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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Fin whales have a global distribution, with populations found from temperate to polar regions in all ocean basins (Edwards et al. 2015). Within the Northern Hemisphere, populations in the North Pacific and North Atlantic oceans can be considered at least different subspecies, if not different species (Archer et al. 2019). The Scientific Committee of the International Whaling Commission (IWC) has proposed stock boundaries for North Atlantic fin whales. Off the eastern United States, Nova Scotia, and the southeastern coast of Newfoundland, fin whales 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, 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).

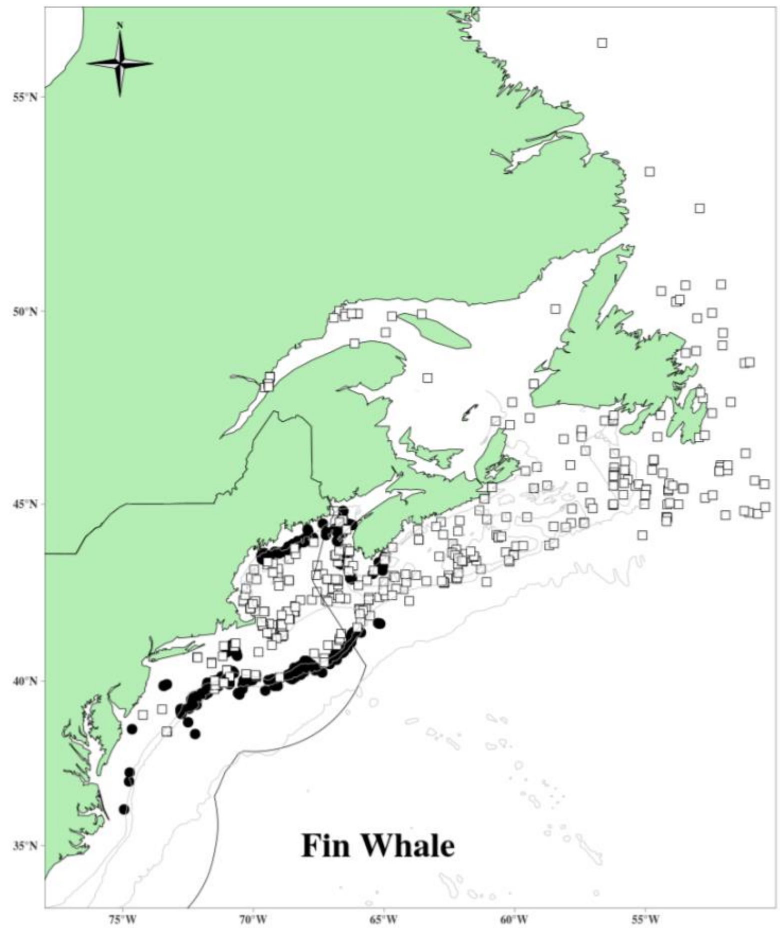

Figure 1. Distribution of fin whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1995, 1998, 1999, 2002, 2004, 2006, 2007, 2008, 2010, 2011, 2016, and 2021 and DFO's 2007 TNASS and 2016 NAISS surveys. Isobaths are the 100-m, 1,000-m and 4000-m depth contours. Circle symbols represent shipboard sightings and squares are aerial sightings.

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). North Atlantic fin whales show a very low rate of genetic diversity throughout their range excluding the Mediterranean (Pampoulie et al. 2008).

Fin whales are common in waters of the U.S. Atlantic Exclusive Economic Zone (EEZ), principally from Cape Hatteras northward (Figure 1). In a 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 30º N; 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 between Cape Hatteras and Nova Scotia during 1978–1982 (CETAP 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 the Atlantic Continental Shelf, and deep-ocean areas detected some level of fin whale singing year round (Watkins et al. 1987; Clark and Gagnon 2002; Morano et al. 2012; Davis et al 2020). 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 and Gulf of St. Lawrence waters represent major feeding grounds 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; Schleimer et al. 2019). 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. Based on an analysis of neonate stranding data, Hain et al. (1992) 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; Silve et al. 2019). 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 available current abundance estimate for fin whales in the North Atlantic stock is 6,802 (CV=0.24), the sum of the 2016 NOAA shipboard and aerial surveys and the 2016 NEFSC and Department of Fisheries and Oceans Canada (DFO) surveys ("Florida to Newfoundland/Labrador (COMBINED)" in Table 1). Because the survey areas did not overlap, the estimates from the two surveys were added together and the CVs pooled using a delta method to produce a species abundance estimate for the stock area. Estimates generated from the 2021 surveys are more recent and focus on U.S. waters, although more of the stock range was covered in the 2016 survey.

Earlier Abundance Estimates

Please see Appendix IV for earlier abundance estimates.

Recent Surveys and Abundance Estimates

An abundance estimate for western North Atlantic fin whales was generated from vessel surveys conducted in U.S. waters of the western North Atlantic during the summer of 2016 (Table 1; Garrison 2020; Palka 2020). One survey was conducted from 27 June to 25 August in waters north of 38ºN latitude and consisted of 5,354 km of on-effort trackline along the shelf break and offshore to the outer limit of the U.S. EEZ (NEFSC and SEFSC 2018). The second vessel survey covered waters from Central Florida to approximately 38ºN latitude between the 100-m isobaths and the outer limit of the U.S. EEZ during 30 June–19 August. A total of 4,399 km of trackline was covered on effort (NEFSC and SEFSC 2018). Both surveys utilized two visual teams and an independent observer approach to estimate detection probability on the trackline (Laake and Borchers 2004). Mark-recapture distance sampling was used to estimate abundance.

DFO generated fin whale estimates from a large-scale aerial survey of Atlantic Canadian shelf and shelf break habitats extending from the northern tip of Labrador to the U.S. border off southern Nova Scotia in August and September of 2016 (Table 1; Lawson and Gosselin 2018). A total of 29,123 km of effort was flown over the Gulf of St. Lawrence/Bay of Fundy/Scotian Shelf stratum and 21,037 over the Newfoundland/Labrador stratum. The Bay of Fundy/Scotian shelf portion of the fin whale population was estimated at 2,235 (CV=0.41) and the Newfoundland/Labrador portion at 2,177 (CV=0.47). The Newfoundland estimate was derived from Twin Otter data using two-team mark-recapture multi-covariate distance sampling methods. The Gulf of St. Lawrence estimate was derived from the Skymaster data using single team multi-covariate distance sampling with left truncation (to accommodate the obscured area under the plane) where size-bias was also investigated, and the Otter-based perception bias correction was applied. An availability bias correction factor, which was based on the cetaceans' surface intervals, was applied to both abundance estimates.

An abundance estimate of 2,240 (CV=0.39) fin whales was generated from vessel surveys conducted in U.S. waters of the western North Atlantic during the summer of 2021 (Table 1; Garrison and Dias 2023; Palka 2023). One survey was conducted from 16 June to 23 August in waters north of 36ºN latitude and consisted of 5,871 km of on-effort trackline along the shelf break and offshore to the outer edge of the U.S. EEZ (NEFSC and SEFSC 2022). The second vessel survey covered waters from central Florida (25ºN latitude) to approximately 38ºN latitude between the 200-m isobaths and the outer edge of the U.S. EEZ during 12 June–31 August. A total of 5,659 km of trackline was covered on effort (NEFSC and SEFSC 2022). Both surveys utilized two visual teams and an independent observer approach to estimate detection probability on the trackline (Laake and Borchers 2004). Mark-recapture distance sampling was used to estimate abundance. No fin whales were seen in the SE portion of the survey.

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_{est}) and coefficient of variation (CV). The estimate considered best is in bold font.

Month/Year	Area	N_{est}	CV
Jun−Sep 2016	Florida to lower Bay of Fundy	2,390	0.40
Aug−Sep 2016	Bay of Fundy/Scotian Shelf	2,235	0.413
Aug−Sep 2016	Newfoundland/Labrador	2,177	0.465
Jun−Sep 2016	**Florida to Newfoundland/Labrador (COMBINED)**	**6,802**	**0.24**
Jun–Aug 2021	New Jersey to lower Bay of Fundy	2,240	0.39
Jun–Aug 2021	Central Florida to New Jersey	0	-
Jun–Aug 2021	Central Florida to lower Bay of Fundy (COMBINED)	2,240	0.39

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 6,802 (CV=0.24). The minimum population estimate for the western North Atlantic fin whale is 5,573 (Table 2).

Current Population Trend

A trend analysis has not been conducted for the fullstock. 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). There is current work to standardize the stratum-specific previous abundance estimates to consistently represent the same regions and include appropriate corrections for perception and availability bias. These standardized abundance estimates will be used in state-space trend models that incorporate environmental factors that could potentially influence the process and observational errors for each stratum.

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 5,573. 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 11.

Table 2. Best and minimum abundance estimates for the western North Atlantic fin whale (*Balaenoptera physalus*) with Maximum Productivity Rate (R_{max}), Recovery Factor (F_r) and PBR.

N_{est}	CV	N_{min}	F_r	R_{max}	PBR
6,802	0.24	5,573	0.1	4	11

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

For the period 2017 through 2021, the annual detected (i.e., observed) human-caused mortality and serious injury to fin whales averaged 2.05 individuals per year (Table 3). This is derived from two components: 1) incidental fishery entanglement records at 1.45 per year and 2) vessel strike records averaging 0.60 per year.

Injury determinations are made based upon the best available information; these determinations may change with the availability of new information (Henry et al. 2023). Only records considered to be confirmed human-caused mortalities or serious injuries are reported in the observed mortality and serious injury (M/SI) rows of Table 4.

Table 3. The total annual observed average human-caused mortality and serious injury for the western North Atlantic fin whale (*Balaenoptera physalus*).

Years	Source	Annual Avg.
2017−2021	Fishery entanglements	1.45
2017−2021	Vessel strikes	0.60
TOTAL		2.05

Fishery-Related Serious Injury and Mortality

United States

U.S. fishery interaction records for large whales are sourced from dedicated fishery observer data, and opportunistic reports compiled in the Greater Atlantic Regional Fisheries Office (GARFO)/NMFS entanglement/stranding database. No confirmed fishery-related mortalities or serious injuries of fin whales have been reported in the NMFS Sea Sampling bycatch database (fishery observers) during this reporting period. Records of stranded, floating, or injured fin whales for the reporting period with substantial evidence of fishery interactions causing serious injury or mortality are presented in Table 4 (Henry et al. 2023). These records likely underestimate entanglements for the stock.

Canada

Confirmed mortalities and serious injuries from the current reporting period that were likely a result of an interaction with Canadian fisheries are included in Table 4.

Table 4. Confirmed human-caused mortality and serious injury records of fin whales (*Balaenoptera physalus*) attributed to entanglement (EN) or vessel strike (VS): 2017–2021[a].

Date[b]	Fate	ID	Location[b]	Assigned Cause	Value against PBR[c]	Country[d]	Gear Type[e]	Description
30May17	Mortality	-	Port Newark, NJ	VS	1	US	-	Fresh carcass on bow of 656 ft vessel. Speed at strike unknown.

Date[b]	Fate	ID	Location[b]	Assigned Cause	Value against PBR[c]	Country[d]	Gear Type[e]	Description
25Aug17	Mortality	-	off Miscou Island, QC	EN	1	CN	PT	Fisher found fresh carcass when hauling gear. Entangled at 78m depth, 51m from trap. Full configuration unknown, but unlikely to have drifted post-mortem into gear.
22Jun18	Mortality	-	off Gaspe, QC	EN	1	CN	NP	No gear present. Fresh carcass with evidence of constricting entanglement across ventral pleats and peduncle with raw injuries to fluke. Evidence of associated bruising. No necropsy, but COD due to entanglement most parsimonious.
14Oct18	Mortality	Ladders	Cape Cod Bay	VS	1	US	-	Floating carcass with great white shark actively scavenging. Landed on 18 Oct. Necropsied on 19 Oct. Left side not examined due to remote location & no heavy equipment. Additional exam conducted on 30 Oct. Evidence of blunt force trauma - fractured mandibles and rostrum with associated hemorrhaging. Histopathology results support findings.
19Jun19	Mortality	-	Off Miscou, QC	EN	1	CN	NR	No necropsy and no gear present but evidence of extensive constricting entanglement injuries across ventral surface, peduncle and fluke insertion. Entanglement as COD is most parsimonious.
18Jul19	Mortality	-	Portugal Cove South, Avalon, NL	EN	1	CN	PT	Carcass anchored in gear with line through mouth. No necropsy but COD from entanglement is most parsimonious.
7Jul20	Prorated Injury	-	off of MacKenzie Point, Pleasant Bay, NS	EN	0.75	XC	NR	Free-swimming. Line crossing from left mouth/head over back and down right side. Attachment point(s) and full configuration unknown. No resights.
Assigned Cause					**5-Year mean (US/CN/XU/XC)**			
Vessel Strike					0.60 (0.60/0/0/0)			
Entanglement					1.45 (0/0.8/0.15/0.5)			

a. For more details on events please see Henry et al. 2023.
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 US, 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, Nav=Navigational buoy.

Other Mortality

Known vessel strike cases are reported in Table 4. Mortality or serious injury as a result of vessel collision has an impact on this stock (Schleimer et al. 2019).

STATUS OF STOCK

This is a strategic stock because the fin whale is listed as an endangered species under the ESA. NMFS records represent coverage of only a portion of the area surveyed for the population estimate for the stock. The total 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, mortality and serious injury in commercial fisheries cannot be considered insignificant and approaching a zero mortality and serious injury rate. The status of this stock relative to its Optimum Sustainable Population (OSP) is unknown. There are insufficient data to determine the population trend for fin whales though there is evidence for a decline of the subpopulation in the northern Gulf of St. Lawrence (Schleimer et al. 2019). 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.

OTHER FACTORS THAT MAY BE AFFECTING THE STOCK

Habitat Issues

The chronic impacts of contaminants (polychlorinated biphenyls [PCBs] and chlorinated pesticides [DDT, DDE, dieldrin, etc.]) on marine mammal reproduction and health are of concern (e.g., Pierce et al. 2008; Jepson et al. 2016; Hall et al. 2018; Murphy et al. 2018), but research on contaminant levels for the western north Atlantic stock of fin whales is lacking.

Climate-related changes in spatial distribution and abundance, including poleward and depth shifts, have been documented in or predicted for plankton species and commercially important fish stocks (Nye et al. 2009; Head et al. 2010; Pinsky et al. 2013; Poloczanska et al. 2013; Hare et al. 2016; Grieve et al. 2017; Morley et al. 2018) and cetacean species (e.g., MacLeod 2009; Sousa et al. 2019). There is uncertainty in how, if at all, the distribution and population size of this species will respond to these changes and how the ecological shifts will affect human impacts to the species.

Phenological changes were documented for fin whales in the Gulf of St. Lawrence by Ramp et al. (2015). Their study documented earlier shifts in the timing of arrival and departure of fin whales in the Gulf of St. Lawrence from 1984–2010. They estimated an arrival date shift of >1 day per year earlier, and a departure date shift of 0.4 day per year earlier in the Jacques Cartier Passage of the Gulf of St. Lawrence. Further, their study found significant relationships between fin whale arrival/departure dates, the first ice-free week in the Gulf of St. Lawrence, and January sea surface temperatures in Cabot Strait. Another study (Pendleton et al. 2022) estimated the date of peak habitat use for fin whales from 1998–2018 in Cape Cod Bay, located in the southwestern Gulf of Maine. This study found a significant positive relationship between the date of peak occupancy of fin whales in Cape Cod Bay and the thermal spring transition date (Friedland et al. 2015) in the eastern Gulf of Maine. These studies suggest that fin whales are adapting to long-term changes in temperature, although the mechanisms behind these relationships and effects on the population are not known at this time.

Chavez-Rosales et al. (2022) documented an overall 178 km northeastward spatial distribution shift of the seasonal core habitat of Northwest Atlantic cetaceans that was related to changing habitat/climatic factors. Results varied by season and species. This study used sightings data collected during seasonal aerial and shipboard line transect abundance surveys during 2010 to 2017. During this time frame, the weighted centroid of the fin whale core habitat moved farthest during fall (223 km towards the northeast) and least during winter (33 km). There is uncertainty in how, if at all, the changes in distribution and population size of cetacean species may interact with changes in distribution of prey species and how the ecological shifts will affect human impacts to the species.

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