

Massachusetts Large Whale Conservation Program

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The Massachusetts Division of Marine Fisheries (*Marine Fisheries*), partnered with the Provincetown Center for Coastal Studies (PCCS), to conduct the Massachusetts Large Whale Conservation Program with the goal of advancing the management of endangered large whales in Massachusetts state and adjacent waters. The program comprises three distinct yet mutually supportive long-term projects with direct conservation impact: aerial surveillance of right whales during winter in Cape Cod Bay; right whale feeding habitat assessment and forecasting during winter in Cape Cod Bay; and entanglement readiness and response year round in waters from New Hampshire to Rhode Island. Survey effort between all platforms within the study area was mutually beneficial. Aerial surveillance especially allowed for directed habitat monitoring and entanglement mitigation.

During the 2012 right whale winter/spring season the aerial survey team flew 28 surveys, complete or partial, from January 7th through May 7th, concentrating efforts on Cape Cod Bay (23 surveys), the area east of Cape Cod (4 surveys), and Massachusetts Bay (1 survey). A total of 144.9 hours were flown, of which 117.3 hours were spent on survey. Right whales were seen on 23 of the 28 aerial surveys in 2012. The first right whale sighted in Cape Cod Bay during the 2012 season was documented on January 7. This also coincided with the first flight of the season, and it should be stated right whales were sighted in Cape Cod Bay prior to this date, in December, 2011. Right whales were last seen in the bay on April 19. During the same time period 19 habitat study cruises (17 habitat assessment and 2 opportunistic; approximately 115 hours at sea) were conducted with 528 zooplankton samples collected and analyzed to describe the food resources that control the distribution of right whales in Cape Cod Bay. Similar to the 2011 right whale season, zooplankton sampling centered on the three dimensional patch dynamics in areas of feeding right whales, as well as the overall resource availability in Cape Cod Bay and surrounding waters. For a more detailed description of aerial survey and habitat methods, including aerial track lines and habitat sampling stations, please see *Surveillance, Monitoring and Management of North Atlantic Right Whales in Cape Cod Bay and Adjacent Water-2009* (Leeney et al., 2009). Between August 1, 2011 and July 31, 2012 the PCCS response team maintained daily readiness and response capabilities, responded (on-water) to 12 whale entanglement cases, resolving the entanglements of one right whale and six humpback whales, and in addition confirmed ten whales had shed their entanglements. Entanglement outreach and disentanglement network communications continued in conjunction with the NMFS Large Whale Disentanglement Coordinator.

Information collected and analyzed during aerial survey flights and habitat research cruises was delivered to the *Marine Fisheries* and to more than 70 colleagues via e-mail in the form of a "Post Flight" report, a "Preliminary Assessment" report, and the detailed "Right Whale Habitat Assessment" progress reports. The reports provided contemporaneous detailed background of right whale behavior and sighting information, forecasting aggregation and feeding by right whales, as well as in-depth analysis of zooplankton ecology and its effect on right whales. All right whale sightings were also reported to the Sighting Advisory System at NMFS. Photographs used for individual right whale identification and collected by all three elements of the Large Whale Conservation Program were submitted to the New England Aquarium (NEA) for further confirmation on identifications, and for inclusion in the North Atlantic right whale catalog and ongoing population monitoring. In addition, data concerning right whale sightings. Sightings collected during the aerial and shipboard surveys of fishing gear, vessels, and

other marine mammals were submitted to the North Atlantic right whale consortium database and archived in-house. Work during the reporting periods (August 2011 – December 2011; June 2012 – July 2012) focused on data analysis and assessment of information collected during the 2011 and 2012 seasons respectively.

Right Whale Aerial Surveillance and Habitat Monitoring

High abundances of right whales in 2012 appeared to be a month or more ahead of schedule the average of the last 15 years, with February abundance more typical of March. By April, more right whales were observed in the western portion of Cape Cod Bay (Figure 1). As right whales appeared to arrive earlier, in December 2011, they also departed Cape Cod Bay earlier in the spring than usual. The number of right whales identified per 100 nm of effort decreased in 2012 as compared to 2011 (Figure 2) (3.22, 2012; 4.34, 2011). Nevertheless, the SPUE of 2012 was comparable with the previous four years, and significantly higher than years previous to 2008 (Figure 2) (4.34, 2011; 2.56, 2010; 3.56, 2009; and 3.41, 2008). During 2012 right whales in Cape Cod Bay reached peak abundance in early February (Figure 3) (65.71/100nm); however this was most likely a function of survey effort, as this was a partial survey in an area with a high concentration of whales. It is more likely, the actual peak abundance occurred in late February and early March (Figure 3) (20.22/100nm, and 15.63/100nm). After the abundance peak, the quantity of right whales fluctuated until April 19th, when the last right whales for the season were seen.

The high abundance of right whales early in the season did not correspond with the higher densities of zooplankton at regular stations in the bay. While the maximum bay-wide zooplankton average density in surface waters (1,157 org/m³) was observed in May, the maximum bay-wide zooplankton average in the upper water column (2,180 org/m³) was observed in January. The majority of behaviors documented during the beginning of the season were in surface active groups (SAG). The combination of higher numbers of right whales displaying behaviors other than normally seen during this time frame has brought to the forefront several questions regarding changes in climate potentially affecting the right whale's behavior and their pattern of residency in Cape Cod Bay. With the possibility that a changing climate may influence behavioral budgets and shift the right whale residency period from February through May to December through early April, probably under the control of altered patterns of zooplankton composition and seasonality, the impact of climate change as demonstrated in 2012 could substantially change the seasonal pattern of the risk to right whales of entanglement and ship strike, and hence the management paradigm.

Of the cataloged right whale population, at least 44% (n=214) was documented by PCCS during the 2012 season (Pettis, 2011). These numbers are similar to those of recent years when approximately half of the right whale population has been seen in Cape Cod Bay and the adjacent waters (61% in 2011, 46% in 2010, 49% Leeney et al. 2009, 40% Leeney et al. 2008). Of the seven calves known to have been born in the Southeast US in 2012, none were documented with their mothers in Cape Cod Bay or adjacent waters. Three entangled right whales were documented by the aerial survey team in 2012 (EGNO 3346, 3821, and 3996), as detailed in the entanglement response activities below.

The zooplankton abundance and distribution usually varies considerably from year-to-year and appears to be related to the variability of environmental parameters including but not limited to temperature, tides, currents, and storms. In 2012 the zooplankton resource did not follow the previously documented patterns of enrichment and impoverishment of the three main copepods: *Calanus finmarchicus*, *Pseudocalanus* spp., and *Centropages* spp. (Figure 4a & b) but uncharacteristically displayed a decreasing trend throughout the majority of the season, with a suppressed peak of *C. finmarchicus* (average density of 296 org/m³), in contrast to the typical average in the thousands for April. The overall zooplankton densities were at their lowest when compared to the previous five years. The total zooplankton densities of the bay never reached above 4,400 org/m³ compared to the previous five years' varying high range of 13,000 – 62,000 org/m³. Furthermore, only two samples of tows in 2012 were above 4,000 org/m³, neither of which were taken in the typical peak season of late March to early April. *Calanus finmarchicus* densities, the main food source, were diminished as well, never reaching above 1,400 org/m³ compared to 3,500-36,000 org/m³ in the previous five year period, suggesting the reason for the observed early exit of right whales from the bay (Figure 5).

PCCS prepared Preliminary Assessments by reviewing zooplankton quality information and right whale distribution and behavior reports provided by the aerial survey team at PCCS. *Marine Fisheries* uses this information to issue alerts to mariners about areas of high concentrations of right whales and the risk of vessel collision. Based upon these reports from PCCS, on March 21, 2012 Massachusetts DMF issued an Alert about a dense, stable right whale aggregation engaging in subsurface and surface feeding (see Attachment A). During the period of the Alert, zooplankton conditions that supported the high concentration of whales around Provincetown were reviewed after each cruise. 2012 was the first year in which an Alert was issued in March. Typically they are issued in April or May (Table 1). This corresponds with the general pattern seen in 2012 of earlier abundance of whales.

Table 1. Number of Advisories to Mariners Issued by DMF

Year	March	April	May
2006	0	1	1
2007	0	1	1
2008	0	3	0
2009	0	1	0
2010	0	1	0
2011	0	1	0
2012	1	0	0

An unusually warm winter also influenced the bay's zooplankton system, as demonstrated in the temperature summary taken from the research vessel's hull thermistor during individual habitat cruises (Figure 6). Although the thermistor data are considered of moderate accuracy ($\pm 0.3^{\circ}\text{C}$), these preliminary data have been corrected against the more accurate CTD casts and the results suggest that the trends documented in Figure 6 are a relatively accurate representation of the unusually high temperatures in the bay. From the preliminary analyses it is clear that relatively warmer temperatures, averaging greater than 2°C, were recorded in 2012 than in previous years. Further analysis combined

with more accurate readings from CTD deployments will be conducted to more precisely determine changes in water temperatures of Cape Cod Bay

For the first year in the last thirteen high concentrations of pteropods were collected during the 2012 right whale season. Pteropod densities exceeded those documented during the previous highs in 1998 and 1999, surpassed only once by molluscs in 1998 (7,435 org/m³; Figure 7). Collaboration with scientists from Woods Hole Oceanographic Institution was initiated to determine the significance of high densities of mollusc in 2012 and, while the analysis is not yet available, it does appear that the zooplankton of Cape Cod Bay was responding to substantial changes in oceanographic characteristics, both temperature and transport, resulting in an unusual and potentially influential change in the food resources available to planktivorous predators, including right whales. To determine if the right whales were utilizing this renewed resource, samples from the path of and area around feeding whales were compared to samples from regular stations in 2012. T-test analysis showed right whales were not feeding preferentially on pteropod patches ($t=-3.332$, $P=0.002$). Finally, a particularly significant note from the 2012 field season was the sighting of a bowhead whale, *Balaena mysticetus*, observed in a surface active group of right whales.

Data collected during this and prior grants/contracts were shared with the conservation community during presentations at the Annual Meeting of the North Atlantic Right Whale Consortium, held in New Bedford, 2-3 November, 2011:

Changes in the Residency Pattern of Right Whales in Cape Cod Bay and the Adjacent Waters: Trends and Management Implications (L. Ganley, C. Hudak, R. Lynch, K. Stamieszkin, and C. Mayo)

Long-term Trends in Right Whale Behavior: A Harbinger of Habitat Change? (C. Hudak, A. Costa, L. Ganley, R. Lynch, K. Stamieszkin, and C. Mayo).

Habitat Use by Individual North Atlantic Right Whales in Jeffreys Ledge and Cape Cod Bay: An Assessment of Habitat Connectivity and Overlap (K. Longley, S. Brault, R. Leeney, M. Weinrich, and T. Cole).

Growth and Rapid Early Development of North Atlantic Right Whales (S. Fortune, A. Trites, W. Perryman, M. Moore, H. Pettis, and M. Lynn).

WHALE ENTANGLEMENT RESPONSE

Between August 1, 2011 and July 31, 2012 the PCCS response team maintained daily readiness and response with a minimum of three trained responders, appropriate safety equipment, documentation media, disentanglement tools and access to a response vessel (*R/V Ibis* and *R/V Shearwater* when necessary). The Massachusetts entanglement reporting hotline was staffed by the response team throughout this period, fielding calls that were solicited through a variety of outreach efforts. All confirmed entangled whale reports were immediately shared with NMFS and subsequently shared with *Marine Fisheries*. Over 150 emergency reports were called in to the network, of which 60 were confirmed at-sea whale entanglement sightings, 37 of which were within the PCCS response area

(reports from outside this response area came from the Bay of Fundy, Maine, Georges Bank, Virginia, North Carolina and South Carolina). During 12 on-water operations the entanglements of seven whales were resolved by the PCCS response team, including one right (WR-2012-13) and six humpback whales (WR-2011-35, WR-2012-07, WR-2012-11, WR-2012-14, WR-2012-18, WR-2012-19) and ten whales were confirmed to have shed their entanglements (WR-2010-21, WR-2011-03, WR-2011-13, WR-2011-19, WR-2011-25, WR-2011-30, WR-2011-31, WR-2012-12, WR-2012-13, WR-2012-16). Photo-documentation gathered during the reporting period was shared with NMFS and the Atlantic Large Whale Disentanglement Network. Samples collected during responses were remanded to NMFS (in the case of gear samples) or appropriately archived or sub-sampled and shared with collaborators (in the case of biological samples) for ongoing research and monitoring. Disentanglement activities were conducted under approved techniques and no human or whale injuries occurred (NOAA permit 932-1905/MA-009526).

Distribution of disentanglement tools to the Atlantic Large Whale Disentanglement Network (ALWDN) continued in collaboration with NMFS. (ALWDN tool distribution included telemetry cutting and/or attachment tools for teams at Campobello, FWC and Georgia DNR.) PCCS advanced-level responders were available at all times to discuss and assess ongoing or otherwise complicated entanglement cases with the NMFS Disentanglement Coordinator or responders from throughout the range of ALWDN and participation in network advancement referrals, including those for US West Coast responders. The PCCS response team maintained its emphasis on safe readiness and response and enhanced in-house training efforts in this regard. All data associated with entanglement reports and disentanglement activities were cataloged and archived for research, permit reporting, legal and management purposes and information from all confirmed sightings was shared with NMFS and the ALWDN via email and the network web site.

During the reporting period the Massachusetts entanglement hotline received over 150 reports of marine animals in trouble (including entanglements, strandings, out of habitat animals, carcasses, etc.). Through detailed follow-up interviews response staff confirmed that of these reports 60 coast-wide and 37 within the response area were entanglement-related sightings within the response area. These involved 26 individuals: five rights, 16 humpbacks, two fin whales and two minke. Information from all of these confirmed or in-progress sightings was immediately shared with appropriate agency personnel. Within the Massachusetts response area seven cases were actively disentangled. Status and response effort for local confirmed cases is detailed below, chronologically (see figure 8 for confirmed entangled whale sightings during the reporting period):

WR-2011-29: Humpback whale, Artillery (PCCS), Stellwagen Bank, 8/2/2011. Whale with hook/monofilament entanglement.

WR-2011-25: Humpback whale, Ganesh (PCCS), Stellwagen Bank, 8/4/2011. Female with dependent calf entangled in line and buoy at minimum. Several attempts to disentangle were unsuccessful. Whale shed gear by 8/12/2011.

WR-2011-19: Fin whale, #1028 (PCCS), Jeffreys Ledge, 7/9/2011. Whale with line and fresh wounds. Likely to have shed gear by 8/5/2011.

WR-2011-30: Humpback whale Echo (PCCS), Stellwagen Bank, 8/14/2011. Whale with hook/monofilament entanglement later found to have shed gear by 5/18/2012.

WR-2011-31: Humpback whale, Checkmark (PCCS), Cape Cod Bay, 9/15/2011. Whale with line wrapped over leading edge of fluke blade. Disentanglement attempt was unsuccessful. Later found to have shed gear by 4/1/2012.

WR-2011-32: Right whale, 2002 calf of 3360 (NEAq), Jeffreys Ledge, 9/18/2011. Whale found entangled in gillnet gear. PCCS attempted response but turned back due to rough seas. Search the following day did not relocate the whale.

WR-2011-35: Humpback whale, Hippocampus (PCCS), Great South Channel, 9/30/2011. Whale found in gillnet gear. PCCS removed all gear (gear retained by fisherman).

WR-2011-38: Humpback whale, Dyad (PCCS), Stellwagen Bank, 11/8/2011. Monofilament entanglement discovered during data analysis.

WR-2012-01: Right whale, #3821(NEAq), Cape Cod Bay, 1/7/2012. Whale with gillnet in mouth. PCCS unsuccessfully attempted to cut this with the projectile cutter on 2/5/2012. On 2/15/2012 PCCS successfully cut the loop of line over the body, leaving the whale with an entanglement that should be shed over time.

WR-2011-13: Right whale #3123 (NEAq), Cape Cod Bay, 2/15/2012. Whale discovered with cryptic entanglement during photo-ID analysis. Later found to have shed gear by 3/20/2012.

WR-2012-05: Right whale #3996 (NEAq), Cape Cod Bay, 2/15/2012. Whale was seen briefly by response team during first disentanglement attempt of #3821 and attempted to cut what was thought to be monofilament. Whale resighted by aerial team on 4/13/2012 with complex entanglement. Response team made three unsuccessful attempts to resolve entanglement with projectile cutter. Whale believed to be carrying lethal entanglement.

WR-2012-09: Humpback whale, No ID (PCCS), Great South Channel, 4/29/2012. Whale anchored in gear. The PCCS response team could not respond due to sea state. An at-sea search a few days later found no entangled whale.

WR-2012-11: Humpback whale Basmati (PCCS), Stellwagen Bank, 5/18/2012. A current mother with line caught in previous entanglement wounds. PCCS removed all but a small length of line to reduce possible complications (gear sample remanded to NMFS). Whale seen gear-free on 5/31/2012.

WR-2012-12: Humpback whale Etch-A-Sketch (PCCS), Stellwagen Bank, 6/9/2012. Whale with hook/monofilament entanglement. Seen gear-free on 6/10/2012.

WR-2004-02: Right whale Kingfisher (NEAq), Great South Channel, 6/10/2012. Ongoing case. Sighting discovered during photo-ID analysis by NEFSC. No views of entanglement.

WR-2012-13: Humpback whale Apex (PCCS), Great South Channel, 6/10/2012. Whale watch witnessed vessel setting recreational hook/monofilament gear on whale. Unclear where point of attachment was. Whale seen subsequently but assessment difficult. Presumed gear-free.

WR-2012-14: Humpback whale Sabot (PCCS), Stellwagen Bank, 6/18/2012. Whale watch sighted whale carrying surface system in mouth. PCCS removed all but a short length of line through mouth (entanglement parted at weak link; gear sample remanded to NMFS).

WR-2012-16: Humpback whale Dome (PCCS), Great South Channel, 6/22/2012. Current mother carrying thin diameter line and small balloon float in mouthline. PCCS responded on two separate days but disentanglement was not possible. Whale verified as gear-free by 7/27/2012.

WR-2012-17: Minke whale No ID, Jeffreys Ledge, 7/1/2012. Whale sighted briefly by recreational boaters carrying small float. No images taken but confirmed through interview. No subsequent sightings to date are known.

WR-2012-18: Humpback whale Hiatus (PCCS), Great South Channel, 7/5/2012. Whale anchored in gear. PCCS removed all gear (gear sample remanded to NMFS).

WR-2012-19: Humpback whale Serengeti (PCCS), Great South Channel, 7/6/2012. Whale anchored in gear. PCCS removed all gear (cut gear was reset so as to reduce the chances of creating ghost gear).

WR-2012-20: Humpback whale Piano (PCCS), Great South Channel, 7/8/2012. Free-swimming whale with severe entanglement. PCCS added a control line to the wraps of line at the flukes but this came free quickly (with minor changes to entanglement configuration). Whale found again the following day during a dedicated aerial search. Disentanglement attempt was unsuccessful. Whale sighted gear-free opportunistically by PCCS on 8/7/2012.

WR-2012-23: Minke whale No ID, Great South Channel, 7/17/2012. Whale sighted briefly by recreational boaters carrying line. The PCCS response team was already on the water and conducted a search of the area without luck. No subsequent sightings to date are known.

WR-2012-24: Humpback whale No ID, Stellwagen Bank, 7/29/2012. A whale watch passenger emailed the PCCS response team with images taken of an entangled calf on the north end of Stellwagen Bank the day prior. PCCS mounted a response that day and searched the area without success.

WR-2012-25: Fin whale #0631 (BOS), Jeffreys Ledge, 7/30/2012. A whale watch reported a fin whale towing buoys. PCCS was conducting a search for WR-2012-24 not far away at the time but due to sea state and time of day a response for this whale was not possible.

Outside of the response area PCCS fielded calls and/or supported efforts for sixteen other cases, including: right whales in the Bay of Fundy and greater Gulf of Maine (WR-2010-21, WR-2011-13, WR-2011-33, WR-2011-34, WR-2011-03, WR-2004-02 and WR-2012-10); humpbacks off Maine (WR-2012-07 and WR-2012-08) and North Carolina (WR-2012-06) and the Bay of Fundy (WR-2011-37); a fin whale off Maine (WR-2012-22); and minkes off Maine (WR-2011-36, WR-2012-15, WR-2012-21) and Virginia (WR-2012-04).

Considering the inherently dangerous nature of disentanglement activities and the unpredictability of entanglement sightings PCCS continued in-house readiness and training efforts through on-water and land-based training sessions, greatly enhancing team and equipment readiness (with sea time generally supported outside of this grant). Training sessions emphasized safety protocols and in many instances

significantly decreased entanglement response time (planned training events were often underway when reports came in) and increased team visibility on the water. During the report period the PCCS response team held five training sessions.

The PCCS response team conducted various activities to share information that enhanced entanglement awareness and ALWDN response efficiency. Public awareness of entanglement and disentanglement activities was achieved through a variety of media including public talks (nine during the time period), the PCCS public web site and newsletter, as well as news articles and interviews. These efforts generally emphasized the dangers of disentanglement, the need for entanglement reporting and the conservation aspects of entanglement. At least two formal reports/presentations included MAER staff, including:

Rope, Sedation, Disentanglement, and Monitoring Tag Lesions in a Terminally Entangled North Atlantic Right Whale (*Eubalaena glacialis*). Moore et al. Presented at the 2011 Right Whale Consortium.

Report of the Second IWC Workshop on the Welfare Issues Associated with the Entanglement of Large Whales with a focus on Entanglement Response: IWC/64/WKM&AWI REP1. 2012. Workshop convened in Provincetown, October 2011.

The PCCS response team continued to support ALWDN communications while NMFS finalizes the next generation disentanglement network web site/database. During the reporting period 70 html pages were updated or added to the current network site and significant sightings were broadcast via a yahoo groups email service. Both the email listserv and password protected web site accounts were maintained continuously.

PROGRAM MANAGEMENT

A portion of the grant funds were also used to support 25% of personnel time for DMF's Co-PI (Burke) to administer the grant and assist in coordination of large whale conservation activities in Massachusetts. During the reporting period, the co-PI managed the contracts and invoices for this grant, as well as collaborating with PCCS about budgets and spending. The co-PI also participated in work related to NMFS' Vertical Line Reduction Strategy to reduce entanglement of large whales in fixed fishing gear. The co-PI assisted DMF's Deputy Director, as well as NMFS and their contractor Industrial Economics, in the development and evaluation of this plan. This involved fixed gear data analysis for Massachusetts, writing comments and strategies, conducting outreach to the fishing industry on the reduction plan, and attending numerous meeting regarding this matter. The co-PI also conducted outreach about NMFS proposed vertical line reduction strategy, including three important meetings with the fixed gear fishing industry. The co-PI made presentations to two Massachusetts Lobstermen's Association meetings and one state-wide public meeting for all Massachusetts lobstermen.

In March 2012, Burke issued an advisory to mariners and conducted outreach about a right whale aggregation around Provincetown with the goal of reducing vessel collision. Burke also conducted outreach presentations about entanglement issues, vertical line risk and the disentanglement program at the Massachusetts Shellfish Officers Association annual meeting and meetings regarding the Provincetown-Truro Aquaculture Development Area. Burke also assisted the Massachusetts Environmental Police in several ghost gear removal trips in Cape Cod Bay.

References

Leeney R.H., Stamieszkin K., Jaquet N., Mayo C.A., Osterberg D. & Marx M.K. 2008. Surveillance, monitoring & management of North Atlantic right whales in Cape Cod Bay and adjacent waters – 2008. Final Report, October 2008.

Leeney RH, Stamieszkin K., Mayo C.A. & Marx M.K. 2009. Surveillance, Monitoring and Management of North Atlantic Right Whales in Cape Cod Bay and Adjacent Waters – 2009. PCCS/DMF annual report.

Pettis H. North Atlantic Right Whale Consortium 2011 Annual Report Card. Report to the North Atlantic Right Whale Consortium, November 2011.



Figure 1: Distribution of identified right whales obtained during aerial surveys from January – May 2012. The size of circles represents the number of right whales, with the smallest circle representing one whale and the largest circle representing combined sightings totaling 28 whales.

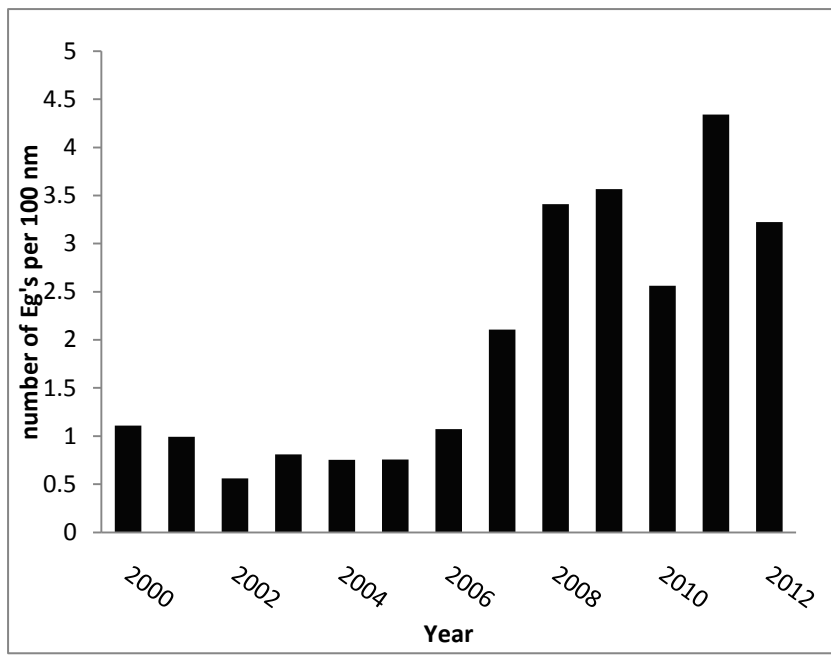


Figure 2: Right whale sightings per 100 nautical miles of flight, recorded by the PCCS Right Whale Aerial Survey Program from the year 2000 to 2012, separated by year; data from 1998 to 1999 is currently unavailable.

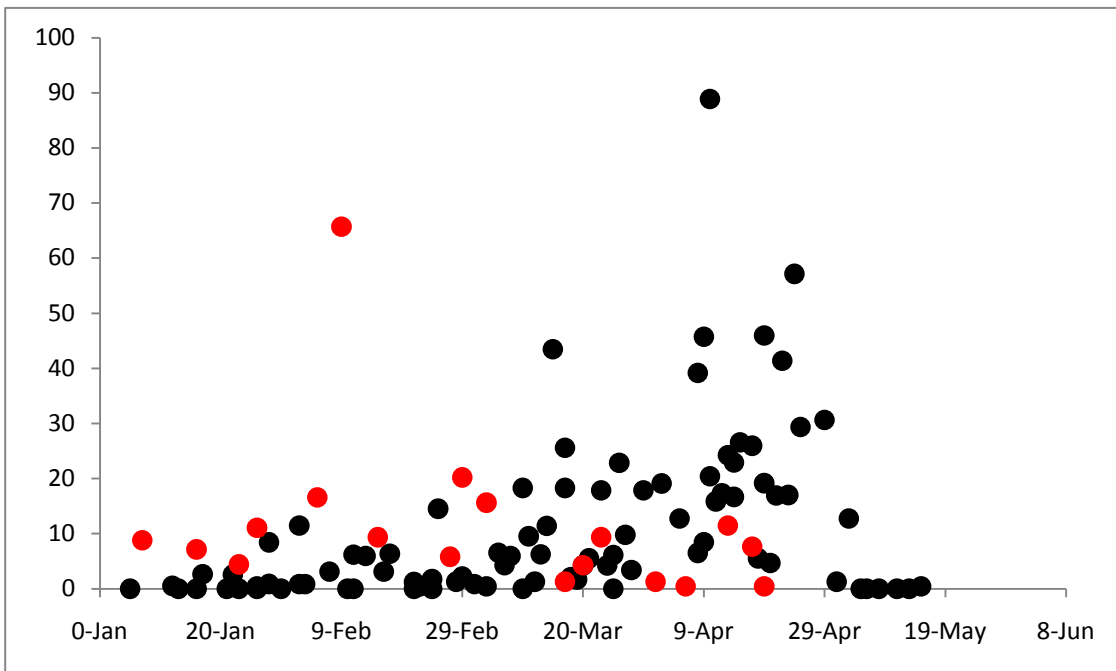


Figure 3: Combined right whale sightings per 100 nautical miles of flight in Cape Cod Bay, recorded by the PCCS Right Whale Aerial Survey Program from the year 2008 – 2012. Red circles depict sightings from 2012, black circles depict sightings from 2008 – 2011.

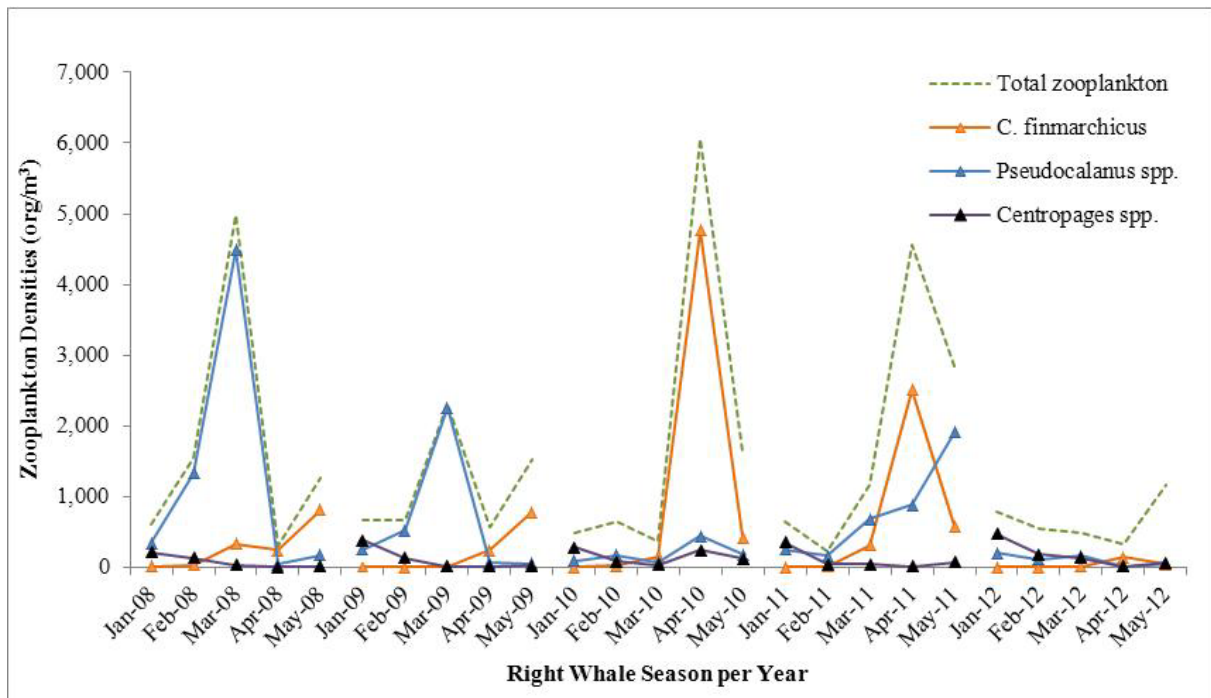


Figure 4a: Surface monthly mean zooplankton densities of total zooplankton, *C. finmarchicus*, *Pseudocalanus* spp., and *Centropages* spp. at regular stations in Cape Cod Bay: 2008 - 2012.

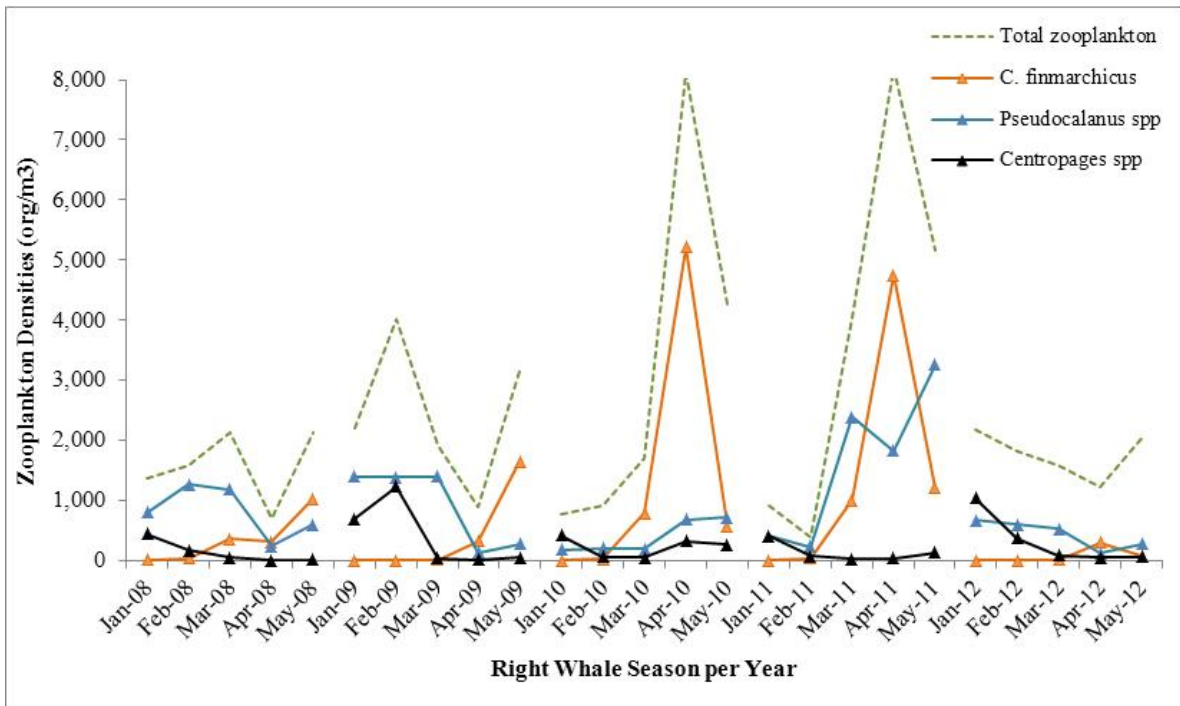


Figure 4b: Upper water column monthly mean zooplankton densities of total zooplankton, *C. finmarchicus*, *Pseudocalanus* spp., and *Centropages* spp. at regular stations in Cape Cod Bay: 2008 – 2012.

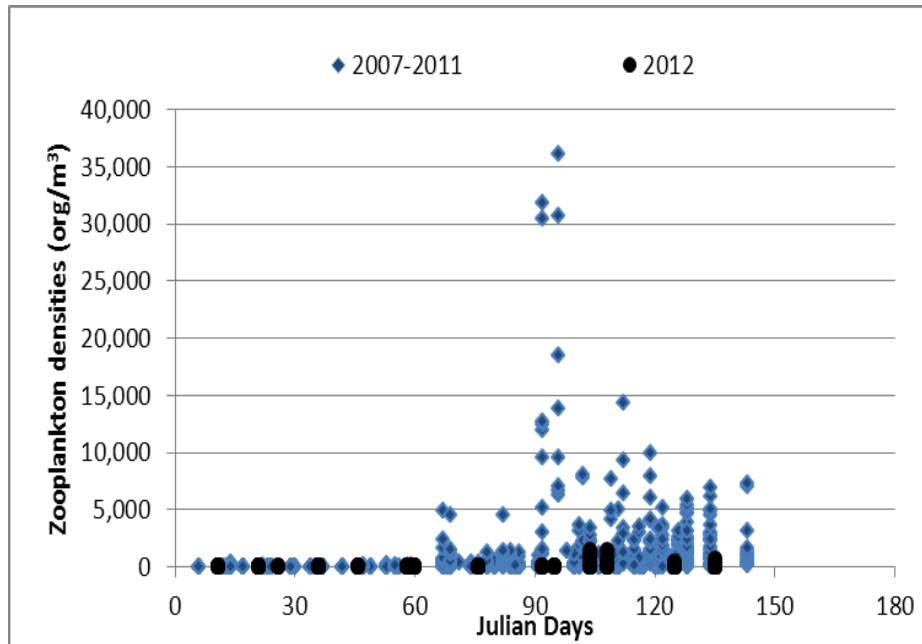


Figure 5: Density comparison of *Calanus finmarchicus* between 2007-2011 and 2012.

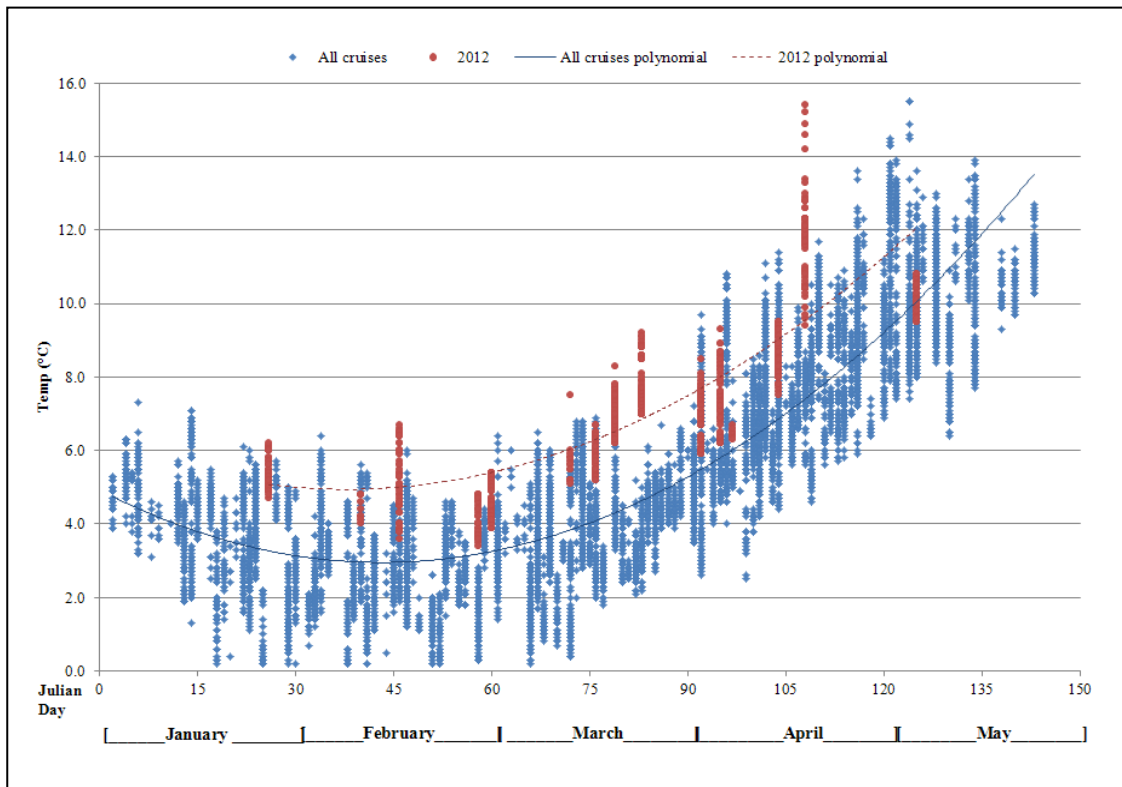


Figure 6: Surface water temperature readings from boat thermistor during habitat cruises throughout Jan-May (1994-2012).

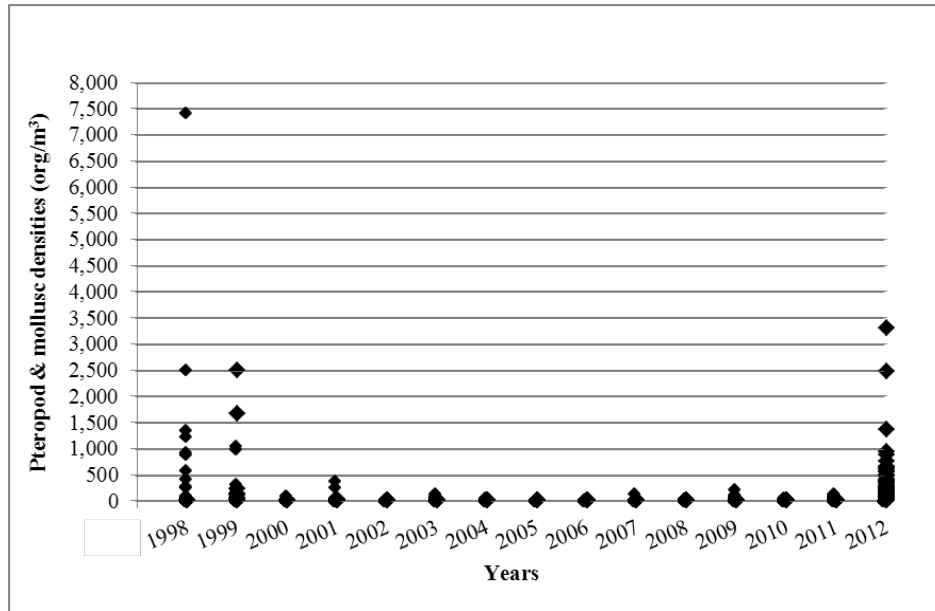


Figure 7. Pteropod / mollusc densities (org/m³) from regular stations in Cape Cod Bay, 1998-2012. Pteropod species were not separated from the mollusc category in 1998 and 2000-2011.

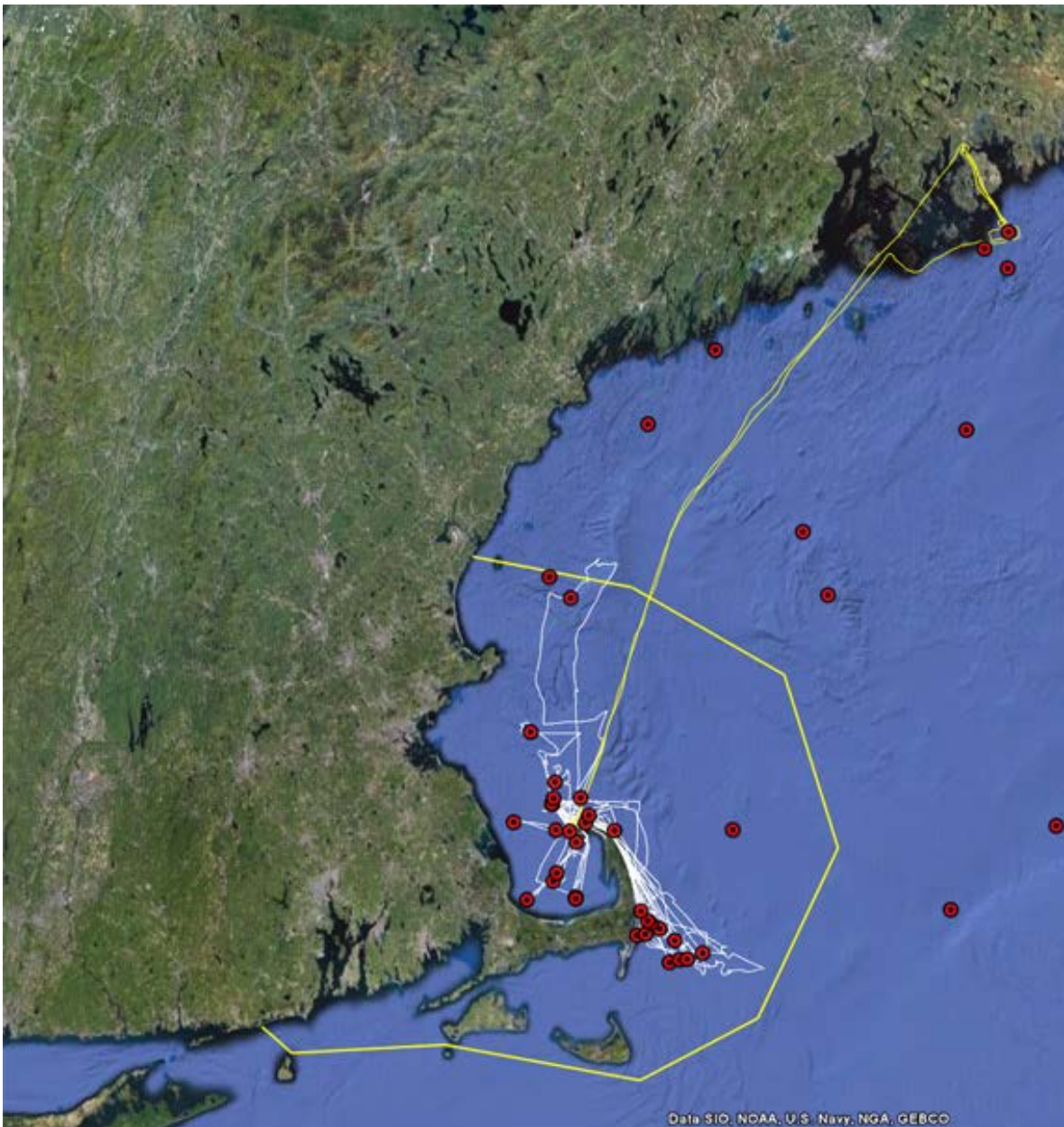


Figure 8. PCCS whale entanglement response area (bounded by yellow lines) with confirmed entanglement sightings in red; tracks of response vessel in white; aerial search tracks in yellow.