November 2010

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 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).

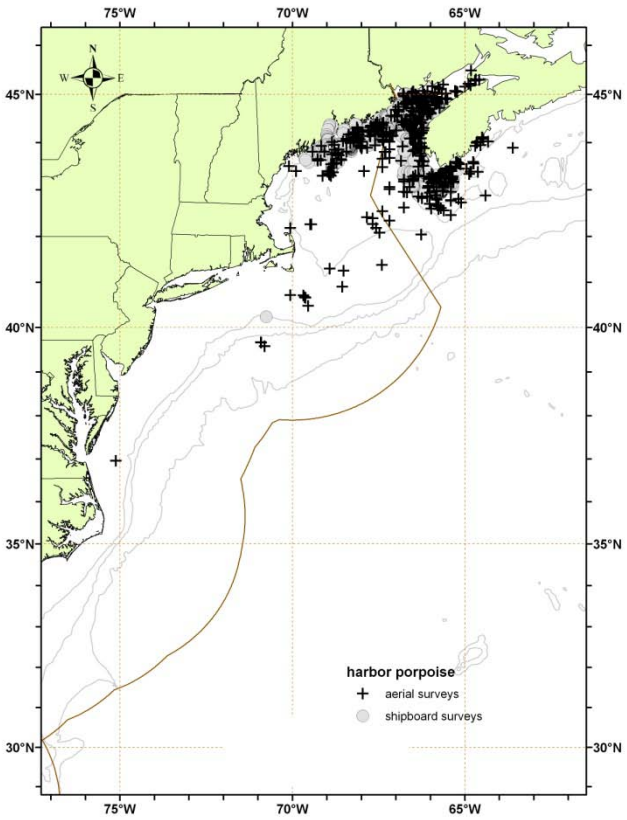

Figure 1. *Distribution of harbor porpoises from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1998, 1999, 2002, 2004, 2006 and 2007. Isobaths are the 100-m, 1000-m, and 4000-m depth contours.*

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.

POPULATION SIZE

To estimate the population size of harbor porpoises in the Gulf of Maine/Bay of Fundy region, eight line-transect sighting surveys were conducted during the summers of 1991, 1992, 1995, 1999, 2002, 2004, 2006, and 2007. 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 covered the largest portion of the harbor porpoise range.

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 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 trackline. 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, NEFSC, pers. comm.).

An abundance estimate of 4,862 (95%CI=2,204-8,801) harbor porpoises from the Gulf of Maine/Bay of Fundy, Gulf of St. Lawrence, and Newfoundland stocks was generated from the Canadian Trans-North Atlantic Sighting Survey (TNASS) in July-August 2007. This aerial survey covered area from northern Labrador to the Scotian Shelf, providing full coverage of the Atlantic Canadian coast. Estimates from this survey have not yet been corrected for availability and perception biases (Lawson 2009).

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
Jul-Aug 2007	Northern Labrador-Scotian Shelf	4,862	0.31

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

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.

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 0.046. 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 703.

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 928+ (CV=0.16) harbor porpoises per year. This is derived from four components: 877 harbor porpoise per year (CV=0.15) from most U.S. fisheries using observer and MMAP data, an unknown number for the Northeast bottom trawl fishery, 45 per year (unknown CV) from Canadian fisheries using observer data, and 6 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, and Northeast bottom trawl fisheries 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 in the Atlantic pelagic drift gillnet fishery during 1991-1998; the fishery ended in 1999. 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). 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 1990-2007 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, 514 (0.31) in 2006, 395 (0.37) in 2007, and 666 (0.48) in 2008 (Table 2). 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, bycatch rates of harbor porpoises 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 2004 to 2008 was 572 (0.17) (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 was 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). 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, 511 (0.32) in 2006, 58 (1.03) in 2007, and 350 (0.75) in 2008. 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 2004 to 2008 was 305 (0.27) (Table 2).

Northeast Bottom Trawl

This fishery is active in New England waters in all seasons. Twenty harbor porpoise mortalities were observed in the Northeast bottom trawl fishery between 1989 and 2008, but many of these are not attributable to this fishery. Decomposed animals are presumed to have been dead prior to being taken by the trawl. One fresh dead take was observed in the Northeast bottom trawl fishery in 2003, 4 in 2005, 1 in 2006, and 1 in 2008. 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, 73, 79, and 58 stranded harbor porpoises on U.S. beaches during 1999 to 2008, 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 harbor porpoise mortality and serious injury in this unknown fishery category for 2004 is 6.0 (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, 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 1-7 September. 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. Bycatch for these years is unknown. The annual average of most recent five years with available data (1997-2001) was 43 animals, so this value is used to estimate the annual average for more recent years.

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, additional harbor porpoises have been documented in Canadian herring weirs where the number of mortalities (releases, and 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; 2 (14, 0) in 2006; 3 (9, 3) in 2007 and 0 (8, 6) in 2008 (Neimanis *et al.* 2004; H. Koopman and A. Westgate, UNCW, pers. comm.).

Average estimated harbor porpoise mortality in the Canadian herring weir fishery during 2004-2008 was 1.8 (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 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	Data Type [a]	Observer Coverage [b]	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
U.S.							
Northeast Sink Gillnet [c]	04-08	Obs. Data, Weighout, Trip Logbook	.06, .07, .04, .07, .05	27, 51, 26, 35, 30	654, 630, 514, 395, 666	.36, .23, .31, .37, .48	572 (0.17)
Mid-Atlantic Gillnet	04-08	Obs. Data Weighout	.02, .03, .04, .06, .03	2, 15, 20, 1, 9	137, 470, 511, 58, 350	.91, .51, .32, 1.03, .75	305 (0.27)
Northeast bottom trawl [g]	04-08	Obs. Data Weighout	.05, .12, .06, .06, .08	0, 4, 1, 0, 1	0, unk, unk, 0, unk	0, unk, unk, 0, unk	unk[g]
U.S. TOTAL	2004-2008						877 (0.15)
CANADA							
Bay of Fundy Sink Gillnet [d,f]	1997-2001	Can. Trips	unk	19, 5, 3, 5, 39	43, 38, 32, 28, 73	unk	43 [f] (unk)
Herring Weir [e]	04-08	Coop. Data	unk	4, 0, 2, 3, 0	4, 0, 2, 3, 0	NA	1.8 (unk)
CANADIAN TOTAL	2004-2008						45 (unk)
GRAND TOTAL							922+ (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. Observer coverage for the U.S. Northeast and mid-Atlantic coastal gillnet fisheries, is based on tons of fish landed.

c. During 2002-2008 in the Northeast gillnet fishery, 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:

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

There were 10, 33, 44, 0, 11, 0, 2, 8, 6, 2, 26, 2, 4, 12, 2, 9 and 6 observed harbor porpoise takes on pinger trips from 1992 to 2008, respectively, that were included in the observed mortality column. In addition, there were 9, 0, 2, 1,1, 4, 0, 1, 7, 21, 33, 24, 7, and 13 observed harbor porpoise takes in 1995 to 2008, 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. The Canadian gillnet fishery was not observed during 2002 and afterwards, but the fishery is still active; thus, the bycatch estimate is estimated using past averages.

g. 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), type of data used (Data Type), mortalities assigned to this fishery (Assigned Mortality), and mean annual mortality.

Fishery	Years	Data Type [a]	Assigned Mortality	Mean Annual Mortality
Unknown gillnet fishery	04-08	Entanglement & Strandings	6, unk[b], unk[b], unk[b], unk[b]	6
TOTAL				6

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 that from 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 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 there were 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 systemic diseases or common symptoms other than emaciation (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.

During 2007, 79 harbor porpoises were reported stranded on Atlantic US beaches. Of these, six were reported as having signs of human interaction. One of these was classified as a fishery interaction, and one had signs of propeller wounds, although the marks appeared to have been made post-mortem.

During 2008, 58 harbor porpoises were reported stranded on Atlantic US beaches. Of these, four were reported as having signs of human interaction. One of these was classified as a fishery interaction.

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. Using only 2004, it is estimated that there were 6 animals per year that were stranded and mutilated and so cause of death was attributed to an unknown human-caused mortality (Table 3).

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, 2004-2008.

Area	Year					**Total**
	2004	2005	2006	2007	2008	
Maine	15	9	9	10	7	**50**
New Hampshire	2	0	1	0	0	**3**
Massachusetts[a]	49	55	23	22	25	**174**
Rhode Island[b]	3	6	3	1	1	**14**
Connecticut	0	1	0	0	0	**1**
New York[c]	8	15	11	10	3	**47**
New Jersey	14	17	6	5	8	**50**
Pennsylvania	0	1	0	0	0	**1**
Delaware	1	3	3	3	0	**10**
Maryland	2	4	2	0	2	**10**
Virginia	8	22	9	8	6	**53**
North Carolina[d]	15	42	6	20	6	**89**
Florida	0	0	0	0	0	**0**
TOTAL U.S.	**117**	**175**	**73**	**79**	**58**	**502**
Nova Scotia	3	5	4	4	6	**22**
Newfoundland and New Brunswick	0	5	0	1	4	**10**
GRAND TOTAL	**120**	**185**	77	**84**	**62**	**534**

a. In Massachusetts, during 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 unsuccessful. One animal was taken to a rehab facility in 2007 and one in 2008.

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

c. Includes one live animal in 2006 in New York.

d. In North Carolina, one animal was relocated and released in 2005, one animal was taken to rehab in 2006, and one animal immediately released in 2008.

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 Department 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 2008 on the coast of Nova Scotia were recorded by the Marine Animal Response Society and the Nova Scotia Stranding Network, including: 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), 4 in 2006 (1 in June, 1 in August, 1 in September, and 1 in December), 4 in 2007, and 6 in 2008 (Table 4).

Five dead stranded harbor porpoises were reported in 2005 by the Newfoundland and Labrador Whale Release and Strandings Program, 1 in 2007 and 4 in 2008 (Ledwell and Huntington 2004; 2006; 2007; 2008; 2009).

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. The Harbor Porpoise Take Reduction Team was reconvened in December 2007 to discuss updated harbor porpoise abundance and bycatch information. The Team recommended modifications to the plan to further reduce harbor porpoise bycatch in commercial fisheries. NMFS is currently undertaking rule-making to modify the plan.

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.

Benjamins, S., J. Lawson and G. Stenson 2007. Recent harbour porpoise bycatch in gillnet fisheries in Newfoundland and Labrador, Canada. J. Cetacean Res. Manage. 9(3): 189-199.

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. draft report 21 pp.

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 pp.

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. Laake *et al.*, (eds.) Marine Mammal Survey and Assessment Methods. Balkema, Rotterdam.

Hiltunen, K.H. 2006. Mixed-stock analysis of harbor porpoises (*Phocoena phocoena*) along the U.S. mid-Atlantic coast using microsatellite DNA markers. MS thesis. The College of Charleston, Charleston, SC.

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. University of Guelph, Guelph, Ontario, Canada. 152 pp.

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 pp.

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 University, Boston, MA.

Lawson, J.W. and J.-F. Gosselin 2008. Distribution and preliminary abundance estimates for cetaceans seen during Canada's Marine Megafauna Survey - A component of the 2007 TNASS. Can. Sci. Advisory Sec. Res. Doc. 208/031. 33 pp.

Ledwell, W. and J. Huntington 2004. Marine animal entrapments in fishing gear in Newfoundland and Labrador and a summary of the Whale Release and Strandings Program during 2004. Report to the Department of Fisheries and Oceans. St. John's, Newfoundland, Canada. 3 pp.

Ledwell, W. and J. Huntington 2006. Whale, leatherback sea turtles. And basking shark entrapments in fishing gear in Newfoundland and Labrador and a summary of the Whale Release and Strandings Program during 2005. Report to the Department of Fisheries and Oceans. St. John's, Newfoundland, Canada. 18 pp.

Ledwell, W. and J. Huntington 2007. Whale and leatherback sea turtle entrapment in fishing gear in Newfoundland and Labrador and a summary of the Whale Release and Strandings Program during 2006. Report to the Department of Fisheries and Oceans. St. John's, Newfoundland, Canada. 3 pp.

Ledwell, W. and J. Huntington 2008. Incidental entrapments in fishing gear reported in 2007 in Newfoundland and

Labrador and a summary of the Whale Release and Strandings Program. A report to the Department of Fisheries and Oceans, Canada-Newfoundland and Labrador region.
Ledwell, W. and J. Huntington 2009. Incidental entrapments in fishing gear and strandings reported to the whale release and strandings group in Newfoundland and Labrador and a summary of the Whale Release and Strandings Program during 2008. A report to the Department of Fisheries and Oceans Canada, Newfoundland and Labrador region.
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
Moore, J.E. and A.J. Read 2008. A Bayesian uncertainty analysis of cetacean demography and bycatch mortality using age-at-death data. Ecol. Appl. 18(8): 1914-1931.
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. 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/publications/crd/crd0007/index.htm
Palka, D.L. 1995b. Abundance estimate of Gulf of Maine harbor porpoise. Rep. Int. Whal. Comm. (Special Issue) 16: 27-50.
Palka, D.L. 2005. Aerial surveys in the northwest Atlantic: estimation of g(0), Pages 12-17 *in*: F. Thomsen, F. Ugarte and P. G. H. Evans, (eds.) 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. final report, phase II.
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

Schofield, D.T., G. Early, F.W. Wenzel, K. Matassa, C. Perry, G. Beekman, B. Whitaker, E. Gebhard, W. Walton and M. Swingle 2008. Rehabilitation and Homing Behavior of a Satellite-Tracked Harbor Porpoise (*Phocoena phocoena*). Aquatic Mammals 34(1): 1-8.

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.

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.