.47'W	
	02/27/02 1650	1	Harbor Seal	42°20.43'N/070°00.43'W	
	02/28/02		No Sightings		
	03/01/02 0600	3	Harbor Seals	42°19.95'N/070°56.33'W	
	03/01/02 0605	3	Harbor Seals	42°19.68'N/070°56.97'W	
	03/01/02 0605	1	Harbor Seal	42°19.68'N/070°56.97'W	
	03/01/02 0625	13+	Harbor Seals	42°18.82'N/070°54.99'W	
WN023 <i>R/V Aquamonitor</i>	03/25/02		No Sightings		
PC023 <i>R/V Aquamonitor</i>	03/28/02 0753	2	Harbor Seals	42°19.30'N/070°52.58'W	
	03/28/02 1846	1	Unidentified Baleen Whale	42°18.00'N/070°48.50'W	
WN024/WF024 <i>R/V Aquamonitor</i>	04/05/02 0830	5	Harbor Seals	41°59.14'N/070°38.73'W	
	04/05/02 1330	1	Finback Whale	42°07.00'N/070°17.40'W	Observed at station F29.
	04/05/02 1440	4-6	Atlantic White-Sided Dolphins	42°11.14'N/070°29.14'W	
	04/05/02 1740	1	Harbor Seal	42°18.24'N/070°49.74'W	
	04/10/02 1300	4-5	Atlantic White-Sided Dolphins	42°32.94'N/070°26.85'W	
	04/10/02 1630	9	Harbor Seals	42°18.91'N/070°54.59'W	
	04/10/02 1640	3	Harbor Seals	42°16.61'N/070°55.50'W	
	04/11/02 0800	1	Harbor Seal	42°16.69'N/070°55.83'W	
	04/12/02 0730	3	Harbor Seals	42°16.58'N/070°55.18'W	
	04/12/02 0740	2	Harbor Seals	42°18.77'N/070°55.86'W	
	04/12/02 0740	1	Harbor Seal	42°18.77'N/070°55.86'W	
	04/12/02 0745	3	Harbor Seals	42°19.79'N/070°56.94'W	
	04/12/02 0750	3	Harbor Seals	42°20.43'N/070°56.40'W	Same group of seals.
	04/12/02 0810	2	Harbor Seals	42°20.40'N/070°56.50'W	
WN024/WF024	04/12/02 1655	9	Harbor Seals	42°18.78'N/070°54.68'W	

Table 1. Marine Mammal Observer Sightings During MWRA 2002 Water Quality Monitoring Program¹

Survey ID	Date\Time	Number	Mammal	Location	Sighting Comments
<i>R/V Aquamonitor</i> (cont.)	04/12/02 1710	3	Harbor Seals	42°16.07'N/070°55.87'W	
PC024/AV022	04/24/02 1440	4	Harbor Seals	42°18.17'N/070°55.50'W	
<i>R/V Aquamonitor</i>	04/24/02 1455	1	Harbor Seal	42°15.86'N/070°55.55'W	
WN025	05/01/02 0735	1	Harbor Seal	42°20.07'N/070°56.25'W	
<i>R/V Aquamonitor</i>	05/22/02		No Sightings		
WN027	6/18/02		No Sightings		
<i>R/V Aquamonitor</i>	07/12/02 0910	1	Finback Whale	42°26.53'N/070°46.46'W	Same Finback Whale spotted several times.
<i>R/V Aquamonitor</i>	07/12/02 0930	1	Finback Whale	42°26.53'N/070°44.27'W	
<i>R/V Aquamonitor</i>	07/12/02 1120	1	Finback Whale	42°22.30'N/070°44.80'W	
<i>R/V Aquamonitor</i>	07/12/02 1240	1	Finback Whale	42°22.05'N/070°42.53'W	
WN029	07/25/02		No Sightings		
<i>R/V Aquamonitor</i>	08/08/02		No Sightings		
WN02A	8/22/02 1330	1	Unidentified Odontocete	42°21.80'N/070°42.46'W	
<i>R/V Aquamonitor</i>	8/22/02 1430	1	Unidentified Odontocete	42°23.64'N/070°45.39'W	
WN02C	9/13/02		No Sightings		
<i>R/V Aquamonitor</i>	09/25/02 0745	3	Harbor Seals	42°16.74'N/070°5.86'W	
<i>R/V Aquamonitor</i>	09/25/02 0755	5	Harbor Seals	42°18.61'N/070°55.28'W	
WF02E/WN02E/	10/10/02 0715	1	Harbor Seal	42°16.44'N/070°55.84'W	
AV025/PC02A/	10/10/02 0725	4	Harbor Seals	42°18.65'N/070°55.87'W	
SW022	10/10/02 0730	1	Harbor Seal	42°20.29'N/070°56.48'W	
<i>R/V Aquamonitor</i>	10/10/02 0730	3	Harbor Seals	42°20.29'N/070°56.48'W	
<i>R/V Aquamonitor</i>	10/10/02 0735	3	Harbor Seals	42°20.36'N/070°56.46'W	
<i>R/V Aquamonitor</i>	10/10/02 0735	1	Harbor Seal	42°20.36'N/070°56.46'W	
WN02F	11/04/02 1550	5	Harbor Seals	42°18.85'N/070°54.63'W	
<i>R/V Aquamonitor</i>	11/04/02 1605	5	Harbor Seals	42°16.13'N/070°55.94'W	
WN02G	11/20/02 1215	1	Harbor Porpoise	42°21.37'N/070°42.43'W	
<i>R/V Aquamonitor</i>	11/20/02 1415	2	Unidentified Odontocetes	42°23.03'N/070°49.54'W	
<i>R/V Aquamonitor</i>	11/20/02 1545	13	Harbor Seals	42°18.85'N/070°54.65'W	
PC02C/AV026	12/10/02 0810	7	Harbor Seals	42°18.57'N/070°55.10'W	
<i>R/V Aquamonitor</i>	12/11/02		No Sightings		
WN02H			No Sightings		
<i>R/V Aquamonitor</i>			No Sightings		

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 2002 Water Quality Monitoring Program^a

Survey ID	Date\Time	Number	Mammal	Location	Sighting Comments
PC027 <i>R/V Aquamonitor</i>	07/23/02 1249	1	Minke Whale	42°24.364'N/070°44.062'W	
WF02B/WN02B/ AV024/PC028/ SW021 <i>R/V Aquamonitor</i>	8/19/02 1058	1	Humpback Whale	42°02.270'N/070°15.323'W	Observed at station F33.
PC029 <i>R/V Aquamonitor</i>	09/26/02 1032	1	Unidentified Whale	42°22.815'N/070°34.640'W	Observed at station F17.
	09/26/02 1032	1	Finback Whale	Not recorded	Whale observed in the vicinity of station F22
	09/26/02 1032	3	Humpback Whales	Not recorded	Whales observed in the vicinity of station F22
WF02E/WN02E/ AV025/PC02A/ SW022 <i>R/V Aquamonitor</i>	10/07/02 1134	1	Humpback Whale	42°23.3'N/070°35.2'W	Observed at station F17.
	10/9/02 1633	2-5	Humpback Whales	42°19.87'N/070°25.2'W	Observed at station F12.
PC02B <i>R/V Aquamonitor</i>	11/19/02 1110	10+	Unidentified Porpoises	42°22.426'N/070°34.733'W	

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.

Table 3. Sightings by area, species, and year

Area\Species	1998	1999	2000	2001	2002	Total Sightings
Stellwagen Bank National Marine Sanctuary						
Right	2	1	0	0	2	5
Minke	3	0	1	0	0	4
Humpback	4	12	29+	1	2-5	48+
Fin	0	27	4	0	1	32
Unidentified	5	7	5-6	1	1	19-20
Stellwagen Totals	14	47	39+	2	6-9	108+
Farfield						
Right	1	0	0	0	0	1
Minke	1	3	0	3	0	7
Humpback	0	0	0	3	4	7
Fin	0	0	0	0	1	1
Unidentified	1	2	1	1	2	7
Farfield Totals	3	5	1	7	7	23
Cape Cod Bay						
Right	1	1	0	7	0	9
Minke	0	0	1	0	0	1
Humpback	0	0	0	0	1	1
Fin	0	0	0	0	0	0
Unidentified	1	4	11	3	0	19
Cape Cod Bay Totals	2	5	12	10	1	30
Nearfield						
Right	0	0	0	0	0	0
Minke	2	1	1	1	1	6
Humpback	1	0	0	0	0	1
Fin	0	0	0	0	1	1
Unidentified	5+	1	0	0	0	6+
Nearfield Totals	8+	2	1	1	2	14+
Sighting Totals	27+	59	53+	20	16-19	175+

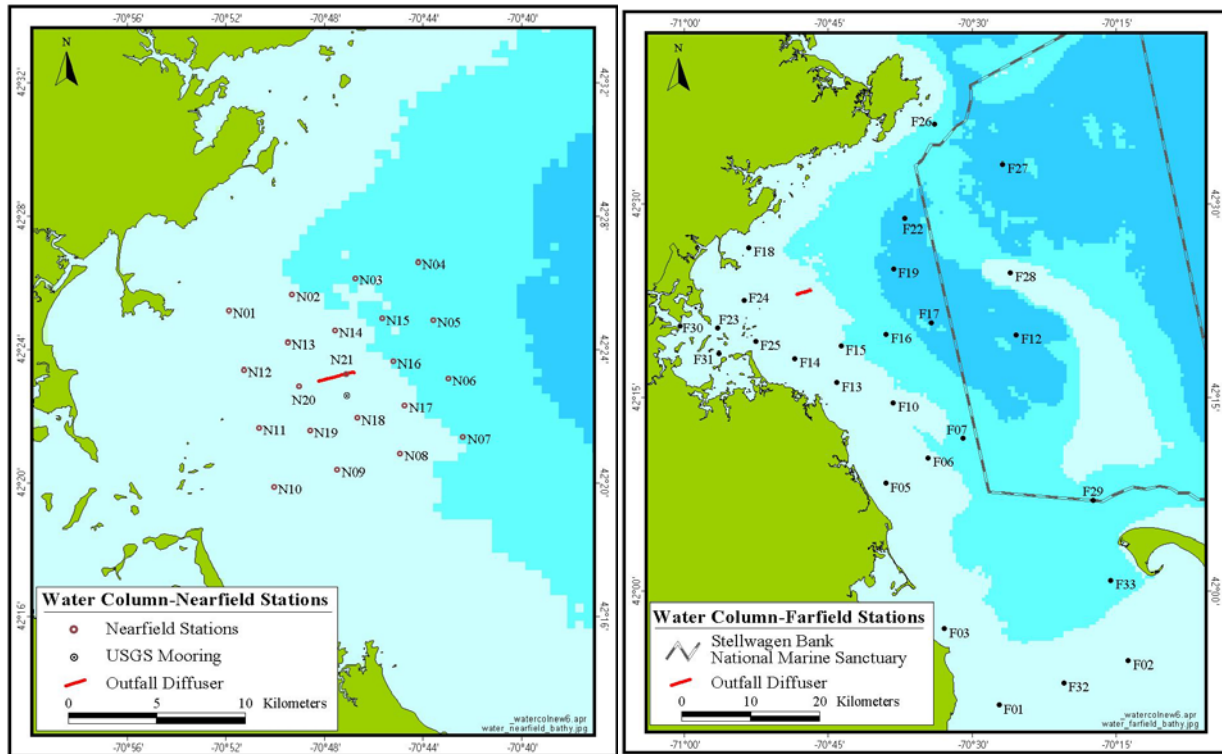


Figure 1. Location of Nearfield (Left) and Farfield Stations (Right)

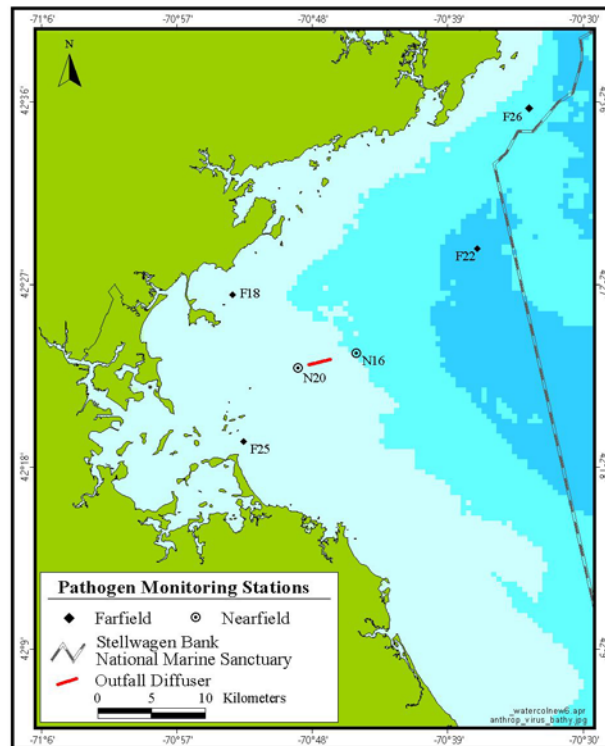


Figure 2. Location of Anthropogenic Virus Stations

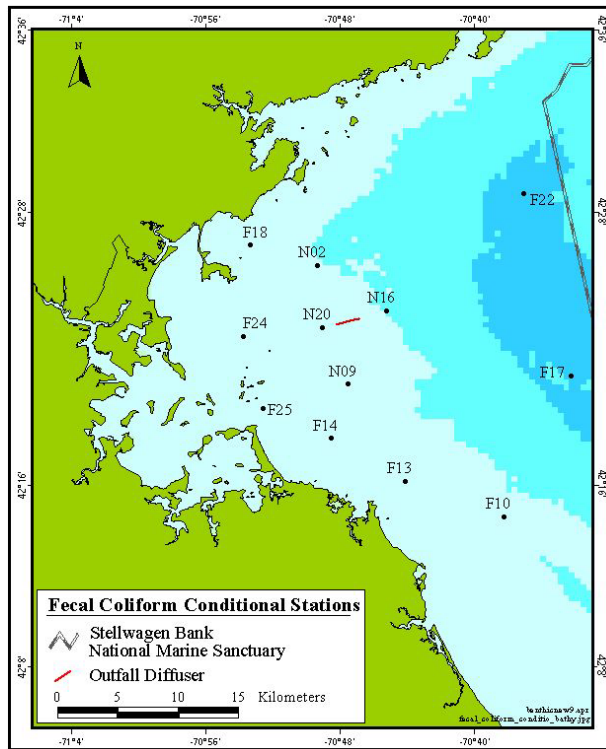


Figure 3. Location of Fecal Coliform Conditional Stations

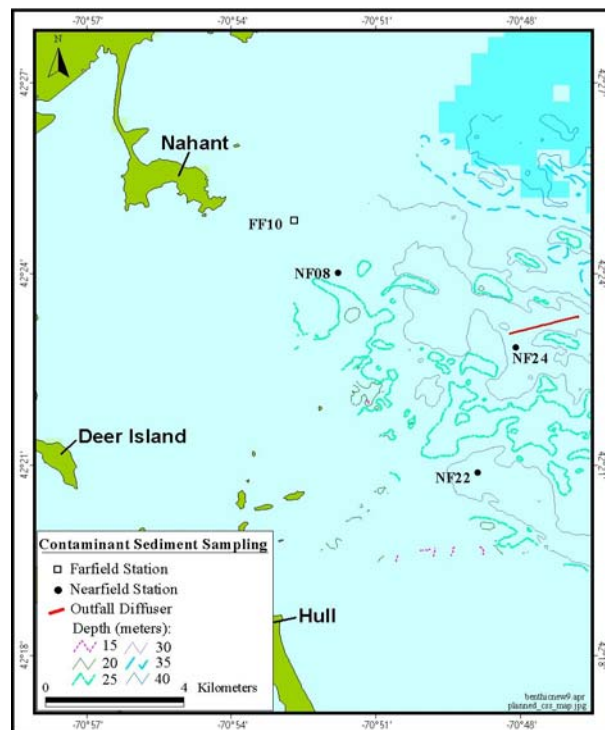


Figure 4. Location of Nearfield Contaminant Special Study Stations

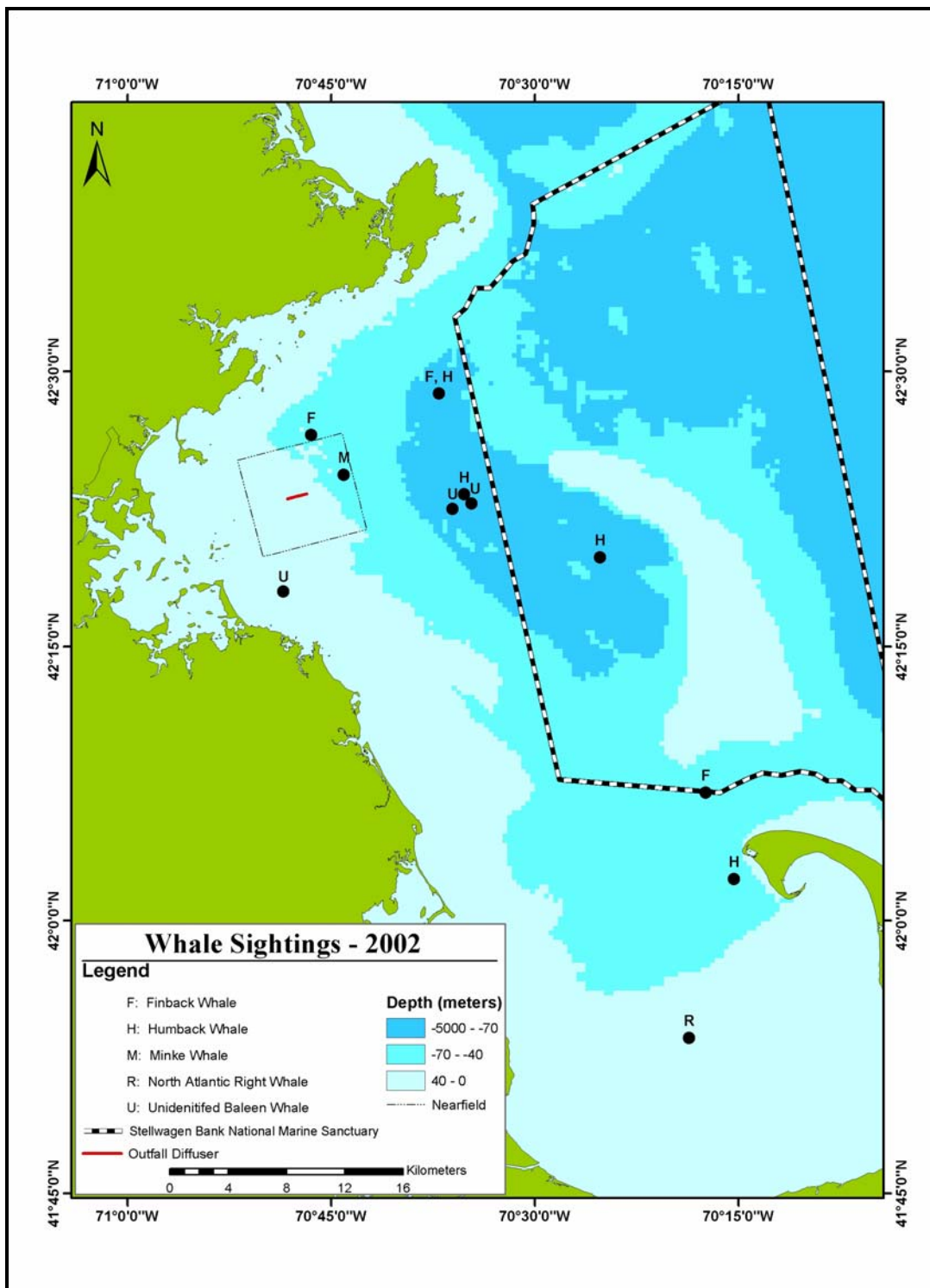


Figure 5. Approximate Locations of Whale Sightings during 2002 MWRA Water Quality Surveys

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

1998 - 2002 Sightings By Area

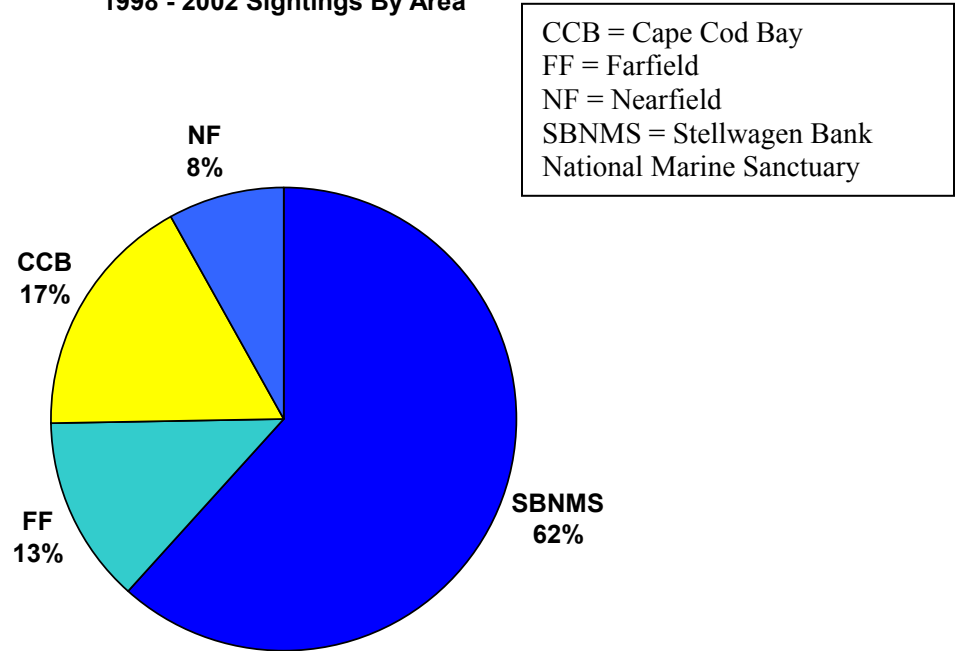


Figure 6. Total Sightings of Whales per Area over 5 years

Number of Whales Sighted By Area

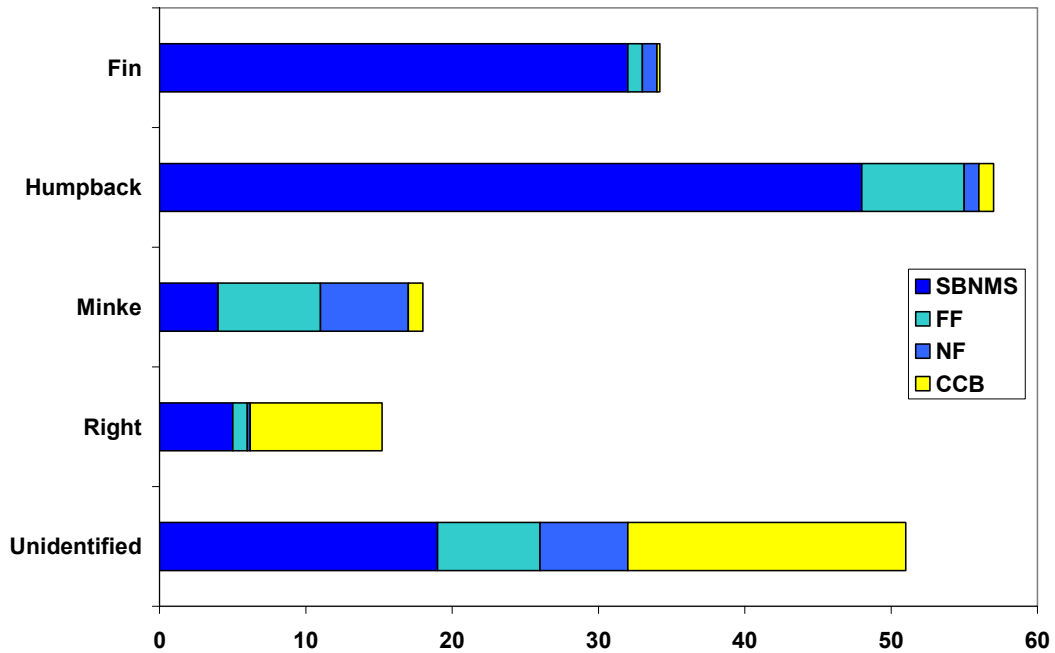


Figure 7. Distribution of Sightings by Species and Area

1998 - 2002 Sightings By Species

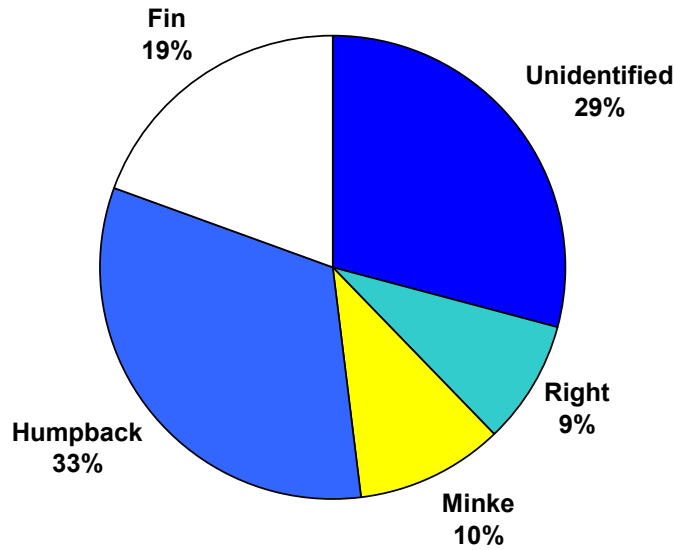


Figure 8. Distribution of sightings within the four identified and unidentified species categories

Pre-Discharge (9/98 - 8/00) vs. Discharge (9/00 - 8/02)

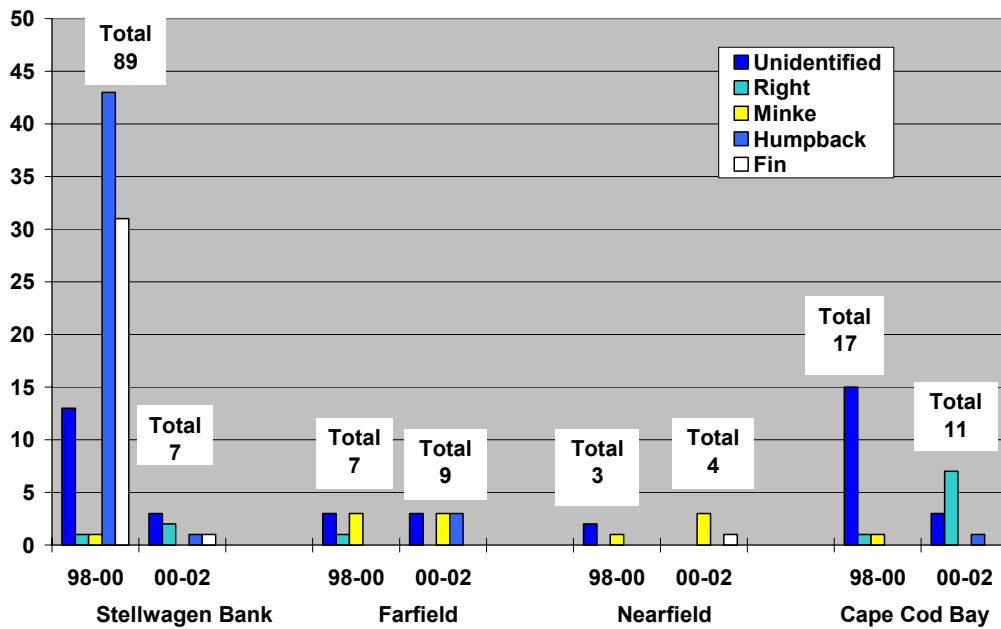


Figure 9. Comparison of pre-discharge vs. post outfall whale sightings by area

ATTACHMENT 1

**Dr. Stormy Mayo
Memo to OMSAMP**

To: OMSAP

From: Stormy Mayo, Center for Coastal Studies

Re: Information Briefing on Observations of right whales and their prey in Cape Cod Bay (to the 1/13/03 OMSAP meeting) – 10 minutes

We have been looking at the zooplankton of the bay as part of the Cape Cod Bay Monitoring Project since the spring of 2000 and have, since then, collected data on the distribution and composition of the zooplankton on a monthly basis. Added to our monitoring data is information on the zooplankton from the period 1975 – 2002, nearly 7,000 samples in all, collected during wintertime studies of the relationship between the zooplankton and the North Atlantic right whale, *Eubalaena (=Balaena) glacialis*.

The collections we report here are corrected to approximate the capture characteristics of baleen filtration, velocity, and foraging strategy determined for a right whale feeding in Cape Cod Bay.

- The zooplankton resource of Cape Cod Bay available to right whales is dominated by seven genera of calanoid copepods.
 - Among the available taxa, three genera appear to be significant in the food stream of right whales during their winter residency in the area. We hypothesize that the seasonal availability of these copepods has a substantial influence on the presence and success of the whales:
 - Initially *Centropages* (most commonly species *typicus*) is found at all depths from the fall through early winter (September through January)
 - During the mid winter, usually January through March, *Pseudocalanus minutus* appears as an important component of the mid-water resource at all depths and the most important food item for the whales both by volume and caloric intake.
 - *Calanus finmarchicus*, the most energetically valuable component of the Cape Cod Bay zooplankton community, is seasonally abundant in the bay starting in mid March and continuing through April into early May.
 - The significant occurrence of taxa other than the three that form the foundation of the zooplanktonic food resource include *Temora longicornis* appearing significantly in June through September, 2001 and May through July, 2002 at or below the thermocline. Interestingly *Temora* was not significantly present in samples from the summer of 2000. *Acartia tonsa*, thought by some to be an indicator of estuarine conditions, was found intermittently in the system and occasionally was a numerically important component (i.e. August through November 2000). These taxa are not found coincident with right whale residency in Cape Cod Bay and are therefore thought to be relatively unimportant in supporting right whales.
 - Using data from 1999 through 2000 (collected under contract to the Massachusetts Division of Marine Fisheries) to supplement information collected for the Cape Cod Bay Monitoring Project, we made comparisons that demonstrate the effects that changes in zooplanktonic foods may have on the Cape Cod Bay system. In many respects the zooplankton resources of the 2002 season progressed as the previous years of our comparisons, with copepod density in the early winter, first as *Centropages* and later as *Pseudocalanus*, appearing relatively typical, if slightly reduced, from most previous seasons. Nevertheless, right whale presence was depressed in the early and middle parts of the season. Most dramatically, at the end of the *Pseudocalanus* portion of the season, during the early and middle part of March, the usual increase in *Calanus* capturable on 333m mesh did not occur. The failure of late-stage *Calanus* in the late winter of 2002 appears to be the factor that cued the early departure of whales from Cape Cod Bay at a time when, in past years, aggregations of whales were commonly observed.
-

- It is clear that the pattern of species dominance during the critical feeding period of late winter and early spring of 2002 was unusual. During 2002 the mid-winter zooplankton resource was dominated by *Pseudocalanus* as was typical of previous years and of all seasons back to 1984. However, in 2002 the *Calanus* of the late winter and early spring was replaced as a dominant by *Acartia tonsa*. For a system that is seasonally and reliably characterized by a period of richness based on *Calanus*, the effects of a change to an *Acartia* - based system might cause a profound change in the success of a midwater planctivorous species such as the right whale.
- While the change in species composition appears to be dramatic when simple dominance is considered, a comparison of seasonal densities of *Acartia* shows that the events of 2002 were not due to a replacement of *Calanus* by *Acartia* in the feeding areas of eastern Cape Cod Bay. Instead *Acartia* remained at typically low densities into the early spring of 2002 while, nevertheless, dominating the copepod resource available to right whales because of the failure of the development of the late-stage *Calanus* resource. The change from a *Calanus* system to an *Acartia* system that apparently contributed to a truncated residency of right whales was due to a failure of late-stage *Calanus* resource to develop at the usual time.



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