COMMON DOLPHIN (*Delphinus delphis delphis*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The common dolphin (*Delphinus delphis delphis*) may be one of the most widely distributed species of cetaceans, as it is found world-wide in temperate and subtropical seas. In the North Atlantic, common dolphins are commonly found along the shoreline of Massachusetts in mass-stranding events (Bogomolni *et al.* 2010; Sharp *et al.* 2014). At-sea sightings have been concentrated over the continental shelf between the 100-m and 2000-m isobaths and over prominent underwater topography and east to the mid-Atlantic Ridge (29˚W; Doksaeter *et al.* 2008; Waring *et al.* 2008). Common dolphins have been noted to be associated with Gulf Stream features (CETAP 1982; Selzer and Payne 1988; Waring *et al.* 1992; Hamazaki 2002). The species is less common south of Cape Hatteras, although schools have been reported as far south as the Georgia/South Carolina border (32º N; Jefferson *et al*. 2009). They exhibit seasonal movements, where they are found from Cape Hatteras northeast to Georges Bank (35˚ to 42˚N) during mid-January to May (Hain *et al.* 1981; CETAP 1982; Payne *et al.* 1984), although some animals tagged and released after stranding in winters of 2010–2012 used habitat in the Gulf of Maine north to almost 44˚N (Sharp *et al*. 2016). Common dolphins move onto Georges Bank, Gulf of Maine, and the Scotian Shelf from mid-summer to autumn. Selzer and Payne (1988) reported very large aggregations (greater than 3,000 animals) on Georges Bank in autumn. Migration onto the Scotian Shelf and continental shelf off Newfoundland occurs during summer and autumn when water temperatures exceed 11ºC (Sergeant *et al.* 1970; Gowans and Whitehead 1995).

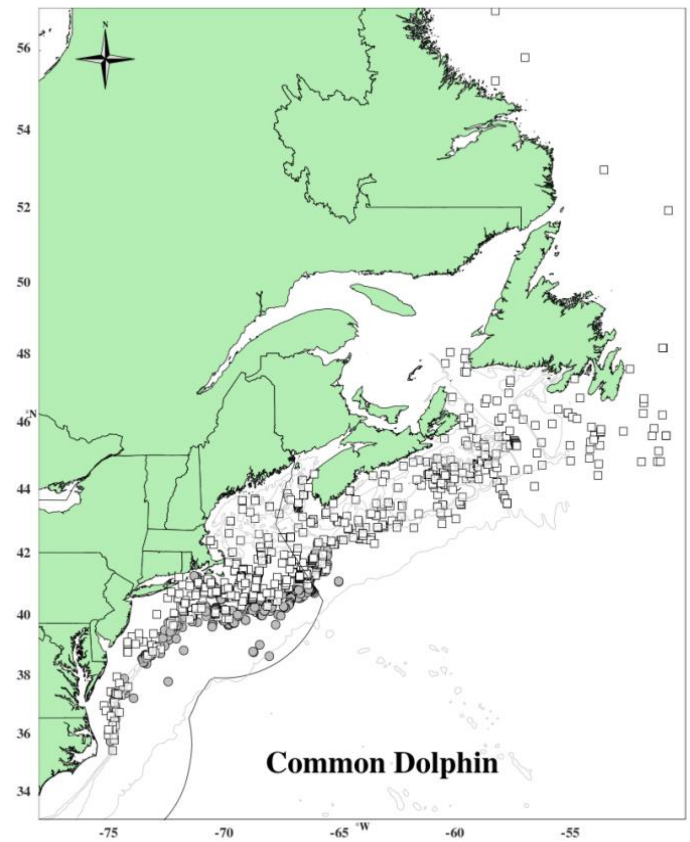

Figure 1. Distribution of common dolphin sightings from NEFSC and SEFSC shipboard and aerial surveys during the ummers of 1998, 1999, 2002, 2004, 2006, 2007, 2010, 2011, 2016 and Department of Fisheries and Oceans Canada 2007 TNASS and 2016 NAISS surveys. Isobaths are the 100-m, 1000-m and 4000-m depth contours.

Westgate (2005) tested the proposed one-population-stock model using a molecular analysis of mitochondrial DNA (mtDNA), as well as a morphometric analysis of cranial specimens. Both genetic analysis and skull morphometrics failed to provide evidence ($p>0.05$) of more than a single population in the western North Atlantic, supporting the proposed one-stock model. However, when western and eastern North Atlantic common dolphin mtDNA and skull morphology were compared, both the cranial and mtDNA results showed evidence of restricted gene flow ($p<0.05$) indicating that these two areas are not panmictic. Cranial specimens from the two sides of the North Atlantic differed primarily in elements associated with the rostrum. These results suggest that common dolphins

in the western North Atlantic are composed of a single panmictic group whereas gene flow between the western and eastern North Atlantic is limited (Westgate 2005, 2007). This was further supported by Mirimin *et al.* (2009) who investigated genetic variability using both nuclear and mitochondrial genetic markers and observed no significant genetic differentiation between samples from within the western North Atlantic region, which may be explained by seasonal shifts in distribution between northern latitudes (summer months) and southern latitudes (winter months). However, the authors point out that some uncertainty remains if the same population was sampled in the two different seasons.

POPULATION SIZE

The current best abundance estimate for Western North Atlantic stock of common dolphins is 172,947 (CV=0.21) which is the total of Canadian and U.S. surveys conducted in 2016 (Table 1). This estimate, derived from shipboard and aerial surveys, covers most of this stock's known range. Because the survey areas did not overlap, the estimates from the three surveys were added together and the CVs pooled using a delta method to produce a species abundance estimate for the stock area.

Earlier Abundance Estimates

Please see Appendix IV for a summary of abundance estimates, including earlier estimates and survey descriptions. As recommended in the guidelines for preparing Stock Assessment Reports (NMFS 2016), estimates older than eight years are deemed unreliable to determine a current PBR.

Recent Surveys and Abundance Estimates

Abundance estimates of 48,723 (CV=0.48) for the Newfoundland/Labrador portion and 43,124 (CV=0.28) for the Bay of Fundy/Scotian Shelf/Gulf of St. Lawrence portion of the stock area were generated from the Canadian Northwest Atlantic International Sightings Survey (NAISS) survey conducted in August–September 2016 (Table 1). This large-scale aerial survey covered Atlantic Canadian shelf and shelf break habitats from the northern tip of Labrador to the U.S border off southern Nova Scotia (Lawson and Gosselin 2018). Line-transect density and abundance analyses were completed using Distance 7.1 release 1 (Thomas *et al*. 2010).

Abundance estimates of 80,227 (CV=0.31) and 900 (CV=0.57) common dolphins were generated from vessel surveys conducted in U.S. waters of the western North Atlantic during the summer of 2016 (Table 1; Garrison 2020; Palka 2020). One survey was conducted from 27 June to 25 August in waters north of 38ºN latitude and consisted of 5,354 km of on-effort trackline along the shelf break and offshore to the outer limit of the U.S. EEZ (NEFSC and SEFSC 2018). The second vessel survey covered waters from Central Florida to approximately 38ºN latitude between the 100-m isobaths and the outer limit of the U.S. EEZ during 30 June–19 August. A total of 4,399 km of trackline was covered on effort (NEFSC and SEFSC 2018). Both surveys utilized two visual teams and an independent observer approach to estimate detection probability on the trackline (Laake and Borchers 2004). Mark-recapture distance sampling was used to estimate abundance. Estimates from the two surveys were combined and CVs pooled to produce a species abundance estimate for the stock area.

Table 1. Summary of recent abundance estimates for western North Atlantic common dolphin (Delphinus delphis delphis) by month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{est}) and coefficient of variation (CV). The estimate considered best in in bold font.

Month/Year	Area	N_{est}	CV
June–Sep 2016	Central Virginia to lower Bay of Fundy	80,227	0.31
June–Aug 2016	Florida to Central Virginia	900	0.57
June–Sep 2016	Newfoundland/Labrador	48,723	0.48
June–Sep 2016	Bay of Fundy/Scotian Shelf/Gulf of St. Lawrence	43,124	0.28
June–Sep 2016	**Florida to Newfoundland/Labrador (COMBINED)**	**172,974**	**0.21**

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for common dolphins is 172,974 animals (CV=0.21), derived from the 2016 aerial and shipboard surveys. The minimum population estimate for the western North Atlantic

common dolphin is 145,216.

Current Population Trend

A trend analysis has not been conducted for this stock. The statistical power to detect a trend in abundance for this stock is poor due to the relatively imprecise abundance estimates and long survey interval (see Appendix IV for a survey history of this stock). For example, the power to detect a precipitous decline in abundance (i.e., 50% decrease in 15 years) with estimates of low precision (e.g., CV>0.30) remains below 80% (alpha=0.30) unless surveys are conducted on an annual basis (Taylor *et al.* 2007). There is current work to standardize the strata-specific previous abundance estimates to consistently represent the same regions and include appropriate corrections for perception and availability bias. These standardized abundance estimates will be used in state-space trend models that incorporate environmental factors that could potentially influence the process and observational errors for each stratum.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Due to uncertainties about the stock-specific life-history parameters, the maximum net productivity rate was assumed to be the default value for cetaceans of 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a recovery factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 145,216 animals. The maximum productivity rate is 0.04, the default value for cetaceans. The recovery factor is 0.5, the default value for stocks of unknown status and with the CV of the average mortality estimate less than 0.3 (Wade and Angliss 1997). PBR for the western North Atlantic stock of common dolphin is 1,452.

Table 2. Best and minimum abundance estimates for the western North Atlantic common dolphin (Delphinus delphis delphis) with Maximum Productivity Rate (R_{max}), Recovery Factor (F_r) and PBR.

N_{est}	CV	N_{min}	F_r	R_{max}	PBR
172,974	0.21	145,216	0.5	0.04	1,452

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Average annual estimated fishery-related mortality or serious injury to this stock during this reporting period are presented in Table 3.

Table 3. The total annual estimated average human-caused mortality and serious injury for the western North Atlantic common dolphin (Delphinus delphis delphis).

Years	Source	Annual Avg.	CV
2015–2019	U.S. fisheries using observer data	390	0.11
2015–2019	Research mortalities	0.2	
2015–2019	Non-fishery stranding mortalities	0.2	
TOTAL		390.4	

Uncertainties not accounted for include the potential that the observer coverage was not representative of the fishery during all times and places. There are no major known sources of unquantifiable human-caused mortality or serious injury for this stock.

Northeast Sink Gillnet

Annual common dolphin mortalities were estimated using annual ratio-estimator methods (Orphanides and Hatch 2017; Orphanides 2019, 2020, 2021; Precoda and Orphanides 2022). See Table 4 for bycatch estimates and observed mortality and serious injury for the current 5-year period, and Appendix V for historical bycatch information.

Mid-Atlantic Gillnet

Common dolphins were taken in observed trips during most years. Annual common dolphin mortalities were estimated using annual ratio-estimator methods (Orphanides and Hatch 2017; Orphanides 2019, 2020, 2021; Precoda and Orphanides 2022). See Table 4 for bycatch estimates and observed mortality and serious injury for the current 5-year period, and Appendix V for historical bycatch information.

Northeast Bottom Trawl

This fishery is active in New England waters in all seasons. Annual common dolphin mortalities were estimated using annual stratified ratio-estimator methods (Lyssikatos and Chavez-Rosales 2022). See Table 4 for bycatch estimates and observed mortality and serious injury for the current 5-year period, and Appendix V for historical bycatch information.

Mid-Atlantic Bottom Trawl

Annual common dolphin mortalities were estimated using annual stratified ratio-estimator methods (Lyssikatos and Chavez-Rosales 2022). See Table 4 for bycatch estimates and observed mortality and serious injury for the current 5-year period, and Appendix V for historical bycatch information.

Pelagic Longline

Pelagic longline bycatch estimates of common dolphins for 2015–2019 were documented in Garrison and Stokes (2017, 2020a, 2020b, 2021). There is a high likelihood that dolphins released alive with ingested gear or gear wrapped around appendages will not survive (Wells *et al.* 2008). See Table 4 for bycatch estimates and observed mortality and serious injury for the current 5-year period, and Appendix V for historical bycatch information.

Research Takes

In October 2016 the University of Rhode Island, Graduate School of Oceanography reported the incidental capture/drowning of a 206-cm female common dolphin during a routine, weekly research trawl fishing trip in Narragansett Bay, Rhode Island. The incident was reported to Mystic Aquarium, Mystic, Connecticut; NOAA GARFO Office, Gloucester, Massachusetts; NOAA law enforcement; and NOAA Protected Species Branch, Woods Hole, Massachusetts. A complete necropsy was conducted at the Wood Hole Oceanographic Institution, Woods Hole, Massachusetts.

Table 4. Summary of the incidental serious injury and mortality of North Atlantic common dolphins (Delphinus delphis delphis) by commercial fishery including the years sampled, the type of data used, the annual observer coverage, the serious injuries and mortalities recorded by on-board observers, the estimated annual serious injury and mortality, the combined serious injury and mortality estimate, the estimated CV of the annual combined serious injury and mortality and the mean annual serious injury and mortality estimate (CV in parentheses).

Fishery	Years	Data Type [a]	Observer Coverage [b]	Observed Serious Injury[d]	Observed Mortality	Estimated Serious Injury[d]	Estimated Mortality	Estimated Combined Mortality	Estimated CVs	Mean Combined Annual Mortality
Northeast Sink Gillnet	2015	Obs. Data, Trip Logbook, Allocated Dealer Data	0.14	0	3	0	55	55	0.54	73 (0.19)
	2016		0.10	0	8	0	80	80	0.38	
	2017		0.12	0	20	0	133	133	0.28	
	2018		0.11	0	10	0	93	93	0.45	
	2019		0.13	0	1	0	5.0	5.0	0.68	
Mid-Atlantic Gillnet	2015	Obs. Data, Weighout	0.06	0	3	0	30	30	0.55	17 (0.31)
	2016		0.08	0	1	0	7	7	0.97	
	2017		0.09	1	1	11	11	22	0.71	
	2018		0.09	0	1	1	7.7	7.7	0.91	
	2019		0.13	0	3	0	20	20	0.56	
Northeast Bottom Trawl [c]	2015	Obs. Data, Logbook	0.19	0	4	0	22	22	0.45	15 (0.27)
	2016		0.12	0	2	0	16	16	0.46	
	2017		0.16	0	0	0	0	0	0	
	2018		0.12	0	4	0	28	28	0.54	
	2019		0.16	0	2	0	10	10	0.62	
Mid-Atlantic	2015	Obs. Data,	0.09	0	26	0	250	250	0.32	281 (0.12)
	2016		0.10	0	22	0	177	177	0.33	

Bottom Trawl [c]	2017 2018 2019	Dealer Data	0.10 0.12 0.12	0 1 2	66 34 52	0 5 15	380 200 395	380 205 395	0.23 0.54 0.23	
Pelagic Longline	2015 2016 2017 2018 2019	Obs. Data, Logbook Data	0.12 0.15 0.12 0.10 0.10	1 0 1 1 0	0 0 0 0 0	9.05 0 4.92 1.44 0	0 0 0 0 0	9.05 0 4.92 1.44 0	1 0 1 1 0	3.1 (0.67)
TOTAL										390 (0.11)

a. Observer data (Obs. Data), used to measure bycatch rates, are collected within the Northeast Fisheries Observer Program and At-sea Monitoring Program. NEFSC collects landings data (unallocated Dealer Data or Allocated Dealer Data) which are used as a measure of total landings and mandatory Vessel Trip Reports (VTR; Trip Logbook) are used to determine the spatial distribution of landings and fishing effort.
b. Observer coverage is defined as the ratio of observed to total metric tons of fish landed for the gillnet fisheries and the ratio of observed to total trips for bottom trawl and Mid-Atlantic mid-water trawl (including pair trawl) fisheries.
c. Fishery related bycatch rates were estimated using an annual stratified ratio-estimator (Lyssikatos and Chavez-Rosales 2022).
d. Serious injuries were evaluated for the period and include both at-sea monitor and traditional observer data (Josephson *et al.* 2022)

Other Mortality

Common dolphins reported stranded between Maine and Florida are reported in Table 5 (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 17 November 2020). The total includes mass-stranded common dolphins in Massachusetts during 2015 (a total of 37 in 13 events), 2016 (a total of 35 animals in 9 events), 2017 (over 90 animals in 20 events), and 2018 (a total of 28 animals in 9 events) and 2019 (28 animals in 9 events). Animals released or last sighted alive include 9 in 2015, 23 in 2016, 70 in 2017, 18 in 2018 and 4 in 2019. In 2015, 2 cases were classified as human interactions, both in Rhode Island, and both related to mutilation likely to be post-mortem. Seven cases in 2016 were coded as human interaction. All but 2 of these were released alive. One of the 2 was a fishery interaction and the other was coded HI (Human Interaction) due to a beachgoer intervention. Six cases in 2017 were coded as human interaction, 2 of which were classified as fishery interactions, 1 classified as a possible boat collision, and 1 released alive. Another dolphin was euthanized after multiple restrandings and another was HI due to beachgoer intervention. In 2018, 5 cases were coded as human interactions. Two were public harassment and 3 involved fishing gear, though only one was classified as a fishery interaction. Eight stranding mortalities in Massachusetts in 2019 were classified as human interactions and one each in New York and Rhode Island. The New York case was a fishery interaction. All were either coded as unlikely or undetermined that the HI contributed to the stranding. In this 5-year period, only 1 interaction (boat strike in 2017) was likely a non-fishery human-caused mortality. In an analysis of mortality causes of stranded marine mammals on Cape Cod and southeastern Massachusetts between 2000 and 2006, Bogomolni (2010) reported that 61% of stranded common dolphins were involved in mass-stranding events, and 37% of all the common dolphin stranding mortalities were disease-related.

The Marine Animal Response Society of Nova Scotia reported 2 common dolphins stranded in 2015, 5 in 2016, 5 in 2017, 5 in 2018, and 4 in 2019 (Tonya Wimmer/Andrew Reid, pers. comm.).

Table 5. Common dolphin (Delphinus delphis delphis) reported strandings along the U.S. Atlantic coast, 2015–2019.

STATE	2015	2016	2017	2018	2019	TOTALS
New Hampshire	1	1	2	0	0	4
Massachusetts[a]	40	67	166	61	95	429
Rhode Island[b]	7	4	5	4	5	25
Connecticut	2	1	1	0	0	4
New York	3	3	15	11	9	41
New Jersey	3	5	0	2	4	14
Delaware	2	0	0	0	1	3

Maryland	1	0	0	0	2	3
Virginia	2	0	1	3	5	11
North Carolina	4	1	0	3	4	12
TOTALS	65	82	190	84	125	546

It should be recognized that evidence of human interaction does not always indicate cause of death, but rather only that there was evidence of interaction with a fishery (e.g., line marks, net marks) or evidence of a boat strike, gunshot wound, mutilation, etc., at some point, including post-stranding. Stranding data probably underestimate the extent of mortality and serious injury because all of the marine mammals that die or are seriously injured may not wash ashore, nor will all of those that do wash ashore necessarily show signs of entanglement or other fishery interaction. Finally, the level of technical expertise among stranding network personnel varies widely as does the ability to recognize signs of fishery interaction. However a recently published human interaction manual (Barco and Moore 2013) and case criteria for human interaction determinations (Moore *et al.* 2013) should help with this.

HABITAT ISSUES

The chronic impacts of contaminants (polychlorinated biphenyls [PCBs] and chlorinated pesticides [DDT, DDE, dieldrin, etc.]) on marine mammal reproduction and health are of concern (e.g., Pierce *et al.* 2008; Jepson *et al.* 2016; Hall *et al.* 2018; Murphy *et al.* 2018), but research on contaminant levels for the western north Atlantic stock of common dolphins is lacking.

Anthropogenic sound in the world's oceans has been shown to affect marine mammals, with vessel traffic, seismic surveys, and active naval sonars being the main anthropogenic contributors to low- and mid-frequency noise in oceanic waters (e.g., Nowacek *et al.* 2015; Gomez *et al.* 2016; NMFS 2018). The long-term and population consequences of these impacts are less well-documented and likely vary by species and other factors. Impacts on marine mammal prey from sound are also possible (Carroll *et al.* 2017), but the duration and severity of any such prey effects on marine mammals are unknown.

Climate-related changes in spatial distribution and abundance, including poleward and depth shifts, have been documented in or predicted for plankton species and commercially important fish stocks (Nye *et al*. 2009; Head *et al*. 2010; Pinsky *et al*. 2013; Poloczanska *et al.* 2013; Hare *et al*. 2016; Grieve *et al.* 2017; Morley *et al.* 2018) and cetacean species (e.g., MacLeod 2009; Sousa *et al.* 2019). There is uncertainty in how, if at all, the distribution and population size of this species will respond to these changes and how the ecological shifts will affect human impacts to the species.

STATUS OF STOCK

Common dolphins are not listed as threatened or endangered under the Endangered Species Act, and the Western North Atlantic stock is not considered strategic under the Marine Mammal Protection Act. The 2015–2019 average annual human-related mortality does not exceed PBR. The total U.S. fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. The status of common dolphins, relative to Optimum Sustainable Population (OSP), in the U.S. Atlantic EEZ is unknown.

REFERENCES CITED

Barco, S. and K.T. Moore. 2013. Handbook for recognizing, evaluating and documenting human interactions in stranded cetaceans and pinnipeds. NOAA Tech. Memo. NMFS-SWFSC-510. 102pp. http://swfsc.noaa.gov/publications/TM/SWFSC/NOAA-TM-NMFS-SWFSC-510.pdf

Barlow, J., S.L. Swartz, T.C. Eagle and P.R. Wade. 1995. U.S. marine mammal stock assessments: Guidelines for preparation, background, and a summary of the 1995 assessments. NOAA Tech. Memo. NMFS-OPR-6. 73pp.

Bogomolni, A.L., K.R. Pugliares, S.M. Sharp, K. Patchett, C.T. Harry, J.M. LaRocque, K.M. Touhey and M. Moore. 2010. Mortality trends of stranded marine mammals on Cape Cod and southeastern Massachusetts, USA, 2000 to 2006. Dis. Aquat. Org. 88:143–155.

Buckland, S.T., D.R. Anderson, K.P. Burnham, J.L. Laake, D.L. Borchers and L. Thomas. 2001. Introduction to distance sampling: Estimating abundance of biological populations. Oxford University Press, London, UK. 432pp.

CETAP [Cetacean and Turtle Assessment Program]. 1982. A characterization of marine mammals and turtles in the mid- and North Atlantic areas of the U.S. outer continental shelf, final report#AA551-CT8-48, Cetacean and Turtle Assessment Program, University of Rhode Island. Bureau of Land Management, Washington, DC. 576pp.

Doksaeter, L., E. Olsen, L. Nottestad and A. Ferno. 2008 Distribution and feeding ecology of dolphins along the mid-Atlantic Ridge between Iceland and the Azores. Deep Sea Res. II 55:243–253.

Garrison, L.P. 2020. Abundance of cetaceans along the southeast U.S. east coast from a summer 2016 vessel survey. Southeast Fisheries Science Center, Protected Resources and Biodiversity Division, 75 Virginia Beach Dr., Miami, FL 33140. PRD Contribution # PRD-2020-04. 17pp.

Garrison, L.P. and L. Stokes. 2017. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2015. NOAA Tech. Memo. NMFS-SEFSC-709. 67pp.

Garrison, L.P. and L. Stokes. 2019. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2016. Southeast Fisheries Science Center, Protected Resources and Biodiversity Division, 75 Virginia Beach Dr., Miami, FL 33140. PRBD Contribution # PRBD-2019-01. 62pp.

Garrison, L.P. and L. Stokes. 2020a. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2017. Southeast Fisheries Science Center, Protected Resources and Biodiversity Division, 75 Virginia Beach Dr., Miami, Florida 33140. PRD Contribution # PRD-2020-05. 61pp.

Garrison, L.P. and L. Stokes. 2020b. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2018. Southeast Fisheries Science Center, Protected Resources and Biodiversity Division, 75 Virginia Beach Dr., Miami, Florida 33140. PRD Contribution # PRD-2020-08. 56pp.

Garrison, L.P. and L. Stokes. 2021. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2019. NOAA Tech. Memo. NMFS-SEFSC-750. 59pp.

Gomez, C., J.W. Lawson, A.J. Wright, A.D. Buren, D. Tollit and V. Lesage. 2016. A systematic review on the behavioural responses of wild marine mammals to noise: The disparity between science and policy. Can. J. Zool. 94:801–819

Gowans, S. and H. Whitehead. 1995. Distribution and habitat partitioning by small odontocetes in the Gully, a submarine canyon on the Scotian Shelf. Can. J. Zool. 73:1599–1608.

Grieve, B.D., J.A. Hare and V.S. Saba. 2017. Projecting the effects of climate change on *Calanus finmarchicus* distribution within the US Northeast continental shelf. Sci. Rep. 7:6264.

Hain, J.H.W., R.K. Edel, H.E. Hays, S.K. Katona and J.D. Roanowicz. 1981. General distribution of cetaceans in the continental shelf waters of the northeastern United States. Pages II.1–II.345 *in:* Cetacean and Turtle Assessment Program, University of Rhode Island. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the US outer continental shelf, annual report for 1979, AA551-CT8-48. Bureau of Land Management, Washington, DC.

Hall, A.J., B.J. McConnell, L.J. Schwacke, G.M. Ylitalo, R. Williams and T.K. Rowles. 2018. Predicting the effects of polychlorinated biphenyls on cetacean populations through impacts on immunity and calf survival. Environ. Poll. 233:407–418.

Hamazaki, T. 2002. Spatiotemporal prediction models of cetacean habitats in the mid-western North Atlantic Ocean (from Cape Hatteras, North Carolina, U.S.A to Nova Scotia, Canada). Mar. Mamm. Sci. 18:920–939.

Hare, J.A., W.E. Morrison, M.W. Nelson, M.M. Stachura, E.J. Teeters, R.B. Griffis, M.A. Alexander, J.D. Scott, L. Alade, R.J. Bell, A.S. Chute, K.L. Curti, T.H. Curtis, D. Kurcheis, J.F. Kocik, S.M. Lucey, C.T. McCandless, L.M. Milke, D.E. Richardson, E. Robillard, H.J. Walsh, M.C. McManus, K.E. Maranick and C.A. Griswold. 2016. A vulnerability assessment of fish and invertebrates to climate change on the Northeast U.S. continental shelf. PLoS ONE 11:e0146756.

Head, E.J.H. and P. Pepin. 2010. Spatial and inter-decadal variability in plankton abundance and composition in the Northwest Atlantic (1958–2006). J. Plankton Res. 32:1633–1648. https://doi.org/10.1371/journal.pone.0146756.s014

Jefferson, T.A., D. Fertl, J. Bolanos-Jimenez and A.N. Zerbini. 2009. Distribution of common dolphins (*Delphinus* spp.) in the western North Atlantic: A critical re-examination. Mar. Biol. 156:1109–1124.

Jepson, P.D., R. Deaville, J.L. Barber, A. Aguilar, A. Borrell, S. Murphy, J. Barry, A. Brownlow, J. Barnett, S. Berrow and A.A. Cunningham. 2016. PCB pollution continues to impact populations of orcas and other dolphins in European waters. Sci. Rep.-U.K. 6:18573.

Josephson, E., F. Wenzel and M.C. Lyssikatos. 2022. Serious injury determinations for small cetaceans and pinnipeds caught in commercial fisheries off the northeast U.S. coast, 2015–2019. Northeast Fish. Sci. Cent. Ref. Doc. 22-03. 26pp.

Laake, J.L. and D.L. Borchers. 2004. Methods for incomplete detection at distance zero. Pages 108–189 *in*: S.T. Buckland, D.R. Andersen, K.P. Burnham, J.L. Laake and L. Thomas (eds). Advanced distance sampling. Oxford University Press, New York, New York.

Laake, J.L., J. Calambokidis, S.D. Osmek and D.J. Rugh. 1997. Probability of detecting harbor porpoise from aerial surveys: Estimating g(0). J. Wildl. Manage. 61:63–75.

Lawson J. and J-F. Gosselin. 2018. Estimates of cetacean abundance from the 2016 NAISS aerial surveys of eastern Canadian waters, with a comparison to estimates from the 2007 TNASS. NAMMCO SC/25/AE/09. 40pp.

Lens, S. 1997. Interactions between marine mammals and deep water trawlers in the NAFO regulatory area. Unpublished meeting document C.M. 1997/Q:08. International Council for the Exploration of the Sea, Copenhagen, Denmark. 10pp.

Lyssikatos, M.C. and S. Chavez-Rosales. 2022. Estimates of cetacean and pinniped bycatch in Northeast and mid-Atlantic bottom trawl fisheries, 2015–2019. Northeast Fish. Sci. Cent. Ref. Doc. NMFS-NE-281. DOI: 10.25923/6sj9-yw17

MacLeod, C.D. 2009. Global climate change, range changes and potential implications for the conservation of marine cetaceans: A review and synthesis. Endang. Species Res. 7:125–136.

Mirimin L., A. Westgate, E. Rogan, P. Rosel, A. Read, J. Coughlan and T. Cross. 2009. Population structure of short-beaked common dolphins (*Delphinus delphis*) in the North Atlantic Ocean as revealed by mitochondrial and nuclear genetic markers. Mar. Biol. 156:821–834. DOI 10.1007/s00227-008-1120-y123

Moore, M., J. van der Hoop, S. Barco, A. Costidis, F. Gulland, P. Jepson, K. Moore, S. Raverty and W. McLellan. 2013. Criteria and case definitions for serious injury and death of pinnipeds and cetaceans caused by anthropogenic trauma. Dis. Aquat. Org. 103:229–264.

Morley, J.W., R.L. Selden, R.J. Latour, T.L. Frolicher, R.J. Seagraves and M.L. Pinsky. 2018. Projecting shifts in thermal habitat for 686 species on the North American continental shelf. PLoS ONE. 13(5):e0196127.

Murphy, S., R.J. Law, R. Deaville, J.Barnett, M W. Perkins, A. Brownlow, R. Penrose, N.J. Davison, J.L. Barber and P.D. Jepson. 2018. Organochlorine contaminants and reproductive implication in cetaceans: A case study of the common dolphin. Pages 3–38 *in*: M.C. Fossi and C. Panti (eds). Marine mammal ecotoxicology: Impacts of multiple stressors on population health. Academic Press, New York, New York.

NMFS [National Marine Fisheries Service]. 2016. Guidelines for preparing stock assessment reports pursuant to the 1994 amendments to the Marine Mammal Protection Act. 23p. https://www.fisheries.noaa.gov/national/marine-mammal-protection/guidelines-assessing-marine-mammal-stocks.

NMFS [National Marine Fisheries Service]. 2018. 2018 Revisions to: Technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing (Version 2.0): Underwater thresholds for onset of permanent and temporary threshold shifts. NOAA Tech. Memo. NMFS-OPR-59. 167pp. https://repository.library.noaa.gov/view/noaa/17892

NEFSC [Northeast Fisheries Science Center] and SEFSC [Southeast Fisheries Science Center]. 2018. Annual report of a comprehensive assessment of marine mammal, marine turtle, and seabird abundance and spatial distribution in US Waters of the Western North Atlantic Ocean. Northeast Fish. Sci. Cent. Ref. Doc. 18-04. 141pp. https://www.fisheries.noaa.gov/resource/publication-database/atlantic-marine-assessment-program-protected-species.

Nowacek, D.P., C.W. Clark, D. Mann, P.J.O. Miller, H.C. Rosenbaum, J.S. Golden, M. Jasny, J. Kraska and B.L. Southall. 2015. Marine seismic surveys and ocean noise: Time for coordinated and prudent planning. Front. Ecol. Environ. 13:378–386.

Nye, J., J. Link, J. Hare and W. Overholtz. 2009. Changing spatial distribution of fish stocks in relation to climate and population size on the Northeast United States continental shelf. Mar. Ecol. Prog. Ser. 393:111–129.

Orphanides, C.D. 2019. Estimates of cetacean and pinniped bycatch in the 2016 New England Sink Gillnet fishery and mid-Atlantic gillnet fisheries. Northeast Fish. Sci. Cent. Ref. Doc. 19-04. 12pp.

Orphanides, C.D. 2020. Estimates of cetacean and pinniped bycatch in the 2017 New England sink and mid-Atlantic gillnet fisheries. Northeast Fish. Sci. Cent. Ref. Doc. 20-03. 16pp. https://www.fisheries.noaa.gov/resource/publication-database/marine-mammal-mortality-and-serious-injury-reports

Orphanides, C.D. 2021. Estimates of cetacean and pinniped bycatch in the 2018 New England Sink Gillnet fishery and mid-Atlantic gillnet fisheries. Northeast Fish. Sci. Cent. Ref. Doc. 21-01. 16pp.

Orphanides, C.D. and J. Hatch. 2017. Estimates of cetacean and pinniped bycatch in the 2015 New England Sink Gillnet fishery and mid-Atlantic gillnet fisheries. Northeast Fish. Sci. Cent. Ref. Doc. 17-18. 21pp.

Precoda, K. and C.D. Orphanides. 2022. Estimates of cetacean and pinniped bycatch in the 2019 New England sink and mid-Atlantic Gillnet fisheries. Northeast Fish. Sci. Cent. Ref. Doc. 22-05. 21pp.

Palka, D.L. 2012. Cetacean abundance estimates in US northwestern Atlantic Ocean waters from summer 2011 line transect survey. Northeast Fish. Sci. Cent. Ref. Doc. 12-29. 37pp. https://repository.library.noaa.gov/view/noaa/4312

Palka, D. 2020. Cetacean abundance estimates in US northwestern Atlantic Ocean waters from summer 2016 line transect surveys conducted by the Northeast Fisheries Science Center. Northeast Fish. Sci. Cent. Ref. Doc. 20-05.

Payne, P.M., L.A. Selzer and A.R. Knowlton. 1984. Distribution and density of cetaceans, marine turtles and seabirds in the shelf waters of the northeast U.S., June 1980–Dec. 1983, based on shipboard observations. Final report, contract NA81FAC00023**.** National Marine Fisheries Service, Woods Hole, Massachusetts. 245pp.

Pierce, G.J. M.B. Santos, S. Murphy, J.A. Learmonth, A.F. Zuur, E. Rogan, P. Bustamante, F. Caurant, V. Lahaye, V. Ridoux, B.N. Zegers, A. Mets, M. Addink, C. Smeenk, T. Jauniaux, R.J. Law, W. Dabin, A. López, J.M. Alonso Farré, A.F. González, A. Guerra, M. García-Hartmann, R.J. Reid, C.F. Moffat, C. Lockyer and J.P. Boon. 2008. Bioaccumulation of persistent organic pollutants in female common dolphins (*Delphinus delphis*) and harbour porpoises (*Phocoena phocoena*) from western European seas: Geographical trends, causal factors and effects on reproduction and mortality. Env. Poll. 153:401–415.

Pinsky, M.L., B. Worm, M.J. Fogarty, J.L. Sarmiento and S.A. Levin. 2013. Marine taxa track local climate velocities. Science 341:1239–1242.

Poloczanska, E.S., C.J. Brown, W.J. Sydeman, W. Kiessling, D.S. Schoeman, P.J. Moore, K. Brander, J.F. Bruno, L.B. Buckley, M.T. Burrows, C.M. Duarte, B.S. Halpern, J. Holding, C.V. Kappel, M.I. O'Connor, J.M. Pandolfi, C. Parmesan, F. Schwing, S.A. Thompson and A.J. Richardson. 2013. Global imprint of climate change on marine life. Nat. Clim. Change 3:919–925.

Selzer, L.A. and P.M. Payne. 1988. The distribution of white-sided (*Lagenorhynchus acutus*) and common dolphins (*Delphinus delphis*) vs. environmental features of the continental shelf of the northeastern United States. Mar. Mamm. Sci. 4:141–153.

Sergeant, D.E., A.W. Mansfield and B. Beck. 1970. Inshore records of Cetacea for eastern Canada, 1949–-68. J. Fish. Res. Board Can. 27:1903–1915.

Sharp, S.M., J.S. Knoll, M.J. Moore, K.M. Moore, C.T. Harry, J.M Hoppe, M.E. Niemeyer, I. Robinson, K.S. Rose, W.B. Sharp and D. Rotstein. 2014. Hematological, biochemical, and morphological parameters as prognostic indicators for stranded common dolphins (*Delphinus delphis)* from Cape Cod, Massachusetts, U.S.A. Mar. Mamm. Sci. 30:864–887.

Sharp, S.M., C.T. Harry, J.M. Hoppe, K.M. Moore, M.E. Niemeyer, I. Robinson, K.S. Rose, W.B. Sharp, S. Landry, J. Richardson and M.J. Moore 2016. A comparison of post release survival parameters between single and mass stranded delphinids from Cape Cod, Massachusetts, U.S.A. Mar. Mamm. Sci. 32:161–180.

Taylor, B.L., M. Martinez, T. Gerrodette, J. Barlow and Y.N. Hrovat. 2007. Lessons from monitoring trends in abundance in marine mammals. Mar. Mamm. Sci. 23:157–175.

Thomas L., J.L. Laake, E. Rexstad, S. Strindberg, F.F.C. Marques, S.T. Buckland, D.L. Borchers, D.R. Anderson, K.P. Burnham, M.L. Burt, S.L. Hedley, J.H. Pollard, J.R.B. Bishop and T.A. Marques. 2009. Distance 6.0. Release 2. University of St. Andrews, Research Unit for Wildlife Population Assessment. St. Andrews, UK. http://distancesampling.org/Distance/

Wade, P.R. and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3–5, 1996, Seattle, Washington. NOAA Tech. Memo. NMFS-OPR-12. 93pp.

Waring, G.T., C.P. Fairfield, C.M. Ruhsam and M. Sano. 1992. Cetaceans associated with Gulf Stream features off the northeastern USA shelf. Unpublished meeting document C.M. 1992/N:12. International Council for the Exploration of the Sea, Copenhagen, Denmark.

Waring, G.T., L. Nottestad, E. Olsen, H. Skov and G. Vikingsson. 2008. Distribution and density estimates of cetaceans along the mid-Atlantic Ridge during summer 2004. J. Cetacean Res. Manage. 10:137–146.

Wells, R.S., J.B. Allen, S. Hofmann, K. Bassos-Hull, D.A. Fauquier, N.B. Barros, R.E. DeLynn, G. Sutton, V. Socha and M.D. Scott. 2008. Consequences of injuries on survival and reproduction of common bottlenose dolphins (*Tursiops truncatus*) along the west coast of Florida. Mar. Mamm. Sci. 24:774–794.

Westgate, A.J. 2005. Population structure and life history of short-beaked common dolphins (*Delphinus delphis*) in the North Atlantic. Ph.D. Thesis. Nicholas School of the Environment and Earth Sciences, Duke University, Beaufort, North Carolina.

Westgate, A.J. 2007. Geographic variation in cranial morphology of short-beaked common dolphins (*Delphinus delphis*) from the North Atlantic. J. Mamm. 88:678–688.

Westgate, A.J. and A.J. Read. 2007. Reproduction in short-beaked common dolphins (*Delphinus delphis*) from the western North Atlantic. Mar. Biol. 150:1011–1024.