BLUE WHALE (*Balaenoptera musculus musculus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The distribution of the blue whale, *Balaenoptera musculus musculus,* in the western North Atlantic generally extends from the Arctic to at least mid-latitude waters. Blue whales are most frequently sighted in the waters off eastern Canada, with the majority of records from the Gulf of St. Lawrence (Sears *et al.* 1987). The species was hunted around Newfoundland in the first half of the 20th century (Sergeant 1966). The present Canadian distribution, broadly described, is spring, summer, and fall in the Gulf of St. Lawrence, especially along the north shore from the St. Lawrence River estuary to the Strait of Belle Isle and off eastern Nova Scotia. The species occurs in winter off southern Newfoundland and also in summer in Davis Strait (Mansfield 1985). Individual identification has confirmed the movement of a blue whale between the Gulf of St. Lawrence and western Greenland (Sears and Larsen 2002), although the extent of exchange between these two areas remains unknown. Similarly, a blue whale photographed on the Scotian Shelf by a NMFS large whale survey in August 1999 had previously been observed in the Gulf of St. Lawrence in 1985 (R. Sears and P. Clapham, unpublished data) and there have been additional photographic resightings between the Gulf of Maine, Scotian Shelf and Gulf of St. Lawrence (R. Sears, pers. comm.).

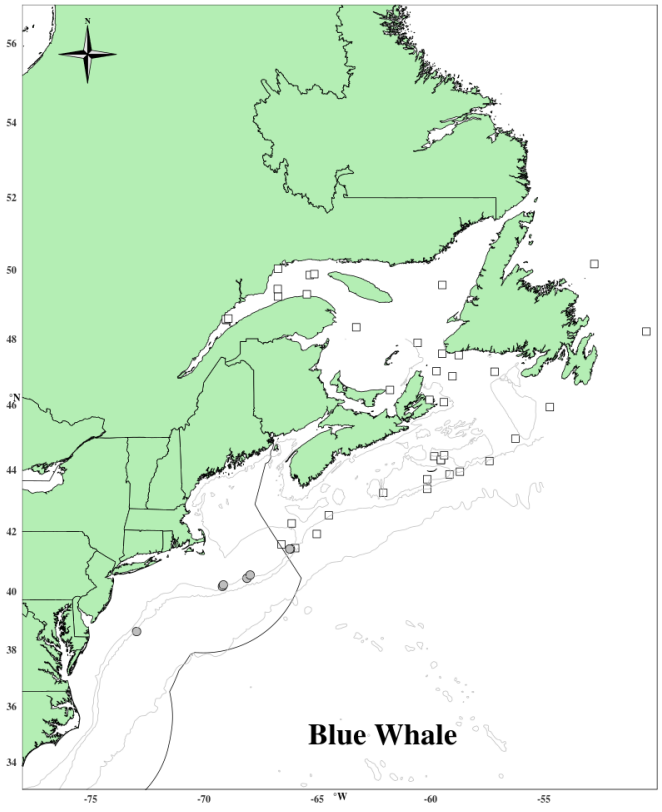

Figure 1: Distribution of blue whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1998, 1999, 2002, 2004, 2006, 2007, 2010, 2011, 2013, and 2016 and DFO's 2007 TNASS and 2016 NAISS surveys. Isobaths are the 100-m, 200-m, 1000-m and 4000-m depth contours. Circle symbols represent shipboard sightings and squares are aerial sightings.

The blue whale is best considered as an occasional visitor in U.S. Atlantic Exclusive Economic Zone (EEZ) waters, which may represent the current southern limit of its feeding range (CETAP 1982; Wenzel *et al.* 1988). All of the five sightings described in the foregoing two references were in August. There were three blue whale sighting by whale-watchers south of Montauk Point, New York, between about the 30- and 50-m isobaths, over a one-week period in July and August 1990, believed to be the same animal each time (Kenney and Vigness-Raposa 2010). Yochem and Leatherwood (1985) summarized records that suggested an occurrence of this species south to Florida and the Gulf of Mexico, although the actual southern limit of the species' range is unknown.

Using the U.S. Navy's SOSUS program, blue whales have been detected and tracked acoustically in much of the North Atlantic, including in subtropical waters north of the West Indies and in deep water east of the U.S. Atlantic EEZ, indicating the potential for long-distance movements (Clark 1995). Most of the acoustic detections were around the Grand Banks area of Newfoundland and west of the British Isles. Recordings made in 2006 and 2007 in the Gully Marine Protected Area at the outer edge of the Scotian Shelf had blue whale vocalizations on 17% of the summer recordings and 4% of winter recordings (Marotte and Moors-Murphy 2015). A 2008 study detected blue whale calls in offshore areas of the New York Bight on 28 out of 258 days of recordings, mostly during winter (Muirhead *et al.*

2018). Historical blue whale observations collected by Reeves *et al*. (2004) show a broad longitudinal distribution in tropical and warm temperate latitudes during the winter months, with a narrower, more northerly distribution in summer. Sigurjónsson and Gunnlaugsson (1990) note that North Atlantic blue whales appear to have been depleted by commercial whaling to such an extent that they remain rare in some formerly important habitats, notably in the northern and northeastern North Atlantic.

Photo-identification in eastern Canadian waters indicates that blue whales from the St. Lawrence, Newfoundland, Nova Scotia, New England and Greenland all belong to the same stock, while blue whales photographed off Iceland and the Azores appear to be part of a separate population (Wenzel *et al.* 1988; Sears and Calambokidis 2002; Sears and Larsen 2002).

POPULATION SIZE

Little is known about the population size of blue whales except for the Gulf of St. Lawrence area. From 1980 to the summer of 2008, a total of 402 blue whales was photo-identified, mainly in the St. Lawrence estuary and northwestern Gulf of St. Lawrence (Ramp and Sears 2013). Biopsies have been taken on nearly 40% of this population (R. Sears, pers. comm.). Each year, from 20 to 105 blue whales are identified in this region. Approximately 40% of the identified blue whales return frequently to the study area, while the others have been observed during fewer than three seasons between 1979 and 2002, which suggests that these individuals range mostly outside the St. Lawrence, possibly in the waters at the edge of the continental shelf, from the Labrador Sea and Davis Strait in the north, east to the Flemish Cap and south to New England (Sears and Calambokidis 2002). Photo-identification data from outside the estuary and Gulf of St. Lawrence are limited. A few blue whales have been photographed along the coast of Newfoundland, on the Scotian Shelf and in the Gulf of Maine, and some are not included among the 402 blue whales that have been identified in the estuary and northwest part of of the Gulf of St. Lawrence (Sears and Calambokidis 2002; Ramp and Sears 2013; J. Lawson, pers. comm.). Ramp *et al*. (2006) estimated the survival rate at 0.975 and the gender ratio of the 139 biopsy sampled individuals at 79 males for 67 females (Sears 2003). Given the small proportion of the distribution range that has been sampled and considering the low number of blue whales encountered and photographed, the current data, based on photo-identification, do not allow for an estimate of abundance of this species in the Northwest Atlantic with a minimum degree of certainty (Sears *et al.* 1987, 1990; Hammond *et al.* 1990; Sears and Calambokidis 2002; Beauchamp *et al*. 2009). Mitchell (1974) estimated that the blue whale population in the western North Atlantic may number only in the low hundreds. R. Sears (pers. comm.) suggests that 400 to 600 individuals may be found in the western North Atlantic.

An abundance estimate of 39 (CV=0.64) blue whales was generated from a shipboard and aerial survey conducted during 27 June–28 September 2016 (Palka 2020) in a region covering 425,192 km^2. The aerial portion included 11,782 km of tracklines that were over waters north of New Jersey from the coastline to the 100-m depth contour, throughout the U.S. waters. The shipboard portion included 4,351 km of tracklines that were in waters offshore of central Virginia to Massachusetts (waters that were deeper than the 100-m depth contour out to beyond the U.S. EEZ). Both sighting platforms used a two-team data collection procedure, which allows estimation of abundance to correct for perception bias of the detected species (Laake and Borchers 2004). The estimates were also corrected for availability bias. Because this estimate is only for the U.S. portion of the stock, the above catalogue count of 402 is considered the best estimate.

Table 1. Summary of recent abundance estimates for western North Atlantic blue whales (Balaenoptera musculus) by 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
1980–2008	Gulf of Saint Lawrence Catalogue	402	-
Jun–Sep 2016	Central Virginia to lower Bay of Fundy	39	0.64

Earlier estimates

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

Minimum Population Estimate

The catalogue count of 402 recognizable individuals from the Gulf of St. Lawrence is considered to be a minimum population estimate for the western North Atlantic stock.

Current Population Trend

There are insufficient data to determine population trends for this species. Off western and southwestern Iceland, an increasing trend of 4.9% a year was reported for the period 1969–1988 (Sigurjónsson and Gunnlaugsson 1990). Pike *et al*. (2009) conducted ship surveys in the Central and Northeast Atlantic in 1987, 1989, 1995 and 2001. Blue whales were most commonly sighted off western Iceland, and to a lesser extent northeast of Iceland. They were very rare or absent in the Northeast Atlantic. Sightings were combined over all surveys to estimate the detection function using standard line-transect methodology, with the addition of a covariate to account for differences between surveys. Total abundance was highest in 1995 (979, 95% CI 137–2,542) and lowest in 1987 (222, 95% CI 115–440). Uncertainty in species identity had little effect on estimates of abundance. There was a significant positive trend in abundance northeast of Iceland and in the total survey area. These estimates should be treated with caution given the effort biases underlying the sightings data on which they were based.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. 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 402. The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for stocks which are endangered, depleted, or threatened or of unknown status relative to optimum sustainable population (OSP), is assumed to be 0.10 because the blue whale is listed as endangered under the Endangered Species Act (ESA). PBR for the Western North Atlantic stock of blue whale is 0.8.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Threats for North Atlantic blue whales are poorly known, but may include ship strikes, pollution, entanglement in fishing gear, and long-term changes in climate (which could affect the abundance of their zooplankton prey). During winter and early spring, ice-related strandings and entrapments have been documented on the southwestern and eastern coasts of Newfoundland (Sears and Calambokidis 2002). There are no recent confirmed records of anthropogenic mortality or serious injury to blue whales in the U.S. Atlantic EEZ or in Atlantic Canadian waters (Henry *et al.* 2020). However, in March 1998 a dead 20-m (66-ft) male blue whale was brought into Rhode Island waters on the bow of a tanker. The cause of death was determined to be ship strike. Although it appears likely that the vessel concerned was responsible, the necropsy revealed some injuries that were difficult to explain in this context. The location of the strike was not determined; given the known rarity of blue whales in U.S. Atlantic waters, and the vessel's port of origin (Antwerp), it seems reasonable to suppose that the whale died somewhere to the north or east of the U.S. Atlantic EEZ.

Fishery Information

No fishery information is presented because there are no observed fishery-related mortalities or serious injury.

HABITAT ISSUES

Anthropogenic noise associated with seismic projects has been shown to affect blue whale acoustic activity in the Saint Lawrence Estuary, Canada (Iorio and Clark 2009). A 2016 DFO study performed a risk-mapping analysis of shipping-noise impacts on blue whales in the Saint Lawrence Estuary (Aulanier *et al.* 2016). It was determined that there was no area correlated with injury risk, and that while a large part of the study area had a low probability of experiencing shipping noise levels exceeding behavioral response thresholds, the risk of behavioral-level impacts near the shipping lanes might be present up to 30% of the time.

Climate-related changes in spatial distribution and abundance, including poleward and depth shifts, have been documented in and predicted for a range of 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.

STATUS OF STOCK

The status of this stock relative to OSP in the U.S. Atlantic EEZ is unknown, but the species is listed as endangered under the ESA. There are insufficient data to determine population trends for blue whales. The total level of human-caused mortality and serious injury is unknown, but it is believed to be insignificant and approaching a zero mortality and serious injury rate. This is a strategic stock because the blue whale is listed as an endangered species under the ESA. A draft of a revised Recovery Plan was published in October of 2018 (NMFS 2018).

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