HARBOR PORPOISE (*Phocoena phocoena phocoena)*: Gulf of Maine/Bay of Fundy Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

This stock is found in U.S. and Canadian Atlantic waters. The distribution of harbor porpoises has been documented by sighting surveys, strandings and takes reported by NMFS observers in the Sea Sampling Programs. During summer (July to September), harbor porpoises are concentrated in the northern Gulf of Maine and southern Bay of Fundy region, generally in waters less than 150 m deep (Gaskin 1977; Kraus *et al.* 1983; Palka 1995), with a few sightings in the upper Bay of Fundy and on Georges Bank (Palka 2000). During fall (October–December) and spring (April–June), harbor porpoises are widely dispersed from New Jersey to Maine, with lower densities farther north and south. They are seen from the coastline to deep waters (>1800 m; Westgate *et al.* 1998), although the majority of the population is found over the continental shelf. During winter (January to March), intermediate densities of harbor porpoises can be found in waters off New Jersey to North Carolina, and lower densities are found in waters off New York to New Brunswick, Canada. There does not appear to be a temporally coordinated migration or a specific migratory route to and from the Bay of Fundy region. However, during the fall, several satellite-tagged harbor porpoises did favor the waters around the 92-m isobath, which is consistent with observations of high rates of incidental catches in this depth range (Read and Westgate 1997). There were two stranding records from Florida during the 1980s (Smithsonian strandings database) and one in 2003 (NE Regional Office/NMFS strandings and entanglement database).

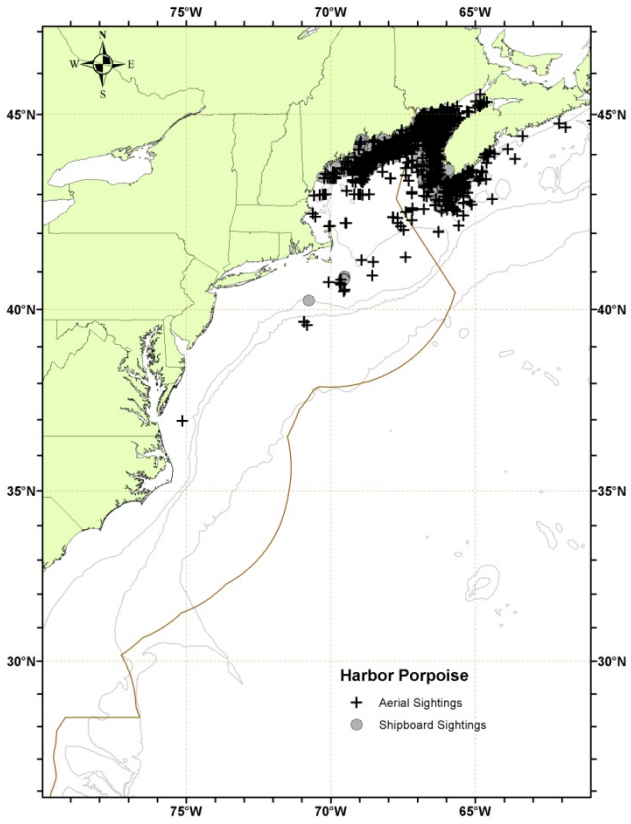

Figure 1. *Distribution of harbor porpoises from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1995, 1998, 1999, 2002, 2004, 2006, 2007, 2008, 2010, and 2011 and DFO's 2007 TNASS survey. Isobaths are the 100-m, 1000-m, and 4000-m depth contours.*

Gaskin (1984, 1992) proposed that there were four separate populations in the western North Atlantic: the Gulf of Maine/Bay of Fundy, Gulf of St. Lawrence, Newfoundland, and Greenland populations. Analyses involving mtDNA (Wang *et al.* 1996; Rosel *et al.* 1999a; 1999b), organochlorine contaminants (Westgate *et al.* 1997; Westgate and Tolley 1999), heavy metals (Johnston 1995), and life history parameters (Read and Hohn 1995) support Gaskin's proposal. Genetic studies using mitochondrial DNA (Rosel *et al.* 1999a) and contaminant studies using total PCBs (Westgate and Tolley 1999) indicate that the Gulf of Maine/Bay of Fundy females were distinct from females from the other populations in the Northwest Atlantic. Gulf of Maine/Bay of Fundy males were distinct from Newfoundland and Greenland males, but not from Gulf of St. Lawrence males according to studies comparing

mtDNA (Palka *et al.* 1996; Rosel *et al.* 1999a) and CHLORs, DDTs, PCBs and CHBs (Westgate and Tolley 1999). Nuclear microsatellite markers have also been applied to samples from these four populations, but this analysis failed to detect significant population sub-division in either sex (Rosel *et al.* 1999a). These patterns may be indicative of female philopatry coupled with dispersal of males. Both mitochondrial DNA and microsatellite analyses indicate that the Gulf of Maine/Bay of Fundy stock is not the sole contributor to the aggregation of porpoises found off the mid-Atlantic states during winter (Rosel *et al.* 1999a; Hiltunen 2006). Mixed-stock analyses using twelve microsatellite loci in both Bayesian and likelihood frameworks indicate that the Gulf of Maine/Bay of Fundy is the largest contributor (~60%), followed by Newfoundland (~25%) and then the Gulf of St. Lawrence (~12%), with Greenland making a small contribution (<3%). For Greenland, the lower confidence interval of the likelihood analysis includes zero. For the Bayesian analysis, the lower 2.5% posterior quantiles include zero for both Greenland and the Gulf of St. Lawrence. Intervals that reach zero provide the possibility that these populations contribute no animals to the mid-Atlantic aggregation.

This report follows Gaskin's hypothesis on harbor porpoise stock structure in the western North Atlantic, where the Gulf of Maine and Bay of Fundy harbor porpoises are recognized as a single management stock separate from harbor porpoise populations in the Gulf of St. Lawrence, Newfoundland, and Greenland. It is unlikely that the Gulf of Maine/Bay of Fundy harbor porpoise stock contains multiple demographically independent populations (Rosel et al. 1999a; Hiltunen 2006), but a comparison of samples from the Scotian shelf to the Gulf of Maine has not yet been made.

POPULATION SIZE

The best current abundance estimate of the Gulf of Maine/Bay of Fundy harbor porpoise stock is from the 2011 survey: 79,883 (CV=0.32). Key uncertainties include: 1) the surveyed area may not have covered the entire area of the stock's habitat at the appropriate time of the year, and 2) the current abundance estimate did not account for availability bias due to submergence of animals. Without a correction for availability bias, the abundance estimate is expected to be biased low. Since the dive times of harbor porpoises are relatively short (~ 4 minutes), it is expected the bias is not large.

Earlier abundance estimates

Please see Appendix IV for a summary of abundance estimates, including earlier estimates and survey descriptions. As recommended in the GAMMS II Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable for the determination of the current PBR.

Recent surveys and abundance estimates

An abundance estimate of 79,883 (CV=0.32) harbor porpoises was generated from a shipboard and aerial survey conducted during June–August 2011 (Palka 2012). The aerial portion that contributed to the abundance estimate covered 5,313 km of tracklines that were over waters north of New Jersey from the coastline to the 100-m depth contour through the U.S. and Canadian Gulf of Maine and up to and including the lower Bay of Fundy. The shipboard portion covered 3,107 km of tracklines that were in waters offshore of central Virginia to Massachusetts (waters that were deeper than the 100-m depth contour out to beyond the U.S. EEZ). Both sighting platforms used a double-platform team data-collection procedure, which allows estimation of abundance corrected for perception bias of the detected species (Laake and Borchers 2004). Estimation of the abundance was based on the independent-observer approach assuming point independence (Laake and Borchers 2004) and calculated using the mark-recapture distance sampling option in the computer program Distance (version 6.0, release 2, Thomas *et al.* 2009).

No harbor porpoises were detected in an abundance survey that was conducted concurrently (June-August 2011) in waters between central Virginia and central Florida. This shipboard survey included shelf-break and inner continental slope waters deeper than the 50-m depth contour within the U.S. EEZ. The survey employed the double-platform methodology searching with 25x150 "bigeye" binoculars. A total of 4,445 km of tracklines was surveyed, yielding 290 cetacean sightings.

Table 1. Summary of recent abundance estimates for the Gulf of Maine/Bay of Fundy harbor porpoise (*Phocoena phocoena phocoena*) by month, year, and area covered during each abundance survey and the resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV

Table 1. Summary of recent abundance estimates for the Gulf of Maine/Bay of Fundy harbor porpoise (*Phocoena phocoena phocoena*) by month, year, and area covered during each abundance survey and the resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Jul-Aug 2011	Central Virginia to lower Bay of Fundy	79,883	0.32

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normal 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 harbor porpoises is 79,883 (CV=0.32). The minimum population estimate for the Gulf of Maine/Bay of Fundy harbor porpoise is 61,415.

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. 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).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Several attempts have been made to estimate potential population growth rates. Barlow and Boveng (1991), who used a re-scaled human life table, estimated the upper bound of the annual potential growth rate to be 9.4%. Woodley and Read (1991) used a re-scaled Himalayan tahr life table to estimate a likely annual growth rate of 4%. In an attempt to estimate a potential population growth rate that incorporates many of the uncertainties in survivorship and reproduction, Caswell *et al.* (1998) used a Monte Carlo method to calculate a probability distribution of growth rates. The median potential annual rate of increase was approximately 10%, with a 90% confidence interval of 3–15%. This analysis underscored the considerable uncertainty that exists regarding the potential rate of increase in this population. Moore and Read (2008) conducted a Bayesian population modeling analysis to estimate the potential population growth of harbor porpoise in the absence of bycatch mortality. Their method used fertility data, in combination with age-at-death data from stranded animals and animals taken in gillnets, and was applied under two scenarios to correct for possible data bias associated with observed bycatch of calves. Demographic parameter estimates were 'model averaged' across these scenarios. The Bayesian posterior median estimate for potential natural growth rate was 0.046. This last, most recent, value will be the one used for the purpose of this assessment.

Key uncertainties in the estimate of the maximum net productivity rate for this stock were discussed in Moore and Read (2008), which included the assumption that the age structure is stable, and the lack of data to estimate the probability of survivorship to maximum age. The authors considered the effects of these uncertainties on the estimated potential natural growth rate to be minimal.

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 61,415. The maximum productivity rate is 0.046. The recovery factor is 0.5 because stock's status relative to OSP is unknown and the CV of the average mortality estimate is less than 0.3 (Wade and Angliss 1997). PBR for the Gulf of Maine/Bay of Fundy harbor porpoise is 706.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The total annual estimated average human-caused mortality and serious injury is 307 harbor porpoises per year (CV=0.16) from U.S. fisheries using observer data, of which 3 harbor porpoises were seriously injured. As the current abundance estimate is only for animals in U.S. waters, Canadian bycatch is not included in the human-caused mortality estimate.

A key uncertainty is the potential that the observer coverage in the Mid-Atlantic gillnet was not representative of the fishery during all times and places, since the observer coverage was relatively low, 0.02 – 0.06.

Fishery Information

Detailed U.S. fishery information is reported in Appendix III.

Earlier Interactions

See Appendix V for more information on historical takes.

U.S.

Northeast Sink Gillnet

Harbor porpoise bycatch in the northern Gulf of Maine occurs primarily from June to September, while in the southern Gulf of Maine and south of New England, bycatch occurs from January to May and September to December. Annual bycatch is estimated using ratio estimator techniques that account for the use of pingers (Hatch and Orphanides 2014, 2015, 2016, Orphanides and Hatch 2017). See Table 2 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

Annual bycatch is estimated using ratio estimator techniques (Hatch and Orphanides 2014, 2015, 2016; Orphanides and Hatch 2017).See Table 2 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

Since 1989, harbor porpoise mortalities have been observed in the northeast bottom trawl fishery, but many of these were not attributable to this fishery because decomposed animals are presumed to have been dead prior to being taken by the trawl. Fishery-related bycatch rates were estimated using an annual stratified ratio-estimator (Chavez-Rosales 2017). See Table 2 for bycatch estimates and observed mortality and serious injury for the current 5-year period, and Appendix V for historical bycatch information.

CANADA

No current estimates exist, but harbor porpoise interactions have been documented in the Bay of Fundy sink gillnet fishery and in herring weirs. Trippel and Shepherd (2004) reported 52 observed harbor porpoise mortalities between the years 1998-2001 in the lower Bay of Fundy demersal gillnet fishery. Total estimated bycatch for that period was 171 animals. That fishery has declined since 2001 (H. Stone, Department of Fisheries and Oceans Canada, pers. comm.).

Table 2. From observer program data, summary of the incidental mortality of Gulf of Maine/Bay of Fundy harbor porpoise (*Phocoena phocoena phocoena*) by commercial fishery including the years sampled, the type of data used, the annual observer coverage, the mortalities and serious injuries recorded by on-board observers, the estimated annual serious injury and mortality, the estimated CV of the annual mortality, and the mean annual combined mortality (CV in parentheses).

Fishery	Years	Data Type [a]	Observer Coverage [b]	Observed Serious Injury [c]	Observed Mortality	Estimated Serious Injury	Estimated Mortality	Combined Serious Injury	Estimated CVs	Mean Annual Combined Mortality
U.S.										
Northeast Sink Gillnet	11-15	Obs. Data, Weighout, Trip Logbook	.19, .15, .11, .18, .14	0, 0, 0, 0, 0	66, 34, 20, 28, 23	0, 0, 0, 0, 0	273, 277, 399, 128, 177	273, 277, 399, 128, 177	.20, .59, .33, .27, .28	251 (0.18)
Mid-Atlantic Gillnet	11-15	Obs. Data Weighout	.02, .02, .03, .05, .06	0, 0, 0, 0, 0	11, 2, 1, 1, 2	0, 0, 0, 0, 0	123, 63, 19, 22, 33	123, 63, 19, 22, 33	.41, .83, 1.06, 1.03, 1.16	52 (0.34)
Northeast Bottom Trawl	11-15	Obs. Data	.26, .17, .15, .17,	1, 0, 0, 0, 0	1, 0, 1, 1, 4	3, 0, 0, 0, 0	2.9, 0, 7, 5.5, 3.71	5.9, 0, 7, 5.5, 3.71	.58, 0, .98, .86, .49	4.4 (0.42)

		Weighout	.19							
U.S. TOTAL	2011-2015									307 (0.16)

NA = Not available.

a. Observer data (Obs. Data) are used to measure bycatch rates; U.S. data are collected by the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program and At-Sea Monitoring Program; Canadian data are collected by DFO. NEFSC collects Weighout (Weighout) landings data that are used as a measure of total effort for the U.S. gillnet fisheries. The Canadian DFO catch and effort statistical system collected the total number of trips fished by the Canadians (Can. Trips), which was the measure of total effort for the Canadian groundfish gillnet fishery. Mandatory vessel trip report (VTR) (Trip Logbook) data are used to determine the spatial distribution of fishing effort in the northeast sink gillnet fishery. Observed mortalities from herring weirs are collected by a cooperative program between fishermen and Canadian biologists (Coop. Data).

b. Observer coverage for the U.S. Northeast and mid-Atlantic coastal gillnet fisheries is based on tons of fish landed. Northeast bottom trawl fishery coverages are ratios based on trips.

c. Serious injuries were evaluated since 2011 using new guidelines and include both at-sea monitor and traditional observer data (Josephson *et al*. 2017)

Other Mortality

U.S.

There is evidence that harbor porpoises were harvested by natives in Maine and Canada before the 1960s, and the meat was used for human consumption, oil, and fish bait (NMFS 1992). The extent of these past harvests is unknown, though it is believed to have been small. Up until the early 1980s, small kills by native hunters (Passamaquoddy Indians) were reported. In recent years it was believed to have nearly stopped (Polacheck 1989) until media reports in September 1997 depicted a Passamaquoddy tribe member dressing out a harbor porpoise. Further articles describing use of porpoise products for food and other purposes were timed to coincide with ongoing legal action in state court.

During 2011, 164 harbor porpoises were reported stranded on Atlantic U.S. beaches. Of these, nine stranding mortalities were reported as having signs of human interaction, three of which were reported to be fishery interactions.

During 2012, 45 harbor porpoises were reported stranded on Atlantic U.S. beaches. Of these, 4 stranding mortalities were reported as having signs of human interaction, one of which was reported to be a fishery interaction.

During 2013, 102 harbor porpoises were reported stranded on Atlantic U.S. beaches. Of these, 9 stranding mortalities were reported as having signs of human interaction, three of which were reported to be fishery interactions.

During 2014, 39 harbor porpoises were reported stranded on Atlantic U.S. beaches. Of these, 5 stranding mortalities were reported as having signs of human interactions, one of which was reported to have been a fishery interaction.

During 2015, 44 harbor porpoises were reported stranded on Atlantic U.S. beaches. Of these, 2 stranding mortalities were reported as having signs of human interactions, neither of which were fishery interactions.

Stranding data probably underestimate the extent of fishery-related 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.

Table 4. Harbor Porpoise (*Phocoena phocoena phocoena*) reported strandings along the U.S. and Canadian Atlantic coast, 2011-2015.

Area	Year					Total
	2011	2012	2013	2014	2015	
Maine[a,f]	15	7	7	5	2	**36**
New Hampshire	1	3	1	1	0	**6**
Massachusetts[a, d, e,f, g]	102	25	40	22	18	**207**
Rhode Island [b, d, h]	4	0	3	0	2	**9**
Connecticut [f]	0	0	1	0	0	**1**
New York[c,d, f]	11	3	15	1	3	**33**
New Jersey [f, g]	1	2	8	4	2	**17**
Delaware	0	0	2	0	0	**2**
Maryland	0	1	3	0	0	**4**
Virginia[d, g]	2	2	15	3	3	**25**
North Carolina[h]	28	2	7	11	14	**62**
TOTAL U.S.	**164**	**45**	**102**	**39**	**44**	**394**
Nova Scotia/Prince Edward Island[i]	13	6	21	9	13	**62**
Newfoundland and New Brunswick[i,j]	0	0	3	0	2	**5**
GRAND TOTAL	**177**	**51**	**126**	**48**	**59**	**461**

a. In Massachusetts in 2011, 5 animals were released alive and one taken to rehab. One Maine animal was taken to rehab in 2012. Three Massachusetts live strandings were taken to rehab in 2013 and 1 Maine animal was released alive.

b. In Rhode Island in 2011, one animal classified as human interaction due to fluke amputation.

c. One of the 2012 New York strandings classified as human interaction due to interaction with marine debris.

d. Nine total HI cases in 2011; 5 in Massachusetts, 1 in Rhode Island, 2 in New York and 1 in Virginia. Two of these Massachusetts animals and the Virginia animal were fishery interactions.

e. Four HI cases in 2012. One of these was a fishery interaction (Massachusetts).

f. Ten total HI cases in 2013 (MA-3, ME-2, NY-3, NJ-1, CT-1), including one released alive (ME). Three of these

were considered fishery interactions, including one entangled in gear in Maine.

g. Five total HI cases in 2014; 2 in Maine, 1 each in Massachusetts, New Jersey and Virginia. The Virginia case was recorded as a fishery interaction.

h. Two HI cases in 2015: 1 in Rhode Island and 1 in North Carolina

i. Data supplied by Nova Scotia Marine Animal Response Society (pers. comm.). One of the 2012 animals trapped in mackerel net. Not included in count for 2014 are at least 8 animals released alive from weirs. One of the 2015 animals a suspected fishery interaction.

j. (Ledwell and Huntington 2011, 2012a, 2012b, 2013, 2014, 2015).

CANADA

Whales and dolphins stranded on the coast of Nova Scotia, New Brunswick and Prince Edward Island are recorded by the Marine Animal Response Society and the Nova Scotia Stranding Network, including 13 (4 released alive) in 2011, 6 in 2012, 21 in 2013, 9 in 2014 and 15 in 2015; Table 4).

Three dead stranded harbor porpoises were reported in 2013 by the Newfoundland and Labrador Whale Release and Strandings Program, and 0 in 2011, 2012, 2014 and 2015 (Ledwell and Huntington 2011, 2012a, 2012b, 2013; 2014; Table 3).

STATUS OF STOCK

Harbor porpoise in the Gulf of Maine/Bay of Fundy are not listed as threatened or endangered under the Endangered Species Act, and this stock is not considered strategic under the MMPA. 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 harbor porpoises, relative to OSP, in the U.S. Atlantic EEZ is unknown. Population trends for this species have not been investigated.

Based on the low levels of uncertainties described in the above sections, it expected these uncertainties will have little effect on the designation of the status of this stock.

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