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GRAY SEAL (*Halichoerus grypus grypus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The gray seal is found on both sides of the North Atlantic, with three major populations: eastern Canada,northwestern Europe and the Baltic Sea (Katona *et al.* 1993). The western North Atlantic stock is equivalent to the eastern Canada population, and ranges from New York to Labrador (Davies 1957; Mansfield 1966; Katona *et al.* 1993; Lesage and Hammill 2001). This stock is separated by geography, differences in the breeding season, and mitochondrial DNA variation from the northeastern Atlantic stock (Bonner 1981; Boskovic *et al.* 1996; Lesage and Hammill 2001). There are two breeding concentrations in eastern Canada; one at Sable Island, and one that breeds on the pack ice in the Gulf of St. Lawrence (Laviguer and Hammill 1993). Tagging studies indicate that there is little intermixing between the two breeding groups (Zwanenberg and Bowen 1990) and, for management purposes, they are treated by the Canadian DFO as separate stocks (Mohn and Bowen 1996). In the mid- 1980s, small numbers of animals and pupping were observed on several isolated islands along the Maine coast and in Nantucket-Vineyard Sound, Massachusetts (Katona *et al.* 1993; Rough 1995: Gilbert *et al.* 2005). In the late 1990s, a year-round breeding population of approximately 400+ animals was documented on outer Cape Cod and Muskeget Island (D. Murley, pers. comm., Mass. Audubon Society, Wellfleet, MA). In December 2001, NMFS initiated aerial surveys to monitor gray seal pup production on Muskeget Island and adjacent sites in Nantucket Sound, and Green and Seal Islands off the coast of Maine (Wood *et al.* 2007). To assess the stock structure of gray seals in the northwest Atlantic, tissue samples were collected from Canadian and U.S. populations for genetic analyses (Wood *et al.* 2011). Based on examination of nine highly variable microsatellite loci, all individuals were placed into one population. This provides additional confirmation that recolonization by Canadian gray seals is the source of the U.S. population.

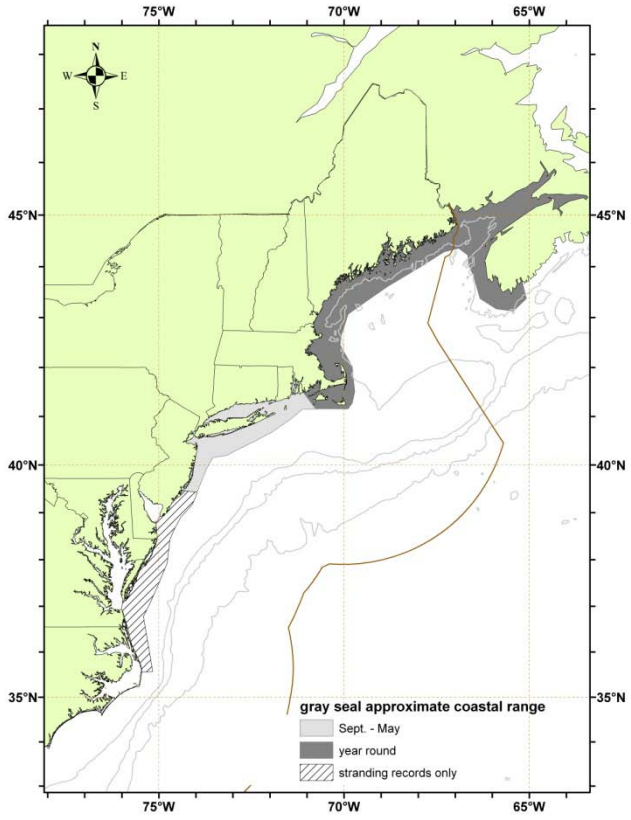

Figure 1. Approximate coastal range of gray seals. Isobaths are the 100-m, 1000-m, and 4000-m depth contours.

POPULATION SIZE

Current estimates of the total western Atlantic gray seal population are not available; although estimates of portions of the stock are available for select time periods. The size of the total Canadian population from 1977 to 2010 has been estimated by modeling gray seal population dynamics and available pup production data divided into three breeding regions: Sable Island, Gulf of St. Lawrence, and Coastal Nova Scotia (Thomas *et al.* 2011). The 2010 total population estimate was 348,900 (95% CI 291,300-414,900). This is 4% higher than the 2009 estimate (335,200; 95% CI 292,300-395,100) (Thomas *et al.* 2011). Average annual rates of total population increase were estimated to be 6% in the 1980s, 9% in the 1990s, and 6% in the 2000s. The authors note that these estimates should be treated with caution due to modeling and data concerns. In comparison to the pooled estimates, Bowen *et al.* (2003) reported that

the Sable Island had been increasing by approximately 13% for nearly 40 years, but subsequently declined to 7% based on the 2004 pup production survey (Trzcinski *et al.* 2005; Bowen *et al.* 2007).

In U.S. waters, gray seals currently pup at three established colonies: Muskeget Island, Massachusetts, Green Island, Maine, and Seal Island, Maine, as well as, more recently, at Matinicus Rock in Maine. Although white coated pups have stranded on eastern Long Island beaches, no pupping colonies have been detected in that region. Gray seals have been observed using the historic pupping site on Muskeget Island in Massachusetts since 1990. Pupping has taken place on Seal and Green Islands in Maine since at least the mid 1990s. Aerial survey data from these sites indicate that pup production is increasing. A minimum of 2,620 pups (Muskeget= 2,095, Green= 59, Seal= 466) were born in the U.S. in 2008 (Wood LaFond 2009). Table 2 summarizes single-day pup counts from the three U.S. pupping colonies from 2001/2002 to 2007/2008 pupping periods. The decrease in pup counts in some years is an artifact of survey timing and not indicative of true declines in those years. In recent years NMFS monitoring surveys have detected an occasional mother/pup (white coats) pair on both Monomoy Island and Noman's Land in Massachusetts. Some of the local breeders have been observed with brands and tags indicating they had been born on Sable Island, Canada (Rough 1995; L. Sette, pers. comm., Provincetown Center for Coastal Studies). The increase in the number of gray seals observed in the U.S. is probably due to both natural increase and immigration.

Gray seals are also observed in New England outside of the pupping season. In April–May 1994 a maximum count of 2,010 was obtained for Muskeget Island and Monomoy combined (Rough 1995). Maine coast-wide surveys conducted during summer revealed 597 and 1,731 gray seals in 1993 and 2001, respectively (Gilbert *et al.* 2005). In March 1999 a maximum count of 5,611 was obtained in the region south of Maine (between Isles of Shoals, Maine and Woods Hole, Massachusetts) (Barlas 1999). In March 2011 a maximum count of 15,756 was obtained in southeastern Massachusetts coastal waters (NMFS unpubl. data). No gray seals were recorded at haul-out sites between Newport, Rhode Island and Montauk Pt., New York (Barlas 1999), although, more recently several hundred gray seals have been recorded in surveys conducted off eastern Long Island (R. DiGiovanni, pers. comm., The Riverhead Foundation for Research and Preservation, Riverhead, NY).

Table 1. Summary of abundance estimates for the western North Atlantic gray seal: year, and area covered during each abundance survey, resulting total abundance estimate and 95% confidence interval.

Month/Year	**Area**	**Nbest**	**CI**
2010[a]	Gulf of St Lawrence + Nova Scotia Eastern Shore + Sable Island	348,900	95% CI 291,300-414,900

[a]Model based estimate derived from pup surveys.

Table 2. The number of pups observed on Muskeget, Seal, and Green Islands 2002-2008. Data are from aerial surveys. These are single-day counts, not estimates of total pup production. (Wood LaFond 2009).

Pupping Season	Muskeget Island	Seal Island	Green Island
2001-2	883	No data	34
2002-3	509	147	No data
2003-4	824	150	26
2004-5	992	365	33
2005-6	868	239	43
2006-7	1704	364	57
2007-8	2095	466	59

Minimum Population Estimate

Based on modeling, the total Canadian gray seal population was estimated to be 348,999 (95% CI 291,300–414,900) (Thomas *et al.* 2011). Present data are insufficient to calculate the minimum population estimate for U.S. waters.

Current Population Trend

Gray seal abundance is likely increasing in the U.S. Atlantic Exclusive Economic Zone (EEZ), but the rate of

increase is unknown. The population in eastern Canada was greatly reduced by hunting and bounty programs, and in the 1950s the gray seal was considered rare (Lesage and Hammill 2001). The Sable Island population was less affected and has been increasing for several decades. Pup production on Sable Island, Nova Scotia, increased exponentially at a rate of 12.8% per year between the 1970s and 1997 (Stobo and Zwanenburg 1990; Mohn and Bowen 1996; Bowen *et al.* 2003; Trzcinski *et al.* 2005; Bowen *et al.* 2007;DFO 2011a), but has declined to about 4% per year between 2007 and 2010 (DFO 2011a). The non Sable Island population increased from approximately 25,000 in the mid-1980s to a peak of 71,500in 2010 (Thomas *et al.* 2011). Modeling estimates of pup production increased from approximately 6,000 in 1985 to 17,400 in 2010 (Thomas *et al.* 2011). Approximately 70% of the western North Atlantic population is from the Sable Island stock. In recent years pupping has been established on Hay Island, off the Cape Breton coast (Lesage and Hammill 2001).

Surveys of winter breeding colonies in Maine and on Muskeget Island may provide some measure of gray seal population trends and expansion in distribution. Sightings in New England increased during the 1980's as the gray seal population and range expanded in eastern Canada. Five pups were born at Muskeget in 1988. The number of pups increased to 12 in 1992, 30 in 1993, and 59 in 1994 (Rough 1995). In January 2002, 883 pups were counted on Muskeget Island and surrounding shoals (Wood Lafond 2009). In recent years NMFS monitoring surveys have detected an occasional mother/pup (white coats) pair on both Monomoy Island and Nomans Land. These observations continue the increasing trend in pup production reported by Rough (1995). The change in gray seal counts from southeastern Massachusetts (i.e., Monomoy, Muskeget and adjacent tidal bars) from 5,611 in spring 1999 to 15,756 in spring 2011 represents an annual increase of 8.6%, however, it has not been determined what proportion of the increase represents growth or immigration. For example, a few gray seals branded as pups on Sable Island in the 1970s and 2000s (Stobo and Zwanenburg 1990; C. denHeyer, pers. comm.. DFO, Halifax), and satellite tagged adults have been sighted in the Cape Cod region. .

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Recent studies estimated the current annual rate of increase at 7% on Sable Island (Trzcinski *et al.* 2005; Bowen *et al.* 2007), which represents a 45% decline from previous estimates (Mohn and Bowen 1996; Bowen *et al.* 2003). For purposes of this assessment, the maximum net productivity rate was assumed to be 0.12. This value is based on theoretical modeling showing that pinniped populations may not grow at rates much greater than 12% 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 unknown. The maximum productivity rate is 0.12, the default value for pinnipeds. The recovery factor (F_R) for this stock is 1.0, the value for stocks of unknown status, but which are known to be increasing. PBR for the western North Atlantic gray seals in U.S. waters is unknown.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

For the period 2006–2010, the total estimated human caused mortality and serious injury to gray seals was 5,253 per year. The average was derived from five components: 1) 853 (Table 3) from the 2006–2010 U.S. observed fishery; 2) 6 from average 2006–2010 non-fishery related, human interaction stranding mortalities (NMFS unpublished data); 3) 1,079 from average 2006–2010 kill in the Canadian hunt; 4) 23 from DFO scientific collections; and 5) 3,292 removals of nuisance animals in Canada.

Fishery Information

Detailed fishery information is given in Appendix III.

U.S.

Northeast Sink Gillnet

Annual estimates of gray seal bycatch in the Northeast sink gillnet fishery reflect seasonal distribution of the species and of fishing effort. There were 375 gray seal mortalities observed in the Northeast sink gillnet fishery between 1993 and 2010. Estimated annual mortalities (CV in parentheses) from this fishery were 0 in 1990-1992, 18 in 1993 (1.00), 19 in 1994 (0.95), 117 in 1995 (0.42), 49 in 1996 (0.49), 131 in 1997 (0.50), 61 in 1998 (0.98), 155 in

1999 (0.51), 193 in 2000 (0.55), 117 in 2001 (0.59), 0 in 2002, 242 (0.47) in 2003, 504 (0.34) in 2004, 574 (0.44) in 2005, 314 (0.22) in 2006, 886 (0.24) in 2007, 618 (0.23) in 2008, 1,063 (0.26) in 2009, and 1155 (0.31) in 2010 (Table 3). There were 2, 9, 14, 8, 14, 6, 8 and 7 unidentified seals observed during 2003-2010, respectively. Since 1997 unidentified seals have not been prorated to a species. This is consistent with the treatment of other unidentified mammals that do not get prorated to a specific species. Average annual estimated fishery-related mortality and serious injury to this stock attributable to this fishery during 2006–2010 was 794 gray seals (CV=0.13) (Table 3). The stratification design used is the same as that for harbor porpoise (Bravington and Bisack 1996).

Mid-Atlantic Gillnet

Gray seal interactions were observed in this fishery in 2010, when nine gray seal and 2 unidentified seal mortalities were observed. Average annual estimated fishery-related mortality and serious injury to this stock attributable to this fishery during 2010 was 53 (CV=0.76).

Mid-Atlantic Mid-Water Trawl

One gray seal mortality was observed in 2010 in this fishery. An expanded bycatch estimate has not been generated. Until this bycatch estimate can be developed, the average annual fishery-related mortality and serious injury for 2006–2010 is calculated as 0.2 animal (1 animal /5 years).

Gulf of Maine Atlantic Herring Purse Seine Fishery

The Gulf of Maine Atlantic Herring Purse Seine Fishery is a Category III fishery. This fishery was not observed until 2003, and was not observed in 2006. No mortalities have been observed, but 15 gray seals were captured and released alive in 2004, 19 in 2005, 0 in 2007, 6 in 2008, 0 in 2009, and 4 in 2010. In addition, 5 seals of unknown species were captured and released alive in 2004, 2 in 2005, 1 in 2007 and none in 2008-2010.

Northeast Bottom Trawl

Vessels in the North Atlantic bottom trawl fishery, a Category III fishery under MMPA, were observed in order to meet fishery management, rather than marine mammal management needs. No mortalities were observed prior to 2005, when four mortalities were attributed to this fishery. No mortalities were observed in 2006. The estimated annual fishery-related mortality and serious injury attributable to this fishery was 0 between 2001 and 2004, and for 2006. Nine gray seal mortalities were attributed to this fishery in 2007, 4 in 2008, 8 in 2009, and 9 in 2010. Estimates have not been generated. Until this bycatch estimate can be developed, the average annual fishery-related mortality and serious injury for 2006–2010 is calculated as 6 animals (30 animals/5 years).

CANADA

An unknown number of gray seals have been taken in Newfoundland and Labrador, Gulf of St. Lawrence, and Bay of Fundy groundfish gillnets, Atlantic Canada and Greenland salmon gillnets, Atlantic Canada cod traps, and in Bay of Fundy herring weirs (Read 1994). In addition to incidental catches, some mortalities (e.g., seals trapped in herring weirs) were the result of direct shooting, and there were culls of about 1,700 animals annually during the 1970s and early 1980s on Sable Island (Anonymous 1986).

In 1996, observers recorded 3 gray seals (1 released alive) in Spanish deep-water trawl fishing on the southern edge of the Grand Banks (NAFO Areas 3) (Lens 1997). Seal bycatch occurred year-round, but interactions were highest during April-June. Many of the seals that died during fishing activities were unidentified. The proportion of sets with mortality (all seals) was 2.7 per 1,000 hauls (0.003).

Table 3. Summary of the incidental mortality of gray seal (*Halichoerus grypus grypus*) 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

Northeast Sink Gillnet[c]	06-10	Obs. Data, Weighout, Logbooks	.04, .07, .05. 04, .17	9, 80, 31, 52, 107	248, 886, 618, 1063, 1155	.47, .24, .23, .26, .31	794 (0.13)
Mid-Atlantic Gillnet	06-10	Obs. Data, Trip Logbook, Allocated Dealer Data	.03, .04, .03, .03, .04	0, 0, 0, 0, 9	0, 0, 0, 0, 265	0, 0, 0, 0, .76	53 (.76)
Northeast Bottom Trawl	06-10	Obs. Data, Weighout	.06, .06, .08, .09, .16	0, 9, 4, 8, 9	0, unk[d], unk[d], unk[d], unk[d]	0, unk[d], unk[d], unk[d], unk[d]	6 (na)[d]
Mid-Atlantic Mid-water Trawl - Including Pair Trawl	06-10	Obs. Data Weighout Trip Logbook	.089, .039, .13, .13, .25	0, 0, 0, 0, 1	0, 0, 0, 0,na	0, 0, 0, 0, unk[d]	0.2 (na)[d]
TOTAL							853 (0.13)

a. Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Observer Program. The Northeast Fisheries Observer Program collects landings data (Weighout), and total landings are used as a measure of total effort for the sink gillnet fishery. Mandatory logbook (Logbook) data are used to determine the spatial distribution of fishing effort in the Northeast multispecies sink gillnet fishery.

b. The observer coverages for the Northeast sink gillnet fishery and the mid-Atlantic gillnet fisheries are ratios based on tons of fish landed. . North Atlantic bottom trawl mid-Atlantic bottom trawl, and mid-Atlantic mid-water trawl fishery coverages are ratios based on trips. Total observer coverage reported for bottom trawl gear and gillnet gear in the year 2010 includes samples collected from traditional fisheries observers in addition to fishery monitors through the Northeast Fisheries Observer Program (NEFOP). In the Northeast region 437 and 658 bottom trawl trips were sampled by observers and monitors, respectively. In the mid-Atlantic region, 661 and 75 bottom trawl trips were sampled by observers and monitors, respectively,

c. Since 1998, takes from pingered and non-pingered nets within a marine mammal time/area closure that required pingers, and takes from pingered and non-pingered nets not within a marine mammal time/area closure were pooled. The pooled bycatch rate was weighted by the total number of samples taken from the stratum and used to estimate the mortality. In 2006- 2010, respectively, 1, 8, 4, 13, and 17 takes were observed in nets with pingers. In 2006 -2010, respectively, 8, 72, 27, 39, and 90 takes were observed in nets without pingers.

d. Analysis of bycatch mortality attributed to the Northeast bottom trawl fishery and midwater trawl fishery has not been generated. Unexpanded values are provisionally provided.

Other Mortality

Canada: In Canada, gray seals were hunted for several centuries by indigenous people and European settlers in the Gulf of St. Lawrence and along the Nova Scotia eastern shore, and were locally extirpated (Laviguer and Hammill 1993). Between 1999 and 2010 the annual kill of gray seals by hunters in Canada was: 1999 (98), 2000 (342), 2001 (76), 2002 (126), 2003 (6), 2004 (0), 2005 (1073), 2006 (1,857) 2007 (1747), 2008 (1,471), 2009 (263), and 2010 (58). (DFO 2003; 2008; 2009; 2011b M. Hammill pers. comm.). The traditional hunt of a few hundred animals is expected to continue off the Magdalen Islands and in other areas, except Sable Island where commercial hunting is not permitted (DFO 2003). DFO established a total allowable catch (TAC) of 12,000 gray seals for 2007 and 2008: 2,000 in the Gulf and 10,000 on the Scotian Shelf. The TAC for 2009 and 2010 was 50,000 seals. Since 2007, a small commercial hunt has taken place on Hay Island in Nova Scotia (http://www.dfo-mpo.gc.ca/fm-gp/seal-phoque/faq-eng.htm). The Hay Island TAC for 2010 was 2,220 (DFO 2011c). The hunting of gray seals will continue to be prohibited on Sable Island (http://www.dfo-mpo.gc.ca/seal-phoque/index_e.htm).

Canada also issues personal hunting licenses which allow the holder to take six gray seals annually (Lesage and

Hammill 2001; DFO 2011b). Hunting is not permitted during the breeding season and some additional seasonal/spatial restrictions are in effect (Lesage and Hammill 2001). Further, between 2005 and 2010 the lethal removal of nuisance seals was: 2005 (3105), 2006 (3437), 2007 (3373), 2008 (3334), 2009 (3381, and 2010 (2933) (DFO 2011b).

U.S: Gray seals, like harbor seals, were hunted for bounty in New England waters until the late 1960s (Katona *et al.* 1993; Lelli *et al*. 2009). This hunt may have severely depleted this stock in U.S. waters (Rough 1995; Lelli *et al*. 2009). Other sources of mortality include human interactions, storms, abandonment by the mother, disease, and predation. Mortalities caused by human interactions include boat strikes, fishing gear interactions, power plant entrainment, oil spill/exposure, harassment, and shooting. The Cape Cod stranding network has documented gray seals entangled in netting or plastic debris around the Cape Cod/Nantucket area, and in recent years have made successful disentanglement attempts.

From 2006 to 2010, 375 gray seal stranding mortalities were recorded, extending from Maine to North Carolina (Table 4; NMFS unpublished data). Most stranding mortalities were in Massachusetts, which is the center of gray seal abundance in U.S. waters. Sixty (16.0%) of the total stranding mortalities showed signs of human interaction (5 in 2006, 8 in 2007, 21 in 2008, 14 in 2009, and 12 in 2010), with 30 having some indication of fishery interaction (5 in 2006, 5 in 2007, 7 in 2008, 9 in 2009, and 4 in 2010). Four gray seals are recorded in the NE stranding database during the 2006 to 2010 period as having been shot–one in Maine in 2009 and one in Maine and two in Massachusetts in 2010.

Table 4. Gray seal (*Halichoerus grypus grypus*) stranding mortalities [a] along the U.S. Atlantic coast (2006–2010) with subtotals of animals recorded as pups in parentheses.

State	2006	2007	2008	2009	2010	Total
ME	3	5 (1)	6 (1)	3	8 (4)	25
NH	0	1 (1)	0	1 (1)	0	2
MA	29 (5)	50 (9)	53 (4)	52 (7)	43 (5)	227
RI	2 (2)	5 (1)	7	10 (2)	8 (3)	32
CT	0	0	0	1(1)	0	1
NY	6 (4)	21 (17)	2 (2)	16 (7)	10 (7)	55
NJ	1 (1)	5 (2)	3	4	4 (1)	17
DE	0	0	1 (1)	0	0	1
MD	0	1	1	1	1	4
VA	0	1	1	2	1	5
NC	2	1 (1)	1 (1)	1 (1)	1	6
Total	43 (12)	90 (32)	75 (9)	91 (19)	76 (20)	375
Unspecified seals (all states)	46	34	51	34	22	187

a. Mortalities include those which stranded dead, died at site, were euthanized, died during transport, or died soon after transfer to rehab.

STATUS OF STOCK

The level of human-caused mortality and serious injury in the U.S. Atlantic EEZ is unknown, but believed to be very low relative to the total stock size; therefore, this is not a strategic stock. The status of the gray seal population relative to OSP in U.S. Atlantic EEZ waters is unknown, but the stock's abundance appears to be increasing in Canadian and U.S. waters. The species is not listed as threatened or endangered under the Endangered Species Act. The total U.S. fishery-related mortality and serious injury for this stock is low relative to the stock size in Canadian and U.S. waters and can be considered insignificant and approaching zero mortality and serious injury rate.

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