FIN WHALE (*Balaenoptera physalus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The Scientific Committee of the International Whaling Commission (IWC) has proposed stock boundaries for North Atlantic fin whales. Fin whales off the eastern United States, Nova Scotia, and the southeastern coast of Newfoundland are believed to constitute a single stock under the present IWC scheme (Donovan 1991). Although the stock identity of North Atlantic fin whales has received much recent attention from the IWC, current understanding of stock boundaries remains uncertain. The existence of a subpopulation structure was suggested by local depletions that resulted from commercial overharvesting (Mizroch *et al.* 1984).

A genetic study conducted by Bérubé *et al.* (1998) using both mitochondrial and nuclear DNA provided strong support for an earlier population model proposed by Kellogg (1929) and others. This postulates the existence of several subpopulations of fin whales in the North Atlantic and Mediterranean with limited gene flow among them. Bérubé *et al.* (1998) also proposed that the North Atlantic population showed recent divergence due to climatic changes (i.e., postglacial expansion), as well as substructuring over even relatively short distances. The genetic data are consistent with the idea that different subpopulations use the same feeding ground, a hypothesis that was also originally proposed by Kellogg (1929). More recent genetic studies have called into question conclusions drawn from early allozyme work (Olsen *et al.* 2014) and North Atlantic fin whales show a very low rate of genetic diversity throughout their range excluding the Mediterranean (Pampoulie *et al*. 2008).

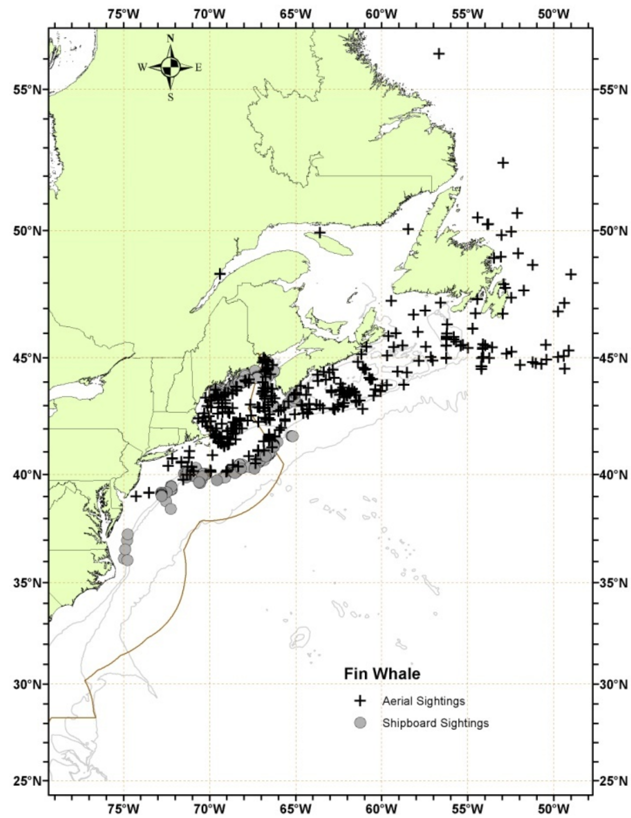

Figure 1. Distribution of fin whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1995, 1998, 1999, 2002, 2004, 2006, 2007, 2008, 2010 and 2011 and DFO's 2007 TNASS survey. Isobaths are the 100-m, 100-m and 4000-m depth contours.

Fin whales are common in waters of the U. S. Atlantic Exclusive Economic Zone (EEZ), principally from Cape Hatteras northward (Figure 1). In a recent globally-scaled review of sightings data, Edwards *et al.* (2015) found evidence to confirm the presence of fin whales in every season throughout much of the U.S. EEZ north of 35º; however, densities vary seasonally. Fin whales accounted for 46% of the large whales and 24% of all cetaceans sighted over the continental shelf during aerial surveys (CETAP 1982) between Cape Hatteras and Nova Scotia during 1978–1982. While much remains unknown, the magnitude of the ecological role of the fin whale is impressive. In this region fin whales are the dominant large cetacean species during all seasons, having the largest standing stock, the largest food requirements, and therefore the largest influence on ecosystem processes of any cetacean species (Hain *et al.* 1992; Kenney *et al.* 1997). Acoustic detections of fin whale singers augment and confirm these visual sighting conclusions for males. Recordings from Massachusetts Bay, New York bight, and deep-ocean areas detected some level of fin whale singing from September through June (Watkins et al. 1987, Clark and Gagnon 2002, Morano et al. 2012). These acoustic observations from both coastal and deep-ocean regions support the conclusion that male fin whales are broadly distributed throughout the western North Atlantic for most of the year.

New England waters represent a major feeding ground for fin whales. There is evidence of site fidelity by females, and perhaps some segregation by sexual, maturational, or reproductive class in the feeding area (Agler *et al.* 1993). Hain *et al.* (1992) showed that fin whales measured photogrammetrically off the northeastern U.S., after deleting all individuals smaller than 14.6 m (the smallest whale taken in Iceland) were significantly smaller (mean length=16.8 m; P<0.001) than fin whales taken in Icelandic whaling (mean=18.3 m). Seipt *et al.* (1990) reported that 49% of identified fin whales sighted on the Massachusetts Bay area feeding grounds were resighted within the same year, and 45% were resighted in multiple years. The authors suggested that fin whales on these grounds exhibited patterns of seasonal occurrence and annual return that in some respects were similar to those shown for humpback whales. This was reinforced by Clapham and Seipt (1991), who showed maternally-directed site fidelity for fin whales in the Gulf of Maine. Despite the suggested similarity in patterns of seasonal occurrence with humpback whales, the U.S. currently recognizes one stock of fin whales in the western North Atlantic.

Hain *et al.* (1992), based on an analysis of neonate stranding data, suggested that calving takes place during October to January in latitudes of the U.S. mid-Atlantic region; however, it is unknown where calving, mating, and wintering occur for most of the population. Results from the Navy's SOSUS program (Clark 1995; Clark and Gagnon 2002) indicated a substantial deep-ocean distribution of fin whales. It is likely that fin whales occurring in the U.S. Atlantic EEZ undergo migrations into Canadian waters, open-ocean areas, and perhaps even subtropical or tropical regions (Edwards *et al.* 2015). However, the popular notion that entire fin whale populations make distinct annual migrations like some other mysticetes has questionable support in the data; in the North Pacific, year-round monitoring of fin whale calls found no evidence for large-scale migratory movements (Watkins *et al.* 2000).

POPULATION SIZE

The best abundance estimate available for the western North Atlantic fin whale stock is 1,618 (CV=0.33). This is the estimate derived from the 2011 NOAA shipboard and aerial surveys and is considered best because it represents the only current data in spite of the survey not including all of the stock's range.

A key uncertainty in the current abundance estimate is the number of animals in Canadian waters. The northern part of the stock's range was not surveyed in the 2011 shipboard survey (Palka 2012). This new abundance estimate largely represents only the U.S. portion of this stock, and a small portion in Canadian waters. Additionally, the current abundance estimate does not account for availability bias due to submerged animals. Without a correction for this bias, the abundance estimate is likely biased low. Finally, since the most current estimate dates from a survey done in 2011, the ability for that estimate to accurately represent the present population size has become increasingly uncertain.

Earlier abundance estimates

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

Recent surveys and abundance estimates

An abundance estimate of 1,595 (CV=0.33) fin whales was generated from a shipboard and aerial survey conducted during June–August 2011 (Palka 2012). The aerial portion that contributed to the abundance estimate covered 5,313 km of tracklines that were over waters north of New Jersey from the coastline to the 100-m depth contour, through the U.S. and Canadian Gulf of Maine and up to and including the lower Bay of Fundy. The shipboard portion covered 3,107 km of tracklines that were in waters offshore of North Carolina to Massachusetts (waters that were deeper than the 100-m depth contour out to beyond the U.S. EEZ). Both sighting platforms used a double-platform data collection procedure, which allows estimation of abundance corrected for perception bias of the detected species (Laake and Borchers 2004). Estimation of the abundance was based on the independent observer approach assuming point independence (Laake and Borchers 2004) and calculated using the multiple-covariate distance sampling (MCDS) option in the computer program Distance (version 6.0, release 2, Thomas *et al.* 2009).The abundance estimates of fin whales include a percentage of the estimate of animals identified as fin/sei whales (the two species being sometimes hard to distinguish).The percentage used is the ratio of positively identified fin whales to the total number of positively identified fin whales and positively identified sei whales; the CV of the abundance estimate includes the variance of the estimated fraction.

An abundance estimate of 23 (CV=0.87) fin whales was generated from a shipboard survey conducted concurrently (June–August 2011) in waters between central Virginia and central Florida. This shipboard survey included shelf-break and inner continental slope waters deeper than the 50-m depth contour within the U.S. EEZ. The survey employed two independent visual teams searching with 25× bigeye binoculars. A total of 4,445 km of tracklines was surveyed.. Estimation of the abundance was based on the independent observer approach assuming point independence (Laake and Borchers 2004) and calculated using the mark-recapture distance sampling option in the computer program Distance (version 6.0, release 2, Thomas *et al.* 2009).

Table 1. Summary of recent abundance estimates for western North Atlantic fin whales with month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Jun-Aug 2011	Central Virginia to lower Bay of Fundy	1,595	0.33
Jun-Aug 2011	Central Florida to Central Virginia	23	0.76
Jun-Aug 2011	Central Florida to lower Bay of Fundy (COMBINED)	1,618	0.33

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 fin whales is 1,618 (CV=0.33). The minimum population estimate for the western North Atlantic fin whale is 1,234.

Current Population Trend

A trend analysis has not been conducted for this stock. The statistical power to detect a trend in abundance for this stock is poor due to the relatively imprecise abundance estimates and variable survey design. For example, the power to detect a precipitous decline in abundance (i.e., 50% decrease in 15 years) with estimates of low precision (e.g., CV>0.30) remains below 80% (alpha=0.30) unless surveys are conducted on an annual basis (Taylor *et al.* 2007).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Based on photographically identified fin whales, Agler *et al.* (1993) estimated that the gross annual reproduction rate was 8%, with a mean calving interval of 2.7 years.

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a recovery factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 1,234. The maximum productivity rate is 0.04, the default value for cetaceans. The recovery factor is 0.10 because the fin whale is listed as endangered under the Endangered Species Act (ESA). PBR for the western North Atlantic fin whale is 2.5. Because uncertainties exist in stock definition and because the current N_{min} used to calculate PBR is not derived from the full range of the stock as currently defined, considerable uncertainties exist in this calculated PBR.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

For the period 2011 through 2015, the minimum annual rate of human-caused mortality and serious injury to fin whales was 2.65 per year. This value includes incidental fishery interaction records, 1.05 (0.2 U.S./0.85 unknown but first reported in U.S. waters); and records of vessel collisions, 1.6 (all U.S.) (Table 2; Henry *et al.* 2017). Human-caused serious injury and mortality records from Canadian waters are reported in Table 2b but not included in the summary calculation as they occurred outside the area covered by the abundance estimate. Annual rates calculated from detected mortalities should not be considered an unbiased representation of human-caused mortality, but they represent a definitive lower bound. Detections are haphazard and not the result of a designed sampling scheme. As such they represent a minimum estimate of human-caused mortality which is almost certainly biased low. The size of this bias is uncertain.

Fishery-Related Serious Injury and Mortality

US

No confirmed fishery-related mortalities or serious injuries of fin whales have been reported in the NMFS Sea Sampling bycatch database. A review of the records of stranded, floating, or injured fin whales for the period 2011 through 2015 on file at NMFS found 2 records with substantial evidence of fishery interactions causing mortality (Table 2a; Henry *et al.* 2017). Serious injury determinations from non-fatal fishery interaction records yielded a value of 3.25 over five years, for an annual average of 0.65 (Table 2a; Henry *et al.* 2017). The resultant estimated minimum annual rate of serious injury and mortality from fishery interactions for this fin whale stock is 1.05. These records are not statistically quantifiable in the same way as the observer fishery records, and they almost surely undercount entanglements for the stock.

CANADA

The audited Greater Atlantic Regional Office/NMFS entanglement/stranding database also contains records of fin whales first reported in Canadian waters or attributed to Canada, of which the confirmed mortalities and serious injuries from the last five years are reported in Table 2b. Two records with substantial evidence of fishery interactions causing mortality and 2 that were classified as serious injuries were reported for the 2011–2015 period, resulting in a 5-year annual average of 0.8 animals. All of these interactions occurred (or were discovered in) waters outside the area covered by the abundance estimate, and so were not included in the totals.

Table 2a. Confirmed human-caused mortality and serious injury records of fin whales (*Balaenoptera physalus*) first reported in U.S. waters or attributed to U.S. where the cause was assigned as either an entanglement (EN) or a vessel strike (VS): 2011–2015[a]

Date[b]	Injury Determination	ID	Location[b]	Assigned Cause	Value against PBR[c]	Country[d]	Gear Type[e]	Description
1/1/2011	Mortality	-	off Portland, ME	EN	1	XU	NP	Fresh carcass w/ evidence of constricting gear.
6/5/2011	Mortality	-	off Long Branch, NJ	VS	1	US	-	Extensive hemorrhage & soft tissue damage to the dorsal & right lateral thoracic region.
9/21/2011	Mortality	-	off Atlantic City, NJ	EN	1	US	NP	Fresh carcass w/ evidence of extensive entanglement.

1/23/2012	Mortality	-	Ocean City, NJ	VS	1	US	-	Hemorrhaging along right, midlateral surface.
2/19/2012	Mortality	-	Norfolk, VA	VS	1	US	-	Deep laceration on head. Skeletal fractures of rostrum and vertebrae. Extensive hemorrhaging.
7/16/2012	Prorated Injury	-	off Portland, ME	EN	0.75	XU	NR	Full configuration unknown.
8/10/2012	Mortality	-	Hampton Bays, NY	VS	1	US	-	Extensive bruising along right lateral and ventral aspects.
10/7/2012	Mortality	-	Boston Harbor, MA	VS	1	US	-	Deep mid-line impression with associated hemorrhaging consistent with being folded across bow of ship.
1/13/2013	Mortality	-	East Hampton, NJ	VS	1	US	-	Fracturing of left cranium with associated hematoma
4/12/2014	Mortality	-	Port Elizabeth, NJ	VS	1	US	-	Fresh carcass on bow of vessel. Large external abrasions w/ associated hemorrhage and skeletal fractures along right side.
23-Jun-14	Prorated Injury		off Chatham, MA	EN	0.75	XU	NR	Free-swimming, trailing 200ft of line. Attachment point(s) unknown. No resights.

20-Aug-14	Prorated Injury		off Provincetown, MA	EN	0.75	XU	NR	Free-swimming, trailing buoy & 200ft of line aft of flukes. Attachment point(s) unknown. No resights.
10/5/2014	Mortality	-	off Manasquan, NJ	VS	1	US	-	Large area of hemorrhage along dorsal, ventral, and right lateral surfaces consistent with blunt force trauma.
06/06/2015	Serious Injury		off Bar Harbor, ME	EN	1	XU	NR	Free-swimming with 2 buoys and 80 ft of line trailing from fluke. Line cutting deeply into right fluke blade. Emaciated. No resights.
Five-year averages		Shipstrike (US/ XU)		1.6 (1.6/ 0.0)				
		Entanglement (US/ XU)		1.05 (0.2/ 0.85)				

a. For more details on events please see Henry *et al.* 2017.

b. The date sighted and location provided in the table are not necessarily when or where the serious injury or mortality occurred; rather, this information indicates when and where the whale was first reported beached, entangled, or injured.

c. Mortality events are counted as 1 against PBR. Serious injury events have been evaluated using NMFS guidelines (NOAA 2012)

d. US=United States, XU=Unassigned 1st sight in U.S.

e. H=hook, GN=gillnet, GU=gear unidentifiable, MF=monofilament, NP=none present, NR=none recovered/received, PT=pot/trap, WE=weir

Table 2b. Confirmed human-caused mortality and serious injury records of fin whales (*Balaenoptera physalus*) first reported in Canadian waters or attributed to Canada where the cause was assigned as either an entanglement (EN) or a vessel strike (VS): 2011–2015[a]

Date[b]	Injury Determination	ID	Location[b]	Assigned Cause	Value against PBR[c]	Country[d]	Gear Type[e]	Description
7/2/2011	Serious Injury	F100	Gulf of St. Lawrence	EN	1	CN	PT	Deep lacerations at peduncle. Unconfirmed if gear free.
7/24/2011	Mortality	-	Cheticamp, Nova Scotia	EN	1	CN	NP	Fresh carcass w/ evidence of extensive entanglement.
6/6/2013	Serious Injury	Capitaine Crochet	St. Lawrence Marine Park, Quebec	EN	1	CN	PT	Pot resting on upper jaw w/ bridle lines embedding in mouth; health decline: emaciation
5/13/2014	Mortality	-	Rocky Harbour, NL	EN	1	CN	PT	Fresh carcass hog-tied in gear.
Five-year averages		Shipstrike (CN/XC)			0			
		Entanglement (CN/XC)			0.8 (0.8/ 0.0)			

a. For more details on events please see Henry *et al.* 2017.

b. The date sighted and location provided in the table are not necessarily when or where the serious injury or mortality occurred; rather, this information indicates when and where the whale was first reported beached, entangled, or injured.

c. Mortality events are counted as 1 against PBR. Serious injury events have been evaluated using NMFS guidelines (NOAA 2012)

d. CN=Canada, XC=Unassigned 1st sight in CN

e. H=hook, GN=gillnet, GU=gear unidentifiable, MF=monofilament, NP=none present, NR=none recovered/received, PT=pot/trap, WE=weir

Other Mortality

After reviewing NMFS records for 2011 through 2015, 8 were found that had sufficient information to confirm the cause of death as collisions with vessels (Table 2; Henry *et al.* 2017). These records constitute an annual rate of serious injury or mortality of 1.6 fin whales from vessel collisions in U.S. waters.

STATUS OF STOCK

This is a strategic stock because the fin whale is listed as an endangered species under the ESA. The total level of human-caused mortality and serious injury is unknown. NMFS records represent coverage of only a portion of the area surveyed for the population estimate for the stock. The total U.S. fishery-related mortality and serious injury for this stock derived from the available records is likely biased low and is not less than 10% of the calculated PBR. Therefore, entanglement rates cannot be considered insignificant and approaching a zero mortality and serious injury rate. The status of this stock relative to OSP in the U.S. Atlantic EEZ is unknown. There are insufficient data to determine the population trend for fin whales. Because the fin whale is ESA-listed, uncertainties with regard to the negatively biased estimates of human-caused mortality and the incomplete survey coverage relative to the stock's defined range would not change the status of the stock.

REFERENCES CITED

Agler, B.A., R.L. Schooley, S.E. Frohock, S.K. Katona and I.E. Seipt. 1993. Reproduction of photographically identified fin whales, *Balaenoptera physalus*, from the Gulf of Maine. J. Mamm. 73:577–587.

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.

Bérubé, M., A. Aguilar, D. Dendanto, F. Larsen, G.N.di Sciara, R. Sears, J. Sigurjónsson, J. Urban-R. and P.J. Palsbøll. 1998. Population genetic structure of North Atlantic, Mediterranean and Sea of Cortez fin whales, *Balaenoptera physalus* (Linnaeus 1758): analysis of mitochondrial and nuclear loci. Mol. Ecol. 15:585–599.

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

Clapham, P.J. and I.E. Seipt. 1991. Resightings of independent fin whales, *Balaenoptera physalus*, on maternal summer ranges. J. Mamm. 72:788–790.

Clark, C.W. 1995. Application of U.S. Navy underwater hydrophone arrays for scientific research on whales. Rep. Int. Whal. Comm. 45:210–212.

Clark, C.W., and Gagnon, G.C. 2002. Low-frequency vocal behaviors of baleen whales in the North Atlantic: Insights from IUSS detections, locations and tracking from 1992 to 1996. J. Underwater Acoust. (USN), 52 (3):609-640.

Donovan, G.P. 1991. A review of IWC stock boundaries. Rep. Int. Whal. Comm. (Special Issue) 13:39–68.

Edwards, E.F., C. Hall, T.J. Moore, C. Sheredy and J. Redfern. 2015. Global distribution of fin whales (*Balaenoptera physalus*) in the post-whaling era (1980 to 2012). Mammal Rev. 45:197–214

Hain, J.H.W., M.J. Ratnaswamy, R.D. Kenney and H.E. Winn. 1992. The fin whale, *Balaenoptera physalus*, in waters of the northeastern United States continental shelf. Rep. Int. Whal. Comm. 42:653–669.

Henry, A.G., T.V.N. Cole, M. Garron, W. Ledwell, D. Morin and A. Reid. 2017. Mortality and serious injury determinations for baleen whale stocks along the Gulf of Mexico, United States East Coast and Atlantic Canadian Provinces, 2011-2015. Northeast Fish. Sci. Cent. Ref. Doc. 17-19, 57 pp.

Kellogg, R. 1929. What is known of the migration of some of the whalebone whales. Ann. Rep. Smithsonian Inst. 1928:467–494.

Kenney, R.D., G.P. Scott, T.J. Thompson and H.E. Winn. 1997. Estimates of prey consumption and trophic impacts of cetaceans in the USA northeast continental shelf ecosystem. J. Northwest Atl. Fish. Sci. 22:155–171.

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

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

Lawson, J.W., and J.-F. Gosselin. 2009. 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. 2009/031. 33 pp.

Lawson, J.W., and J.-F. Gosselin 2011. Fully-corrected cetacean abundance estimates from the Canadian TNASS survey. Working Paper 10. National Marine Mammal Peer Review Meeting. Ottawa, Canada. 28 pp.

Mizroch, S.A., D.W. Rice and J.M. Breiwick. 1984. The fin whale, *Balaenoptera physalus*. Mar. Fish. Rev. 46:20–24.

Morano, J.L., D.P. Salisbury, A.N. Rice, K.L. Conklin, K.L. Falk and C.W. Clark. 2012. Seasonal changes in fin whale (*Balaenoptera physalus*) 20-Hz song in the Western North Atlantic Ocean. J. Acoust. Soc. Am. 132:1207–1212.

Olsen, M. T., C. Pampoulie, A.K. Daníelsdóttir, E. Lidh, M. Bérubé, G.A. Víkingsson, and P.J. Palsbøll. 2014. Fin whale MDH-1 and MPI allozyme variation is not reflected in the corresponding DNA sequences. Ecol. Evol. 4:1787–1803. doi: 10.1002/ece3.1046

NMFS 2016. Guidelines for preparing stock assessment reports pursuant to the 1994 amendments to the MMPA. NMFS Instruction 02-204-01. 24 pp.

Palka, D.L. 2012. Cetacean abundance estimates in US northwestern Atlantic Ocean waters from summer 2011 line transect survey. Northeast Fish. Sci. Cent. Ref. Doc. 12-29. 37 pp. http://www.nefsc.noaa.gov/nefsc/publications/crd/crd1229/

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.

Pampoulie, C., A. Danielsdottir, M. Berube, P. Palsbøll, A. Arnarson, T. Gunnlaugsson, D. Olafsdottir, N. Øien, L. Witting and G. Vikingsson. 2008. Lack of genetic divergence among samples of the north Atlantic fin whale collected at feeding grounds; congruence among microsatellite loci and mtDNA in the new Icelandic dataset. Unpublished Scientific Committee meeting document SC/60/PFI11. International Whaling Commission, Cambridge, UK.

Seipt, I.E., P.J. Clapham, C.A. Mayo and M.P. Hawvermale. 1990. Population characteristics of individually identified fin whales *Balaenoptera physalus* in Massachusetts Bay. Fish. Bull. 88:271–278.

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

Thomas L, J.L. Laake, E. Rexstad, S. Strindberg, F.F.C. Marques, S.T. Buckland, D.L. Borchers, D.R. Anderson, K.P. Burnham, M.L. Burt, S.L. Hedley, J.H. Pollard, J.R.B. Bishop and T.A. Marques. 2009. Distance 6.0. Release 2. [Internet]. University of St. Andrews, Research Unit for Wildlife Population Assessment, St. Andrews, UK. Available from: http://www.ruwpa.st-and.ac.uk/distance/

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

Watkins, W.A., P. Tyack,K.E. Moore and J.E. Bird. 1987. The 20-Hz signals of finback whales (*Balaenoptera physalus*). J. Acoust. Soc. Am. 82:1901–1912.

Watkins, W.A., M.A. Daher, G.M. Reppucci, J.E. George, D.L. Martin, N.A. DiMarzio and D.P. Gannon. 2000. Seasonality and distribution of whale calls in the North Pacific. Oceanography 13:62–67.