HARBOR PORPOISE (*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 Program. 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 1995a; Palka 1995b), with a few sightings in the upper Bay of Fundy and on the northern edge of 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).

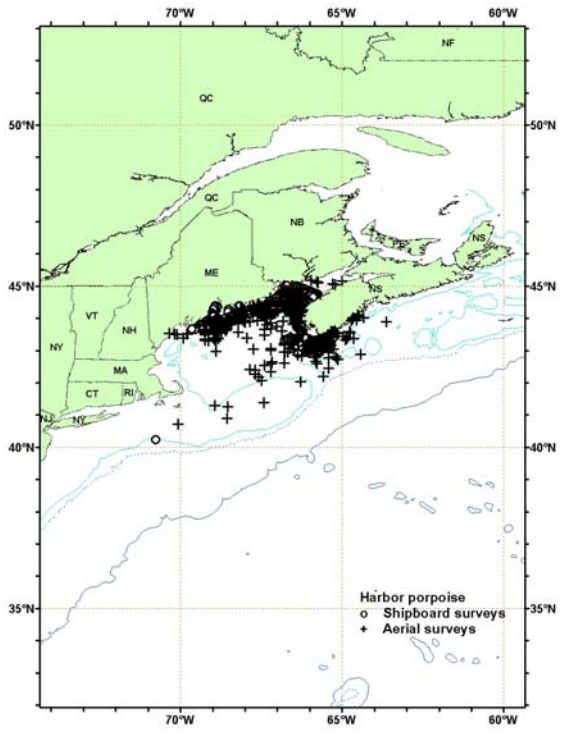

Figure 1. *Distribution of harbor porpoises from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1998, 1999, 2002, 2004, and 2006. Isobaths are the 100-m, 1000-m, and 4000-m depth contours.*

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. Recent analyses involving mtDNA (Wang *et al.* 1996; Rosel *et al.* 1999a; Rosel *et al.* 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). Analyses of stranded animals from the mid-Atlantic states suggest that this aggregation of harbor porpoises consists of animals from more than just the Gulf of Maine/Bay of Fundy stock (Rosel *et al.* 1999a). However, the majority of the samples used in the Rosel *et al.* (1999a) study were from stranded juvenile animals. Further work is needed to examine adult animals from this region. 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. 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.

POPULATION SIZE

To estimate the population size of harbor porpoises in the Gulf of Maine/Bay of Fundy region, seven line-transect sighting surveys were conducted during the summers of 1991, 1992, 1995, 1999, 2002, 2004, and 2006. The best current abundance estimate of the Gulf of Maine/Bay of Fundy harbor porpoise stock is 89,054 (CV=0.47), based on the 2006 survey results (Table 1). This is because the 2006 estimate is the most current, and this survey covered the largest portion of the harbor porpoise range.

Earlier abundance estimates

Earlier abundance calculations include estimates of 37,500 harbor porpoises in 1991 (CV=0.29, 95% confidence interval (CI)=26,700-86,400) (Palka 1995b), 67,500 harbor porpoises in 1992 (CV=0.23, 95% CI=32,900-104,600), and 74,000 harbor porpoises in 1995 (CV=0.20, 95% CI=40,900-109,100) (Palka 1996). The inverse variance weighted-average abundance estimate (Smith *et al.* 1993) of the 1991 to 1995 estimates was 54,300 harbor porpoises (CV=0.14, 95% CI=41,300-71,400). Possible reasons for inter-annual differences in abundance and distribution include experimental error, inter-annual changes in water temperature and availability of primary prey species (Palka 1995b), and movement among population units (e.g., between the Gulf of Maine and Gulf of St. Lawrence).

Kingsley and Reeves (1998) estimated there were 12,100 (CV=0.26) harbor porpoises in the entire Gulf of St. Lawrence during 1995, and 21,700 (CV=0.38) in the northern Gulf of St. Lawrence during 1996. These estimates are presumed to be of the Gulf of St. Lawrence stock of harbor porpoises. The highest densities were north of Anticosti Island, with lower densities in the central and southern Gulf. During the 1995 survey, 8,427 km of track lines were flown in an area of 221,949 km^2 during August and September. During the 1996 survey, 3,993 km of track lines were flown in an area of 94,665 km^2 during July and August. Data were analyzed using Quenouille's jackknife bias reduction procedure on line transect methods that modeled the left truncated sighting curve. These estimates were not corrected for visibility biases such as *g(0)*.

An abundance estimate of 89,700 (CV=0.22, 95% CI=53,400-150,900) harbor porpoises was obtained from a July to August 1999 sighting survey conducted by a ship and airplane covering waters from Georges Bank to the mouth of the Gulf of St. Lawrence (Palka 2000). Total trackline length was 8,212 km. One of the reasons the 1999 estimate is larger than previous estimates is that, for the first time, the upper Bay of Fundy and northern Georges Bank were surveyed and harbor porpoises were seen in both areas. This indicates the harbor porpoise summer habitat is larger than previously thought (Palka 2000). As recommended in the GAMMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable and should not be used for PBR determinations.

Recent surveys and abundance estimates

An abundance estimate of 64,047 (CV=0.48) harbor porpoises was derived from an aerial survey conducted in August 2002 which covered 7,465 km of trackline over waters from the 1000 m depth contour on the southern edge of Georges Bank to Maine (Table 1). The value of *g(0)* used for this estimation was derived from the pooled data of 2002, 2004 and 2006 aerial survey data.

An abundance estimate of 51,520 (CV=0.65) harbor porpoises was obtained from a line-transect sighting survey conducted during 12 June to 4 August 2004 by a ship and plane that surveyed 6,180 km of trackline from the 100-m depth contour on the southern Georges Bank to the lower Bay of Fundy. The Scotian shelf south of Nova Scotia was not surveyed (Table 1). Shipboard data were collected using the two independent team line transect method and analyzed using the modified direct-duplicate method (Palka 1995b) accounting for biases due to school size and other potential covariates, reactive movements (Palka and Hammond 2001), and *g(0)*, the probability of detecting a group on the track line. Aerial data were collected using the Hiby circle-back line-transect method (Hiby 1999) and analyzed accounting for *g(0)* and biases due to school size and other potential covariates (Palka 2005).

An abundance estimate of 89,054 (CV=0.47) harbor porpoises was generated from an aerial survey conducted in August 2006 which surveyed 10,676 km of trackline in the region from the 2000 m depth contour on the southern edge of Georges Bank to the upper Bay of Fundy and to the entrance of the Gulf of St. Lawrence. (Table 1; Palka pers. comm.).

Table 1. Summary of recent abundance estimates for the Gulf of Maine/Bay of Fundy harbor porpoise. 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
Aug 2002	S. Gulf of Maine to Maine	64,047	0.48
Jun-Jul 2004	Gulf of Maine to lower Bay of Fundy	51,520	0.65
Aug 2006	S. Gulf of Maine to upper Bay of Fundy to Gulf of St. Lawrence	89,054	0.47

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 harbor porpoises is 89,054 (CV=0.47). The minimum population estimate for the Gulf of Maine/Bay of Fundy harbor porpoise is 60,970.

Current Population Trend

A trend analysis has not been conducted for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Although current population growth rates of Gulf of Maine/Bay of Fundy harbor porpoises have not been estimated due to lack of data, 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. Consequently, for the purposes of this assessment, the maximum net productivity rate was assumed to be 4%, consistent with values used for other cetaceans for which direct observations of maximum rate of increase are not available, and following a recommendation from the Atlantic Scientific Review Group. The 4% 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 60,970. The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because 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 610.

ANNUAL HUMAN-CAUSED MORTALITY

Data to estimate the mortality and serious injury of harbor porpoise come from U.S. and Canadian Sea Sampling Programs, from records of strandings in U.S. and Canadian waters, and from records in the Marine Mammal Authorization Program (MMAP). See Appendix III for details on U.S. fisheries and data sources. Estimates using Sea Sampling Program and MMAP data are discussed by fishery under the Fishery Information section (Table 2). Strandings records are discussed under the Unknown Fishery in the Fishery Information section (Table 3) and under the Other Mortality section (Table 4).

The total annual estimated average human-caused mortality is 874 (CV=0.13) harbor porpoises per year. This is derived from four components: 866 harbor porpoise per year (CV=0.13) from U.S. fisheries using observer and MMAP data, 2 per year (unknown CV) from Canadian herring weir fisheries using observer data, and 5.7 per year from unknown U.S. fisheries using strandings data.

Fishery Information

Recently, Gulf of Maine/Bay of Fundy harbor porpoise takes have been documented in the U.S. Northeast sink gillnet, mid-Atlantic gillnet, Northeast bottom trawl and in the Canadian Bay of Fundy groundfish sink gillnet and herring weir fisheries (Table 2). Detailed U.S. fishery information is reported in Appendix III.

Earlier Interactions

One harbor porpoise was observed taken from the Atlantic pelagic drift gillnet fishery during 1991-1998; the fishery ended in 1998. This observed bycatch was notable because it occurred in continental shelf edge waters adjacent to Cape Hatteras (Read *et al.* 1996). Estimated annual fishery-related mortality (CV in parentheses) attributable to this fishery was 0.7 in 1989 (7.00), 1.7 in 1990 (2.65), 0.7 in 1991 (1.00), 0.4 in 1992 (1.00), 1.5 in 1993 (0.34), 0 during 1994-1996 and 0 in 1998. The fishery was closed during 1997.

U.S.

Northeast Sink Gillnet

In 1984 the Northeast sink gillnet fishery was investigated by a sampling program that collected information concerning marine mammal bycatch. Approximately 10% of the vessels fishing in Maine, New Hampshire, and Massachusetts were sampled. Among the 11 gillnetters who received permits and logbooks, 30 harbor porpoises were reported caught. It was estimated, using rough estimates of fishing effort, that a maximum of 600 harbor porpoises were killed annually in this fishery (Gilbert and Wynne 1985; Gilbert 1987).

In 1990, an observer program was started by NMFS to investigate marine mammal takes in the Northeast sink gillnet fishery (Appendix III). There have been 578 harbor porpoise mortalities related to this fishery observed between 1990 and 2006. Bycatch in the northern Gulf of Maine occurs primarily from June to September, while in the southern Gulf of Maine, bycatch occurs from January to May and September to December. Estimated annual bycatch (CV in parentheses) from this fishery during 1990-2006 was 2,900 in 1990 (0.32), 2,000 in 1991 (0.35), 1,200 in 1992 (0.21), 1,400 in 1993 (0.18) (CUD 1994; Bravington and Bisack 1996), 2,100 in 1994 (0.18), 1,400 in 1995 (0.27) (Bisack 1997), 1,200 in 1996 (0.25), 782 in 1997 (0.22), 332 in 1998 (0.46), 270 in 1999 (0.28) (Rossman and Merrick 1999), 507 in 2000 (0.37), 53 (0.97) in 2001, 444 (0.37) in 2002, 592 (0.33) in 2003, 654 (0.36) in 2004, 630 (0.23) in 2005, and 514 in 2006. There appeared to be no evidence of differential mortality in U.S. or Canadian gillnet fisheries by age or sex in animals collected before 1994, although there was substantial inter-annual variation in the age and sex composition of the bycatch (Read and Hohn 1995). Using observer data collected during 1990-1998 and a logit regression model, females were 11 times more likely to be caught in the offshore southern Gulf of Maine region, males were more likely to be caught in the south Cape Cod region, and the overall proportion of males and females caught in a gillnet and brought back to land were not significantly different from 1:1 (Lamb 2000).

Scientific experiments that demonstrated the effectiveness of pingers in the Gulf of Maine were conducted during 1992 and 1993 (Kraus *et al.* 1997). After the scientific experiments, experimental fisheries were allowed in the general fishery during 1994 to 1997 in various parts of the Gulf of Maine and south of Cape Cod areas. During these experimental fisheries, harbor porpoise takes in pingered nets were less than in non-pingered nets.

Average estimated harbor porpoise mortality and serious injury in the Northeast sink gillnet fishery during 1994-1998, before the Take Reduction Plan, was 1,163 (0.11). The average annual harbor porpoise mortality and serious injury in the Northeast sink gillnet fishery from 2002 to 2006 was 567 (0.14) (Table 2).

Mid-Atlantic Gillnet

Before an observer program was in place for this fishery, Polacheck *et al.* (1995) reported one harbor porpoise incidentally taken in shad nets in the York River, Virginia. In July 1993 an observer program was initiated in the mid-Atlantic gillnet fishery by the NEFSC Sea Sampling program (Appendix III). Documented bycatch after 1995 were from December to May. Bycatch estimates were calculated using methods similar to that used for bycatch estimates in the Northeast sink gillnet fishery (Bravington and Bisack 1996; Bisack 1997). After 1998, a separate bycatch estimate was made for the drift gillnet and set gillnet sub-fisheries. The number presented here is the sum of these two sub-fisheries. The estimated annual mortality (CV in parentheses) attributed to this fishery was 103 (0.57) for 1995, 311 (0.31) for 1996, 572 (0.35) for 1997, 446 (0.36) for 1998, 53 (0.49) for 1999, 21 (0.76) for 2000, 26 (0.95) for 2001, unknown in 2002, 76 (1.13) in 2003, 137 (0.91) in 2004, 470 (0.51) in 2005, and 511 (0.32) in 2006. During 2002, the overall observer coverage was lower than usual, 1%, where 65% of that coverage was off Virginia, and most of the rest of the area was not sampled at all. Thus, due to this non-representative and low

observer coverage, a bycatch estimate for harbor porpoises cannot be confidently estimated. Annual average estimated harbor porpoise mortality and serious injury from the mid-Atlantic gillnet fishery during 1995 to 1998, before the Take Reduction Plan, was 358 (CV=0.20). The average annual harbor porpoise mortality and serious injury in the mid-Atlantic gillnet fishery from 2002 to 2006 was 299 (0.27), which is the 4-year average estimate from 2003, 2004, 2005, and 2006.

Northeast Bottom Trawl

This fishery is active in New England waters in all seasons. Eight harbor porpoise mortalities were observed in the Northeast bottom trawl fishery between 1989 and 2006. The first take occurred in February 1992 east of Barnegat Inlet, New Jersey at the continental shelf break. The animal was clearly dead prior to being taken by the trawl, because it was severely decomposed and the tow duration of 3.3 hours was insufficient to allow extensive decomposition. The second take occurred in January 2001 off New Hampshire in a haul trawling for flounder. This animal was clearly dead prior to being taken by the trawl, because it was severely decomposed (the skull broke off while the net was emptying) and the tow duration was 3.1 hours. This take was observed in the same time and area stratum that had documented gillnet takes. One fresh dead take was observed in the Northeast bottom trawl fishery in 2003, 4 in 2005, and 1 in 2006. Estimates have not been generated for this fishery.

Unknown Fishery

The strandings and entanglement database, maintained by the New England Aquarium and the Northeast Regional Office/NMFS, reported 228, 27, 113, 79, 122, 118, 174, and 73 stranded harbor porpoises on U.S. beaches during 1999 to 2006, respectively (see Other Mortality section for more details). Of these, it was determined that the cause of death of 19, 1, 3, 2, 9, and 6 stranded harbor porpoises in 1999 to 2004, respectively, were due to unknown fisheries and these animals were in areas and times that were not included in the above mortality estimate derived from observer program data (Table 3). As of 2005, the cause of death of stranded animals is not being evaluated and so will not be included in annual human-induced mortality estimates. The three-year average harbor porpoise mortality and serious injury in this unknown fishery category from 2002 to 2004 is 5.7 (CV is unknown).

CANADA

Hooker *et al.* (1997) summarized bycatch data from a Canadian fisheries observer program that placed observers on all foreign fishing vessels operating in Canadian waters, on 25-40% of large Canadian fishing vessels (greater than 100 feet long), and on approximately 5% of smaller Canadian fishing vessels. No harbor porpoises were observed taken.

Bay of Fundy Sink Gillnet

During the early 1980s, Canadian harbor porpoise bycatch in the Bay of Fundy sink gillnet fishery, based on casual observations and discussions with fishermen, was thought to be low. The estimated harbor porpoise bycatch in 1986 was 94-116 and in 1989 it was 130 (Trippel *et al.* 1996). The Canadian gillnet fishery occurs mostly in the western portion of the Bay of Fundy during the summer and early autumn months, when the density of harbor porpoises is highest. Polacheck (1989) reported there were 19 gillnetters active in 1986, 28 active in 1987, and 21 in 1988.

More recently, an observer program implemented in the summer of 1993 provided a total bycatch estimate of 424 harbor porpoises (± 1 SE: 200-648) from 62 observed trips, (approximately 11.3% coverage of the Bay of Fundy trips) (Trippel *et al.* 1996). During 1994, the observer program was expanded to cover 49% of the gillnet trips (171 observed trips). The bycatch was estimated to be 101 harbor porpoises (95% confidence limit: 80-122), and the fishing fleet consisted of 28 vessels (Trippel *et al.* 1996). During 1995, due to groundfish quotas being exceeded, the gillnet fishery was closed from July 21 to August 31. During the open fishing period of 1995, 89% of the trips were observed, all in the Swallowtail region. Approximately 30% of these observed trips used pingered nets. The estimated bycatch was 87 harbor porpoises (Trippel *et al.* 1996). No confidence interval was computed due to lack of coverage in the Wolves fishing grounds. During 1996, the Canadian gillnet fishery was closed during 20-31 July and 16-31 August due to groundfish quotas. From the 107 monitored trips, the bycatch in 1996 was estimated to be 20 harbor porpoises (DFO 1998; Trippel *et al.* 1999). Trippel *et al.* (1999) estimated that during 1996, gillnets equipped with acoustic alarms reduced harbor porpoise bycatch rates by 68% over nets without alarms in the Swallowtail area of the lower Bay of Fundy. During 1997, the fishery was closed to the majority of the gillnet fleet during 18-31 July and 16-31 August, due to groundfish quotas. In addition a time-area closure to reduce porpoise bycatch in the Swallowtail area occurred during September 1-7. From the 75 monitored trips, 19 harbor porpoises

were observed taken. After accounting for total fishing effort, the estimated bycatch in 1997 was 43 animals (DFO 1998). Trippel *et al.* (1999) estimated that during 1997, gillnets equipped with acoustic alarms reduced harbor porpoise bycatch rates by 85% over nets without alarms in the Swallowtail area of the lower Bay of Fundy. The number of monitored trips (and observed harbor porpoise mortalities were 111 (5) for 1998, 93 (3) for 1999, 194 (5) for 2000, and 285 (39) for 2001. The estimated annual mortality estimates were 38 for 1998, 32 for 1999, 28 for 2000, and 73 for 2001 (Trippel and Shepherd 2004). Estimates of variance are not available.

There has been no observer program during the summer since 2002 in the Bay of Fundy region, but the fishery was active. Thus, it is not known what the bycatch for these years is. The estimated harbor porpoise mortality in the Canadian groundfish sink gillnet fishery during 2001 was 73. An estimate of variance is not possible.

Herring Weirs

Harbor porpoises are taken in Canadian herring weirs, but there have been no recent efforts to observe takes in the U.S. component of this fishery. Smith *et al.* (1983) estimated that in the 1980s approximately 70 harbor porpoises became trapped annually and, on average, 27 died annually. In 1990, at least 43 harbor porpoises were trapped in Bay of Fundy weirs (Read *et al.* 1994). In 1993, after a cooperative program between fishermen and Canadian biologists was initiated, over 100 harbor porpoises were released alive (Read *et al.* 1994). Between 1992 and 1994, this cooperative program resulted in the live release of 206 of 263 harbor porpoises caught in herring weirs. Mortalities (and releases) were 11 (50) in 1992, 33 (113) in 1993, and 13 (43) in 1994 (Neimanis *et al.* 1995). Since that time, an additional 623 harbor porpoises have been documented in Canadian herring weirs, of which 637 were released or escaped, 36 died, and 9 had an unknown status. Mortalities (and releases, unknowns) were 5 (60, 0) in 1995; 2 (4, 0) in 1996; 2 (24, 0) in 1997; 2 (26, 0) in 1998; 3 (89, 0) in 1999; 0 (13, 0) in 2000 (A. Read, pers. comm), 14 (296, 0) in 2001, 3 (46, 4) in 2002, 1 (26, 3) in 2003, 4 (53, 2) in 2004; 0 (19, 5) in 2005; and 2 (14, 0) in 2006 (Neimanis *et al.* 2004; H. Koopman and A. Westgate, pers. comm.).

Average estimated harbor porpoise mortality in the Canadian herring weir fishery during 2002-2006 was 2.0 (Table 2). An estimate of variance is not possible.

Gulf of St. Lawrence gillnet

This fishery interacts with the Gulf of St. Lawrence harbor porpoise stock, not the Gulf of Maine/Bay of Fundy harbor porpoise stock. Using questionnaires to fishermen, Lesage *et al.* (2006) determined a total of 2215 (95% CI 1151-3662) and 2394 (95% CI 1440-3348) harbor porpoises were taken in 2000 and 2001, respectively. The largest takes were in July and August around Miscou and the North Shore of the Gulf of St. Lawrence. According to the returned questionnaires, the fish species most usually associated with incidental takes of harbor porpoises include Atlantic cod, herring and mackerel. An at-sea observer program was also conducted during 2001 and 2002. However, due to low observer coverage that was not representative of the fishing effort, Lesage *et al.* (2006) concluded that resulting bycatch estimates were unreliable.

Newfoundland gillnet

This fishery interacts with the Newfoundland harbor porpoise stock, not the Gulf of Maine/Bay of Fundy harbor porpoise stock. Estimates of incidental catch of small cetaceans, where the vast majority are likely harbor porpoises was 862 in 2001, 1,428 in 2002, and 2,228 in 2003 for the Newfoundland nearshore cod and Greenland halibut fisheries, and the Newfoundland offshore fisheries in lumpfish, herring, white hake, monkfish and skate (Benjamins *et al.* 2007) .

Table 2. From observer program data, summary of the incidental mortality of harbor porpoise (*Phocoena phocoena*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years			Observer Coverage[b]	Observed Mortality			Mean Annual Mortality
U.S.								
Northeast Sink Gillnet	02-06	unk	Obs. Data, Weighout, Trip Logbook	.02 .03, .06, .07, .04	10[c], 12[c], 27[c], 51[c], 26	444[c], 592, 654[c], 630[c], 514	.37, .33, .36, .23, .31	567 (0.14)
Mid-Atlantic Gillnet	02-06	unk	Obs. Data Weighout	.01, .01, .02, .03, .04	unk[f], 1, 2, 15, 20	unk[f], 76, 137, 470, 511	unk[f], 1.13, .91, .51, .32	299[f] (0.27)
Northeast bottom trawl	02-06	unk	Obs. Data Weighout	.03, .04, .05, .12, .06	0,1,0,4,1	0,unk[h],0,unk[h], unk	0, unk, 0, unk, 0	Unk[h]
U.S. TOTAL	2002-2006							866 (0.13)
CANADA								
Groundfish Sink Gillnet	02-06	unk	Can. Trips	0[g],0[g],0[g],0[g],0[g]	unk[g],unk[g], unk[g], unk[g] unk[g]	unk[g],unk[g], unk[g], unk[g] unk[g]	unk	unk
Herring Weir	02-06	1998=255 licenses[d] 2002=22[e]	Coop. Data	unk	3, 1, 4, 0, 2	3, 1, 4, 0, 2	NA	2.0 (unk)
CANADIAN TOTAL	2002-2006							2 (unk)
GRAND TOTAL								868 (unk)

NA = Not available.

a. Observer data (Obs. Data) are used to measure bycatch rates; the U.S. data are collected by the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program, the 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. The observer coverages for the U.S. and Canadian sink gillnet fisheries are ratios based on trips, and for the mid-Atlantic coastal gillnet fishery, the unit of effort is tons of fish landed.

c. During 2002-2006, harbor porpoises were taken on pingered strings within strata that required pingers but that stratum also had observed strings without pingers. For estimates made during 1998 and after, a weighted bycatch rate was applied to effort from both pingered and non-pingered hauls within a stratum. The weighted bycatch rate was:

$$\sum_{i}^{ping,non-ping} \frac{\#\ porpoise_i}{sslandings_i} \cdot \frac{\#\ hauls_i}{total\#\ hauls}$$

There were 10, 33, 44, 0, 11, 0, 2, 8, 6, 2, 26, 2, 4, 12, and 2 observed harbor porpoise takes on pinger trips from 1992 to 2006, respectively, that were included in the observed mortality column. In addition, there were

9, 0, 2, 1,1, 4, 0, 1, 7, 21, 33, and 24 observed harbor porpoise takes in 1995 to 2006, respectively, on trips dedicated to fish sampling versus dedicated to watching for marine mammals; these were also included in the observed mortality column (Bisack 1997).

d. There were 255 licenses for herring weirs in the Canadian Bay of Fundy region.

e. There were 22 active weirs around Grand Manan. The number of weirs elsewhere is unknown.

f. Sixty-five percent of sampling by the NEFSC fisheries observer program was concentrated in one area off the coast of Virginia. Coverage in other areas of the mid-Atlantic was <1%. Because of the low level of sampling that was not distributed proportionally throughout the mid-Atlantic region, the observed mortality is considered unknown in 2002. The four-year average (2003-2006) estimated mortality was applied as the best representative estimate.

g. The Canadian gillnet fishery was not observed during 2002 and afterwards, but the fishery is still active; thus, the bycatch estimate is unknown.

h. Estimates of bycatch mortality attributed to the Northeast bottom trawl fishery have not been generated.

Table 3. From strandings and entanglement data, summary of confirmed incidental mortality of harbor porpoises (*Phocoena phocoena*) by fishery: includes years sampled (Years), number of vessels active within the fishery (Vessels), type of data used (Data Type), mortalities assigned to this fishery (Assigned Mortality), and mean annual mortality.

Fishery	Years			Assigned Mortality	Mean Annual Mortality
Unknown gillnet fishery	02-06	NA	Entanglement & Strandings	2, 9, 6, unk[b], unk[b]	5.7
TOTAL					5.7

NA=Not Available.

a Data from records in the entanglement and strandings data base maintained by the New England Aquarium and the Northeast Regional Office/NMFS (Entanglement and Strandings).

b. As of 2005, the cause of death of stranded animals is not being evaluated and so will not be included in annual human-induced mortality estimates. Thus, the annual mortality is an average from the years 2002-2004.

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 2002, 82 harbor porpoises were reported stranded on Atlantic US beaches (Table 4). Eleven animals displayed signs of emaciation and two showed signs of fishery interactions (Table 4). Both of the strandings with fishery interactions were in the mid-Atlantic (Maryland and Virginia) during March and were not in a time and area that was part of a bycatch estimate derived from observer data (Table 3).

During 2003, 122 harbor porpoises were reported stranded (Table 4). The number of reported fishery interactions by state are: 1 in Massachusetts (October), 1 in Maryland (March), 6 in Virginia (3 in March, 2 in April, and 1 in May), and 1 in North Carolina (February). Three harbor porpoises were reported mutilated in North Carolina. All of these strandings reported with fishery interactions were in areas and times that were not part of a bycatch estimate derived from the observer data (Table 3).

During 2004, 117 harbor porpoises were reported stranded on Atlantic US beaches. There were 8 reported fishery interactions by state: 1 in Massachusetts (May), 1 in New York (May), and 3 in Virginia (February, March, and April), and 3 in North Carolina (April). In addition, there was 1 mutilation in Delaware during March. Of these

8 fishery interactions, six were in areas and times that were not part of a bycatch estimated derived from the observer data (Table 3).

During 2005, 175 harbor porpoises were reported stranded on Atlantic US beaches. Although 24 animals were classified as having signs of human interaction, and of those 24, 7 showed signs of fishery interaction, in no case was cause of death directly attributable to these interactions. An Unusual Mortality Event was declared for harbor porpoise in North Carolina, as 38 stranded in that state between 1 January and 28 March 2005. Most of these were young of the year, and histopathological examinations of 6 of these animals showed no common symptoms other than emaciation or any systemic disease (MMC 2006).

During 2006, 73 harbor porpoises were reported stranded on Atlantic US beaches. Eight of these were reported as having signs of human interaction, but in no case was cause of death directly attributable to these interactions. In fact, in three cases the human interaction was post-mortem. One of the human interaction mortalities was classified as a fishery-interaction (with no further detail), one as a boat collision, and one was involved in an oil spill.

As of 2005, the cause of death of stranded animals is not being evaluated and so will not be included in annual human-induced mortality estimates. Averaging 2002 to 2004, there were 0.8 animals per year that were stranded and mutilated and so cause of death was attributed to an unknown human-caused mortality.

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*) reported strandings along the U.S. Atlantic coast and Nova Scotia, 2002-2006.

Area	Year					**Total**
	2002	2003	2004	2005	2006	
Maine[a]	10	5	15	9	9	**48**
New Hampshire	2	2	2	0	1	**7**
Massachusetts[b]	43	35	49	55	23	**205**
Rhode Island[c]	1	2	3	6	3	**15**
Connecticut	1	0	0	1	0	**2**
New York	6	8	8	15	11	**48**
New Jersey	6	5	14	17	6	**48**
Pennsylvania	0	0	0	1	0	**1**
Delaware	3	1	1	3	3	**11**
Maryland	1	5	2	4	2	**14**
Virginia	6	19	8	22	9	**64**
North Carolina[d]	3	39	15	42	6	**105**
Florida	0	1	0	0	0	**1**
TOTAL U.S.	**82**	**122**	**117**	**175**	**73**	**569**
Nova Scotia	5	3	4	6	4	**22**
GRAND TOTAL	**87**	**125**	**121**	**181**	**77**	**591**

a. In Maine, one animal stranded alive in March 2002, brought to Mystic Aquarium but died 2 days later.
b. In Massachusetts, during 2002, three animals stranded alive and were rehabilitated at Mystic Aquarium (1 in February, March and May). In 2005, 2 animals were relocated and released. In 2006 one stranding record was of an emaciated calf swimming in shallow water, but capture attempts were unsucessful.

c. In Rhode Island, one animal stranded alive in 2006, and was taken to rehab.

d. In North Carolina, one animal was relocated and released in 2005.

CANADA

The Nova Scotia Stranding Network documented whales and dolphins stranded between 1991 and 1996 on the coast of Nova Scotia (Hooker *et al.* 1997). Researchers with the Canadian Dept. of Fisheries and Oceans documented strandings on the beaches of Sable Island during 1970 to 1998 (Lucas and Hooker 2000). Sable Island is approximately 170 km southeast of mainland Nova Scotia. On the mainland of Nova Scotia, a total of 8 stranded harbor porpoises were recorded between 1991 and 1996: 1 in May 1991, 2 in 1993 (July and September), 1 in August 1994 (released alive), 1 in August 1994, and 3 in 1996 (March, April, and July (released alive)). On Sable Island, 8 stranded dead harbor porpoises were documented, most in January and February; 1 in May 1991, 1 in January 1992, 1 in January 1993, 3 in February 1997, 1 in May 1997, and 1 in June 1997. Two strandings during May-June 1997 were neonates (> 80 cm). The harbor porpoises that stranded in the winter (January-February) were on Sable Island, those in the spring (March to June) were in the Bay of Fundy (2 in Minas Basin and 1 near Yarmouth) and on Sable Island (2), and those in the summer (July to September) were scattered along the coast from the Bay of Fundy to Halifax.

Whales and dolphins stranded between 1997 and 2006 on the coast of Nova Scotia as recorded by the Marine Animal Response Society and the Nova Scotia Stranding Network are as follows (Table 4): 3 harbor porpoises stranded in 1997 (1 in April, 1 in June and 1 in July), 2 stranded in June 1998, 1 in March 1999, 3 in 2000 (1 in February, 1 in June, and 1 in August); 2 in 2001 (1 in July and 1 in December), 5 in 2002 (3 in July (1 released alive), 1 in August, and 1 in September (released alive)), 3 in 2003 (2 in May (1 was released alive) and 1 in June (disentangled and released alive)), 4 in 2004 (1 in April, 1 in May, 1 in July (released alive) and 1 in November), 6 in 2005 (1 in April (released alive), 1 in May, 3 in June and 1 in July), and 4 in 2006 (1 in June, 1 in August, 1 in September, and 1 in December).

USA Management measures taken to reduce bycatch

A ruling to reduce harbor porpoise bycatch in USA Atlantic gillnets was published in the Federal Register (63 FR 66464) on 02 December 1998 and became effective 01 January 1999. The Gulf of Maine portion of the plan pertains to all fishing with sink gillnets and other gillnets capable of catching regulated groundfish in New England waters, from Maine through Rhode Island. This portion of the rule includes time and areas closures, some of which are complete closures; others are closed to gillnet fishing unless pingers are used in the prescribed manner. Also, the rule requires those who intend to fish to attend training and certification sessions on the use of the technology. The mid-Atlantic portion of the plan pertains to waters west of 72º30'W longitude to the mid-Atlantic shoreline from New York to North Carolina. This portion of the rule includes time and area closures, some of which are complete closures; others are closed to gillnet fishing unless the gear meets certain restrictions. The MMPA mandates that the take reduction teams that developed the above take reduction measures periodically meet to evaluate the effectiveness of the plan and modify it as necessary.

STATUS OF STOCK

The status of harbor porpoises, relative to OSP, in the U.S. Atlantic EEZ is unknown. On 7 January 1993, the National Marine Fisheries Service (NMFS) proposed listing the Gulf of Maine harbor porpoise as threatened under the Endangered Species Act (NMFS 1993). On 5 January 1999, NMFS determined the proposed listing was not warranted (NMFS 1999). On 2 August 2001, NMFS made available a review of the biological status of the Gulf of Maine/Bay of Fundy harbor porpoise population. The determination was made that listing under the Endangered Species Act (ESA) was not warranted and this stock was removed from the ESA candidate species list (NMFS 2001). Population trends for this species have not been investigated. 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. This is a strategic stock because average annual human-related mortality and serious injury exceeds PBR.

REFERENCES CITED

Barlow, J. and P. Boveng 1991. Modeling age-specific mortality for marine mammal populations. Mar. Mamm. Sci. 7: 50-65.

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. 73 pp.

Benjamins, S., J. Lawson and G. Stenson 2007. Recent harbor porpoise bycatch in Newfoundland, Canada's gillnet fisheries. J. Cetacean Res. Manage. 9(3): 189-200.
Bisack, K. D. 1997. Harbor porpoise bycatch estimates in the U.S. New England multispecies sink gillnet fishery: 1994 and 1995. Rep. Int. Whal. Comm. 47: 705-714.
Bravington, M. V. and K. D. Bisack 1996. Estimates of harbour porpoise bycatch in the Gulf of Maine sink gillnet fishery, 1990-1993. Rep. Int. Whal. Comm. 46: 567-574.
Caswell, H., S. Brault, A. J. Read and T. D. Smith 1998. Harbor porpoise and fisheries: An uncertainty analysis of incidental mortality. Ecol. Appl. 8(4): 1226-1238.
CUD 1994. Estimating harbor porpoise bycatch in the Gulf of Maine sink gillnet fishery. Conservation and Utilization Division. Northeast Fish. Sci. Cent. Ref. Doc. 94-24.
DFO 1998. Harbour porpoise bycatch in the lower Bay of Fundy gillnet fishery. DFO Maritimes Regional Fisheries Status Report 98/7E. Available from Department of Fisheries and Oceans, Resource management Branch, P.O. Box 550, Halifax, NS B3J 2S7, Canada.
Gaskin, D. E. 1977. Harbour porpoise, *Phocoena phocoena* (L.), in the western approaches to the Bay of Fundy 1969-75. Rep. Int. Whal. Comm. 27: 487-492.
Gaskin, D. E. 1984. The harbor porpoise *Phocoena phocoena* (L.): Regional populations, status, and information on direct and indirect catches. Rep. Int. Whal. Comm. 34: 569-586.
Gaskin, D. E. 1992. The status of the harbour porpoise. Can. Field-Nat. 106: 36-54.
Gilbert, J. R. 1987. Marine Mammal Interaction with New England Gillnet Fisheries. NMFS. NA84EAC00070**:** 21.
Gilbert, J. R. and K. M. Wynne 1985. Harbor seal populations and fisheries interactions with marine mammals in New England, 1984. NMFS. NA80FAC00029 and NA84EAC00070**:** 15.
Hiby, L. 1999. The objective identification of duplicate sightings in aerial survey for porpoise. Pages 179-189 *in*: G. W. Garner, S. C. Amstrup, J. L. Laakeet al, (eds.) Marine Mammal Survey and Assessment Methods. Balkema, Rotterdam.
Hooker, S. K., R. W. Baird and M. A. Showell 1997. Cetacean strandings and bycatches in Nova Scotia, Eastern Canada, 1991-1996. Meeting document SC/49/O5 submitted to the 1997 International Whaling Commission Scientific Committee meeting in Bournemouth, UK.
Johnston, D. W. 1995. Spatial and temporal differences in heavy metal concentrations in the tissues of harbour porpoises (*Phocoena phocoena* L.) from the western North Atlantic. M.S. thesis. Guelph, Ontario, Canada, University of Guelph. 152 pp.
Kingsley, M. C. S. and R. R. Reeves 1998. Aerial surveys of cetaceans in the Gulf of St. Lawrence in 1995 and 1996. Can. J. Zool. 76: 1529-1550.
Kraus, S. D., J. H. Prescott and G. S. Stone 1983. Harbor porpoise, *Phocoena phocoena*, in the U.S. coastal waters off the Gulf of Maine: a survey to determine seasonal distribution and abundance. NMFS. NA82FAC00027**:** 22.
Kraus, S. D., A. J. Read, A. Solow, K. Baldwin, T. Spradlin, E. Anderson and J. Williamson 1997. Acoustic alarms reduce porpoise mortality. Nature 388(6642): 525.
Lamb, A. 2000. Patterns of harbor porpoise mortality in two US Atlantic sink gillnet fisheries and changes in life history parameters. M.S. thesis. Boston, MA, Boston University.
Lesage, V., J. Keays, S. Turgeon and S. Hurtubise 2006. Bycatch of harbour porpoises (*Phocoena phocoena*) in gillnet fisheries of the Estuary and Gulf of St. Lawrence in 2000-2002. J. Cetacean Res. Manage. 8(1): 67-78.
Lucas, Z. N. and S. K. Hooker 2000. Cetacean strandings on Sable Island, Nova Scotia, 1970-1998. Can. Field-Nat. 114(1): 46-61.
MMC 2006. US Marine Mammal Commission Annual Report to Congress, 2005. Marine Mammal Commission, Bethesda, MD. Vi+163 pp. http://www.mmc.gov/reports/annual/pdf/2005annualreport.pdf
Neimanis, A. S., H. N. Koopman, A. J. Westgate, L. D. Murison and A. J. Read 2004. Entrapment of harbour porpoises (*Phocoena phocoena*) in herring weirs in the Bay of Fundy, Canada. J. Cetacean Res. Manage. 6(1): 7-17.
Neimanis, A. S., A. J. Read, A. J. Westgate, H. N. Koopman, J. Y. Wang, L. D. Murison and D. E. Gaskin 1995. Entrapment of harbour porpoises (*Phocoena phocoena*) in herring weirs in the Bay of Fundy, Canada. International Whaling Commission, Dublin, Ireland., Working paper SC/47/SM18.
NMFS 1992. Harbor porpoise in Eastern North America: Status and Research Needs. Results of a scientific workshop held May 5-8, 1992 at NEFSC, Woods Hole, MA, USA. National Marine Fisheries Service, Silver Spring, Maryland. Northeast Fish. Sci. Cent. Ref. Doc. 92-06. 28 pp.

NMFS 1993. Proposed listing of Gulf of Maine population of harbor porpoises as threatened under the Endangered Species Act. Federal Register 58: 3108-3120.
NMFS 1999. Listing of Gulf of Maine/Bay of Fundy population of harbor porpoise as threatened under the Endangered Species Act. Federal Register 64(2): 465-471.
NMFS 2001. Status review of the Gulf of Maine/Bay of Fundy population of harbor porpoise under the Endangered Species Act (ESA). Federal Register 66(203): 53195-53197.
Palka, D. 1995a. Influences on spatial patterns of Gulf of Maine harbor porpoises. Pages 69-75 *in*: A. S. Blix, L. Walloe and O. Ulltang, (eds.) Whales, Seals, Fish and Man. Elsevier Science.
Palka, D. 2000. Abundance of the Gulf of Maine/Bay of Fundy harbor porpoise based on shipboard and aerial surveys during 1999. Northeast Fish. Sci. Cent. Ref. Doc. 00-07. 29 pp. http://www.nefsc.noaa.gov/psb/pubs/palkalabref00-07.pdf
Palka, D. L. 1995b. Abundance estimate of Gulf of Maine harbor porpoise. Rep. Int. Whal. Comm. (Special Issue) 16: 27-50.
Palka, D. L. 1996. Update on abundance of Gulf of Maine/Bay of Fundy harbor porpoises. Northeast Fish. Sci. Cent. Ref. Doc. 96-04. 35 pp. http://www.nefsc.noaa.gov/nefsc/publications/crd/crd9604.pdf
Palka, D. L. 2005. Aerial surveys in the northwest Atlantic: estimation of *g(0)*. Proceedings of a Workshop on Estimation of *g(0)* in Line-Transect Surveys of Cetaceans, European Cetacean Society's 18th Annual Conference; Kolmården, Sweden; Mar. 28, 2004.
Palka, D. L. and P. S. Hammond 2001. Accounting for responsive movement in line transect estimates of abundance. Can. J. Fish. Aquat. Sci 58: 777-787.
Palka, D. L., A. J. Read, A. J. Westgate and D. W. Johnston 1996. Summary of current knowledge of harbour porpoises in US and Canadian Atlantic waters. Rep. Int. Whal. Comm. 46: 559-565.
Polacheck, T. 1989. Harbor porpoises and the gillnet fishery. Oceanus 32(1): 63-70.
Polacheck, T., F. W. Wenzel and G. Early 1995. What do stranding data say about harbor porpoise (*Phocoena phocoena*)? Rep. Int. Whal. Comm. (Special Issue) 16: 169-180.
Read, A. J., J. E. Craddock and D. Gannon 1994. Life history of harbour porpoises and pilot whales taken in commercial fishing operations off the northeastern United States. Final Report, Phase II. 50-EANE-2-00082.
Read, A. J. and A. A. Hohn 1995. Life in the fast lane: the life history of harbour porpoises from the Gulf of Maine. Mar. Mamm. Sci. 11(4): 423-440.
Read, A. J., J. R. Nicolas and J. E. Craddock 1996. Winter capture of a harbor porpoise in a pelagic drift net off North Carolina. Fish. Bull. 94(2): 381-383.
Read, A. J. and A. J. Westgate 1997. Monitoring the movements of harbour porpoises (*Phocoena phocoena)* with satellite telemetry. Marine Biology 130: 315-22.
Rosel, P. E., S. C. France, J. Y. Wang and T. D. Kocher 1999a. Genetic structure of harbour porpoise *Phocoena phocoena* populations in the northwest Atlantic based on mitochondrial and nuclear markers. Mol. Ecol. 8: S41-S54.
Rosel, P. E., R. Tiedemann and M. Walton 1999b. Genetic evidence for limited trans-Atlantic movements of the harbor porpoise *Phocoena phocoena*. Marine Biology 133: 583-591.
Rossman, M. C. and R. L. Merrick 1999. Harbor porpoise bycatch in the Northeast Multispecies Sink Gillnet Fishery and the Mid-Atlantic Coastal Gillnet Fishery in 1998 and during January-May 1999. Northeast Fish. Sci. Cent. Ref. Doc. 99-17. 36 pp. http://www.nefsc.noaa.gov/nefsc/publications/crd/crd9917.pdf
Smith, G. J. D., A. J. Read and D. E. Gaskin 1983. Incidental catch of harbor porpoises, *Phocoena phocoena* (L.), in herring weirs in Charlotte County, New Brunswick, Canada. Fish. Bull. 81(3): 660-2.
Smith, T., D. Palka and K. Bisack 1993. Biological Significance of By-catch of Harbor Porpoise in the Gulf of Maine Demersal Gillnet Fishery. Northeast Fish. Sci. Cent. Ref. Doc. 93-23. 15 pp.
Trippel, E. A. and T. D. Shepherd 2004. By-Catch of harbour porpoise (*Phocoena phocoena*) in the Lower Bay of Fundy gillnet fishery from 1998-2001. Department of Fisheries and Oceans, Ottawa, Ontario. DFO Research Document 2004/2521.
Trippel, E. A., M. B. Strong, J. M. Terhune and J. D. Conway 1999. Mitigation of harbour porpoise (*Phocoena phocoena*) bycatch in the gillnet fishery in the lower Bay of Fundy. Can. J. Fish. Aquat. Sci 56: 113-123.
Trippel, E. A., J. Y. Wang, M. B. Strong, L. S. Carter and J. D. Conway 1996. Incidental mortality of harbour porpoise (*Phocoena phocoena*) by the gill-net fishery in the lower Bay of Fundy. Can. J. Fish. Aquat. Sci 53: 1294-1300.

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. 93 pp.

Wang, J. Y., D. E. Gaskin and B. N. White 1996. Mitochondrial DNA analysis of harbour porpoise, *Phocoena phocoena*, subpopulations in North American waters. Can. J. Fish. Aquat. Sci 53: 1632-45.

Westgate, A. J., D. C. G. Muir, D. E. Gaskin and M. C. S. Kingsley 1997. Concentrations and accumulation patterns of organochlorine contaminants in the blubber of harbour porpoises, *Phocoena phocoena*, from the coast of Newfoundland, the Gulf of St. Lawrence and the Bay of Fundy/Gulf of Maine. Envir. Pollut. 95: 105-119.

Westgate, A. J., A. J. Read, T. M. Cox, T. D. Schofield, B. R. Whitaker and K. E. Anderson 1998. Monitoring a rehabilitated harbor porpoise using satellite telemetry. Mar. Mamm. Sci. 14(3): 599-604.

Westgate, A. J. and K. A. Tolley 1999. Geographical differences in organochlorine contaminants in harbour porpoises *Phocoena phocoena* from the western North Atlantic. Mar. Ecol. Prog. Ser. 177: 255-268.

Woodley, T. H. and A. J. Read 1991. Potential rates of increase of a harbor porpoise (*Phocoena phocoena*) population subjected to incidental mortality in commercial fisheries. Can. J. Fish. Aquat. Sci 48: 2429-35.