

Right Whale Surveillance and Habitat Monitoring in Cape Cod Bay and Adjacent Waters

NOAA Grant No. NA17NMF4720067

Final Report: August 1, 2018 – July 31, 2019

Principal Investigator – Erin Burke

Massachusetts Division of Marine Fisheries
836 S. Rodney French Boulevard
New Bedford, MA 02744
508-742-9725
Erin.Burke@state.ma.us

Federal Assistance Coordinator – Stephanie Cunningham

Massachusetts Division of Marine Fisheries
Annisquam River Marine Fisheries Station
30 Emerson Ave.
Gloucester, MA 01930
978-282-0308 x 133
Stephanie.Cunningham@state.ma.us

Submitted to NOAA: October 2019

The Center for Coastal Studies (CCS) with support from the Massachusetts Division of Marine Fisheries (*Marine Fisheries*) manages the Right Whale Ecology Program, partially supported by the National Marine Fisheries Service (NMFS), to assess the distribution and behavior of the North Atlantic right whale population in Cape Cod Bay and adjacent waters. The program is comprised of distinct yet mutually supportive long-term projects with direct conservation impact: aerial surveillance of North Atlantic right whales during the winter and spring in Cape Cod Bay and adjacent waters and right whale feeding habitat assessment and forecasting during the winter and spring seasons.

SUMMARY

During the 2019 right whale winter/spring season the CCS aerial survey team flew thirty-eight (38) surveys (partial or complete) from 12 November 2018 through 16 May 2019, concentrating efforts on Cape Cod Bay (twenty-nine surveys); the area east of Cape Cod (five surveys); and exploratory surveys funded by other sources (one of Massachusetts Bay and three of Jeffreys Ledge). A total of 194.6 hours were flown, of which 176.3 hours were spent on survey. Right whales were seen on all but three aerial surveys of Cape Cod Bay, and on two of the five eastern shore surveys in 2019. The first right whales sighted in Cape Cod Bay during the 2019 season were documented on 11 December and last seen by CCS in Cape Cod Bay on 11 May. The final Cape Cod Bay aerial survey was completed on 16 May with no right whales sighted. For a detailed description of aerial survey methods, including aerial track lines, please see Cetacean and Turtle Assessment Program, 1982 and Surveillance, Monitoring and Management of North Atlantic Right Whales in Cape Cod Bay and Adjacent Waters – 2009 (Leeney *et al.* 2009).

The combination of the overall lower concentrations and shortened period of dominance of *Calanus finmarchicus* compared to previous years and the limited vertical rise of *Pseudocalanus* spp. from the deeper depths as the season progressed resulted in the right whales' greater deep feeding behavior and less surface activity within Cape Cod Bay than in the previous decade.

The Marine Animal Entanglement Response program (MAER) at CCS continued its work to document and mitigate confirmed entangled whale and sea turtle cases within its response area off Massachusetts, New Hampshire and Rhode Island. Thirty-six cases of live and dead entangled whales were discovered within this area, representing 70.5% of all confirmed cases discovered along the US and Canadian east coast. The program also managed the Massachusetts Sea Turtle Disentanglement Network and confirmed 14 cases of entangled leatherback sea turtles. The MAER team mounted thirty responses and disentangled four humpback whales and 12 leatherback sea turtles.

RIGHT WHALE AERIAL SURVEILLANCE

The 2019 CCS right whale season differed from the 2018 season in several ways. The peak of number of individuals in Cape Cod Bay occurred mid-April (as it has historically); however, in 2018 the peak occurred in late April to early May. The distribution was heavily concentrated in the mid to northeast portion of the bay during the onset of the peak in 2019, compared to the 2018 season's high densities in the northwest (Figure 1). Atypical behavior during the peak (e.g. long dives) were observed during much of the 2019 season and likely influenced detectability; this pattern differs from previous seasons (including 2018) when shallow subsurface and skim feeding was often documented. Lastly, there were seven known calves documented in 2019, compared to zero in 2018.

Of the estimated living right whale population based on individual identification and the Pace model (Pace *et al.* 2017), a minimum of 65.7% (n= 270) of the population was documented by CCS (Pettis *et al.* 2018) in Cape Cod Bay and the adjacent Massachusetts waters during the 2019 season. This number includes right whales seen by all CCS research teams (aerial, shipboard, and opportunistic land based). For the purpose of this report only individual whales matched to the catalog or given intermatch codes were considered in the total number of identified individuals; this preliminary number may increase as photo analysis continues. The total number of individuals and the percentage of the best population estimate documented during the 2019 season is the second highest in our study's history, only superseded by 2011 when 66.7% (n= 327) were recorded, while the estimated number of whales in the population has continued to decrease.

Of the 270 individuals documented: 151 were male, 92 were female, and 27 were of unknown sex; 220 were adults, 34 were juveniles, 12 were of unknown ages, and four were calves. Seven calves were documented with their mothers off the southeastern US coast, and out of those our team documented four cow-calf pairs. The first cow-calf pair was observed in Cape Cod Bay on 07 April 2019 (EGNO 1204 and calf).

One actively entangled right whale, EGNO 2310, was documented by the CCS aerial team in 2019. This individual had a previously known entanglement first reported on 20 December 2018 south of Nantucket, and was observed in Cape Cod Bay by CCS on 25 April 2019. The aerial team provided support for the disentanglement response by MAER. Two right whales known to be previously entangled (EGNOs 3960 and 4091) were documented and confirmed to be gear free. Details of these cases can be found in the entanglement response section below.

Of the seventy right whales listed by NEAq as injured or in poor condition (Pettis 2018) twenty-five were photo-documented by CCS during the reporting period. Additionally, ten individuals were submitted by CCS for consideration as new additions to the list.

The number of individual right whales identified in Cape Cod Bay per 100 km of aerial survey effort (IPUE) was 1.94 in 2019; a decrease from the prior two seasons (2.17 in 2018, 2.54 in 2017). The 2019 IPUE was slightly lower than the previous five-year average (1.84, 2014-2018), but still higher than the overall programs average (Figure 2). Resightings of individual right whales were common throughout this season (3 surveys on average) and longer residency times were documented in 2019, with one individual's potential occupancy lasting up to 112 days between their first and last sighting (EGNO 3420). During the 2019 season the individual right whale abundance in Cape Cod Bay gradually increased beginning in February until the peak in early April, and then declined through mid-May (Figure 3). Prior to the mass influx into Cape Cod Bay at the end of March large aggregations of right whales were reported south of Nantucket in February through early April, and it seems likely that many of those individuals came to Cape Cod Bay.

Emergency regulations were implemented during the 2019 season by the Division of Marine Fisheries in response to the aggregations reported by CCS RWEP (Appendix). The Division extended the fixed gear closure in state waters portions of Cape Cod Bay in the Massachusetts Bay Restricted Area. This was done to protect persistent aggregations of right whales in the Bay from entanglement in fishing gear that would be set when the closure lifted May 1. Survey flights were flown regularly during this period (some in higher sea conditions) in order to provide additional coverage. The closure extension was lifted May 9 when right whales were documented to have exited the Bay.

During the 2019 surveillance season the CCS Right Whale Ecology Program continued to input the near-real-time sightings of all right whales into the NMFS operated Sighting Advisory System (SAS) database directly. We submitted photographs used for individual right whale identification and collected by all three elements of the Large Whale Conservation Program to the New England Aquarium (NEAq) for further confirmation of individual identifications, for inclusion in the North Atlantic right whale catalog, and ongoing population monitoring. CCS personnel submitted all sightings of right whales, other marine mammals, fishing gear, and vessels during the aerial and shipboard surveillance to the North Atlantic Right Whale Consortium (NARWC) database housed at University of Rhode Island and archived in-house (Figures 4-6).

CCS contracted with AvWatch, Inc., of Plymouth, MA, for pilot and aircraft services and primarily flew in and out of Provincetown Municipal Airport (PVC), and, secondarily, in and out of Chatham Municipal Airport (CQX). AvWatch operates a Cessna 337D Skymaster and a Cessna O-2 Skymaster aircraft, which have been configured to meet the safety and operational requirements of CCS and equivalent practices specified under 14 CFR FAR Part 135. These platforms adhered to all Commercial Aviation Services Requirements as required by NMFS, and both aerial survey and vessel operations were conducted with strict adherence to the

requirements of the CCS research permit #19315-01 from the Office of Protected Resources, NOAA.

RIGHT WHALE HABITAT PROGRAM

The CCS habitat research crew conducted 27 research cruises and joined with the CCS Cape Cod Bay Monitoring Program in one opportunistic research cruise, totaling approximately 178 hours at sea for a total of 28 cruises before and during the 2019 right whale winter/spring season. This contract supported 10 research cruises, with an additional 17 cruises supported by supplemental CCS and grant funding. One cruise was conducted in October for environmental (e)DNA research and three cruises were conducted in December based on the presence of right whales in recent years. Six of the 28 cruises were used to document the bay-wide food resource in order to monitor the changing dynamics of the zooplankton at the surface and at-depth (up to 19 meters) to obtain comparison zooplankton densities as the field season progressed. Seventeen cruises were focused on documenting the food resource in the area of right whales. Six hundred and fourteen zooplankton samples were collected, counted, and analyzed to map the food resources that control the distribution of right whales in Cape Cod Bay (Table 1). The monitoring of the zooplankton's temporal and spatial concentrations within Cape Cod Bay continued along with the assessment of the three-dimensional zooplankton patch dynamics, the assessment of prey preferences based on right whale demographics, as well as the dynamics of the *Pseudocalanus* spp. patches in the lower water column and at the bottom.

To document the zooplankton resource, research staff conducted surface and oblique conical net tows at eight or nine regular stations per habitat characterization cruise, at stations documenting the food resource in the path of and near right whales, and in unique areas (e.g. fronts, slicks) throughout Cape Cod Bay. Horizontal transect and water column pump samples were used to document the vertical and horizontal characteristics of the zooplankton patches. For a more detailed description of habitat methods, including habitat sampling stations, see *Surveillance, Monitoring and Management of North Atlantic Right Whales in Cape Cod Bay and Adjacent Waters – 2009* (Leeney *et al.*, 2009).

During the 2019 field season, the timing of the enrichment and quality of the zooplankton resource in Cape Cod Bay did not fully follow the fluctuation as in years past, with a decrease in median total zooplankton densities from December to February and increase in densities into March (as previous years), however the median total zooplankton densities dropped in April before rising again in May (deviation from previous years except in 2012) (Figure 7).

Twenty-two percent of the samples collected during the 2019 field season were above the estimated feeding threshold of 4,000 org/m³, comparable to the 2013 field season. The previous five years ranged from 26% to 57% (2014: 42%, 2015: 26%, 2016: 41%, 2017: 57% and 2018: 43%; SD of total # of samples: 160, mean of total # of samples: 459). Eighty-six percent of the 2019 field season cruises had at least one sample above the estimated feeding threshold. *Calanus*

finmarchicus dominated the majority of high-density samples ($>4,000$ org/m³) in 2019, similar to percentages seen in the past three years.

The seasonal pattern of enrichment by the primary food resources in the bay (*C. finmarchicus*, *Pseudocalanus* spp., and *Centropages* spp.) overlapped as in past years, with a few exceptions. The season started with high concentrations of *Centropages* spp. (1,000 – 5,000 org/m³) in January, transitioned to *Pseudocalanus* spp. dominance by early to mid-February, and then to *C. finmarchicus* dominance by early April. However, by mid-April, *C. finmarchicus* was not consistently the dominant species and was surpassed by *Pseudocalanus* spp. in the lower water column or by other copepods or balanoids in the upper water column. The lack of *C. finmarchicus* dominance during the last weeks of the season was a unique feature of the 2019 season.

The overall daily averages of total zooplankton densities bay-wide in the upper water column (to 19 meters) during the 2019 field season (759 – 3777 org/m³) were similar to those of previous years, however daily averages were lower in the last quarter of the field season (year day 112-150) compared to average densities seen in the past four years. Similar to 2018, the higher concentrations were in the upper water column, rather than at the surface. The maximum bay-wide daily average total zooplankton density at the surface during the 2019 season was 669 org/m³ on 09 March, and 6,884 org/m³ in the water column (to 19 meters) on 09 March.

The total zooplankton densities in the upper water column (≤ 19 meters) of Cape Cod Bay during the beginning of the field season (January through February) fluctuated between low to high concentrations ($\sim 6.0 - 8,000$ org/m³), until the beginning of March, when densities increased variably (up to 19,000 org/m³) throughout the bay. However, the densities decreased by the end of March and maintained the variable concentrations seen in January and February. In a comparison of total zooplankton densities between the upper water column (≤ 19 m) and lower water column (≥ 20 m), the higher concentrations were found throughout the bay in the lower water column throughout the season versus highly variable concentrations in the upper water column (Figure 8 & 9).

The first major aggregation of whales in Cape Cod Bay (~ 33 whales) corresponded to the high concentrations of *Pseudocalanus* spp. in late February (Figure 10). As the field season progressed a drop in total zooplankton densities occurred throughout the bay around mid-March, most notably in the surface and upper water column samples; this drop was likely due to high wind and rough sea conditions, the result of multiple storms with strong winds from the NW and S during that period. During the same time period, right whales that were documented in the bay were on deep diving patterns. At the time of the peak whale aggregation in mid-April, right whales were likely feeding on deep patches of *Pseudocalanus* spp. and *Calanus finmarchicus*.

A total of 16 CTD casts in combination with vertical pump sampling was conducted during the reporting period. Vertical pump sampling was conducted in February and early March to

compare water column zooplankton concentrations with previous years and to monitor changes in near-bottom zooplankton resources during the period of changing zooplankton species dominance. Further vertical and horizontal pump sampling was conducted during late March to mid-May to monitor the depth of the right whale food resource.

During the reporting period, sub-surface temperatures were collected using the boat thermistor located approximately 1-2 meters below the surface. Median water temperatures ranged from 2.61°C in January to 7.69°C in May, with the lowest in February (1.70°C). Based on CTD measurements, the thermocline in Cape Cod Bay formed at the beginning of April, with water temperatures ranging from approximately 4.5°C to 6.2°C.

In collaboration with and supported by the Oregon State University, Cornell University, NOAA-Northeast Fisheries Science Center, and NOAA-Pacific Islands Fisheries Science Center, CCS conducted six monthly eDNA sampling at 16 designated stations throughout Cape Cod Bay, spatial and temporal eDNA sampling variations in the vicinity of right whales, and assisted in the placement of an array of passive-acoustic buoys in Cape Cod Bay. A total of 309 eDNA samples were collected during the reporting period. All samples were filtered at the CCS analytical laboratory immediately after the research cruise and frozen for later transport to Oregon State University for further processing. While this special program of study was supported by other funding, the work done during the eDNA studies substantially enriched the survey work reported here, providing sightings and individual photo ID data, supplementing the surveillance results.

The preliminary 2019 studies of the zooplankton resource distribution and movement and the behavioral response of right whales contributes important information to the understanding of the influence of zooplankton structure and aggregation as it impacts the exposure of right whales to ship strike and entanglement. Overall, the 2019 season was characterized by shortened period of *Calanus finmarchicus* dominance, the layering of *Pseudocalanus* spp. at depths below the upper water column (> 19m), and fluctuating densities of zooplankton corresponding with the fluctuation of the right whale presence and deep sub-surface feeding behavior in Cape Cod Bay.

The rapid dissemination of information collected and analyzed during aerial survey flights and habitat research cruises was delivered to the Massachusetts Division of Marine Fisheries and to more than 70 colleagues via e-mail in the form of a post-aerial survey report, a detailed post cruise report, and/or a “Preliminary Habitat Assessment” report. The reports provided coinciding detailed background of right whale behavior, sighting information, food resource-based forecasting of aggregation and feeding, as well as in-depth analysis of zooplankton ecology and species composition and its effect on right whales. The Right Whale Risk Alerts embedded in the post-aerial survey report notify DMF of the likelihood of dense aggregations of feeding whales in areas of high vessel activity in Cape Cod Bay and adjacent areas. Based on the survey data provided by CCS, DMF broadcasted an Advisory on 8 March announcing the seasonal small vessel (< 65 ft) speed limit of 10 knots in Cape Cod Bay. On 26 April, also based on surveillance data, DMF extended the seasonal speed limit restriction and the seasonal trap gear

closure through 8 May and on 6 May further extended the seasonal trap gear closure through 14 May. Based upon CCS surveillance data indicating departure of right whales and a sharp decline in the zooplankton food resource, on 9 May DMF rescinded the seasonal large whale trap gear closure and the seasonal speed limit Cape Cod Bay (see Appendix).

CCS personnel shared data collected during this and prior grants/contracts with the conservation community, along with multiple phone and in-person interviews and press releases through printed, electronic, and audio news outlets resulting in media coverage locally, nationally, and internationally. Throughout the reporting period, CCS continued to expand upon the local community's awareness about right whales and disentanglement events through additional outreach activities. Presentations were given by Dr. Charles Mayo at the Gulf of Maine Council, Cape Cod Natural History Conference, Wheaton College, Atlantic Large Whale Take Reduction Team meeting, U.S. State Department/CZM meeting with Chinese delegation, Pew Foundation, and the Massachusetts CEC/NOAA on OCS development and more. CCS maintained and actively updated its public website, Facebook, Twitter, and Instagram accounts, and newsletters regarding right whales research and education. The media was kept aware of the progression of the season and relevant conservation regulations through multiple press releases as well as published interviews in Washington Post, Cape Cod Times, WBGH, Martha's Vineyard Magazine, various Boston television news stations and documentary crews, and WCAI. Please see the appendix for additional outreach.

Additionally, the following conference presentations and peer-reviewed publications occurred during the reporting period:

Accardo, C. M.; Ganley, L. C.; Brown, M. W.; Duley, P. A.; George, J. C.; Reeves, R. R.; Heide-Jorgensen, M. P.; Tynan, C. T.; **Mayo, C. A.** (2018). Sightings of a bowhead whale (*Balaena mysticetus*) in the Gulf of Maine and its interactions with the other baleen whales. *Journal of Cetacean Research and Management*. 19: 23–30

Cabrera, A.A., Hoekensjijk, J.P., Aguilar, A., Barco, S. G., Berrow, S., Bloch, D., Borrell, A... **Landry, S...** (2019) Fin whale (*Balaenoptera physalus*) mitogenomics: A cautionary tale of defining sub-species from mitochondrial sequence monophyly *Molecular Phylogenetics and Evolution* 135:86-97.

Ganley L.C., Pendelton D.E., Stuardinger M.D., Adams J., Sutherland C, Jordaan A., **Mayo C.A.** (2019), *Assessing threats from vessel traffic to North Atlantic right whales in Massachusetts: A general framework for assessing the dynamics of risk given anthropogenic and climatic factors.* Presentation at the 75th Annual Northeast Fish and Wildlife Conference, Groton, CT.

Ganley, L., Brault, S., **Mayo, C.A.** (2019) What we see is not what there is: estimating North Atlantic right whale *Eubalaena glacialis* local abundance *Endangered Species Research* 38:101-113.

Good, C. P.; Garrison, L. P. McLellan, W. A.; **Landry, S.**; Kenney, R. D.; Palka, D. L.; Cole, T. V. N.; Knowlton, A. R. (2018). Investigation of North Atlantic right whale (*Eubalaena glacialis*) migratory pathways in the Mid-Atlantic region. Oral Presentation at: North Atlantic Right Whale Consortium held in New Bedford, 7-8 November, 2018.

Hudak, C.; James, A.; McKenna, B. E. and Ogilvie, A. (2019). A Night with the Right Whale Team: Stories from the Field. Oral presentation at Napi's Winter Lecture Series; January 2019; Provincetown, MA USA.

Hudak, C.A.; Sette, L. (2019) Opportunistic detection of anthropogenic micro debris in harbor seal (*Phoca vitulina vitulina*) and gray seal (*Halichoerus grypus atlantica*) fecal samples from haul-outs in southeastern Massachusetts, USA. *Marine Pollution Bulletin* 145:390-395.

Landry, S.; C. Henry, H. G.; Pettis, H. M. (2018) Right whale entanglement and injury events in 2018. Oral Presentation at: North Atlantic Right Whale Consortium held in New Bedford, 7-8 November, 2018.

Record, N. R.; Runge, J. A.; Pendleton, D. E.; Balch, W. A.; Davies, K. T. A.; Pershing, A. J.; Johnson, C.; Stamieszkin, K.; Ji, R.; Feng, Z.; Kraus, S. D.; Kenney, R. D.; Thompson, C. R. S.; **Hudak, C.;** **Mayo, C. A.;** Chen, C. (2018) Climate-driven circulation changes threaten conservation of endangered North Atlantic right whales. Oral Presentation at: North Atlantic Right Whale Consortium held in New Bedford, 7-8 November, 2018.

Record, N.R., Runge, J.A., Pendleton, D.E., Balch, W.M., Davies, K.T.A, Pershing, A.J... **Hudak, C.A., Mayo, C.A...** (2019) Rapid climate-driven circulation changes threaten conservation of endangered North Atlantic right whales *Oceanography* 32:2. 162-169.

Richardson, K., Asmutis-Silvia, R., Drinkwin, J., Gilardi, K.V.K., Giskes, I., Jones, G., O'Brien, K..., **Landry, S...** (2019) Building evidence around ghost gear: Global trends and analysis for sustainable solutions at scale *Marine Pollution Bulletin* 138:222-229.

Staudinger, M.D.; Mills, K.E.; Stamieszkin, K.; Record, N.R.; **Hudak, C.A.;** Allyn, A.; Diamond, A... (2019) It's about time: A synthesis of changing phenology in the Gulf of Main ecosystem. *Fisheries Oceanography* 1-34

WHALE ENTANGLEMENT RESPONSE

During the reporting period the CCS 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. The

CCS team immediately shared all confirmed entangled whale reports with National Marine Fisheries Service (NMFS) and subsequently shared with *Marine Fisheries*.

A total of 292 emergency calls came into the hotline concerning marine animals and of these reports 130 were confirmed as entangled whale calls, representing 51 live and dead cases, from the Gulf of St. Lawrence to Florida. Of these 51 cases, 36 were seen within the CCS response area, representing five right whales, 24 humpback whales, one fin whale, and six minke whales (Figure 11). Not all cases represented lethal entanglements, with 11/30 of the humpback whale cases involved individuals carrying hook and monofilament line. The CCS team mounted 25 responses and managed to disentangle or partially disentangle four humpback whales. Gear samples were collected from two of these cases and these were remanded to the NMFS gear team for ongoing analysis. CCS supported tracking efforts for an entangled right whale that was tagged in the Gulf of St. Lawrence. The whale eventually traveled into US waters and was aided by CCS responders outside the time period of this report. Specialized entanglement response tools were distributed to the Atlantic Large Whale Disentanglement Network, including NMFS GARFO, Florida Fish and Wildlife Conservation Commission, Department of Fisheries and Oceans, Brier Island Whale and Seabird Cruises, Campobello Whale Rescue Team, Grand Manan Whale and Seabird Research Station and Marine Animal Response Society.

SEA TURTLE ENTANGLEMENT RESPONSE

Between August 1, 2018 and July 31, 2019 the CCS 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*). 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 sea turtle reports were immediately shared with NMFS and subsequently shared with *Marine Fisheries* and the Massachusetts Sea Turtle Disentanglement Network (MASTDN). CCS received 48 calls regarding sea turtles during the reporting period and 14 entanglement cases were confirmed, all leatherbacks, including 13 live and 1 dead animal (Figure 11). CCS mounted nine responses and coordinated five responses with network partners and disentangled 12 turtles. All information gathered during responses was shared with all network partners and STERF forms were sent to the NMFS sea turtle coordinator.

REFERENCES

Leeney R.H., Stamieszkin K., Mayo C.A., & Marx M.K. Surveillance, monitoring & management of North Atlantic right whales in Cape Cod Bay and adjacent waters – 2009. Final Report, November 2009.

Pace, R.M., Corkeron, P.J., Kraus, S.D. (2017). State–space mark–recapture estimates reveal a recent decline in abundance of North Atlantic right whales. *Ecol Evo.* 1-12.

Pettis, H.M., Pace, R.M. III, Hamilton, P.K. (2018). North Atlantic Right Whale Consortium 2018 Annual Report Card. Report to the North Atlantic Right Whale Consortium, November 2018.

Pettis, H.M. (2018) Monitoring Injured North Atlantic Right Whales: December 2018 Report.

APPENDIX

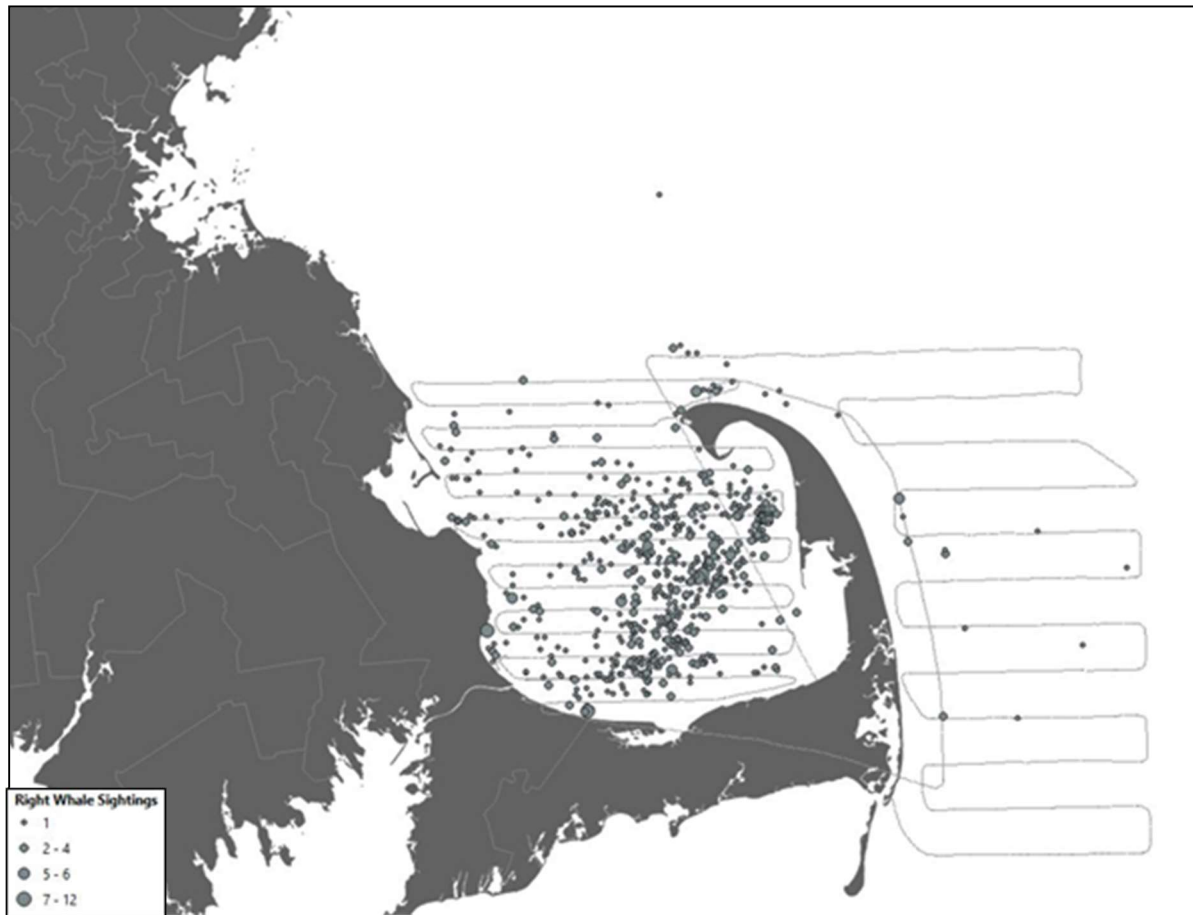


Figure 1. Right whale sightings throughout the 2019 field season (December 2018 – May 2019) from CCS aerial surveys, with examples of the Cape Cod Bay and the Eastern Shore aerial survey track lines.

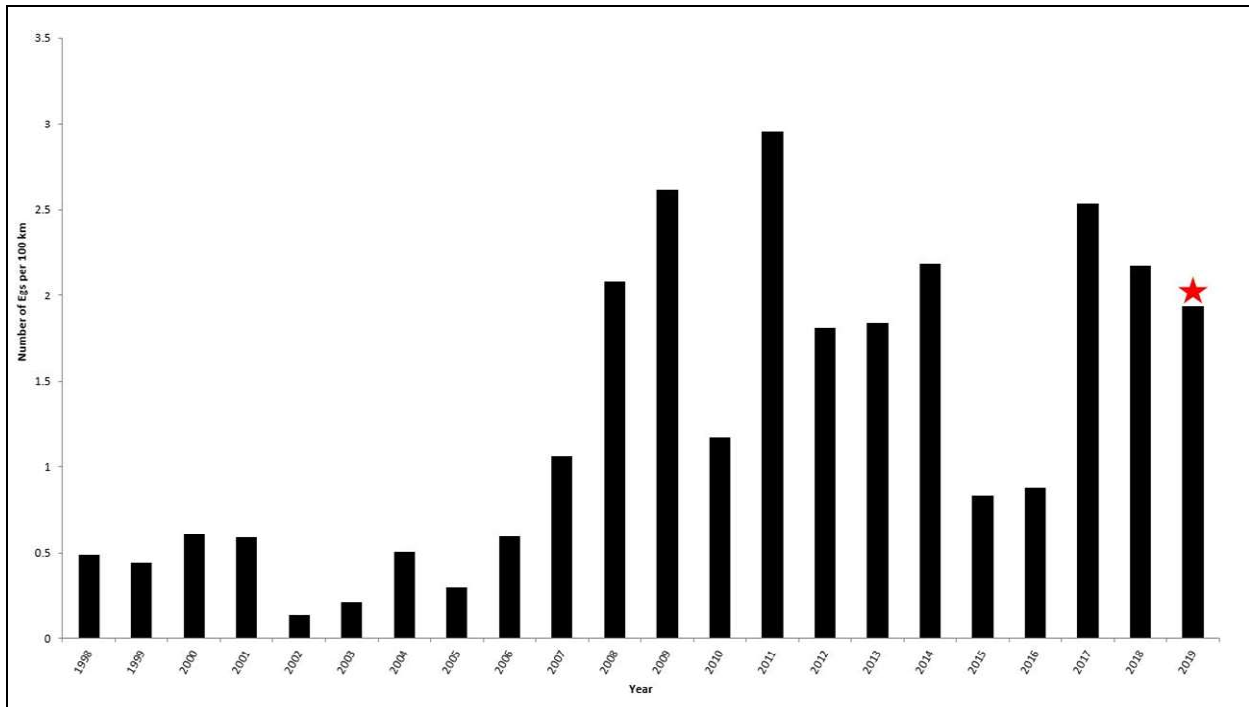


Figure 2. Right whale individual sightings per 100 kilometers of aerial survey effort in Cape Cod Bay, separated by year, between 1998 to 2019. *IPUE will likely increase as more individuals are identified.

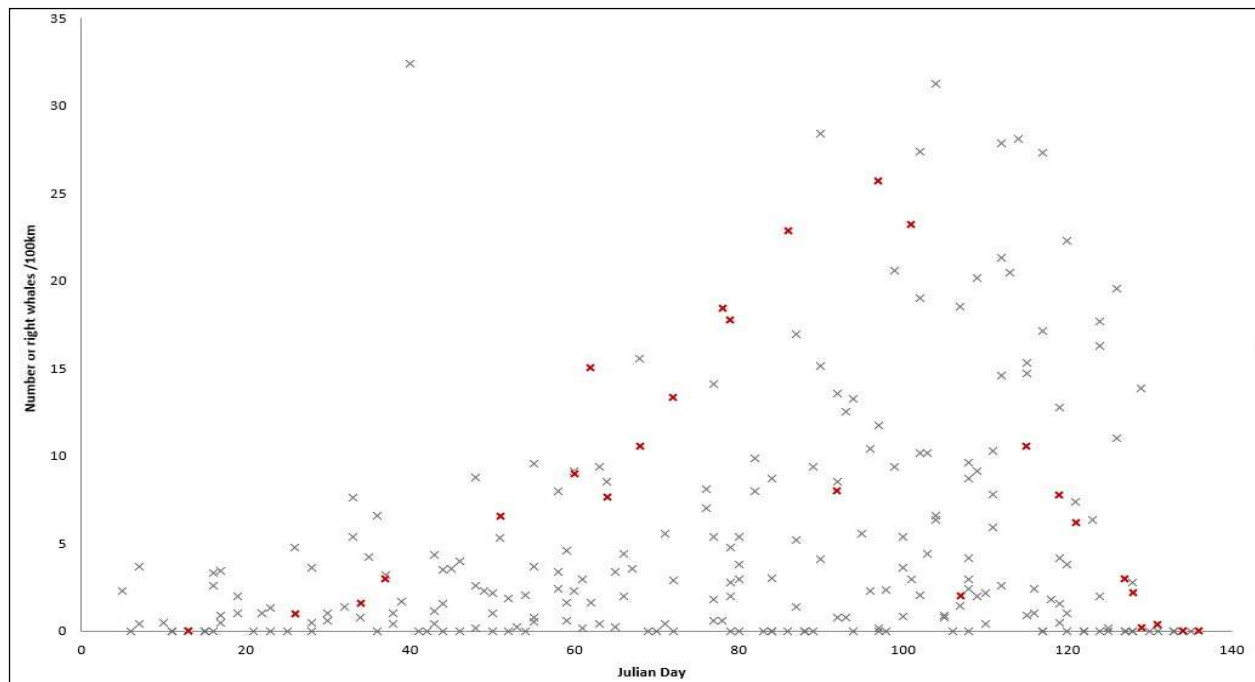


Figure 3. Combined right whale individuals per 100 km of aerial survey effort in Cape Cod Bay (track lines 1-15), from 2010 - 2019. X depicts sightings from 2019, all remaining years are X. December sightings are excluded.

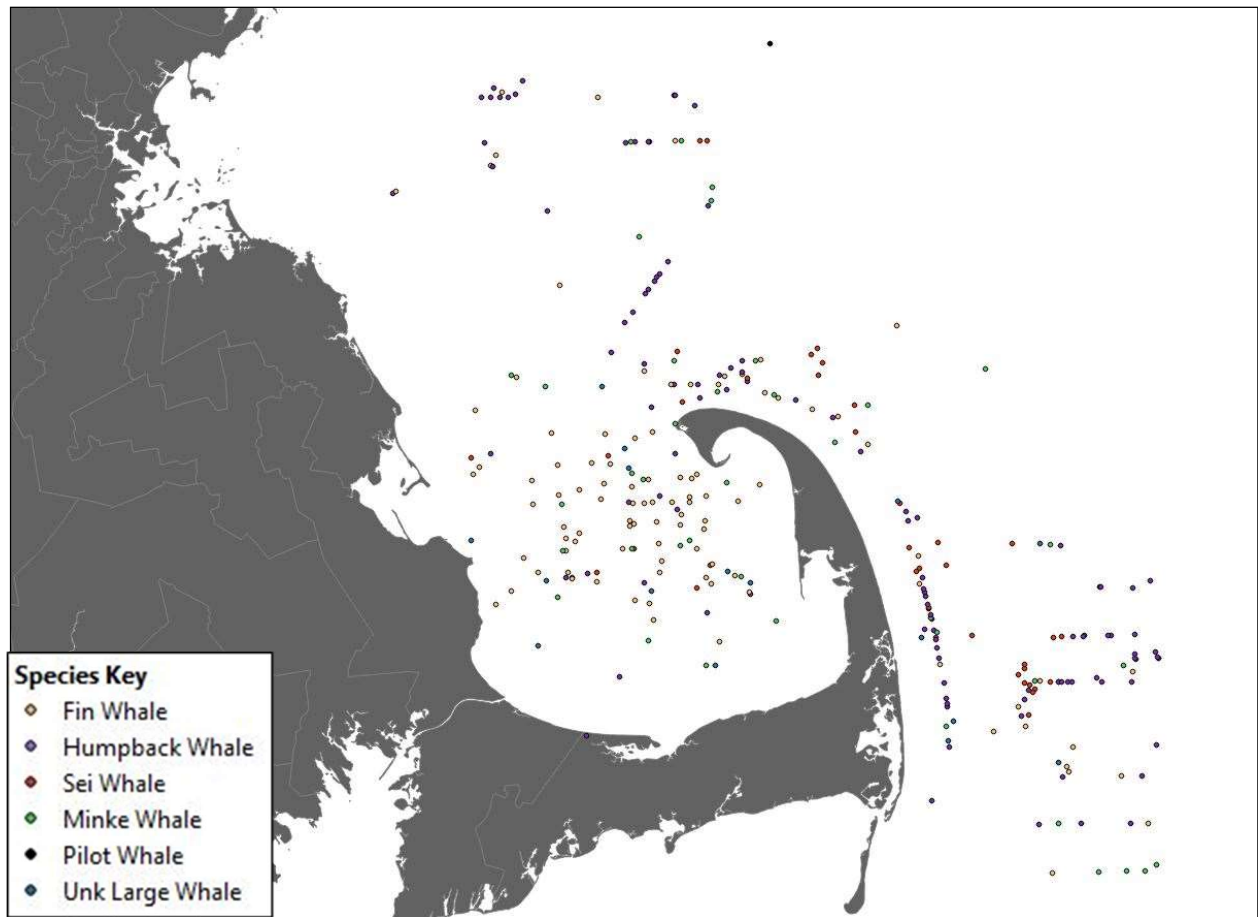


Figure 4. Fin whale, humpback whale, sei whale, minke whale, pilot whale, and unknown large whale sightings locations recorded during CCS aerial surveys in 2019. Note: The number of whales are not depicted on this map.

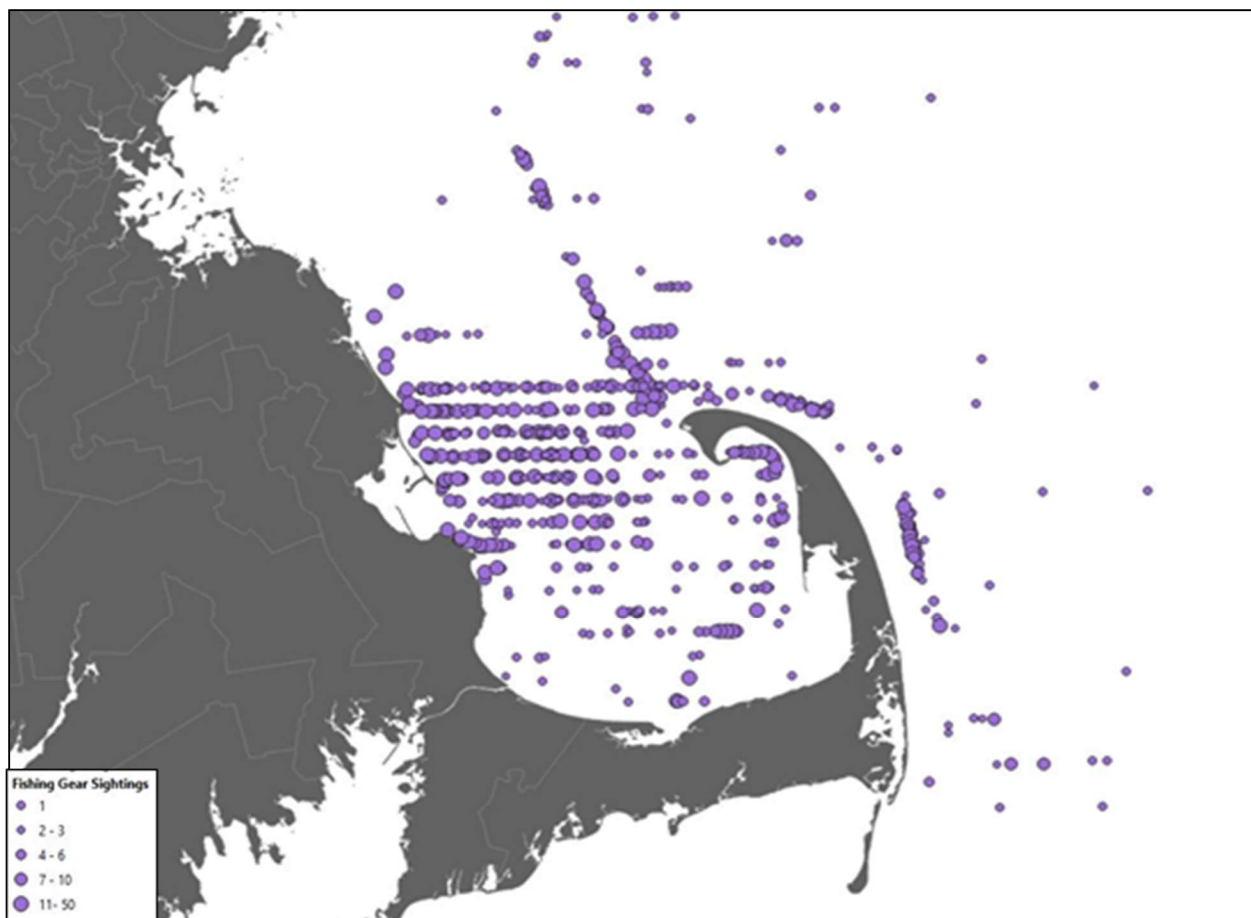


Figure 5. Fixed fishing gear sightings recorded during CCS aerial surveys in 2019. Note: these are gear sightings observed in the vicinity of the aerial track line effort and are not intended to present a comprehensive description of fixed fishing effort throughout the survey area.

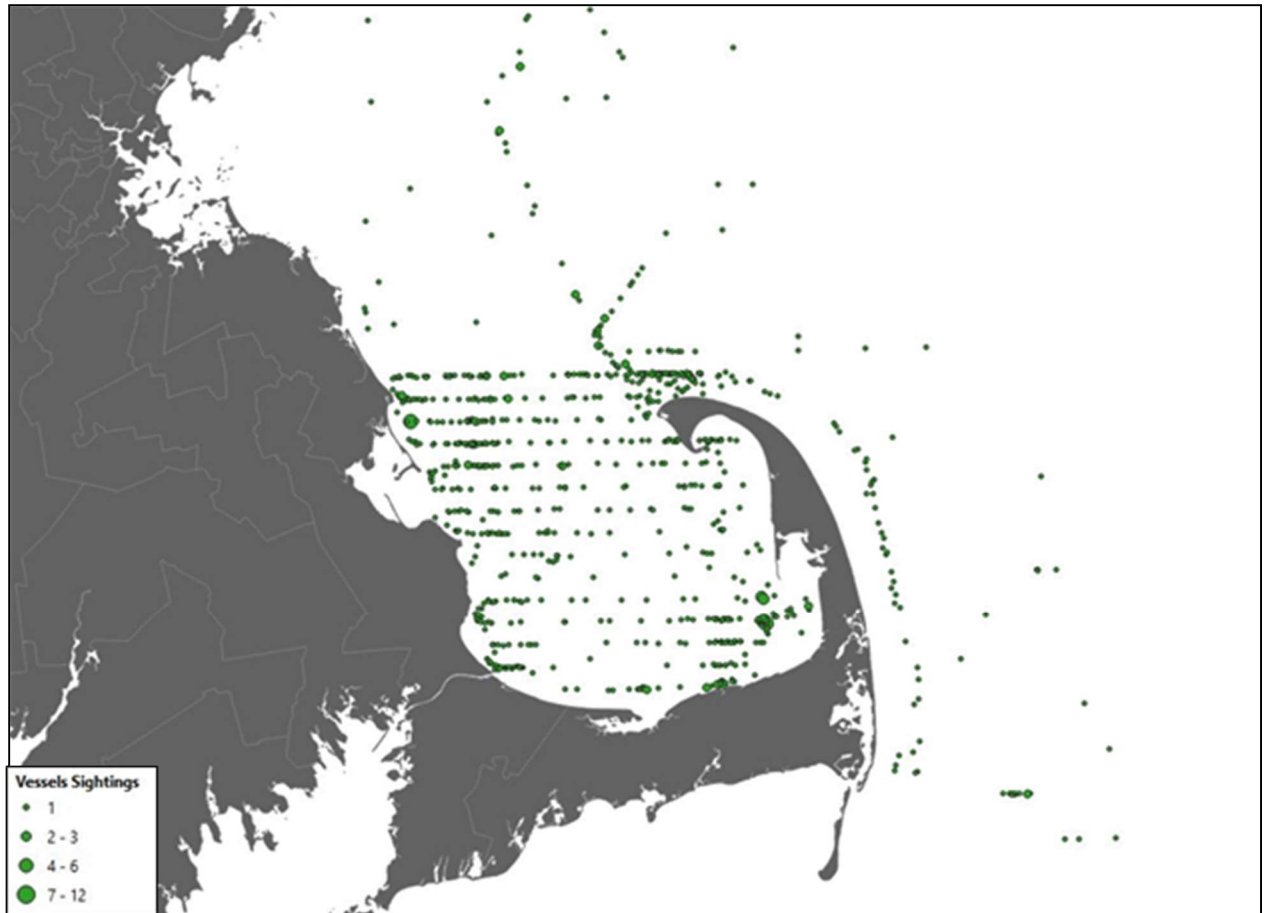


Figure 6. Vessel sightings recorded during CCS aerial surveys in 2019.
Note: these are sightings observed in the vicinity of the aerial track line effort and are not intended to present a comprehensive description of vessel effort throughout the survey area.

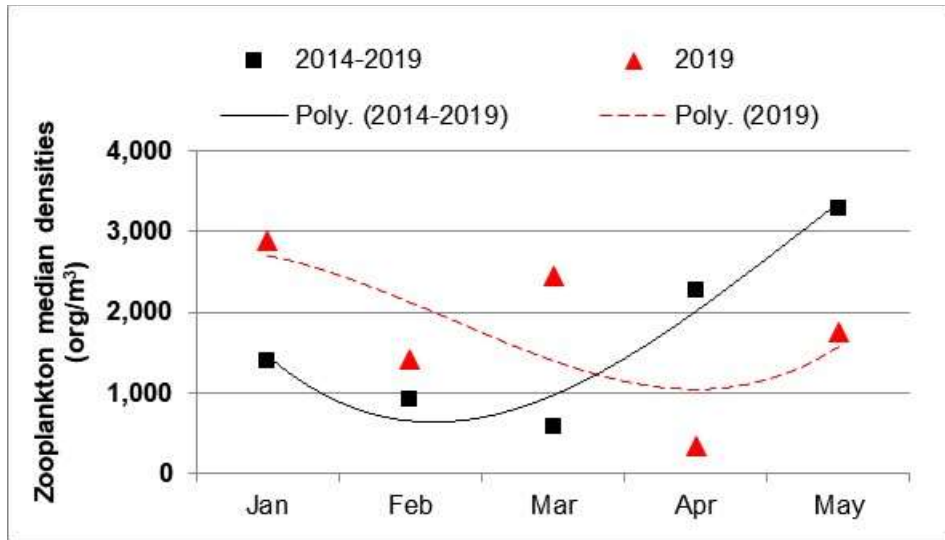


Figure 7. Monthly median zooplankton densities of all tows at regular stations: 2014-2018 and 2019. Calculations do not include zooplankton densities at special stations.

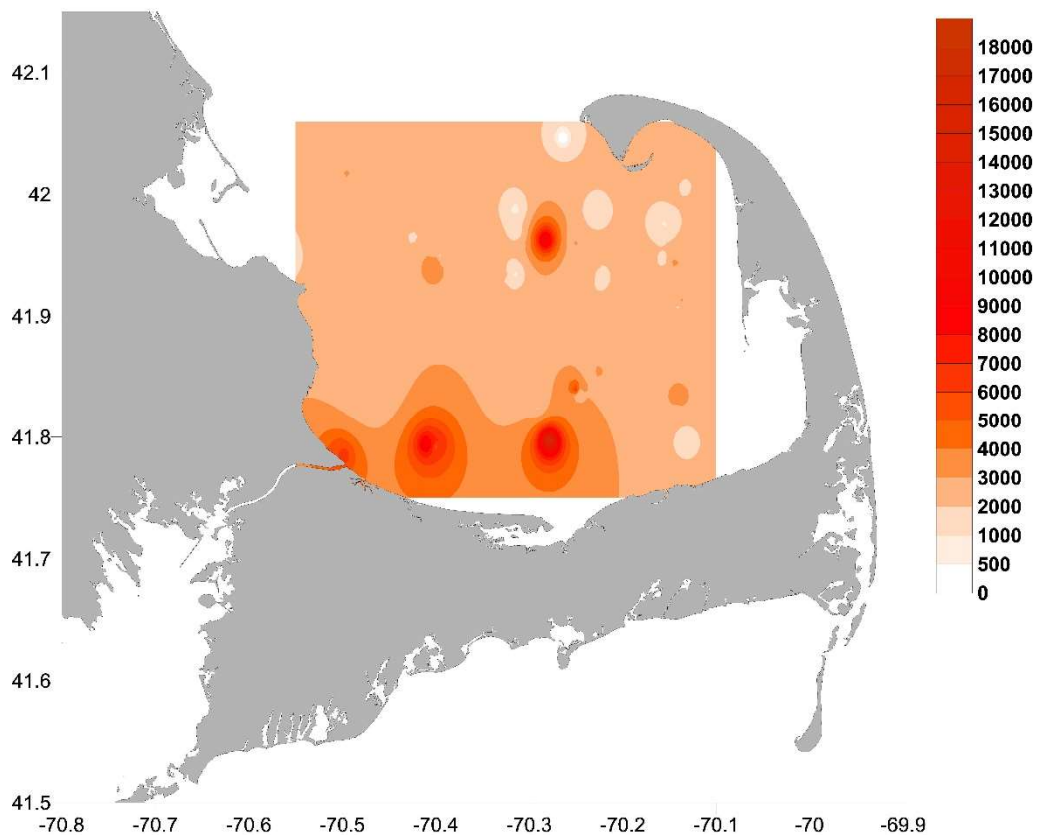


Figure 8. Total zooplankton density contours (< 20 meter depth) for the 2019 right whale season (January – May) in Cape Cod Bay.

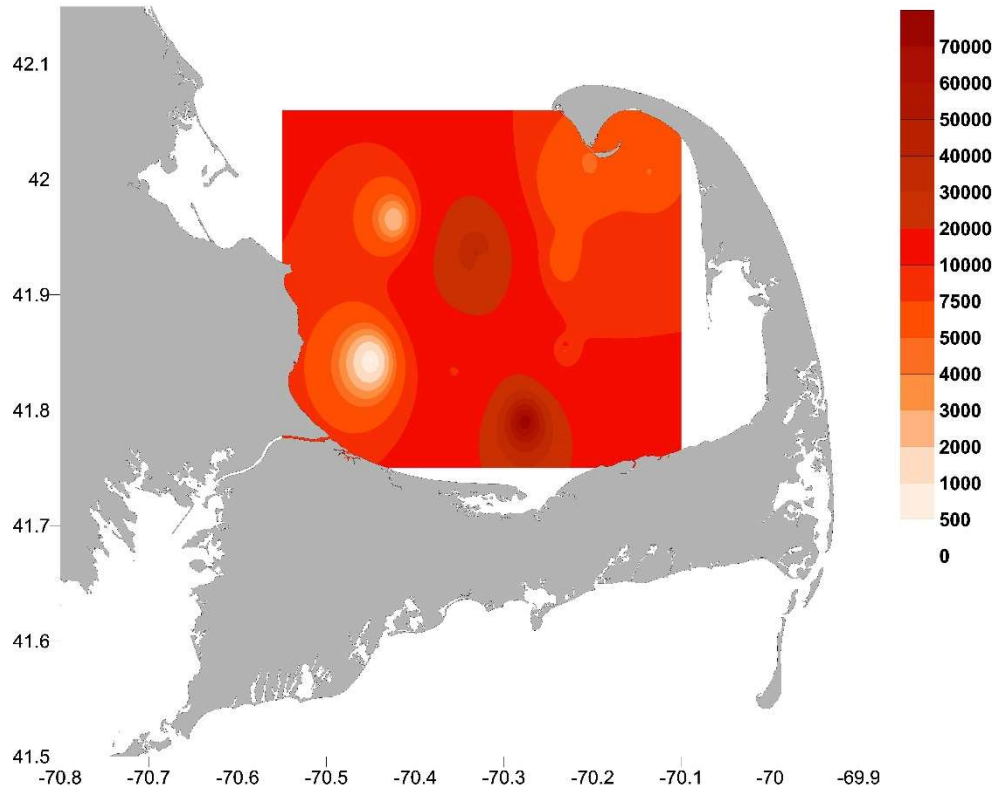


Figure 9. Total zooplankton density contours (> 20 meter depth) for the 2019 right whale season (January – May) in Cape Cod Bay.

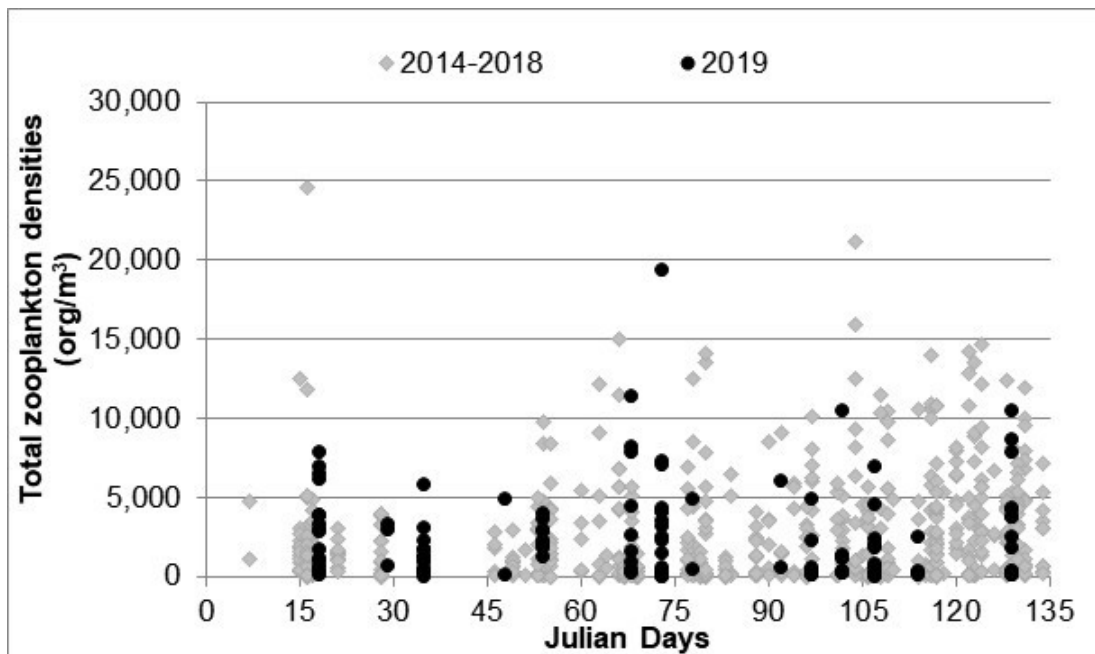


Figure 10. Total zooplankton densities from regular stations through the field season (Jan 1 – May 15) for 2014-2018 and 2019.

Figure 11. All confirmed whale and sea turtle sightings within the MAER response area. Right whale sightings in red, humpback whale sightings in blue; minke whale sightings in pink; fin whale sighting in purple; leatherback sightings in green. Tracks of response vessel in white.

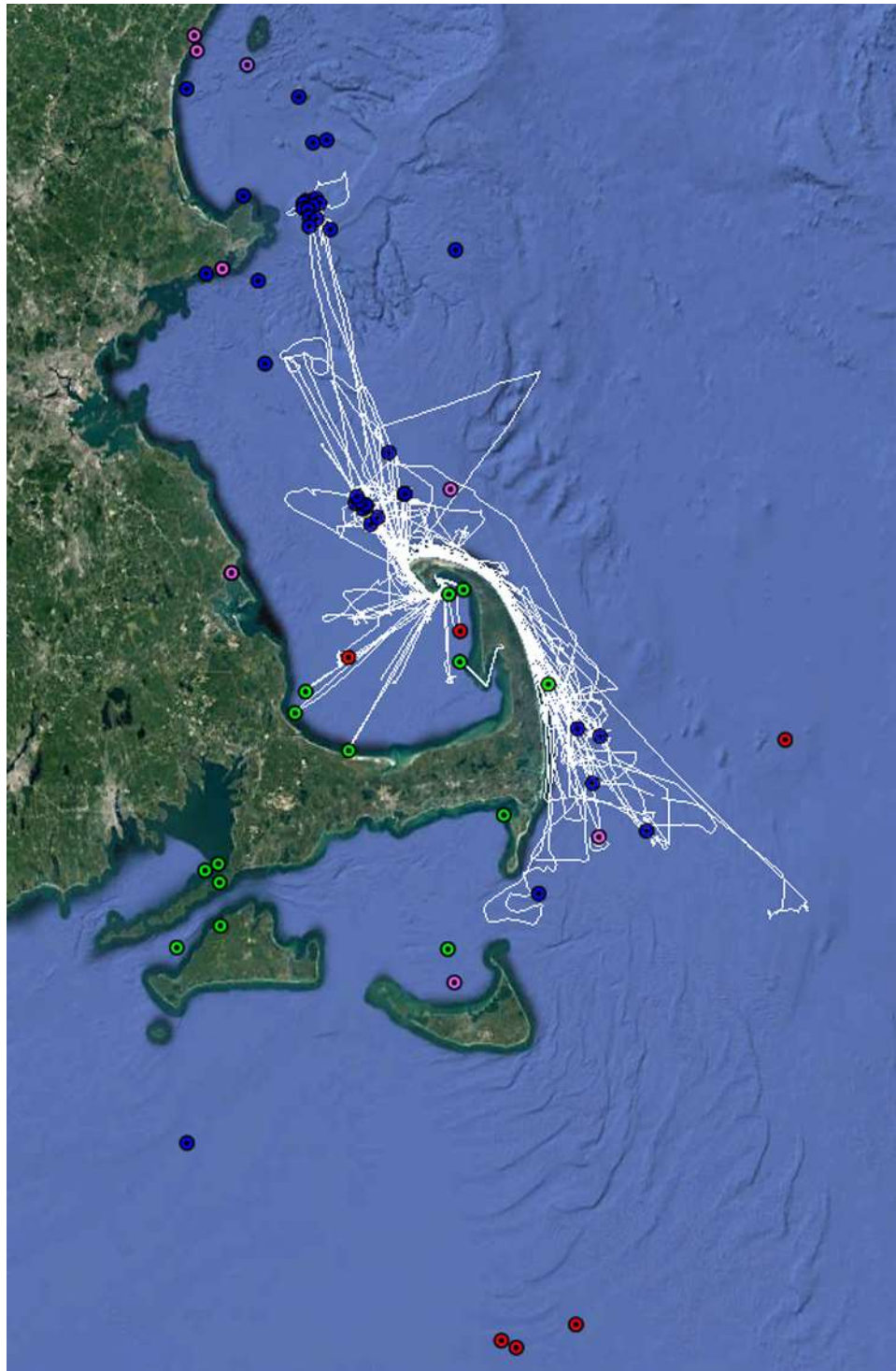


Table 1. 2019 Cape Cod Bay Habitat Cruises

Cruise	Date	On-Station Surface Tows	Off- Station Surface Tows	On- Station Oblique Tows	Off- Station Oblique Tows	Pump Samples*	Total	eDNA sampling
SW1166	09-Oct-18	0	0	4	0	0	4	16
SW1170	01-Dec-18	4	0	5	0	0	9	5
SW1172	11-Dec-18	0	0	5	0	0	5	16
SW1173	14-Dec-18	8	1	8	0	0	17	0
SW1175	18-Jan-19	8	0	9	0	0	17	9
R012919	29-Jan-19	0	0	3	0	0	3	16
R020419	04-Feb-19	8	0	8	0	0	16	0
SW1177	17-Feb-19	1	0	1	0	9	11	4
SW1178	23-Feb-19	0	0	8	0	14	22	17
SW1179	01-Mar-19	0	3	0	3	0	6	7
SW1180	09-Mar-19	5	0	5	0	0	10	0
SW1181	13-Mar-19	0	2	0	1	33	36	4
SW1182	14-Mar-19	8	0	9	0	0	17	16
SW1183	19-Mar-19	1	3	1	3	0	8	16
R033019	30-Mar-19	0	3	0	2	0	5	22
SW1185	02-Apr-19	1	2	1	2	10	16	0
SW1186	07-Apr-19	3	0	4	0	36	43	14
SW1188	12-Apr-19	6	0	6	0	16	28	18
SW1189	14-Apr-19	0	3	0	1	32	36	18
SW1190	17-Apr-19	8	0	8	0	0	16	16
SW1191	24-Apr-19	2	0	2	0	42	46	0
SW1192	25-Apr-19	0	0	0	0	0	0	9
SW1193	29-Apr-19	1	3	1	1	59	65	17
SW1194	01-May-19	0	1	0	1	39	41	20
SW1195	04-May-19	0	1	0	1	109	111	17
SW1196	09-May-19	8	0	9	0	0	17	16
SW2000	09-Jun-19	0	0	8	1	0	9	16
		72	22	105	16	399	614	309

* collected by filtering a pumped volume of water from either 1) the near-surface as the vessel steamed along a horizontal transect, or 2) specific depths in the water column while the vessel was on-station

List of Interviews and Presentations conducted by Dr. Charles A. Mayo during the reporting period

<u>Number</u>	<u>Event</u>
9	The Cape Cod Times (newspaper, interviews)
3	The Provincetown Banner (newspaper, interviews)
2	The Cape Codder (newspaper, interviews)
2	Martha's Vineyard Times (newspaper, interviews)
1	Wellfleet Oysterfest (presentation)
4	Boston Globe (newspaper, interviews)
1	Gulf of Maine Council (presentation)
1	CCS Executive Committee (presentation)
1	Fishing gear modifications meeting (presentation, expert panelist)
3	Massachusetts CZM Habitat Working Group meetings (expert panelist)
4	National Public Radio (interviews)
1	Cape Cod Natural History Conference (technical presentation)
1	Wheaton College (presentation)
1	Chatham Bars Inn ((presentation)
1	Hull Public Library (presentation)
3	Atlantic Large Whale Take Reduction Team 4 days (presentation, expert panelist, phone conference)
1	Cape Cod Museum of Art ((presentation)
5	Documentaries on right whales (5 interviews)
1	U.S. State Department/CZM meeting with Chinese delegation (presentation)
1	Pew Foundation (presentation and expert panelist)
1	Nantucket Whaling Museum (presentation)
1	New Bedford Whaling museum (presentation and expert panelist)
1	Massachusetts CEC/NOAA on OCS development (presentation and expert panelist)
1	Thoreau Documentary (interview on right whales)

additionally:

- informal presentations related to right whales, the threat to the species, feeding behavior, and CCS research at approximately 35 meetings
- approximately 20 interviews by radio and print media



David E. Pierce, PhD.
Director

Commonwealth of Massachusetts

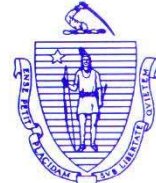
Division of Marine Fisheries

251 Causeway Street, Suite 400

Boston, Massachusetts 02114

(617) 626-1520

fax (617) 626-1509



Charles D. Baker
Governor

Karyn E. Pollito
Lieutenant Governor

Matthew A. Beaton
Secretary

Ronald S. Amidon
Commissioner

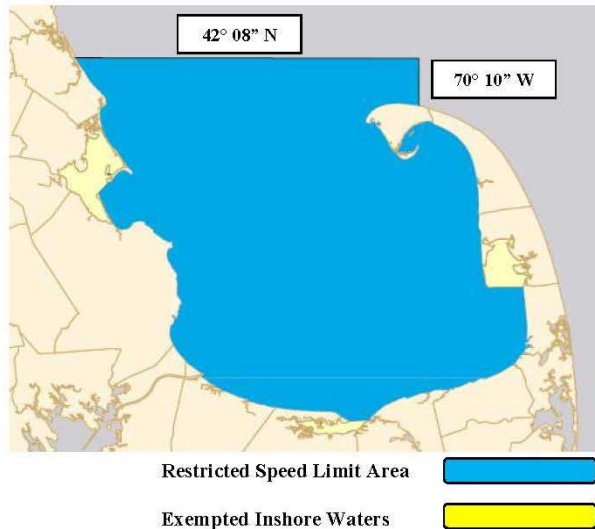
Mary-Lee King
Deputy Commissioner

March 8, 2019

Marine Fisheries Advisory

SEASONAL SMALL VESSEL SPEED LIMIT IN CAPE COD BAY

The Division of Marine Fisheries (DMF) has implemented a seasonal small vessel speed limit of 10 knots for certain waters of Cape Cod Bay. This speed limit will be in effect annually during the months of March and April within those waters of Cape Cod Bay south of 42° 08' north latitude, this includes those waters north of Cape Cod that are west of 70° 10' west longitude (see map). The term small vessel refers to all vessels less than 65' overall length. A complementary federal speed limit applies to all vessels 65' overall length and greater. Small vessel traffic within the inshore waters of Plymouth, Duxbury, Kingston, Barnstable and Wellfleet Harbors are exempt from this speed limit. The speed limit also does not apply to emergency and enforcement personnel, including federal whale disentanglement teams.



This speed limit has been implemented to protect endangered right whales from ship strikes. During the late-winter and early-spring, right whales migrate into and aggregate in Cape Cod Bay where they feed on zooplankton. As we move from the winter into the spring they begin to surface feed. This behavior leaves them particularly susceptible to ship strikes. Ship strikes are a significant source of mortality to these endangered whales. However, the lethality of ship strikes is greatly reduced when vessels are operating at less than 10 knots speed.

For more information regarding the management of protected marine species in Massachusetts, please visit our website (www.mass.gov/marinefisheries) or call DMF at 617-626-1520.



David E. Pierce, Ph.D.
Director

Commonwealth of Massachusetts

Division of Marine Fisheries

251 Causeway Street, Suite 400

Boston, Massachusetts 02114

(617) 626-1520

fax (617) 626-1509



Charles D. Baker
Governor

Karyn E. Polito
Lieutenant Governor

Matthew A. Beaton
Secretary

Ronald S. Amidon
Commissioner

Mary-Lee King
Deputy Commissioner

April 26, 2019

Marine Fisheries Advisory

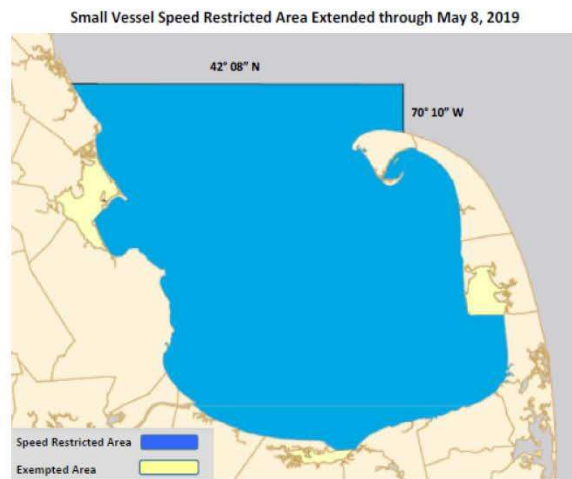
SEASONAL SPEED LIMIT RESTRICTION EXTENDED THROUGH MAY 8TH

As a result of the continued presence of endangered right whales off Cape Cod, the Director of the Division of Marine Fisheries is extending the seasonal speed limit restrictions through May 8th ([Notice of Declaration](#)). Accordingly, all vessels with an overall length of less than 65' (small vessels) operating within those waters of Cape Cod Bay south of 42° 08' north latitude and north and east of Cape Cod west of 70° 10' west longitude may not travel at a speed of greater than 10 knots (see map). Vessels with an overall length of 65' or greater are subject to a federal 10 knot speed limit rule in this area through May 15th ([federal rule](#)).

Exempt from this are law enforcement and emergency personnel operating within their course of authorized duties, including federal whale disentanglement personnel responding to an entangled whale, as well as any small vessel operating in the inshore waters of Plymouth, Kingston, Duxbury, Barnstable and Wellfleet harbors. The duration of this speed limit restriction may be shortened or extended based on continuing aerial and vessel based surveys. DMF will update the public regarding any such adjustments.

On April 25, 2019, the Provincetown Center for Coastal Studies conducted an aerial survey for right whales along Cape Cod. The survey estimated there were approximately 57 right whales feeding at or near the surface in Cape Cod Bay. Additionally, *Calanus* plankton counts are high indicating that the whales are likely to remain aggregated in the area to feed. The extension of this speed limit restriction will protect these endangered whales from ship strikes, which are a major source of mortality for these animals. Right whales are critically endangered species and their population has been decreasing since 2010 due to continued mortality and low birth rates. They seasonally migrate into Massachusetts waters and aggregate in Cape Cod Bay to feed on zooplankton. In recent years more than 50% of the known right whale population has been observed in our waters during late winter and early spring.

For more information about the management of protected species in Massachusetts, contact DMF at 617-626-1520 or visit our website at www.mass.gov/marinefisheries.





David E. Pierce, PhD.
Director

Commonwealth of Massachusetts

Division of Marine Fisheries

251 Causeway Street, Suite 400

Boston, Massachusetts 02114

(617) 626-1520

fax (617) 626-1509



Charles D. Baker
Governor

Karyn E. Polito
Lieutenant Governor

Matthew A. Beaton
Secretary

Ronald S. Amidon
Commissioner

Mary-Lee King
Deputy Commissioner

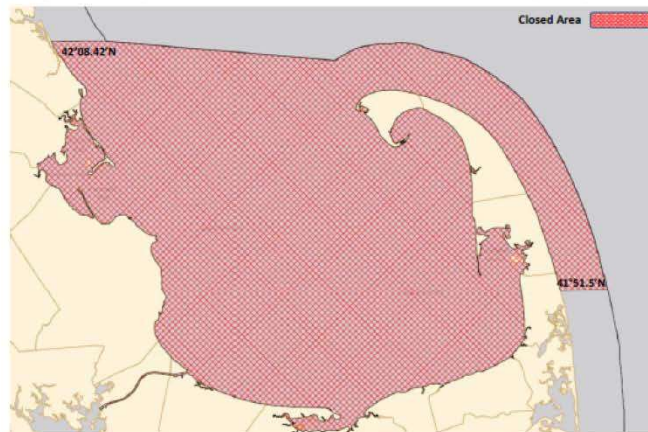
April 26, 2019

Marine Fisheries Advisory

SEASONAL TRAP GEAR CLOSURE EXTENDED THROUGH MAY 8TH

The continued presence of endangered right whales off Cape Cod results in the Director of the Division of Marine Fisheries extending the seasonal Large Whale Seasonal Trap Gear Closure through May 8th ([Notice of Declaration](#)) for certain waters within Cape Cod Bay and along the Outer Cape. This extended closure only applies within those waters under the jurisdiction of the Commonwealth within Cape Cod Bay south of 42° 8.42' north latitude and east of Cape Cod north of 41° 51.5' north

Large Whale Trap Gear Closure Extension Area – Area Closed Through May 8, 2019



latitude at Nauset Light (see map). This closure does not extend into any federal waters, including those waters north of Cape Cod on Stellwagen Bank. Accordingly, both recreational and commercial trap fishermen are prohibited to setting any trap gear in these waters until May 9th. The duration of this closure extension may be shortened or extended based on continuing aerial and vessel based surveys and fishermen will be notified of any such adjustments.

On April 25, 2019, the Provincetown Center for Coastal Studies conducted an aerial survey for right whales along Cape Cod. The survey estimated there were approximately 57 right whales feeding at or near the surface in Cape Cod Bay. Additionally, *Calanus* plankton counts are high indicating that the whales are likely to remain aggregated in the area to feed. This trap gear closure extension protects these endangered whales from entanglements in fixed fishing gear, which are a major source of mortality for these animals. Right whales are critically endangered species and their population has been decreasing since 2010 due to continued mortality and low birth rates. They seasonally migrate into Massachusetts waters and aggregate in Cape Cod Bay to feed on zooplankton. In recent years, more than 50% of the known right whale population has been observed in our waters during late winter and early spring.

For more information about the management of protected species in Massachusetts, contact DMF at 617-626-1520 or visit our website at www.mass.gov/marinefisheries.



David E. Pierce, PhD.
Director

Commonwealth of Massachusetts

Division of Marine Fisheries

251 Causeway Street, Suite 400

Boston, Massachusetts 02114

(617) 626-1520

fax (617) 626-1509



Charles D. Baker
Governor

Karyn E. Polito
Lieutenant Governor

Matthew A. Beaton
Secretary

Ronald S. Amidon
Commissioner

Mary-Lee King
Deputy Commissioner

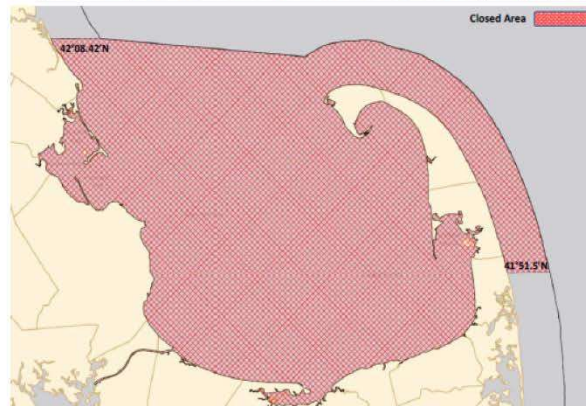
May 6, 2019

Marine Fisheries Advisory

SEASONAL TRAP GEAR CLOSURE EXTENDED THROUGH MAY 14TH

The continued presence of endangered right whales in the waters off Cape Cod results in the Director of the Division of Marine Fisheries extending the seasonal Large Whale Seasonal Trap Gear Closure through May 14, 2019 ([Notice of Declaration](#)). This closure extension applies only in certain waters within Cape Cod Bay and along the Outer Cape. This extended closure only applies within those waters under the jurisdiction of the Commonwealth within Cape Cod Bay south of 42° 8.42' north latitude and east of Cape Cod north of 41° 51.5' north latitude at Nauset Light (see map). This closure does not extend into any federal waters, including those waters north of Cape Cod on Stellwagen Bank. Accordingly, both recreational and commercial trap fishermen are prohibited to setting any trap gear in these waters until May 15th.

Large Whale Trap Gear Closure Extension Area – Area Closed Through May 14, 2019



Recent aerial surveys by the Provincetown Center for Coastal Studies demonstrate that right whales remain in the waters of Cape Cod Bay feeding at or near the surface in Cape Cod Bay. Additionally, *Calanus* plankton counts indicate that the whales are likely to remain aggregated and feeding in the area. DMF will continue to closely monitor the presence of whales off Cape Cod and the duration of trap gear closure extension may be shortened or extended in response. DMF will update the public regarding any such adjustments.

Right whales are critically endangered species and their population has been decreasing since 2010 due to continued mortality and low birth rates. These whales seasonally migrate into Massachusetts waters and aggregate in Cape Cod Bay to feed on zooplankton. In recent years, more than 50% of the known right whale population were observed in our waters during late winter and early spring. This trap gear closure extension protects these endangered whales from entanglements in fixed fishing gear, which are a major source of mortality for these animals.

For more information about the management of protected species in Massachusetts, contact DMF at 617-626-1520 or visit our website at www.mass.gov/marinefisheries.



David E. Pierce, PhD.
Director

Commonwealth of Massachusetts

Division of Marine Fisheries

251 Causeway Street, Suite 400

Boston, Massachusetts 02114

(617) 626-1520

fax (617) 626-1509



Charles D. Baker
Governor

Karyn E. Polito
Lieutenant Governor

Kathleen Theoharides
Secretary

Ronald S. Amidon
Commissioner

Mary-Lee King
Deputy Commissioner

May 9, 2019

Marine Fisheries Advisory

DMF RESCINDS SEASONAL LARGE WHALE TRAP GEAR CLOSURE AND SEASONAL SPEED LIMIT IN WATERS OFF CAPE COD

The most recent aerial survey by the Provincetown Center for Coastal Studies demonstrate that right whales have migrated out of those state-waters adjacent to Cape Cod. As a result, the Director of the Division of Marine Fisheries has rescinded both the Large Whale Trap Gear Closure Extension and Seasonal Speed Limit Restrictions ([Notice of Declaration](#)) effective May 10th. These rules were previously in place through May 14th.

Effective tomorrow, commercial and recreational lobstermen may set their trap gear in those waters north and east of Cape Cod that were previously closed to fixed gear. Additionally, boaters operating vessels that are smaller than 65' over length may operate at a boat speed of greater than 10 knots. We advise that vessel operators continue to operate with caution. Through May 15th, vessels with an overall length of 65' and greater shall comply with the federal 10 knot speed limit in the waters of Cape Cod Bay ([federal rule](#)).

Right whales are a critically endangered species and their population has been decreasing since 2010 due to continued mortality and low birth rates. These whales seasonally migrate into Massachusetts waters and aggregate in Cape Cod Bay to feed on zooplankton. In recent years, more than 50% of the known right whale population was observed in our waters during late winter and early spring. The Large Whale Trap Gear Closure and Cape Cod Bay Seasonal Speed Restriction protects these endangered whales from entanglements in fixed fishing gear and vessel collisions, which are a major sources of mortality for these endangered animals.

For more information about the management of protected species in Massachusetts, contact DMF at 617-626-1520 or visit our website at www.mass.gov/marinefisheries.