Species Status Assessment

Common Name: Blue whale **Date Updated:** 10/10/2024

Scientific Name: *Balaenoptera musculus* **Updated by:** Meghan Rickard

Class: Mammalia

Family: Balaenopteridae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

The blue whale is the largest animal to have ever lived on Earth and can be found in all the world's oceans (Mizroch et al. 1984, Sears and Perrin 2018). There are five recognized blue whale subspecies (Cooke 2018). The northern subspecies, *Balaenoptera musculus musculus,* includes the blue whales found in New York waters. It remains unclear if blue whales in the eastern and western portions of the North Atlantic Ocean are the same population. Because of this, the International Whaling Commission (IWC) recognizes all North Atlantic blue whales to be one stock or management unit, which is supported by the existence of only one blue whale song type in the North Atlantic (Donovan 1991, NMFS 2020a). Ten song types have been described globally and remain stable, which can be used to distinguish populations when there is no genetic data (McDonald et al. 2006). Photo identification further indicates blue whales in the Gulf of St. Lawrence, eastern Canada, New England, and Greenland belong to one population, with no known matches to the eastern population (Sears et al. 1990).

In the Western North Atlantic, blue whales are found from the Arctic to mid-latitude waters. Little is known about the population size except within the Gulf of St. Lawrence (Hayes et al. 2020). Blue whales have a wide distribution and are highly migratory in nature, spending summer in the high latitudes (characterized by a narrow distribution with presence on feeding grounds) and traveling south to warmer water during the winter, where they are more dispersed and utilize calving areas. They spend most of their time far offshore and so are rarely encountered, though their occasional presence in the mid-Atlantic and Southern New England canyons is regular (Johnson et al. 2021). It is believed that blue whales are using waters of the U.S. mid-Atlantic largely as part of their migration routes, and there is some speculation that their presence here in the winter might be linked to breeding or calving (Lesage et al. 2018). The species has been documented visually and acoustically in the New York Bight primarily in offshore waters greater than 25 miles from the coast and during fall, winter, and early spring (Sadove and Cardinale 1993, Muirhead et al. 2018, Zoidis et al. 2021, Estabrook et al. 2025). The documentation of more recent sightings in the summer challenge the notion that blue whales are only present in New York at certain times of year and highlight how much is still unknown about blue whales in the Western North Atlantic.

I. Status

a. Current legal protected Status

i. **Federal:** Endangered **Candidate:**

ii. **New York:** Endangered

b. Natural Heritage Program

i. **Global:** G3G4

ii. **New York:** SNA **Tracked by NYNHP?:** Yes

Other Ranks:

-New York 2025 SGCN status: High Priority Species of Greatest Conservation Need

-IUCN Red List: Endangered

-CITES: Appendix I

-Northeast Regional SGCN: Highly imperiled migratory species; very high conservation concern

-Canada Species at Risk Act (SARA): Endangered

-Committee on the Status of Endangered Wildlife in Canada (COSEWIC): Endangered

-Marine Mammal Protection Act (MMPA): Strategic

Status Discussion:

Blue whale stocks worldwide were severely depleted by modern industrial whaling throughout their range during the 19th and early 20th centuries. Blue whales delivered the most yield due to their large size, and as such, blue whales were among the first species to be significantly reduced by modern industrial whaling. In the North Atlantic, blue whales were hunted off northern Norway, Svalbard, Iceland, the British Isles, and Newfoundland (Mizroch et al.1984). Typically, one location was targeted for 10 to 15 years, and when catches declined, whalers moved on to another location (Tonnessen & Johnson 1982).

Since the start of modern whaling in northern Norway in the 1860s, at least 11,000 blue whales were recorded killed throughout the North Atlantic, which is believed to have been approximately 70% of the population (Beauchamp et al. 2009, Jonsgard 1977, Sigurjónsson and Gunnlaugsson 1990). Over 2,000 blue whales were taken off Newfoundland, about 500 in the Gulf of St Lawrence, and nearly 1,000 around the Faeroes, Scotland, and Ireland (Sigurjónsson and Gunnlaugsson 1990, Yochem and Leatherwood 1985, Reeves et al. 1998, Sears and Calambokidis 2002, Reeves and Kenney 2003). These numbers do not account for the struck and lost rates during pre-industrial whaling (IWC 2017), nor any blue whales included in the additional 13,000 unspecified large whales that were recorded as caught in the late 19th and early 20th centuries (Allison 2017).

The 1946 moratorium on whaling declared by the International Whaling Commission (IWC) went into effect for North Atlantic blue whales in 1955, though they were still hunted under exception by some countries such as Norway until 1960 (Best 1993). Estimates after this protection was granted put the population in the “very low hundreds, at most” in the western North Atlantic (Mitchell 1974). The last recorded direct catches were six blue whales taken off of Spain in 1978 (Allison 2017).

Blue whales were listed as endangered under the U.S. Endangered Species Act (ESA) in 1973 and were originally listed as “very rare and believed to be decreasing in numbers” on the IUCN Red List in 1965. Currently, they are listed as endangered on the IUCN Red List. The blue whale U.S. Recovery Plan, as well as the 5-year Review, mandated under the ESA were revised in November 2020 (NMFS 2020a, NMFS 2020b). The most recent Stock Assessment Report, mandated under the Marine Mammal Protection Act (MMPA), was completed for 2019 (Hayes et al. 2020). All three of these U.S. management documents are due for updates in 2025. In Canada, blue whales were listed as a species of special concern in 1983. The Canadian population was split into two stocks in 2002, and the North Atlantic stock was listed as endangered under the Species at Risk Act (SARA) that year. Its status was reviewed again in 2012 and confirmed as endangered (COSEWIC 2012).

The current global mature population size is unknown, but it is estimated to be 5,000-15,000 individuals, which is an 89%-97% reduction of the 1926 global mature population estimate of at

least 140,000 individuals (Cooke 2018). There are no precise estimates of original abundance in the North Atlantic and evidence of population increase is difficult to prove (Thomas et al. 2016). Before whaling, there may have been as many as 15,000 blue whales in the entire North Atlantic; now, there may be 1,000 – 3,000 individuals in the entire North Atlantic (Yochem and Leatherwood 1985, Cooke 2018). Based on cumulative catches from 1898 to 1915, researchers have estimated that the pre-whaling western North Atlantic blue whale population was between 1,100 and 1,500 individuals (Sergeant 1966, Allen 1970) and .

II. Abundance and Distribution Trends

Region	Present ?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Unknown	Unknown	Late 19th century to present		Choose an item.
Northeastern US	Yes	Unknown	Unknown		Endangered	Yes
New York	Yes	Unknown	Unknown		Endangered	Yes
Connecticut	Yes	Unknown	Unknown		Not listed	No
Massachusetts	Yes	Unknown	Unknown		Endangered	Yes
Rhode Island	Yes	Unknown	Unknown		Not listed	No
New Jersey	Yes	Unknown	Unknown		Endangered	No
Pennsylvania	No	Choose an item.	Choose an item.			Choose an item.
Vermont	No	Choose an item.	Choose an item.			Choose an item.
Ontario	No	Choose an item.	Choose an item.			Choose an item.
Quebec	Yes	Unknown	Unknown		Endangered	Choose an item.

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

Blue whales are difficult to study due to their low abundance and tendency to inhabit deep water, and funding for visual surveys is extremely limited. Until 2016, monitoring of large whales in New York was very narrow in scope. Previous examples of surveys that included the New York area and recorded large whales were done coast-wide, seasonally, and/or focused on multiple taxa and were therefore not carried out at the most appropriate temporal or spatial scale for an assessment of large whale species in the New York Bight (CETAP 1982).

One of the first NYB-focused large whale surveys was a passive acoustic monitoring effort that took place from 2008 to 2009 (Muirhead et al. 2018). The 258-day project included 10 sites, with a

line of moored receivers perpendicular to Long Island and 3 sites around the entrance to NY Harbor. The data was analyzed for blue, fin, humpback, and North Atlantic right whales only.

In 2010, the Atlantic Marine Assessment for Program for Protected Species (AMAPPS) joint program between the National Oceanic and Atmospheric Administration (NOAA) and the Bureau of Ocean Energy Management (BOEM) began, with the goal of determining the abundance and distribution of protected species along the U.S East Coast. The NOAA Northeast Fisheries Science Center (NEFSC) Protected Species Branch leads the surveys which are conducted primarily by plane and ship. AMAPPS is a broadscale survey and therefore does not match the specific needs of New York Bight monitoring in time or space but has, however, recorded sightings of blue whales in and around New York. AMAPPS II (2015-2019) and AMAPPS III (2019-2024) have both been completed but AMAPPS was not picked up for continued funding by BOEM. Instead, the U.S. Navy plans to work with NOAA on similar surveys beginning in 2025 (US Navy 2024).

NOAA conducts regular, year-round monitoring focused on North Atlantic right whales (i.e., the North Atlantic Right Whale Sighting Advisory System) which also collects data on other taxa including blue whales (Johnson et al. 2021). In addition, the New England Aquarium also conducts regular aerial surveys, and sometimes shipboard surveys, in the Southern New England area and records sightings of blue whales. Sightings of blue whales off the coast of New England are regular but at varying times, and the number of individuals is always small, usually one single animal.

In 2016, to support the state's commitment to offshore wind energy, the New York State Energy Research and Development Authority (NYSERDA) began a seasonal 3-year ultra-high resolution digital aerial survey of all marine taxa within the New York Bight (e.g., the offshore planning area delineated by NY Dept. of State; NYSERDA 2021). Also in 2016, the Woods Hole Oceanographic Institute (WHOI) deployed the first of an ongoing succession of real-time monitoring buoys, and later gliders, to record the presence of large whales in the New York Bight (WHOI 2025). This effort had first been introduced off the coast of Massachusetts and proved helpful for both data collection and real-time management of ship speeds to prevent collision with whales. Currently, the data shared publicly is limited to four large whale species (sei, humpback, fin, and North Atlantic right whales) and does not include blue whales.

Beginning in 2017, DEC launched the first three years of a long-term monitoring program for large whales. Using monthly visual aerial surveys and 24/7 passive acoustic monitoring, the NYS Whale Monitoring Program gathered enough data to estimate large whale abundance in the NYB and identified probable discreet periods of space and time that blue whales are likely to be found (Tetra Tech and LGL 2020, Estabrook et al. 2021). The NYS Whale Monitoring Program will conduct another three years of visual aerial surveys for a total of 18 surveys beginning in November 2024. Marine mammal stranding response is performed by two federally permitted groups in New York: the New York Marine Rescue Center (NYMRC) and the Atlantic Marine Conservation Society (AMSEAS). For all live and dead large whale events, AMSEAS is the lead response team. The DEC has supplied funding for stranding response in New York since the program began in 1980. Strandings provide valuable data, making stranding response an essential component of monitoring. To date, there are no records of a stranded blue whale in New York.

Currently, the only active monitoring effort appropriate for the assessment of blue whales in the New York Bight are the DEC large whale aerial surveys (2024-2027).

Trends Discussion *(insert map of North American/regional distribution and status):*

Overall, blue whale abundance and distribution trends have shifted over the past decade, matching shifts seen in other large whale species. When the CETAP surveys were active in the late 1970s and early 1980s, the expected distribution of blue whales began at the border of the U.S. and Canada in the Gulf of Maine (CETAP 1982). Now, blue whales have been recorded regularly as far south as offshore Brunswick, Georgia (Palka et al. 2021). Importantly, despite the increase in New York- and/or large whale-focused research over the past ten years, data continues to be insufficient to determine trends in abundance (Hayes et al. 2020).

Historical blue whale sightings indicate a wide distribution in warmer latitudes during the winter and a smaller northern distribution in the summer (Reeves et al. 2004). Passive acoustic tracking of individuals suggests that blue whales move over vast distances, likely covering most of the North Atlantic basin (Clark 1994). This wide distribution and highly migratory nature complicate arriving at a reasonable and confident population estimate. Sigurjónsson and Gunnlaugsson (1990) noted that North Atlantic blue whales appeared to have been depleted by commercial whaling to such an extent that they remained rare in some formerly important habitats. However, there are still no recent estimates of abundance available throughout the North Atlantic (Cooke 2018).

A long-term decline of western North Atlantic blue whales followed the hunting of the species and by 1955 the population was severely depleted. Based on compiled survey and photo identification data, it is likely that the number of blue whales throughout the entire North Atlantic Ocean now ranges from 600 to 1,500 animals (Sears and Calambokidis 2002). Mitchell (1974) estimated that the blue whale population in the western North Atlantic may number only in the low hundreds and there has been some suggestion that 400 to 600 individuals may be found in the western North Atlantic (Hayes et al. 2020). However, accurate pre- and post-whaling blue whale abundance and trends are currently unknown. Minimal trend information is available for western North Atlantic blue whales in the Gulf of St. Lawrence, where most sightings and research have occurred. Long-term studies (1980 to 2008) have photographically identified over 400 individual blue whales (Beauchamp 2009, Ramp and Sears 2013). Each year, 20 to 105 blue whales are identified and about 40% return to the Gulf of St. Lawrence regularly, while others have been seen for less than three seasons between 1979 – 2002 (COSEWIC 2012). Some studies say there is likely only 250 mature individuals in Canada (COSEWIC 2012). Based on sightings from 1979 to 2002, the annual adult survival rate is estimated to be 0.975 for whales in the Gulf of St. Lawrence region (Ramp 2006). Researchers in the Gulf of St. Lawrence report that only 21 calves have been recorded in over 32 years of annual survey effort and, although blue whales are present off Newfoundland and Nova Scotia, no cow-calf pairs have been sighted there (COSEWIC 2012). Regardless of any potential trends, these studies cannot be used to infer trends for blue whales in areas outside the Gulf of St. Lawrence.

In Iceland prior to 1990 there was enough consistent survey effort over a short period of time to show 5% annual growth, but such growth has not been confirmed elsewhere or in Iceland since (Sigurjónsson and Gunnlaugsson 1990). Christensen et al. (1992) noted that despite the apparent population increase in Iceland prior to 1990, all other North Atlantic area abundance was still very low and brought into question whether the previously established migratory patterns of the species were still true. Indeed, there have been more frequent visual and/or acoustic recordings of blue whale presence outside of what was once considered their range, specifically, in the U.S. Mid-Atlantic. Wenzel (1988) published the first documented sightings in U.S. continental shelf waters in the Gulf of Maine from whale watch boats in the late summer and early fall months. These seemingly rare sightings indicated at that time that the Northeast U.S. was likely part of the southernmost extent of the range.

Data gaps highlight the importance of long-term monitoring to understand trends in abundance (NMFS 2020a). More data is needed to understand blue whale habitat use in the western North Atlantic and in the New York Bight. Overall, it remains difficult to determine population estimates

and trends for this species (Ramp and Sears 2013). The small sampling area and low detection rates cannot produce an estimate with a minimum degree of certainty (Sears et al. 1987, Sears et al. 1990, Cooke 2018, Beauchamp 2009). However, the most recent IUCN Red List assessment indicates that the species is increasing with no continued decline of mature individuals. Per the assessment: "the global population size in 2018 is plausibly in the range 10,000-25,000 total or 5,000-15,000 mature, compared with a 1926 global population of at least 140,000 mature. The current mature population would therefore be between 3 and 11% of the 1926 level" (Cooke 2018). The assessment also states that "there are no complete estimates of recent or current abundance for the other regions, but plausible total numbers would be 1,000-3,000 in the North Atlantic" (Cooke 2018). In the U.S., surveys from June to September 2016 resulted in an abundance estimate for Virginia to the lower Bay of Fundy of 39 individuals. Currently, the Gulf of St. Lawrence catalogue count of 402 recognizable individuals is considered NOAA Fisheries' best population estimate for the Western North Atlantic stock (Hayes et al. 2020).

Figure 1. Conservation status of blue whale in North America (NatureServe 2024).

Figure 2. Geographic range of the blue whale (NMFS 2023).

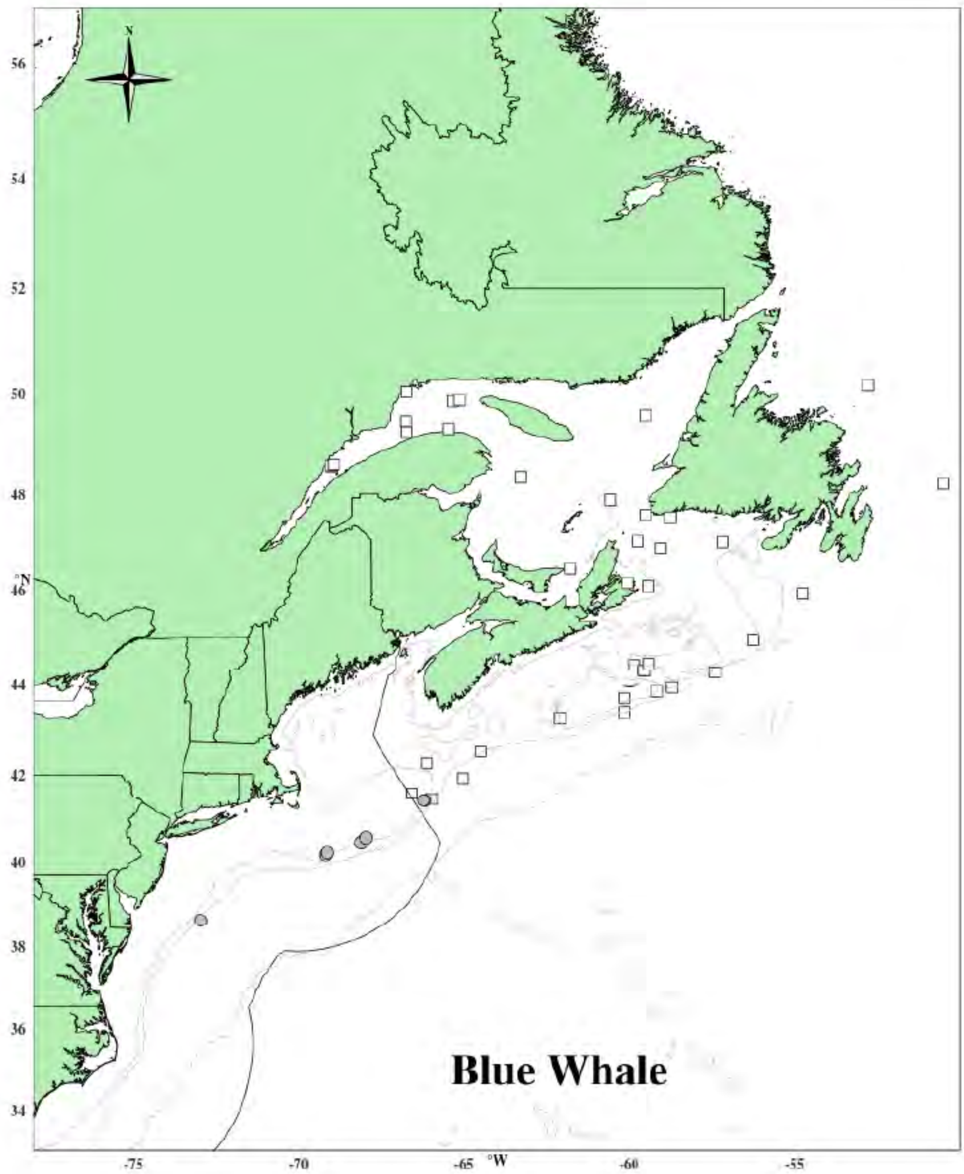


Figure 3. Distribution of blue whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1998, 1999, 2002, 2004, 2006, 2007, 2010, 2011, 2013, and 2016 and DFO's 2007 TNASS and 2016 NAISS surveys. Circle symbols represent shipboard sightings and squares are aerial sightings (Hayes et al. 2020).

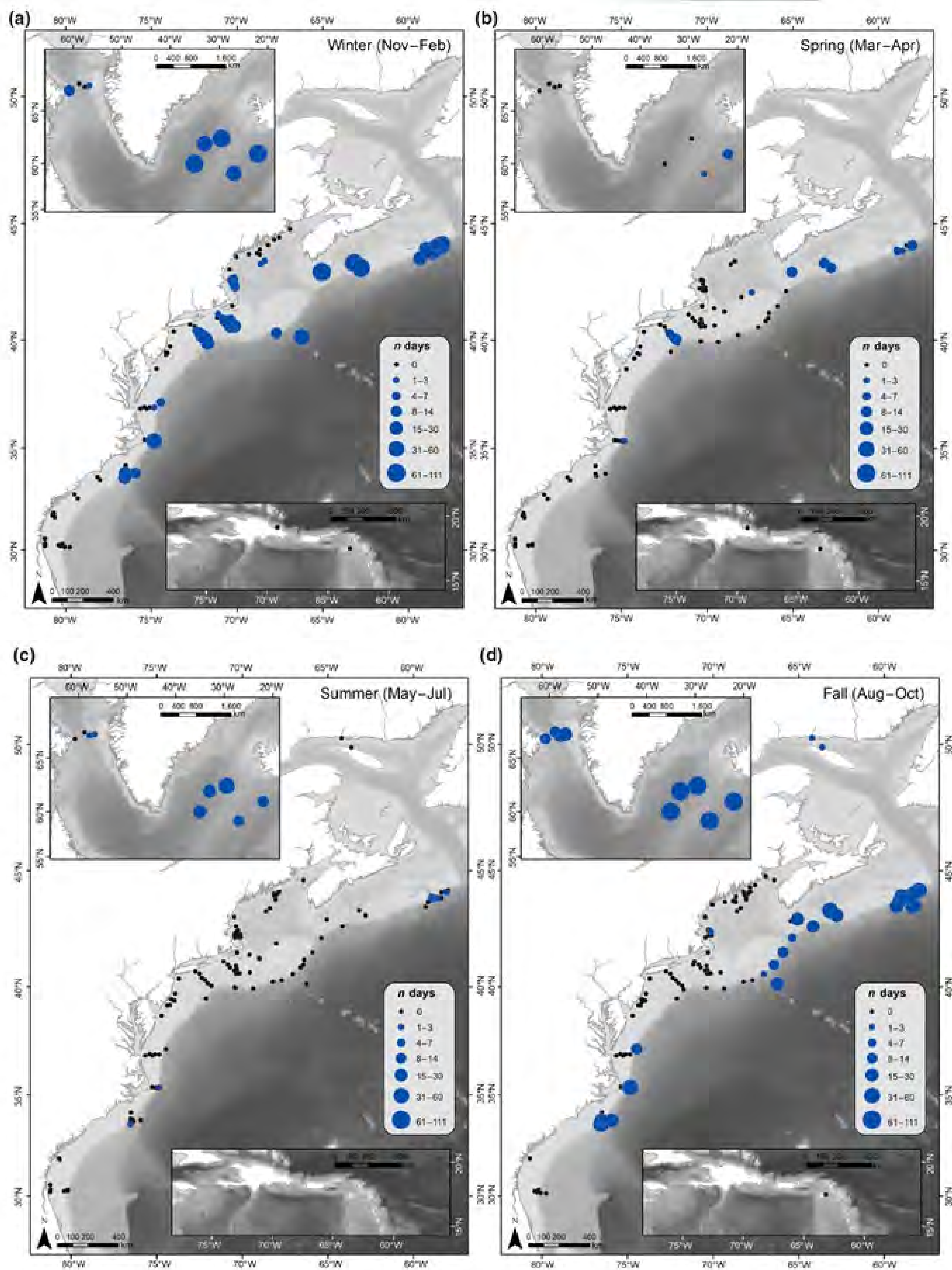


Figure 4. Blue whale seasonal occurrence maps. The number of days per season with confirmed North Atlantic blue whale acoustic detections, summarized for all available recording locations (2004-2014). Filled blue circles indicate blue whale acoustic presence, and circle size indicates the number of days with blue whale acoustic detections during a season. Black dots indicate recorder locations with no blue whale acoustic presence for any year during that season (defined as: (a) Winter (November-February); (b) Spring (March-April); (c) Summer (May-July); and (d) Fall (August-October) (Davis et al. 2020).

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

Details of historic and current occurrence:

Prior to 1988 there were no documented sightings of blue whales on the U.S. continental shelf and the only published record was a stranding in Maryland in 1891 (Wenzel 1988). However, Edwards and Rattray (1932) reported a blue whale stranding in Sagaponack, Long Island. Kenney and Vigness-Raposa (2010) compiled available data for cetaceans in Rhode Island waters that included five reported sightings of blue whales: 3 in summer, 1 in spring, and 1 at an unknown time. Three of the sightings were by whale-watchers south of Montauk Point, NY between the 30- and 50-m isobaths over a one-week period in July and August 1990; it's believed to have been the same animal each time (Kenney and Vigness-Raposa 2010). By 1993, Sadove and Cardinale (1993) had reported less than a dozen blue whale sightings during 15 years of boat-based surveys. All sightings occurred at least 25 miles offshore, were in waters at least 30 m deep, and were of single animals with groups of fin whales that were probably feeding but could not be confirmed. All individuals were adults over 19 m long. Additionally, a 63-foot male blue whale was found dead on the bow of a tanker heading into Providence, Rhode Island in 1998; it's likely to have been hit during transit near New York (Kenney and Vigness-Raposa 2010).

Acoustic detections of blue whales were recorded in New York in 2008, and since that time, visual sightings and further acoustic detections continue to establish the NYB as a likely portion of the present-day western North Atlantic blue whale population's habitat. During the 2008-2009 passive acoustic monitoring effort funded by NYSDEC, blue whales were detected on 11% of the 258-day period (Muirhead et al. 2018). Detections increased with distance from shore, and most detections were recorded during January, February, and March, though some were recorded during spring. Detections occurred in short periods spanning 1 to 11 days during the winter and early spring months. No detections were recorded at sites within 25 km of shore.

While blue whales are detected relatively rarely compared to the number of recorded days (about 16%), acoustic presence is still recorded every year (PACM 2025). One buoy anchored at the shelf break in Babylon Canyon (just west of Hudson Canyon) has detected blue whales from December 2016 to March 2017, December 2017 to March 2018, and November 2018 to March 2019 (Palka et al. 2022). Other sites across multiple deployment years continuously detect blue whales in the Southern New England area stretching west into the New York Bight from at least December through March (PACM 2025). Davis et al. (2020) found that after 2010, blue whales increased the amount of time spent in the northern latitudes and were present in the NYB in the winter from December through March. It's important to note that only blue whale song is used to determine detections in passive acoustic data, and song is only produced by males, so presence according to passive acoustic data is a minimum presence.

AMAPPS visual surveys by plane and ship have also recorded sightings, the nearest being one documented sighting southeast of Montauk (Palka et al. 2021, Palka et al. 2022). Interestingly, the northeast blue whale sightings occurred during the summer and fall. During NYSERDA's digital aerial surveys, which were flown seasonally from 2016-2020, there were two sightings of blue whales, one in November 2016 just beyond the shelf break, and one in March 2017 on the continental shelf about 100 km south of Long Island. The DEC's 2017-2020 NYB Whale Monitoring Program's aerial and acoustic surveys have, to date, produced the most blue whale data for New York. Zoidis et al. (2021) summarizes the visual aerial findings: "Blue whales were observed 3 times: 2 groups totaling 4 individuals sighted in the plain zone in winter (in January and February) of Year 1, and a single individual in the fall (September) seen on the slope in Year 3." We concluded that, while rare, blue whales may be regularly occurring in the NYB in low numbers. The September sighting was of a confirmed juvenile blue whale, the first juvenile blue whale recorded in the mid-Atlantic, suggesting that the NYB is indeed part of blue whale habitat and should

continue to be monitored. The PAM effort detected blue whales on 5% (50) of the recorded days, only at sites near the shelf edge, and only between November and February (Estabrook et al. 2025).

As previously noted, while not abundant, sightings of blue whales in Southern New England (e.g., Great South Channel and south of the islands Martha's Vineyard and Nantucket) are regular. In recent years, multiple blue whale sightings have been recorded at the shelf break off Virginia, establishing presence south of the NYB (Engelhaupt et al. 2020). Engelhaupt et al. (2020) reported two documented sightings of individuals about 100 km off the Virginia coast, one in April 2018 and one in February 2019. These sightings support the theory that the U.S. Mid-Atlantic is the southernmost extent of the species' range. Acoustic deployments along the U.S. East Coast detect blue whales annually, including off Georgia where detections are most common from August through January (PACM 2025). Satellite tags deployed on blue whales in the Gulf of St. Lawrence confirmed movement to the mid-Atlantic, which is now identified as a probable wintering, and possibly breeding or calving, area (Lesage et al. 2017). The most recent sightings of blue whales in New York have occurred in both fall and summer, in October 2023, July 2024, and September 2024. All sightings occurred offshore at the continental slope and shelf edge (Johnson et al. 2021).

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
1-25%	Core	

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

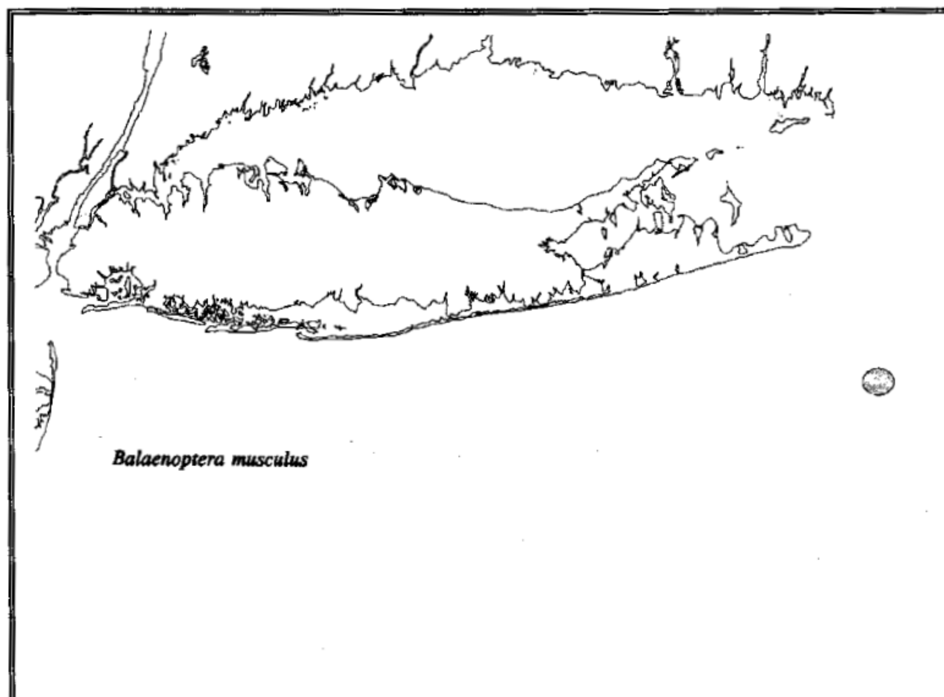
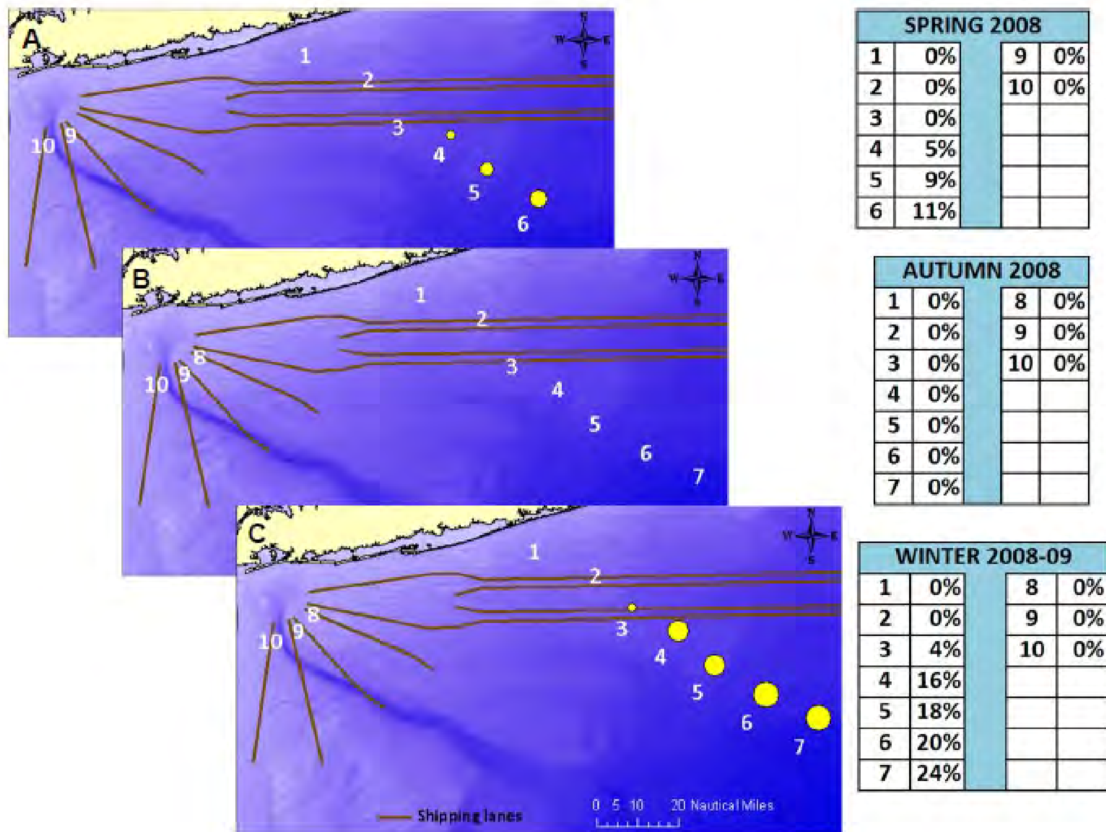


Figure 5. Blue whale sighting area based on survey data collected from 1970s to1990s (Sadove and Cardinale 1993).



SPRING 2008			
1	0%	9	0%
2	0%	10	0%
3	0%		
4	5%		
5	9%		
6	11%		

AUTUMN 2008			
1	0%	8	0%
2	0%	9	0%
3	0%	10	0%
4	0%		
5	0%		
6	0%		
7	0%		

WINTER 2008-09			
1	0%	8	0%
2	0%	9	0%
3	4%	10	0%
4	16%		
5	18%		
6	20%		
7	24%		

Figure 6. Seasonal presence of blue whales in the New York Bight region. A) blue whale presence during spring (1 March – 14 May 2008), B) presence during autumn (31 August – 2 Dec 2008), and C) presence during winter (5 December 2008 – 3 March 2009). Tables to the right of each plot show the actual percentages of days with blue whale song during each season (BRP 2010).

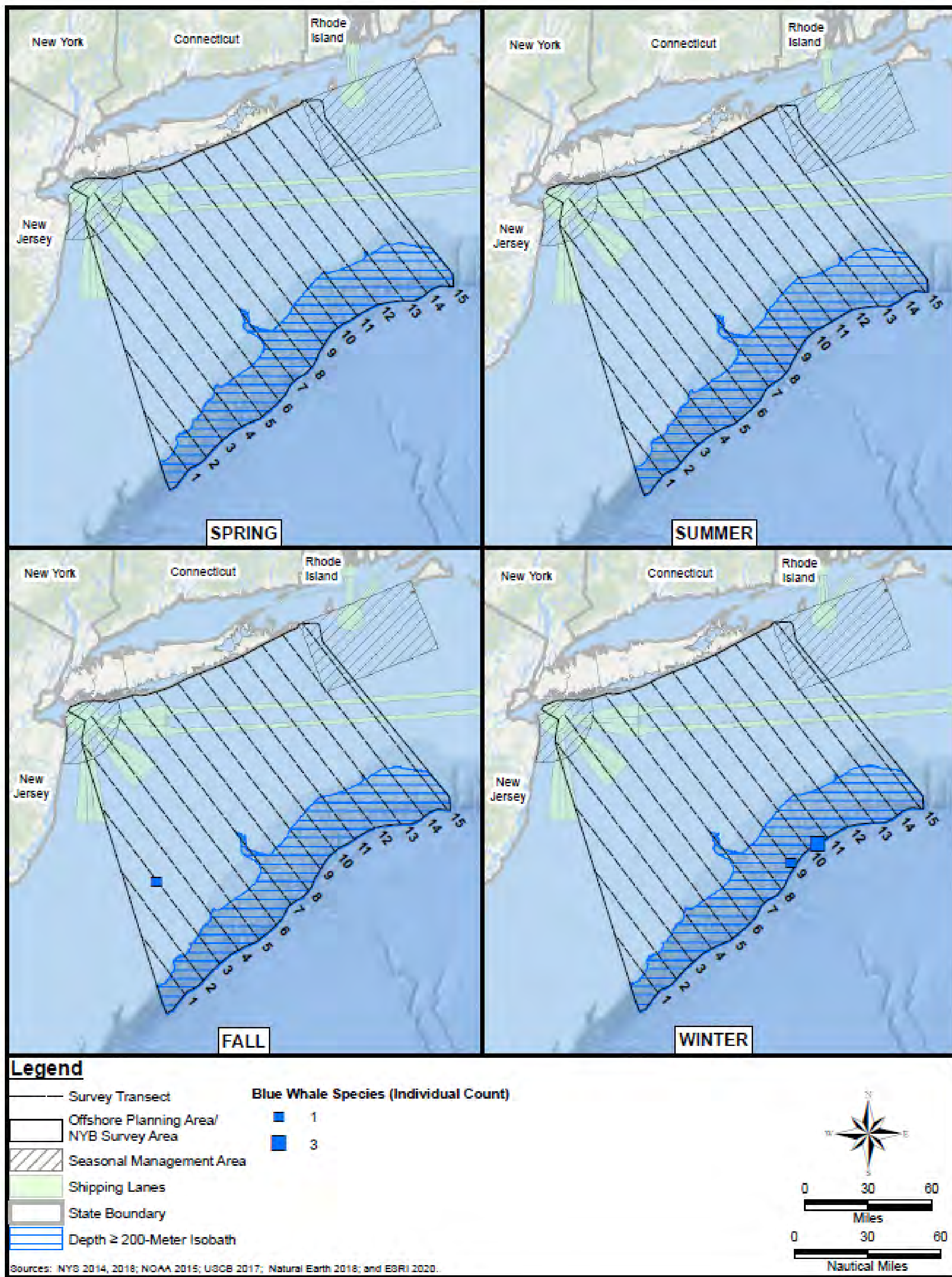


Figure 7. Locations of all blue whale sightings by count and season – Years 1, 2, and 3 (Tetra Tech and LGL 2020).

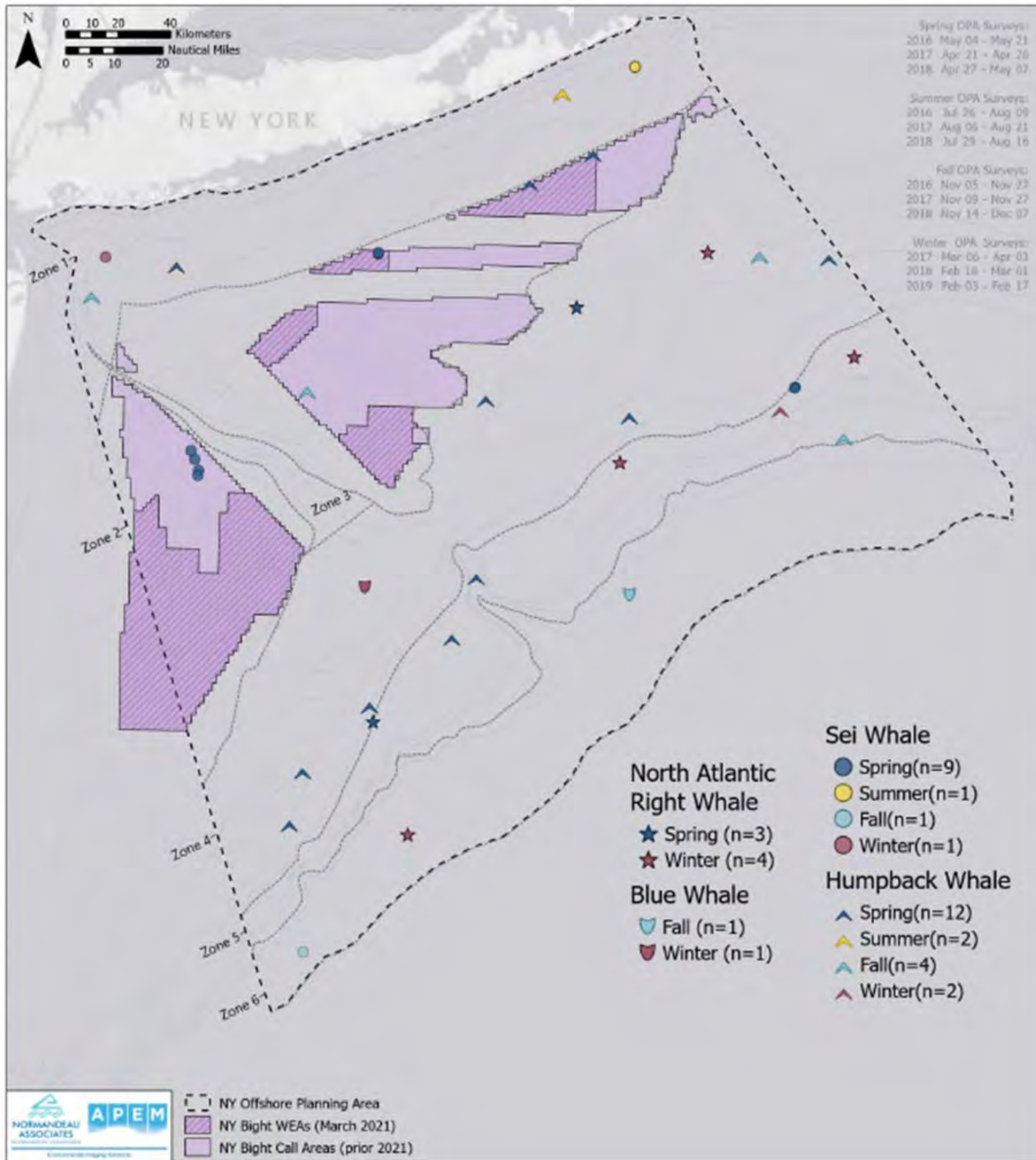


Figure 8. Spatial distribution of low-frequency cetacean species with fewer than 30 occurrences across all surveys (NYSERDA 2021).

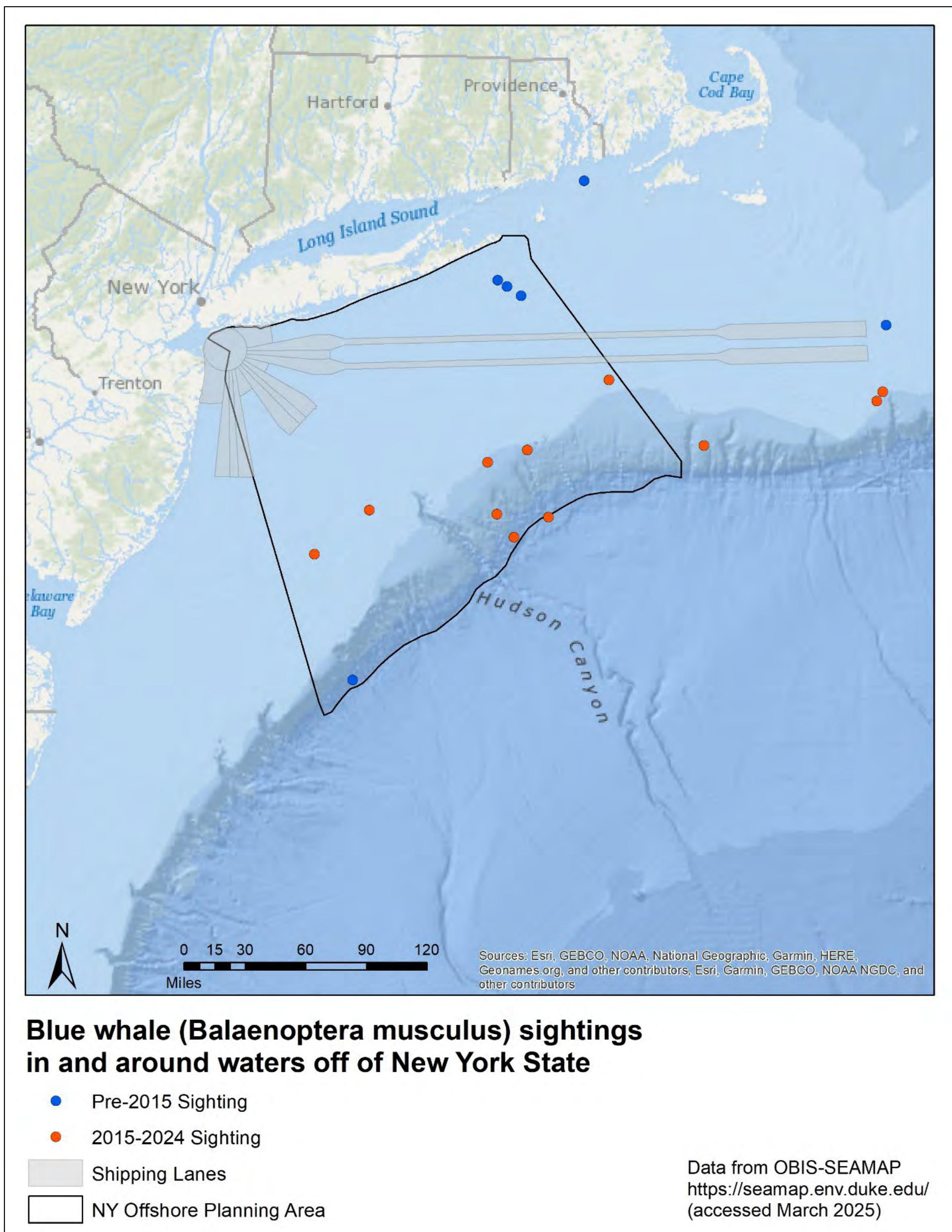


Figure 9. Blue whale sightings in and around the New York Bight. Data downloaded from OBIS-SEAMAP and mapped in ArcMap 10.2.

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. Pelagic

b. Marine, Deep Subtidal

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
No	No	Increasing	2015 to present

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

Habitat use by blue whales in New York waters is not well understood. Likewise, overall migration patterns are not well understood and vary. Blue whales are highly mobile and generally migrate seasonally from the Arctic to at least the mid-latitudes, between feeding areas in the summer and mating and calving areas in the winter. Historically, blue whales were known to stay in subtropical waters throughout fall and winter (Reeves et al. 2004). While in Canada they can occur relatively close to shore, there is a strong offshore (e.g., open ocean) presence off the U.S. East Coast. Preference for shelf breaks, seamounts, and other highly productive areas has been reported (Clark and Gagnon 2004). However, unlike other baleen whale species, blue whales don't fast on breeding grounds or most of their migration (Sirovic and Oleson). Instead, they forage along the migration route and in breeding areas, highlighting that prey availability is the primary driver of their behavioral and habitat choices. Each population of blue whales has extremely specific prey preferences; in the North Atlantic, *Thysanoessa inermis* has been reported as the primary choice (Nemoto 1957).

Re-sightings within years in the Gulf of St. Lawrence indicate they have varying levels of site fidelity, and multiple instances of traveling more than 400 km in two weeks have been documented (Sears et al. 1990). However, both wintering and summering areas appear to be occupied at some level throughout the year. Some individuals may reside year-round in habitats of high productivity, while others undertake long migrations from tropical waters to high latitude feeding grounds, but possibly stopping to feed in areas of high productivity on route, or may migrate very limitedly (Lesage *et al.* 2017). Year-round occurrence off Atlantic Canada has been further confirmed through additional passive acoustic monitoring (Wingfield et al. 2022, Delarue et al. 2022).

The Gulf of St. Lawrence is mainly used to feed in the summer but blue whales can occur there year-round. Most leave by early winter when ice cover becomes a threat. Blue whales were observed an average of two days per season with an average occupancy of 22 days (Ramp and Sears 2013). Blue whales have been tracked from the Gulf of St. Lawrence to the New England Seamounts and coasts of North and South Carolina in the winter (Lesage et al. 2017). Acoustic detections of blue whales have been recorded as far south as Savannah, Georgia at offshore locations, indicating presence of blue whales along the U.S. East Coast that is not likely otherwise detected (Kowarski et al. 2022).

The drivers of blue whale distribution and habitat use are deep water and prey aggregations (Beauchamp 2009). Blue whales travel to where krill abundance is greatest, which is typically associated with bathymetric features such as continental shelf edges, underwater canyons, and

deep channels where upwelling occurs, creating highly productive areas (Beauchamp 2009). The dense aggregations of krill are targeted by blue whales (Hazen et al. 2015).

If blue whales are feeding while migrating through New York they may be found in areas where their prey could be expected to be concentrated. Further research is needed to be able to determine which areas of New York waters are most frequently used by this species. Research is also needed to determine if blue whales are feeding while in this area.

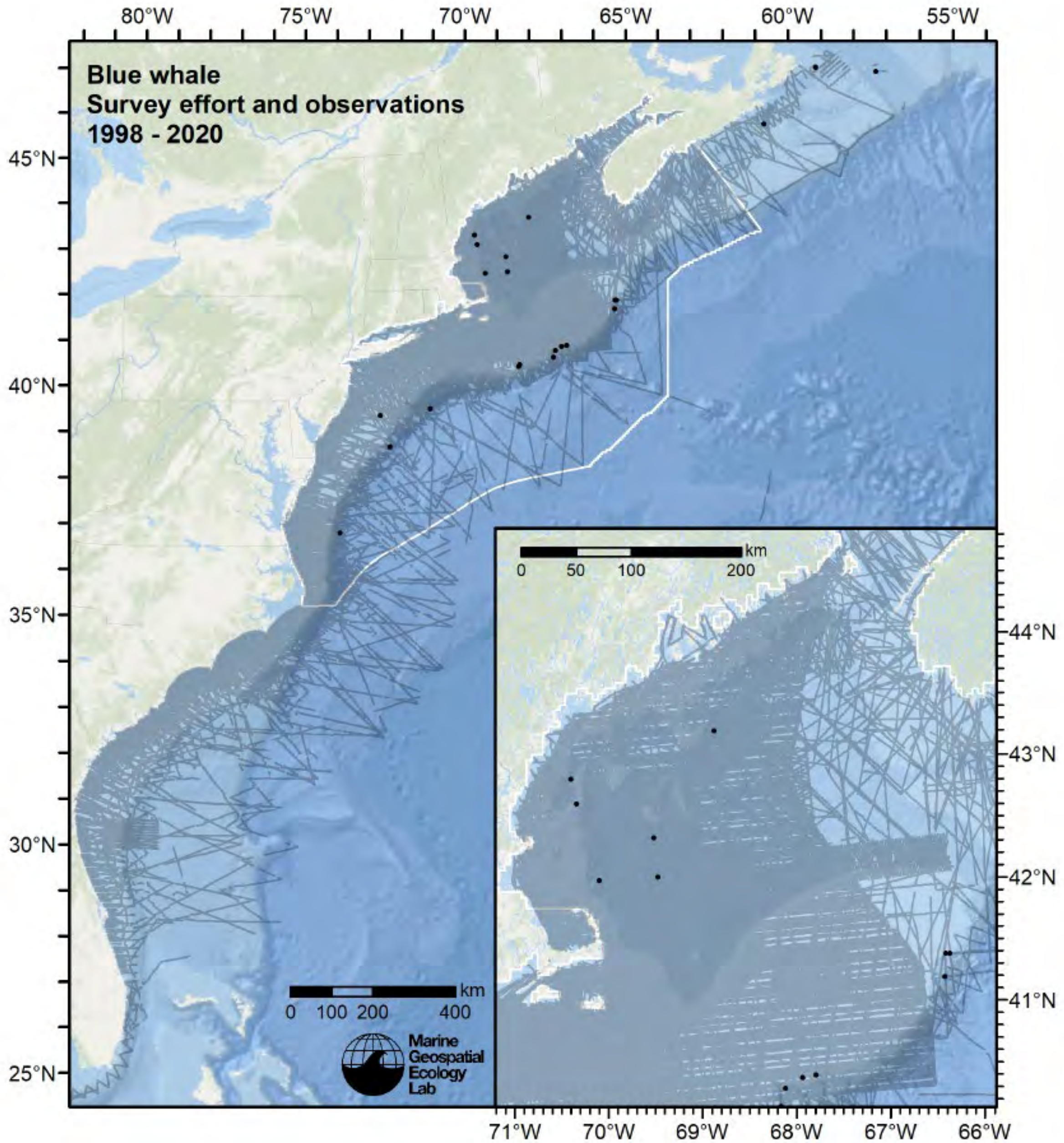


Figure 10. Survey effort and blue whale observations available for density modeling, after detection functions were applied, and excluded segments and truncated observations were removed (Roberts et al. 2022).

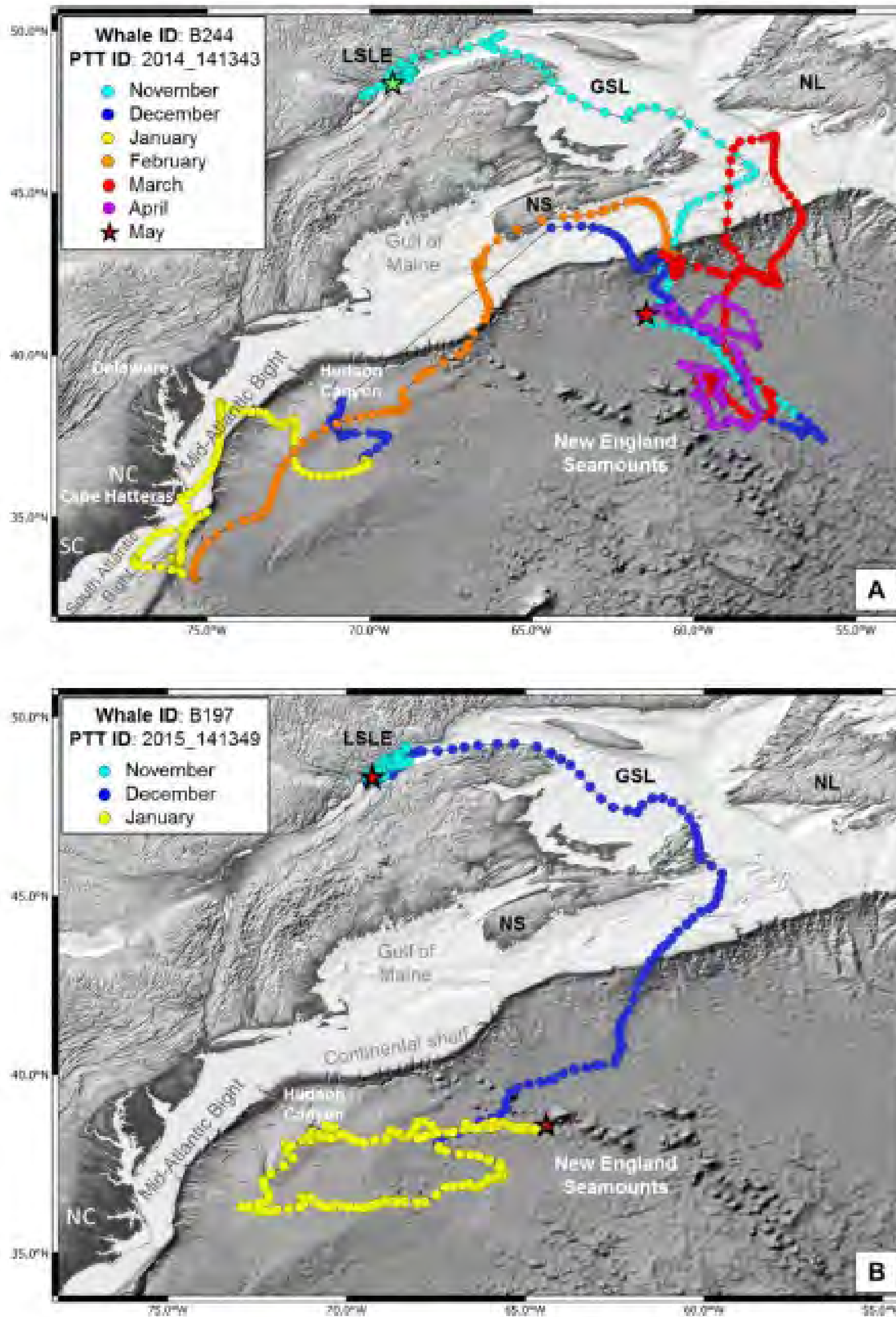


Figure 11. Switching state-space model estimated positions for 2 female blue whales: (a) whale B244 and (B) whale B197. Stars indicate where tags were deployed in the St. Lawrence Estuary, Canada and where transmissions ceased in the North Atlantic (Lesage et al. 2017).

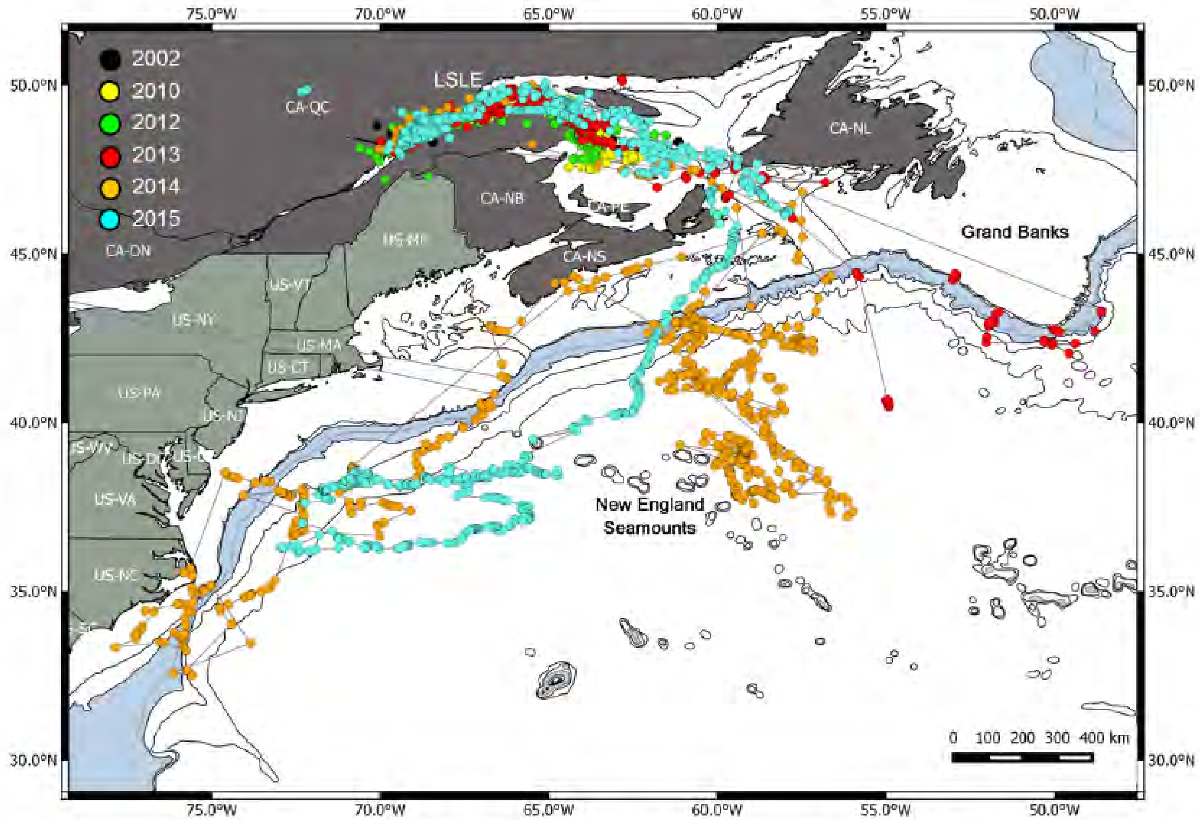


Figure 12. Argos raw satellite tracks from 23 blue whales tagged in the Estuary and Gulf of St. Lawrence, Quebec in 2002 (n=1), 2010 (n=2), 2012 (n=5), 2013 (n=8), 2014 (n=2), and 2015 (n=5). Shaded blue polygon depicts the continental shelf slope (depth 500-2500; Lesage et al. 2016).

V. Species Demographics and Life History

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Unknown	Choose an item.	Unknown	Choose an item.	Unknown	Choose an item.

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

The life history of blue whales is not well understood. Life span is estimated to be around 80 to 90 years, though the oldest known blue whale, aged using the ear plug, was around 110 years old (Yochem and Leatherwood 1985). The annual survival rate for adults based on sightings from 1979 to 2002 was estimated to be 0.975 for individuals in the Gulf of St. Lawrence region (Ramp et al. 2006). Generation time is estimated to be 31 years (Taylor et al. 2007).

Blue whales can weigh more than 150,000 kilograms (165 tons) and reach 32 meters in length. There are geographic differences in size: North Atlantic blue whales are generally smaller than Southern Ocean blue whales, reaching a maximum of 27 m in length (NMFS 2020a). In addition, baleen whales exhibit sexual dimorphism so female blue whales are slightly larger than males (Lockyer 1984, Yochem and Leatherwood 1985). At birth, blue whales are 7 meters and 3 tons. Not only are blue whales the largest animals on Earth, they are also the loudest, with calls measuring up to 186 decibels, louder than a jet (DFO 2020). Blue whales can swim at speeds of up to 36 kilometers per hour but have a typical cruising speed of 2 to 8 kilometers per hour (DFO 2020).

Like other species of baleen whales, blue whales are solitary animals. They may partake in short-term associations, migrating or feeding in pairs or small groups, but the only true bond is between mothers and calves (Sears et al. 1990, Reeves et al. 1998, Sears and Calambokidis 2002). Semi-stable male-female pairs on feeding grounds during the summer have also been reported (Schall et al. 2019, Sears and Larsen 2002, Berchok et al. 2006). However, concentrations of 20 to 40 blue whales have been documented in areas with abundant food (Beauchamp et al. 2009). Because blue whales are lunge feeders, foraging is energetically expensive and prey concentration needs to meet a minimum threshold (Goldbogen et al. 2011); when krill density is high, at the surface or at depth, feeding is efficient (Donoil-Valcroze et al. 2007). The blue whale diet consists primarily of euphausiids (i.e., krill). In the western North Atlantic their diet consists of two main species: *Thysanoessa inermis* and *Meganyctiphanes norvegica*. Blue whales have to meet a threshold of consumption of very high krill concentrations in order to increase body fat and store reserves (Lockyer 1984). One whale may eat up to 40 million pounds (6 tons) of krill per day (Yochem and Leatherwood 1985, Sears and Perrin 2009, DFO 2020). The reserves accumulating during the feeding season are needed for winter migration and reproduction (Lockyer 1984). Through summer, foraging pregnant females eat 60% of their body weight (Lockyer 1984). Without reserves, migration and/or reproduction may be significantly hampered.

Reproductive activity, including mating and calving, takes place in winter. The breeding grounds for the western North Atlantic population are still unknown but are likely to occur in warmer low-latitude waters (NMFS 2020a). Little is known about the blue whale mating system but anatomy and behavior during the breeding season point to a polygynous, antagonistic male-male competition strategy (Brownell and Ralls 1986, Sears et al. 2013). It's estimated that males and females reach sexual maturity at approximately 10 years of age though some sources say it ranges between 5 and 15 years of age (Rice 1963, Mizroch et al. 1984, Yochem and Leatherwood 1985, Sears et al. 2013). Taylor et al. (2007) estimated age at first reproduction for blue whales to immediately follow maturity (e.g., at 11 years old) and estimated the proportion of mature individuals to be 72% for a stable population or 48% for an increasing population, with an increase rate of 5%. The average calving interval is 2 to 3 years, depending on the female's ability to gain weight during lactation (Lockyer 1984). It is unknown if the calving interval has changed due to the cessation of whaling pressure on the species. Females give birth after a 10-to-12-month gestation period and calves are nursed for 6 to 7 months before being weaned on route to or on summer feeding grounds (Mackintosh and Wheeler 1929).

The western North Atlantic population of blue whales is known to be wide-ranging, which may work to their advantage. Only 13 calves were observed from 1979 to 2002 in the Gulf of St. Lawrence (Ramp et al. 2006), suggesting there are unknown areas where whales of all demographics frequent. Whales photographically identified in the Gulf of St. Lawrence have been seen in New England waters, off the coast of Greenland, and over the Scotian Shelf (Beauchamp 2009). At least some portion of the population remains in these waters year-round while others travel to lower latitude breeding grounds in the winter. Lesage et al. (2017) discovered evidence of possible wintering in the U.S. mid-Atlantic that is likely for breeding or calving. In addition, North Atlantic blue whales have recently begun to recolonize whaling-era habitat. For example, Covelo et al. (2017) reported the first record of a blue whale at the Iberian peninsula in over three decades.

Blue whales exhibit three different call types – A, B, and D. Temporal differences in the production of the call types suggest they may be used in different contexts (Romagosa et al. 2020). D calls, a non-

song sound, are a down sweep commonly associated with foraging and produced by males and females. D calls don't seem to vary much between populations and have been observed to occur between or among pairs or groups of blue whales (Oleson et al. 2007). D calls are most likely to be heard on feeding grounds during spring and summer and, as such, have been hypothesized to signal to other whales that an area is good for feeding (Sirovic and Oleson 2022). Blue whale songs tend to be unique to distinct populations, and likely function as a reproductive display (McDonald et al. 2006, Sirovic and Oleson 2022). While mating behavior is largely unknown, breeding displays include songs produced by males (McDonald et al. 2006, Oleson 2007, Sirovic and Oleson 2022). Male singers generally sing the same song type, which is separated specifically by the migratory behavior and habitat characteristics of each population. Oceanic populations, like the western North Atlantic stock, tend to have fewer complex vocalizations (Berchok et al. 2006). The North Atlantic Ocean has a single song type, compared to other locations like the Pacific Ocean which has four and the Indian Ocean which has three (Berchok et al. 2006, McDonald et al. 2006).

Blue whales are known to hybridize with other large whale species like fin and humpback whales, and these events have been reported since the 19th century (Berube and Aguilar 1998, Reeves et al. 2002, Berube et al. 2017, Pampoulie et al. 2021). Though instances of hybridization are still believed to be relatively rare, albeit underestimated, it's likely that the biodiversity and biomass lost during industrial whaling interrupted blue whale reproduction and facilitated hybridization events (Pampoulie et al. 2021). Pampoulie et al. (2021) analyzed eight samples collected in Iceland and found that all but one had a blue whale mother, suggesting unidirectional hybridization. The authors also presented for the first time the existence of a second-generation adult male hybrid resulting from a female hybrid and a male fin whale (Pampoulie et al. 2021). The existence of a second-generation adult hybrid proves that a first-generation fin-blue hybrid is not only able to breed with one of the parent species, but that their offspring can survive into adulthood. The hypothesis for this phenomenon proposes that females from the rarer species (e.g., blue whales) reject males from the more common species but eventually mate with the common species due to lack of conspecifics (Pampoulie et al. 2021). Hybridization events do not come without concern: they are considered a potential threat to the recovery of blue whales through loss of blue whale calves or through overestimation of the population size, since hybrids aren't likely to be visually discernable. In an already compromised population, where recovery has been slowed by resource competition and climate change, hybridization is an additional complicating factor (Reeves et al. 1998, Thomas et al. 2016, Pampoulie et al. 2021). Further evidence exists in the first reported fin-blue hybrid in the Mediterranean Sea in 2022 (Fioravanti et al. 2022).

As previously mentioned, natural mortality in blue whales may occur via ice entrapment or predation (NMFS 2020a). Animals that become caught in ice can die from physical injury by the ice or can drown if their breathing holes freeze over, though ice entrapment events occur only in the Gulf of St. Lawrence or further north (Sears et al. 1990, Stenson et al. 2003). A small percent of individuals seen in the Gulf of St. Lawrence have scars from ice (Sears et al. 1990). From 1868 to 1992, 23 ice entrapment events between March and April involving 41 individuals (1 to 4 individuals per event) were reported southeast of Newfoundland. Of the 41 involved, 28 died, 5 escaped, and 8 were unaccounted for. Most individuals that died were examined and found to be mature and one was pregnant (Stenson 2003). Due to their size, blue whales are an unlikely target for orcas and sharks, but calves and sick individuals are occasionally killed (Sears and Perrin 2018). Predation events infrequent and may or may not be fatal (Reeves et al. 1998, Totterdell et al. 2022).

There has been considerable discussion overtime about interspecific competition among baleen whales (Mitchell 1975). The substantial dietary overlap among these species establishes the potential for interference competition but no conclusive evidence exists that interspecific competition among baleen whales is affecting population recovery rates (Clapham and Brownell 1996). Savenkoff et al. (2013) found that blue whales in the St. Lawrence Estuary apparently do not need to compete for krill. However, more research is needed to determine if competition exists, if it might exist in the near-future, and how species may or may not adapt. One recent study of baleen whales off Iceland found blue and fin whale niche overlap which suggests strong interspecific competition (Garcia-Vernet et al. 2021). As

the authors note, “in a scenario of increasing environmental variability associated to global warming, the overlap between ecological niches may have to decrease to allow long-term coexistence” (Garcia-Vernet et al. 2021).

VI. Threats *(from NY 2015 SWAP or newly described)*

In general, threats to blue whales are not well understood, in part because most carcasses are not detected (NMFS 2020a, NMFS 2020b). Redfern et al. (2013) estimated blue whale carcass detection and recovery off Southern California to be less than or equal to 17%. And, because of the western North Atlantic population’s small size, activities affecting even a small number of individuals can have a significant impact on the species’ survival in the Atlantic. Most threats to the species are anthropogenic and include vessels strikes, anthropogenic noise, and loss of prey due to climate change (NMFS 2020a). It remains unknown whether and to what extent these threats are putting the species at risk.

Vessel Strikes

Over the past 50 years, increasing vessel traffic has been correlated with a three- to four-fold increase in the number of large whales reportedly struck by vessels annually (Vanderlaan et al. 2009). The increasing number of incidents is likely related to a combination of factors, one of which is the increase in vessel numbers, sizes, and transits (Redfern et al. 2020, Womersley et al. 2023). The global shipping fleet doubled in size from 2005 to 2022, and it’s estimated that the number of vessel transits could increase by up to 1200% by 2050 (Sardain et al. 2019, Womersley et al. 2023). The increase in strikes is also related to variable species distributions as habitats shift due to climate change (Meyer-Gutbrod et al. 2022, Redfern et al. 2020).

Vessel speed is a primary factor in lethal vessel strike events involving whales, with faster vessel speed increasing the likelihood of interactions and mortality resulting from an interaction (Vanderlaan and Taggart 2007, Conn and Silber 2013, Garrison et al. 2025). Using simple biophysical models, Kelley et al. (2021) determined that whales can be seriously injured or killed by vessels of all sizes and that a collision with a 50-ton vessel transiting at seven knots has a probability of lethality greater than 50%. Vessel strikes can cause broken bones and massive internal injuries, known as blunt force trauma, or cuts from propellers (e.g., lacerations), known as sharp force trauma. Both blunt and sharp force trauma have been observed as the cause of death for North Atlantic right whales. Importantly, there is not always obvious external impacts with blunt force trauma, which requires a necropsy for determination (Moore et al. 2013, 2020).

Ship strikes involving blue whales appear to be less common than with other baleen whale species (Laist et al. 2001). From 1975 to 2002, there were eight reported vessel strikes involving a blue whale in the U.S. (Jensen and Silber 2004). All of the strikes resulted in death but only one took place in the North Atlantic. The one documented event that occurred in the North Atlantic involved a juvenile blue whale in Rhode Island (Jensen and Silber 2004). Unfortunately, it is extremely difficult to determine where the vessel strike occurred because, as in this instance, the reported location indicates where the carcass (or injured whale) was discovered, not where the actual collision took place. In the Gulf of St. Lawrence, 16% of the blue whales in the photo identification catalogue have scars or wounds from vessel strikes (Sears and Calambokidis 2002). Blue whale behavior may play a significant role in their vulnerability to vessel strikes; McKenna et al. (2015) found that blue whales do not demonstrate effective avoidance behavior when ships are close by.

Ultimately, it is not known what impact ship strikes have on the western North Atlantic blue whale population (NOAA 2020a). This is especially problematic as changes in Arctic Sea ice extent may increase the number of vessels blue whales contend with; the opening of the Northwest Passage and Northern Sea Route is likely to increase the volume of vessel traffic transiting blue whale habitat (NOAA

2020a). Recreational vessels also pose the threat of vessel strike though are unlikely in New York to encounter blue whales due to their offshore distribution (Zoidis et al. 2021).

Entanglement

Fishing effort, and therefore entanglement risk, is pervasive, though the offshore distribution of blue whales in the northeast U.S. likely significantly decreases any entanglement risk to blue whales. However, commercial fishing still occurs far offshore. The ultimate cost of entanglement to an individual, especially in smaller endangered populations, can be extreme, though the full scope of impact on blue whales is currently unknown. Whales that survive an initial entanglement may shed the gear and heal over time. During this period, they can suffer from reduced feeding ability and suppressed immune system function, all leading to higher indirect mortality or reduced fecundity (van der Hoop et al. 2017). Even whales that survive the physical aspect of an entanglement (e.g., the gear is completely shed or removed) may suffer from reduced survival and fecundity, as has been documented in North Atlantic right whales (Knowlton et al. 2012).

Because reports of entangled blue whales are extremely rare, there is an assumption that entanglements are not common (Ramp et al. 2021). Ramp et al. (2021) compared photo-identification photographs from between 2009 and 2016 to drone images from 2018 and 2019, all collected in the Gulf of St. Lawrence. The study found that 13.1% of blue whales showed entanglement scars from photo-ID photos and that the more the caudal peduncle (e.g., tail area) was in the photo, the more scars there were: when the caudal peduncle was considered, the portion of the population with scars went to nearly 60%. This study revealed the importance of full-body documentation in scar assessments and highlights the lack of information for blue whales due to the fact that the majority of their dives are non-fluking (e.g., there is no view of the caudal peduncle area). It also indicates that entanglements and their impacts may be more significant than previously thought, even though no entanglement mortality or serious injuries of Western North Atlantic blue whales have been documented in U.S. fisheries (Hayes et al. 2020). A similar case can be made for marine debris, since whales may become entangled in it or may ingest it accidentally, but there have been no documented cases of blockage by debris in blue whales.

– *Aquaculture*

Expansions to the aquaculture industry, both inshore and offshore, may also affect blue whales. The addition of vertical lines in the water increases the risk of entanglement, both directly through whale interactions with aquaculture gear or secondarily through the entanglement of trailing gear on a whale with fixed aquaculture gear (Price et al. 2017). Increased vessel traffic in and around aquaculture farms will increase ambient noise levels and the risk of vessel strikes (Price et al. 2017). There may also be oceanographic changes to areas used for aquaculture that could affect the physical environment or create changes to prey availability.

Stranding and entanglement response in New York is done by the New York Marine Rescue Center (NYMRC) and the Atlantic Marine Conservation Society (AMSEAS). Each group is federally permitted and responsible for a different subset of cases. All large whale events – live and dead – fall under the purview of AMSEAS, however they are not authorized to disentangle large whales. The nearest group authorized to perform disentanglements is in Provincetown, Massachusetts.

Anthropogenic Noise

Another major threat due to human activities is noise pollution. Anthropogenic noise in the marine environment has increased substantially since the 1950s, and this rapid change in the acoustic environment may have significant implications for whales (McDonald et al. 2006, Hildebrand 2009,

Clark et al. 2009). The primary sources of anthropogenic noise in the ocean are shipping, oil and gas exploration (e.g., seismic surveys and air guns), military activities, and marine construction (e.g., pile-driving, dredging, etc.) (Nowacek et al. 2007). Cetaceans, including blue whales, rely primarily on sound to survive in the ocean. Despite their powerful vocalizations, the increasing levels of anthropogenic noise may hamper a blue whale's ability to carry out life stages in the form of masking (e.g., not hearing conspecifics), displacement, temporary or permanent hearing loss, stress, and other behavioral changes (Gordon et al. 2004, Nowacek et al. 2007, Tyack 2008, Southall et al. 2019). Noise may seriously disrupt marine mammal communication, navigational ability, and social patterns, but noise is also highly variable in its generation and its reception. Noise may be intermittent or continuous, steady or impulsive, and may be generated by stationary or passing sources. Noise exposure can result in a multitude of impacts, ranging from those causing little to no impact to more severe outcomes like serious injury or mortality (Richardson et al. 1995, Foote et al. 2004).

Response to anthropogenic noise exists on a spectrum, from minor physiological changes to death, and the level of response varies due to many factors. The potential effects of chronic noise on baleen whales include stress, acoustic masking, behavioral disturbance, displacement from habitat, temporary hearing loss and, in extreme cases, permanent loss of hearing or other physiological damage (Weilgart 2007). Hearing damage is usually categorized as causing either a temporary threshold shift (TTS) or a permanent threshold shift (PTS) (Southall et al. 2017, 2019). Excessive noise exposure may be particularly damaging during early development and may cause stress hormone fluctuations (Weilgart 2007). There are also short-term and long-term behavioral changes. Long-term changes include displacement from habitat (which may or may not be recolonized), sensitization (i.e., increased behavioral or physiological responsiveness over time) to noise that could exacerbate other effects, and habituation (i.e., decreased behavioral responsiveness over time) to chronic noise that could cause animals to remain close to noise sources. Except for displacement, long-term behavioral changes are subtle and therefore difficult to detect and quantify. Short-term changes include stopping a behavior such as feeding, resting, or socializing. Behavioral reactions can vary not only among individuals but also for a given individual between one specific set of variables and another, depending on previous experience (Szesciorka et al. 2019). Behavioral changes can include more calls, longer calls, or a different frequency of calls (Parks et al. 2007, Parks et al. 2009, Di Iorio and Clark 2010). Several species of large whales have been found to increase the amplitude of their calls in response to large levels of noise, which could lead to increased energy consumption (Holt et al. 2009, Parks et al. 2011). In contrast, above a certain level of noise, some whale species are known to stop vocalizing (Melcón 2012). There is also the potential for masking of calls if background noise occurs within the frequencies used by whales (Melcón 2012). In a large, solitary species, this could lead to difficulty finding other whales, including potential mates. The disturbance in sending and receiving acoustic signals can impact individual animals, groups of animals, or entire populations (Richardson et al. 1995). Continuous compensation for ambient noise levels could have significant energetic consequences, particularly if these shifts in vocalizing impact foraging efficiency. The acoustic monitoring in the New York Bight in 2008-2009 and 2017-2020 recorded elevated levels of ambient noise, sometimes over the NOAA-established limit for harassment and behavioral impacts (BRP 2010, Southall et al. 2019, Estabrook et al. 2021).

– *Military Activity*

Acute, intermittent noise from military activity, especially from mid-frequency sonar and explosions, is likely to result in significant behavioral disruption and responses, and, at sufficiently high levels, may result in mortality from acoustic trauma for some baleen whale species (Weilgart 2007). Controlled experiments have shown clear behavioral responses to simulated military sonar and sounds by blue whales, including cessation of feeding, increased swimming speed, and travel away from the sound source (Goldbogen et al. 2013, Southall et al. 2014).

– *Oil and Gas Exploration*

As with military activity, the acute, intermittent noise from seismic mineral exploration is likely to cause significant behavioral change and, for some baleen whale species at high enough levels, result in mortality (Gailey et al. 2007, Dunlop et al. 2017, Harris et al. 2018). Baleen whales are known to detect the low-frequency sound pulses emitted from air guns used during seismic surveys and have been observed changing their behavior due to the presence of seismic survey vessels (McCauley et al. 2000, Stone and Tasker 2006). Stone et al. (2003) found that baleen whales were sighted less frequently and exhibited avoidance behavior when air guns were active. In addition, whales tended to dive less at these times, possibly because noise levels are lower near the surface than at depth (Richardson et al. 1995).

Seismic operations have also been linked to more extended area avoidance and louder vocalization levels by baleen whales (Castellote et al. 2012a, Nieukirk et al. 2012). Kavanagh et al. (2019) found a significant effect of seismic surveys on baleen whales; by modelling cetacean survey data from the East Atlantic Ocean, the authors found that seismic activity resulted in an 88% reduction in baleen whale sightings. Again, the continuous compensation in high-activity areas, such as the east coast of Canada which has been subject to much oil and gas exploration, may have lingering impacts on a blue whale's overall fitness and studies have highlighted concerns about the long-term effects of prolonged exposure to air guns (Delarue et al. 2018). In response to an active seismic array, migrating baleen whales changed their behavior and respiration rates, and their progression migrating was slowed to below normal speeds (Dunlop et al. 2017). Changing the time of arrival on the breeding or feeding grounds may impact the availability of resources in terms of mates or prey, respectively (Szesciorka et al. 2020). Dunlop et al. (2020) showed further impacts of seismic arrays and vessel noise, reporting the reduction of social interactions when vessels were present, even if the seismic array was inactive. Importantly, the distance at which this impact occurred is much greater than that considered for mitigation measures currently.

– *Shipping*

Shipping is the main source of low-frequency noise in the oceans (Ruppel et al. 2022). Over the past few decades, the contribution of shipping activities to ambient noise has increased by 12 dB (Hildebrand 2009). As highly migratory species, blue whales, like all baleen whales, depend on long-range communication to maintain individual and population health (Payne and Webb 1971). As such, noise pollution may make a previously occupied area unsuitable for this species. Large vessels generate loud noise at low frequencies, which degrades the blue whale acoustic environment and changes whale behavior (DFO 2020). Cholewiak et al. (2018) determined that vessel noise near shipping lanes, which includes most of the New York Bight, significantly decreases the communication space of multiple baleen whale species. Additionally, Clark et al. (2009) found that baleen whales showed diminished call rates in the presence of passing vessels.

In the Gulf of St. Lawrence, where the greatest concentration of blue whales exist, is Eastern Canada's main shipping route, the St. Lawrence Seaway. Because shipping noise overlaps with the low frequency vocalizations of baleen whales, calls are masked near shipping lanes (Aulanier et al. 2016). Aulanier et al. (2016) found that a blue whale's risk of ear injury due to shipping noise was practically non-existent, but the risk of behavioral response and communication masking was present. The risk of behavioral response was higher at daytime feeding depths and peaked at 30% within 20 km of the shipping lane, though the risk of the entire Gulf area was generally under 10%. Aulanier et al. also found that D-calls are more at risk of masking by shipping noise than A-calls. Overall, the Gulf area was fragmented by shipping noise, implying even more difficulty to send and receive signals rather than simply a reduced communication space. Furthermore, seven of the ten blue whale song types identified worldwide have shifted linearly downward in tonal frequency (Nieukirk et al. 2005, McDonald et al. 2009). There are several hypotheses for this shift, the most likely being "cultural conformity and sexual selection" (McDonald et al. 2009).

Offshore Energy Development

The effects of other anthropogenic activities, such as offshore energy development and oil spills, are also largely unknown. Pre-construction, construction, operation, and decommissioning encompass a wide range of underwater sound in addition to pile driving noise (Ruppel et al. 2022). In addition, offshore energy development could potentially degrade blue whale habitat or displace them from common foraging or breeding areas. Studies have found evidence of this in passive acoustic data that showed the Southern New England area is an important area for blue whales and other endangered cetacean species (Stone et al. 2017, Van Parijs et al. 2023). Development of offshore wind energy areas will also introduce a significant amount of vessel traffic, compounding impacts (Van Parijs et al. 2023). In addition, baleen whales are at the highest risk of entanglement in the moorings and associated power cables used to anchor offshore renewable energy, including wind, wave, and tidal energy (Benjamins et. al. 2014, Maxwell et al. 2022).

– *Oil Spills*

Oil spills that occur while blue whales are present could result in skin irritation, baleen fouling, ingestion of oil, respiratory distress from fumes, ingestion of contaminated prey, and displacement from habitat (Geraci 1990). Actual impacts would depend on the extent and duration of contact and the characteristics of the oil. Most likely, the effects would be irritation to the respiratory system and absorption of hydrocarbons into the bloodstream (Geraci 1990). Oil can be ingested if whales attempt to feed while swimming through an oil slick, poisoning them and causing damage to internal systems such as the immune and endocrine systems. Health assessments conducted on bottlenose dolphins after the Deepwater Horizon Oil Spill indicated that persistent lung disease and impaired stress response were present for at least 4 years after the disaster (Smith et al 2017). Additionally, Marques et al. (2023) found that it would take 11 years for the Gulf of Mexico sperm whale stock to recover to 95% of the pre-spill baseline. Oil spills would likely also have effects down the food chain, potentially causing energetic effects for sei whales who may have to travel further to forage.

Climate Change

With a low birth rate, late sexual maturity, and specific, limited food resources, blue whales may be significantly impacted by climate change. Long-term changes in climate and oceanographic processes could have numerous effects on blue whales (MacLeod 2009). Blue whales feed almost exclusively on euphausiids and are dependent on high concentrations of this prey source to survive (Beauchamp et al. 2009). Climate change could alter the suitability of certain areas for euphausiids. For example, one of the primary types of krill consumed by blue whales depends on a cold intermediate layer, which very well may be lost in the increasing water temperature that has been observed in the North Atlantic (Beauchamp et al. 2009, Simard et al. 1986). Oceanographic conditions might become less favorable to species such as krill in higher latitudes like the Gulf of St. Lawrence (Hays et al. 2005). Between 1750 and 1994, ocean surface pH decreased with a corresponding 26% increase in acidity, particularly at high latitudes (Bindoff et al. 2007). Increasing ocean acidity will likely significantly impact krill availability in time and space, and krill quality (Kawaguchi et al. 2011). The blue whale's relatively specialized diet might make them more vulnerable to climate change impacts on their prey, compared to species that practice prey switching. Because blue whales rely mostly on stored energy reserves for reproduction, they seek the highest densities of krill to feed efficiently (Guilpin et al. 2019). However, modeling results show that reduced krill densities and/or repeated interactions with vessels (e.g., the closest approach distance) lead to a decrease in the net energy gained during feeding (Guilpin et al. 2020).

As stated in the U.S. Recovery Plan: "The effects of climate-induced shifts in productivity, biomass, and species composition of prey on the foraging success of blue whales have received little attention and more research is needed to understand possible impacts and the extent to which these impacts might impede blue whale recovery" (NMFS 2020a). Distribution shifts in blue whales as they follow their prey to novel areas is of particular concern due to the probable lack of management measures to protect blue whales in these new areas. Redfern et al. (2020) found that blue whales off the California coast have exhibited a broad scale shift northward, likely in response to changing oceanographic conditions, and that these shifts were associated with an increased risk of vessel strike. The same northward shift has also been detected in North Atlantic blue whales (Kowarski et al. 2022). Szesciorka et al. (2020) concluded that while krill is the driving force behind blue whale movements, blue whales have a plastic response to prey availability, meaning they may arrive and/or leave feeding grounds earlier or later depending on conditions. The ability to respond to interannual variability in oceanographic conditions is essential for life in the age of climate change, though longer times at feeding grounds may also increase risk to anthropogenic activities due to lack of existing mitigation measures (Szesciorka et al. 2020). Recent analysis of passive acoustic monitoring data revealed that during a marine heatwave, there was reduced foraging effort in blue whales followed by reduced reproductive effort, showing the cascading effects of climate change on the species (Barlow et al. 2023). It's unclear if certain blue whale populations have different adaptive capabilities, as one study in Iceland found that blue whales did not show evidence of adapting to shifts in prey availability (Garcia-Vernet et al. 2021).

Marine Debris

According to the United Nations Global Compact, more than 8 million tons of plastic ends up in the ocean every year, and the amount of plastic in the ocean is expected to quadruple by 2040 (United Nations Global Impact 2025). Plastic ingestion has been well documented in cetaceans including several species of baleen whales. Ingestion of marine debris by cetaceans may include internal injuries or cause complete blockage to the digestive tract leading to malnutrition, starvation, and mortality (Simmonds 2012, Baulch and Perry 2014). Most cetacean ingestion of marine debris is discovered through necropsies of stranded animals and has been documented in more than half of extant cetacean species, including nine baleen whale species, with ingestion rates as high as 31% in certain populations (Baulch and Perry 2014, Weir 2017).

Kahane-Rapport et al. (2022) further investigated microplastic ingestion by baleen whales off California. The study found that baleen whales feed at the same depth of the highest microplastic concentrations and 99% of microplastic ingestion occurs via tropic transfer. These two factors resulted in estimates indicating that krill-feeding whales, like blue whales, may ingest 10 million pieces of microplastic per day (compared to fish-feeding whales which may ingest 200,000 pieces of microplastic per day). The authors state that "over the course of a feeding season…a large blue whale may ingest over one billion pieces of microplastic". Werth et al. (2024) likewise found that the ability of plastic pollution to be captured and collected in baleen poses a problem for all baleen whale species.

Contaminants, Toxins, and Chemical Pollution

Research on contaminants, toxins, and other chemical pollutants is lacking for the western North Atlantic blue whale stock (Hayes et al. 2019). It was believed that contaminants such as organochlorines and heavy metals do not negatively impact baleen whales as much as other marine mammals, but it remains to be seen whether this holds true over time (O'Shea and Brownell 1995). In the Gulf of St. Lawrence, the concentrations of PCBs, DDT, and other organochlorine compounds were found in higher concentrations in the blubber of male blue whales, indicating there is maternal transfer of contaminants from females to their calves (Metcalfe et al. 2004). A lifetime reconstruction by Trumble et al. (2013) of a male blue whale using the earplug showed significant maternal transfer of pesticides,

PCVs, and other organic contaminants during the animal's first year of life. This transfer was about 20% of the whale's total lifetime burden. Additional lifetime profiles have been constructed for blue whales, showing significant chemical exposure to persistent organic pollutants (POPs) such as DDT and PCBs (Winfield et al. 2020). These POPs were dominant throughout the 80-year profiles and were detected as early as the 1930s. The Winfield et al. (2020) study used earplugs from blue whales in both the Atlantic and Pacific Oceans and estimated that lifetime bioaccumulation rates were 56 times higher in the North Pacific compared to the North Atlantic, indicating increased levels of exposure in the North Pacific.

While no exceedingly significant effects of contaminants have yet been documented in blue whales, it is possible that exposure has long-term effects such as reduced reproductive success and/or long-term survival. There remains a risk of bioaccumulation for this long-lived species, and lack of understanding of health impacts of contaminants is particularly concerning in this small population with emerging toxins and chemicals. It's also true that some toxic contaminants do not accumulate in the tissues after exposure but may still have negative impacts. Perhaps most concerningly, climate change may serve to amplify the effects of contaminants and the presence of certain pathogens in the marine environment, which is another example of the importance of considering and understanding cumulative impacts (Schiedek et al. 2007).

- *Harmful Algal Blooms (HABs)*

There has been a global increase in cases of poisoning in cetaceans due to harmful algal blooms (HABs; Harvell et al. 1999). The algae produce a neurotoxin called saxitoxin, which cetaceans ingest through their prey, and which subsequently causes neurological issues that may be fatal. Sub-lethal effects of HABs may include lower reproductive success and increased susceptibility to other threats (Leandro et al. 2010).

A HAB was linked to the largest baleen whale mass mortality ever recorded, which killed hundreds of sei whales in Chilean Patagonia in 2015 (Häussermann et al. 2017). Based on the findings of Häussermann et al. (2017), the effects of biotoxins in HABs can be potentially catastrophic for small populations (i.e., endangered species like blue whales), as hundreds of animals may die in a single episode. Recent analysis of HAB events indicates that there is not as strong a relationship between HAB occurrence and whale injuries and deaths on the east coast as there is on the west coast, but there remains a risk as intensity and frequency of HABs are expected to increase with ocean warming (Gobler et al. 2017, Silber and Silber 2024). For example, higher than usual precipitation in the St. Lawrence Estuary during the summer of 2008 caused a rise in water temperature and a decrease in salinity that triggered a red tide event killing many marine species including a fin whale (Dufour et al. 2010).

Threat Level 1	Threat Level 2	Threat Level 3	Spatial Extent	Severity	Immediacy	Trend	Certainty
3. Energy Production & Mining	3.1 Oil & Gas Drilling	Choose an item.	Restricted	Slight	Near-term	Stable and ongoing	Choose an item.Low
3. Energy Production & Mining	3.3 Renewable Energy	3.3.2 Wind farms	Restricted	Slight	Near-term	Intensifying	Choose an item.Moderate
4. Transportation & Service Corridors	4.3 Shipping Lanes	4.3.1 Shipping	Pervasive	Moderate	Immediate	Intensifying	Choose an item.High
4. Transportation & Service Corridors	4.3 Shipping Lanes	4.3.2 Dredging of shipping lanes	Small	Slight	Immediate	Unknown	Choose an item.Low
5. Biological Resource Use	5.4 Fishing & Harvesting Aquatic Resources	5.4.2 Commercial fishing	Large	Slight	Immediate	Intensifying	Choose an item.High
6. Human Intrusions & Disturbance	6.2 War, Civil Unrest & Military Exercises	6.2.3 Military exercises	Restricted	Moderate	Immediate	Unknown	Choose an item.Low
8. Invasive & Other Problematic Species	8.2 Problematic Native Plants & Animals	8.2.6 Increased predation by large predators	Small	Slight	Immediate	Intensifying	Choose an item.Low
8. Invasive & Other Problematic Species	8.4 Pathogens	Choose an item.	Restricted	Slight	Immediate	Unknown	Choose an item.Unknown
8. Invasive & Other Problematic Species	8.5 Intrinsic Biological Limitations	8.5.1 Loss of genetic diversity	Pervasive	Moderate	Long-term	Unknown	Choose an item.Low
9. Pollution	9.1 Domestic & Urban Wastewater	Choose an item.	Restricted	Slight	Near-term	Stable and ongoing	Choose an item.Low
9. Pollution	9.2 Industrial & Military Effluents	Choose an item.	Restricted	Slight	Near-term	Unknown	Choose an item.Low
9. Pollution	9.4 Garbage & Solid Waste	9.4.4 Drifting plastic and entanglement rubbis	Pervasive	Slight	Immediate	Intensifying	High

9. Pollution	9.6 Excess Energy	9.6.3 Noise pollution	Pervasive	Moderate	Near-term	Intensifying	Choose an item.High
11. Climate Change	11.1 Habitat Shifting & Alteration	11.1.2 Phenological mismatch	Large	Moderate	Near-term	Intensifying	Choose an item.High
11. Climate Change	11.2 Changes in Geological Regimes	Choose an item.	Large	Moderate	Near-term	Intensifying	Moderate
11. Climate Change	11.3 Changes in Temperature Regimes	Choose an item.	Large	Moderate	Near-term	Intensifying	Choose an item.Modera te

Table 1. Threats to blue whales.

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: _✓_ **No:** _____ **Unknown:** _____

If yes, describe mechanism and whether adequate to protect species/habitat:

The blue whale is protected in the United States by its status as a federally endangered species under the Endangered Species Act (ESA). In addition, the blue whale (along with all other marine mammals) receives federal protection under the Marine Mammal Protection Act (MMPA). The blue whale is protected internationally from commercial hunting under the International Whaling Commission's (IWC) global moratorium on whaling. The moratorium was introduced in 1986 and is voted on by member countries (including the United States) at the IWC's annual meeting.

At the state level, blue whales are also protected under the Environmental Conservation Law (ECL) of New York, where the blue whale is listed as an endangered species. Section 11 – 0535 protects all state-listed endangered and threatened species and makes it illegal to take, import, transport, possess, or sell any listed species or part of a listed species. In addition, Article 17 of the ECL works to limit water pollution, and Article 14 presents the New York Ocean and Great Lakes Ecosystem Conservation Act.

Whether these protections are adequate is currently unknown.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

It is still largely unknown how frequently blue whales utilize New York waters, when they are most likely to be present, and what they are doing when they're here. Long-term surveys and monitoring strategies are being developed and implemented but remain underfunded. Additional more robust information about blue whale abundance and distribution in the New York Bight can assist with management and conservation decisions. Studies focused on blue whale behavior to determine whether they are feeding, migrating, or mating/calving will inform recovery plans and better prioritize research efforts. Satellite tagging of blue whales while they are present in the New York Bight would shed light on the length of residency if in fact blue whales are using the Bight and greater mid-Atlantic for wintering as has been hypothesized.

Finally, little is known about general life history and demography of this species, and the actual impact of the threats in New York waters are unknown. Further research into the effects of anthropogenic threats such as vessel strikes and climate change on blue whales is warranted. Specifically, quantifying the level of anthropogenic threats for blue whales in the New York Bight could help determine whether management action outside of research initiatives are needed.

In addition, education on this species and the importance of reporting sightings and interactions would support potential research and conservation measures. Given the sustained lack of recovery of the stock, law enforcement and economic incentives or disincentives should be considered. Alliance and partnership development should be prioritized so that actions taken reflect all available information and are implemented with the support of stakeholders.

Action Category	Action	Description
A.1 Direct Habitat Management	A.1.3 Mitigate human environmental impact	Implement seasonal speed restrictions on vessels in high use and/or high-risk areas
A.2 Direct Species Management	A.2.1 Stewarding wild individuals	Continue funding stranding response
B.3 Outreach	B.3.1 Outreach, communication and distribution	Encourage responsible human behavior
B.4 Law Enforcement and Prosecution	B.4.1 Detection and intervention B.4.2 Prosecution and conviction	Enforce potential regulations and maintain presence in high-use and/or high-risk areas to deter problematic activity
B.5 Economic and Other Incentives	B.5.4 Economic incentives and disincentives	Consider possible incentives and disincentives to support compliance and/or precautionary measures
C.6 Design and Plan Conservation	C.6.5 Conservation planning	Long-term conservation and management strategies should be developed.
C.7 Legislative and Regulatory Framework or Tools	C.7.1 Create, amend, or influence legislation, regulation, or codes C.7.2 Create or amend policies, guidelines, or best practices	Identify potential appropriate regulations, policies, etc.
C.8 Research and Monitoring	C.8.1 Basic research and status monitoring	Monitor blue whale presence in the New York Bight long-term Research on blue whale behavior to determine if they are feeding or mating while migrating Utilize tags and new technology to assess behavior and risk Investigate fine-scale seasonal and interannual trends
C.10 Institutional Development	C.10.3 Alliance and partnership development	Establish and maintain partnerships that bring additional resources to research and/or mitigation

Action Category	Action	Description
		Explore opportunities to collaborate on long-term monitoring, including public reporting systems Engage with local organizations and companies that are invested in whale conservation

Table 2. Recommended conservation actions for the blue whale.

VII. References

Aguilar, A. and C. Lockyer. 1987. Growth, physical maturity, and mortality of fin whales (*Balaenoptera physalus*) inhabiting the temperate waters of the northeast Atlantic. Canadian Journal of Zoology 65253–264.

Allen, K.R. 1970. A note on baleen whale stocks of the north west Atlantic. Reports to the International Whaling Commission 20:112-113.

Allison C. 2017. The IWC Catch Data Base, version 6.1. [online]. Available at: International Whaling Commission www.iwc.int.

Aulanier, F., Simard, Y., Roy, N., Bandet, M. and Gervaise, C., 2016a, July. Groundtruthed probabilistic shipping noise modeling and mapping: Application to blue whale habitat in the Gulf of St. Lawrence. In *Proceedings of Meetings on Acoustics* (Vol. 27, No. 1, p. 070006). Acoustical Society of America.

Aulanier, F., Simard, Y., Roy N., Gervaise, C., and Bandet, M. 2016b. Spatial-temporal exposure of blue whale habitats to shipping noise in St. Lawrence system. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/090. vi + 26 p.

Barlow, D. R., Klinck, H., Ponirakis, D., Branch, T. A., & Torres, L. G. (2023). Environmental conditions and marine heatwaves influence blue whale foraging and reproductive effort. Ecology and Evolution, 13(2), e9770.

Baulch, S. and Perry, C., 2014. Evaluating the impacts of marine debris on cetaceans. Marine pollution bulletin, 80(1-2), pp.210-221.

Beauchamp, J., Bouchard, H., de Margerie, P., Otis, N., Savaria, J. Y. 2009. Recovery Strategy for the blue whale (Balaenoptera musculus), Northwest Atlantic population, in Canada [FINAL]. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa. 62 pp.

Benjamins, S., Harnois, V., Smith, H.C.M., Johanning, L., Greenhill, L., Carter, C. and Wilson, B. 2014. Understanding the potential for marine megafauna entanglement risk from renewable marine energy developments. Scottish Natural Heritage Commissioned Report No. 791.

Berchok, C.L., Bradley, D.L. and Gabrielson, T.B., 2006. St. Lawrence blue whale vocalizations revisited: Characterization of calls detected from 1998 to 2001. *The Journal of the Acoustical Society of America*, *120*(4), pp.2340-2354.

Berube, M. and A. Aguilar. 1998. A new hybrid between a blue whale, Balaenoptera musculus, and a fin whale, B. physalus: Frequency and implications of hybridization. Marine Mammal Science 14: 82-98.

Bérubé, M., T. Oosting, A. Aguilar, K.M. Kovacs, F. Larsen, C. Lydersen, N. Oien, R. Prieto, C. Ramp, J. Robbins, R. Sears, M. Silva, G. Vikingsson, and P. Palsbøll. 2017. Are the “Bastards” coming back? Molecular Identification of the first live blue and Fin Whale hybrids in the north Atlantic Ocean. Oral presentation at 22nd Biennial Conference on the Biology of Marine Mammals, 22-27 October 2017, Halifax, NS, Canada.

Best, P.B. 1993. Increase rates in severely depleted stocks of baleen whales. ICES Journal of Marine Science 50:169-186.

Bindoff, N.L., J. Willebrand, V. Artale, A. Cazenave, J. Gregory, S. Gulev, K. Hanawa, C.L. Quéré, S. Levitus, Y. Nojiri, C.K. Shum, L.D. Talley and A. Unnikrishnan. 2007. Observations: Oceanic Climate Change and Sea Level. Pages 385-432 in S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller eds. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Bioacoustics Research Program [BRP]. 2010. Determining the seasonal occurrence of cetaceans in New York coastal waters using passive acoustic monitoring. Cornell Lab of Ornithology: Bioacoustics Research Program. TR 09-07. 60 pp.

Brownell, R.L., Jr. and K. Ralls. 1986. Potential for sperm competition in baleen whales. Special Issue 8: 97-112.

Castellote, M., C.W. Clark, and M.O. Lammers. 2012. Acoustic and behavioural changes by fin whales (Balaenoptera physalus) in response to shipping and airgun noise. Biological Conservation 147:115–122.

Cetacean and Turtle Assessment Program [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 Ref. No. AA551-CT8-48 of Cetacean and Turtle Assessment Program (CETAP) to the Bureau of Land Management, U.S. Department of the Interior, Washington, D.C.

Christensen, I., T. Haug and N. Øien. 1992. Seasonal distribution, exploitation, and present abundance of stocks of large baleen whales (Mysticeti) and sperm whales (Physeter macrocephalus) in Norwegian and adjacent waters. ICES Journal of Marine Science 49: 341355.

Cholewiak, D., Clark, C.W., Ponirakis, D., Frankel, A., Hatch, L.T., Risch, D., Stanistreet, J.E., Thompson, M., Vu, E. and Van Parijs, S.M., 2018. Communicating amidst the noise: modeling the aggregate influence of ambient and vessel noise on baleen whale communication space in a national marine sanctuary. Endangered Species Research, 36, pp.59-75.

Clapham, P.J. and R.L. Brownell, Jr. 1996. The potential for interspecific competition in baleen whales. Report of the International Whaling Commission 46: 361-367.

Clark, C.W. 1994. Blue deep voices: insights from the Navy's Whales '93 program. Whalewatcher 28(1):6-11.

Clark, C. W., Gagnon, G. C. 2004. Low-frequency vocal behaviors of baleen whales in the North Atlantic: Insights from IUSS detections, locations and tracking from 1992 to 1996. Journal of Underwater Acoust 52:609-640.

Clark, C.W., W.T. Ellison, B.L. Southall, L. Hatch, S.M. Van Parijs, A. Frankel, and D. Ponirakis. 2009. Acoustic masking in marine ecosystems: intuitions, analysis, and implication. Marine Ecology Progress Series 395:201–222.

Conn, P.B. and Silber, G.K., 2013. Vessel speed restrictions reduce risk of collision-related mortality for North Atlantic right whales. *Ecosphere*, *4*(4), pp.1-16.

Cooke, J.G. 2018. Balaenoptera musculus (errata version published in 2019). The IUCN Red List of Threatened Species 2018: e.T2477A156923585. http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T2477A156923585.en

Committee on the Status of Endangered Wildlife in Canada [COSEWIC]. 2012. COSEWIC status appraisal summary on the Blue Whale Balaenoptera musculus, Atlantic population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xii pp. (www.registrelep-sararegistry.gc.ca/default_e.cfm).

Davis, G. E., Baumgartner, M. F., Corkeron, P. J., Bell, J., Berchok, C., Bonnell, J. M., Bort Thornton, J., Brault, S., Buchanan, G. A., Cholewiak, D. M., Clark, C. W., Delarue, J., Hatch, L. T., Klinck, H., Kraus, S. D., Martin, B., Mellinger, D. K., Moors-Murphy, H., Nieukirk, S., Nowacek, D. P., … Van Parijs, S. M. (2020). Exploring movement patterns and changing distributions of baleen whales in the western North Atlantic using a decade of passive acoustic data. Global Change Biology, 26(9), 4812–4840. https://doi.org/10.1111/gcb.15191

Delarue, J. J. Y., Moors-Murphy, H., Kowarski, K. A., Davis, G. E., Urazghildiiev, I. R., & Martin, S. B. (2022). Acoustic occurrence of baleen whales, particularly blue, fin, and humpback whales, off eastern Canada, 2015-2017. Endangered Species Research, 47, 265-289.

Di Iorio, L. and C.W. Clark. 2009. Exposure to seismic survey alters blue whale communication. Biol Lett 6: 51-54. 23 September 2009. 10.1098/rsbl.2009.0651.

Donovan, G.P. 1991. A review of IWC stock boundaries. Reports of the International Whaling Commission (special issue) 13:39–68.

Dunlop, R.A., Noad, M.J., McCauley, R.D., Kniest, E., Slade, R., Paton, D. and Cato, D.H., 2017. The behavioural response of migrating humpback whales to a full seismic airgun array. Proceedings of the Royal Society B: Biological Sciences, 284(1869), p.20171901.

Dunlop, R.A., McCauley, R.D. and Noad, M.J., 2020. Ships and air guns reduce social interactions in humpback whales at greater ranges than other behavioral impacts. Marine Pollution Bulletin, 154, p.111072.

Edwards, E. J. and Rattray, J. E. 1932. Whale Off! The story of American shore whaling. Frederick A. Stokes Co., New York. 285 pp.

Engelhaupt, D. T., Pusser, T., Aschettino, J. M., Engelhaupt, A. G., Cotter, M. P., Richlen, M. F., and Bell, J. T. 2020. Blue whale (Balaenoptera musculus) sightings off the coast of Virginia. Marine Biodiversity Records 13(6): https://doi.org/10.1186/s41200-020-00189-y

Estabrook, B.J., Hodge, K.B., Salisbury, D.P., Rahaman, A. Ponirakis, D., Harris, D.V., Zeh, J.M., Parks, S.E., & Rice, A.N. (2021). Final report for New York Bight Whale Monitoring Passive Acoustic Surveys October 2017-October 2020. New York State Department of Environmental Conservation.

Estabrook, B.J., Bonacci-Sullivan, L.A., Harris, D.V., Hodge, K.B., Rahaman, A., Rickard, M.E., Salisbury, D.P., Schlesinger, M.D., Zeh, J.M., Parks, S.E. and Rice, A.N., 2025. Passive acoustic monitoring of baleen whale seasonal presence across the New York Bight. PloS one, 20(2), p.e0314857.

Fioravanti, T., Maio, N., Latini, L., Splendiani, A., Guarino, F.M., Mezzasalma, M., Petraccioli, A., Cozzi, B., Mazzariol, S., Centelleghe, C. and Sciancalepore, G., 2022. Nothing is as it seems: Genetic analyses on stranded fin whales unveil the presence of a fin-blue whale hybrid in the Mediterranean Sea (Balaenopteridae). The European Zoological Journal, 89(1), pp.590-600.

Fisheries and Oceans Canada [DFO]. 2020. Action Plan for the Blue Whale (Balaenoptera musculus), Northwest Atlantic Population, in Canada. Species at Risk Act Action Plan Series. Fisheries and Oceans Canada, Ottawa. iv + 23 pp.

Foote, A.D., Osborne, R.W. and Hoelzel, A.R., 2004. Whale-call response to masking boat noise. Nature, 428(6986), pp.910-910.

Gailey, G., Würsig, B. and McDonald, T.L., 2007. Abundance, behavior, and movement patterns of western gray whales in relation to a 3-D seismic survey, Northeast Sakhalin Island, Russia. Environmental Monitoring and Assessment, 134, pp.75-91.

García-Vernet, R., Borrell, A., Víkingsson, G., Halldórsson, S.D. and Aguilar, A., 2021. Ecological niche partitioning between baleen whales inhabiting Icelandic waters. Progress in Oceanography, 199, p.102690.

Garrison, L.P., Lisi, N.E., Gahm, M., Patterson, E.M., Blondin, H. and Good, C.P., 2025. The effects of vessel speed and size on the lethality of strikes of large whales in US waters. *Frontiers in Marine Science*, *11*, p.1467387.

Geraci, J.R. 1990. Physiologic and toxic effects on cetaceans, pp. 167–192. In: Sea mammals and oil: confronting the risks J.R. Geraci and D.J. St. Aubin, Editors. First ed., Academic Press, Inc. San Diego, California: 239 p.

Goldbogen, J.A., J. Calambokidis, E. Oleson, J. Potvin, N.D. Pyenson, G. Schorr and R.E. Shadwick. 2011. Mechanics, hydrodynamics and energetics of blue whale lunge feeding: Efficiency dependence on krill density. Journal of Experimental Biology 214: 131-146.

Goldbogen, J.A., Southall, B.L., DeRuiter, S.L., Calambokidis, J., Friedlaender, A.S., Hazen, E.L., Falcone, E.A., Schorr, G.S., Douglas, A., Moretti, D.J. and Kyburg, C., 2013. Blue whales respond to simulated mid-frequency military sonar. *Proceedings of the Royal Society B: Biological Sciences*, *280*(1765), p.20130657.

Gordon, J., Gillespie, D., Potter, J., Frantzis, A., Simmonds, M.P., Swift, R. and Thompson, D. (2004). A review of the effects of seismic surveys on marine mammals. Marine Technology Society Journal, 37: 16–34.

Guilpin, M., Lesage, V., McQuinn, I., Goldbogen, J.A., Potvin, J., Jeanniard-du-Dot, T., Doniol-Valcroze, T., Michaud, R., Moisan, M. and Winkler, G., 2019. Foraging energetics and prey

density requirements of western North Atlantic blue whales in the Estuary and Gulf of St. Lawrence, Canada. Marine Ecology Progress Series, 625, pp.205-223.

Guilpin, M., Lesage, V., McQuinn, I., Brosset, P., Doniol-Valcroze, T., Jeanniard-du-Dot, T. and Winkler, G., 2020. Repeated vessel interactions and climate-or fishery-driven changes in prey density limit energy acquisition by foraging blue whales. Frontiers in Marine Science, 7, p.626.

Harris, C.M., Thomas, L., Falcone, E.A., Hildebrand, J., Houser, D., Kvadsheim, P.H., Lam, F.P.A., Miller, P.J., Moretti, D.J., Read, A.J. and Slabbekoorn, H., 2018. Marine mammals and sonar: Dose-response studies, the risk-disturbance hypothesis and the role of exposure context. *Journal of Applied Ecology*, *55*(1), pp.396-404.

Hayes, S.A., Josephson, E., Maze-Foley, K., & Rosel, P.E. (2020). US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2019. NOAA Tech Memo NMFS-NE-264.

Hays, G., A. Richardson and C. Robinson. 2005. Climate change and marine plankton. Trends in Ecology and Evolution 20: 337-344. 10.1016/j.tree.2005.03.004.

Hildebrand, J. A. (2009). Anthropogenic and natural sources of ambient noise in the ocean. Mar. Ecol. Prog. Ser. 395, 5–20.

Holt, M. M., D. P. Noren, V. Veirs, C. K. Emmons and S. Veirs. 2009. Speaking up: killer whales (*Orcinus orca*) increase their call amplitude in response to vessel noise. Journal of the Acoustical Society of America 125(1): EL27 - EL32.

International Whaling Commission [IWC]. 2017. The Catch Series. J. Cetacean Res. Manage. 19(Suppl.): 152-160.

Jensen, A. S., and G. K. Silber. 2004. Large Whale Ship Strike Database. U.S. Department of Commerce, NMFS-OPR-25 37.

Johnson H, Morrison D, Taggart C. (2021). WhaleMap: a tool to collate and display whale survey results in near real-time. Journal of Open Source Software, 6(62), 3094, https://joss.theoj.org/papers/10.21105/joss.03094

Jonsgard, A. 1977. Tables showing the catch of small whales (including minke whales) caught by Norwegians in the period 1938–75, and large whales caught in different North Atlantic waters in the period 1868–1975. Report of the International Whaling Commission 27:413–426.

Kahane-Rapport, S.R., Czapanskiy, M.F., Fahlbusch, J.A., Friedlaender, A.S., Calambokidis, J., Hazen, E.L., Goldbogen, J.A. and Savoca, M.S., 2022. Field measurements reveal exposure risk to microplastic ingestion by filter-feeding megafauna. Nature communications, 13(1), p.6327.

Kavanagh, A.S., Nykänen, M., Hunt, W., Richardson, N. and Jessopp, M.J., 2019. Seismic surveys reduce cetacean sightings across a large marine ecosystem. *Scientific reports*, *9*(1), p.19164.

Kawaguchi, S., H. Kurihara, R. King, L. Hale, T. Berli, J.P. Robinson and A. Ishimatsu. 2011. Will krill fare well under Southern Ocean acidification? Biol Lett 7: 288-291.

Kelley, D.E., Vlasic, J.P. and Brillant, S.W., 2021. Assessing the lethality of ship strikes on whales using simple biophysical models. *Marine Mammal Science*, *37*(1), pp.251-267.

Kenney, R.D. and K. J. Vigness-Raposa. 2010. Marine Mammals and Sea Turtles of Narragansett Bay, Block Island Sound, Rhode Island Sound, and Nearby Waters: An Analysis of Existing Data for the Rhode Island Special Area Management Plan. University of Rhode Island, Technical Report #10. 337 p.

Knowlton, A.R., Hamilton, P.K., Marx, M.K., Pettis, H.M. and Kraus, S.D., 2012. Monitoring North Atlantic right whale Eubalaena glacialis entanglement rates: a 30 yr retrospective. Marine Ecology Progress Series, 466, pp.293-302.

Kowarski KA, Martin SB, Maxner EE, Lawrence CB, Delarue JJ-Y, Miksis-Olds JL. (2022) Cetacean acoustic occurrence on the US Atlantic Outer Continental Shelf from 2017 to 2020. Marine Mammal Science mms.12962. doi: 10.1111/mms.12962

Laist, D.W., A.R. Knowlton, J.G. Mead, A.S. Collet and M. Podesta. 2001. Collisions between ships and whales. Marine Mammal Science 17: 35-75.

Lesage, V., Gavrilchuk, K., Andrews, R.D., and Sears, R. 2016. Wintering areas, fall movements and foraging sites of blue whales satellite-tracked in the Western North Atlantic. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/078. v + 38 p.

Lesage, V., Gavrilchuk, K., Andrews, R. D., Sears, R. 2017. Foraging areas, migratory movements and winter destinations of blue whales from the western North Atlantic. Endangered Species Research, 34, 27-43.

Lesage, V., Gosselin, J.-F., Lawson, J.W., McQuinn, I., Moors-Murphy, H., Plourde, S., Sears, R., Simard, Y. (2018). Habitats important to blue whales (Balaenoptera musculus) in the western North Atlantic. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/080. iv + 50 p.

Lockyer, C. 1984. Review of baleen whale (Mysticeti) reproduction and implications for management. Report of the International Whaling Commission Special Issue 6: 27-50.

Mackintosh, N.A. and J.F.G. Wheeler. 1929. Southern blue and fin whales. Discovery Reports 1: 257-540.

MacLeod, C.D. 2009. Global climate change, range changes and potential implications for the conservation of marine cetaceans: a review and synthesis. Endang. Species Res. 7:125–136.

Marques, T.A., Thomas, L., Booth, C.G., Garrison, L.P., Rosel, P.E., Takeshita, R., Mullin, K.D. and Schwacke, L., 2023. Population consequences of the Deepwater Horizon oil spill on pelagic cetaceans. *Marine Ecology Progress Series*, *714*, pp.1-14.

Maxwell, S.M., Kershaw, F., Locke, C.C., Conners, M.G., Dawson, C., Aylesworth, S., Loomis, R. and Johnson, A.F., 2022. Potential impacts of floating wind turbine technology for marine species and habitats. Journal of Environmental Management, 307, p.114577.

McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M.N., Penrose, J.D., Prince, R.I.T., Adhitya, A., Murdoch, J. and McCabe, K., 2000. Marine seismic surveys—a study of environmental implications. The APPEA Journal, 40(1), pp.692-708.

McDonald, M. A., Mesnick, S. L., & Hildebrand, J. A. (2006). Biogeographic characterization of blue whale song worldwide: using song to identify populations. Journal of cetacean research and management, 8(1), 55-65.

McDonald, M.A., J.A. Hildebrand and S. Mesnick. 2009. Worldwide decline in tonal frequencies of blue whale songs. Endangered Species Research 9: 13-21.

McKenna, M.F., J. Calambokidis, E.M. Oleson, D.W. Laist and J.A. Goldbogen. 2015. Simultaneous tracking of blue whales and large ships demonstrates limited behavioral responses for avoiding collision. Endangered Species Research 27: 219-232.

Melcón, M. L., A. J. Cummins, S. M. Kerosky, L. K. Roche, S. M Wiggins, and J. A. Hildebrand. 2012. Blue whales respond to anthropogenic noise. PLoS ONE 7(2): e32681. doi:10.1371/journal.pone.0032681

Mellinger, D.K. and Clark, C.W., 2003. Blue whale (Balaenoptera musculus) sounds from the North Atlantic. *The Journal of the Acoustical Society of America*, *114*(2), pp.1108-1119.

Metcalfe, C., B. Koenig, T. Metcalfe, G. Paterson and R. Sears. 2004. Intra- and inter-species differences in persistent organic contaminants in the blubber of blue whales and humpback whales from the Gulf of St. Lawrence, Canada. Marine Environmental Research 57: 245–260.

Meyer-Gutbrod EL, Davies KTA, Johnson CL, Plourde S, Sorochan KA, Kenney RD, Ramp C, Gosselin J, Lawson JW, Greene CH. 2022. Redefining North Atlantic right whale habitat-use patterns under climate change. Limnology & Oceanography lno.12242. doi: 10.1002/lno.12242

Mitchell, E.D. 1974. Present status of northwest Atlantic fin and other whale stocks. Pp. 108-169 *In* W.E. Schevill. The whale problem: a status report. Harvard University Press, Massachusetts, 419 p.

Mitchell, E. 1975. Trophic relationships and competition for food in northwest Atlantic whales. *In* Proceedings of the Canadian Society of Zoologists Annual Meeting, 1974. Downsview, Ont. Pp. 123-133.

Mizroch, S.A., D.W. Rice, and J.M. Breiwick. 1984. The blue whale, *Balaenoptera musculus*. Marine Fisheries Review 46(4):15-19.

Moore, M., J. van der Hoop, S. Barco, A. Costidis, F. Gulland, P. Jepson, K. Moore, S. Raverty and W. McLellan. 2013. Criteria and case definitions for serious injury and death of pinnipeds and cetaceans caused by anthropogenic trauma. Dis. Aquat. Org. 103:229–264.

Moore, M.J., Mitchell, G.H., Rowles, T.K. and Early, G., 2020. Dead cetacean? Beach, bloat, float, sink. *Frontiers in Marine Science*, *7*, p.333.

Muirhead, C. A., Warde, A. M., Biedron, I. S., Nicole Mihnovets, A., Clark, C. W., & Rice, A. N. (2018). Seasonal acoustic occurrence of blue, fin, and North Atlantic right whales in the New York Bight. Aquatic Conservation: Marine and Freshwater Ecosystems, 28(3), 744-753.

National Marine Fisheries Service [NMFS]. 2020a. Recovery Plan for the Blue Whale (Balaenoptera musculus) - First Revision. National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD.

National Marine Fisheries Service [NMFS]. 2020b. Blue Whale (Balaenoptera musculus) 5-year review: Summary and evaluation. National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD.

National Marine Fisheries Service [NMFS]. 2023. *Blue Whale*. https://www.fisheries.noaa.gov/species/blue-whale. Accessed 12 March 2025.

National Research Council [NRC]. 2003. Ocean Noise and Marine Mammals. National Academic Press, Washington, D.C.

NatureServe. 2024. NatureServe Explorer. Page last published 11/1/2024. https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.101880/Balaenoptera_musculus. Accessed November 13, 2024.

New York State Energy Research and Development Authority (NYSERDA). 2021. "Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy: Spatial and Temporal Marine Wildlife Distributions in the New York Offshore Planning Area, Summer 2016–Spring 2019," NYSERDA Report Number 21-07d. Prepared by Normandeau Associates, Inc., Gainesville, FL, and APEM, Ltd., Stockport, UK. nyserda.ny.gov/publications.

Nieukirk, S.L., D.K. Mellinger, J.A. Hildebrand, M.A. McDonald and R.P. Dziak. 2005. Downward shift in the frequency of blue whale vocalizations. Pages 205 Sixteenth Biennial Conference on the Biology of Marine Mammals. San Diego, California.

Nieukirk, S.L., D.K. Mellinger, S.E. Moore, K. Klinck, P. Dziak, and J. Goslin. 2012. Sounds from airguns and fin whales recorded in the mid-Atlantic Ocean, 1999–2009. Journal of the Acoustical Society of America 131(2): 1102–1112.

Nowacek, D.P., Thorne, L.H., Johnston, D.W. and Tyack, P.L. (2007). Responses of cetaceans to anthropogenic noise. Mammal Review, 37: 81–115.

Oleson, E.M., Calambokidis, J., Burgess, W.C., McDonald, M.A., LeDuc, C.A. and Hildebrand, J.A., 2007. Behavioral context of call production by eastern North Pacific blue whales. *Marine Ecology progress series*, *330*, pp.269-284.

O'Shea, T., and R. L. Brownell Jr. 1994. Organochlorine and metal contaminants in baleen whales: a review and evaluation of conservation implications. Science of the Total Environment 154(2-3):179-200.

Passive Acoustic Cetacean Map [PACM]. 2025. Passive acoustic cetacean map, v1.1.10, accessed 17 Feb 2025. NOAA Northeast Fisheries Science Center, Woods Hole, MA.

Palka, D., Aichinger Dias, L., Broughton, E., Chavez-Rosales, S., Cholewiak, D., Davis, G., DeAngelis, A., Garrison, L., Hass, H., Hatch, J., Hyde, K., Jech, M., Josephson, E., Mueller-Brennan, L., Orphanides, C., Pegg, N., Sigourney, D., Soldevilla, M., & Walsh, H. (2021). Atlantic Marine Assessment Program for Protected Species: FY15-FY19. US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2021-051. U.S. Deptartment of the Interior, Bureau of Ocean Energy Management, Washington, DC

Palka, D. et al. (2022). 2021 Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US waters of the Western North Atlantic Ocean – AMAPPS III. https://doi.org/10.25923/jazw-5467

Pampoulie, C., Gíslason, D., Ólafsdóttir, G., Chosson, V., Halldórsson, S. D., Mariani, S., ... & Víkingsson, G. A. (2021). Evidence of unidirectional hybridization and second-generation adult hybrid between the two largest animals on Earth, the fin and blue whales. Evolutionary Applications, 14(2), 314-321.

Parks, S.E., Clark, C.W. and Tyack, P. (2007). Short- and long-term changes in right whale calling behavior: The potential effects of noise on acoustic communication. Journal of the Acoustical Society of America, 122: 3725–3731.

Parks, S.E., Urazghildiiev, I. and Clark, C.W., 2009. Variability in ambient noise levels and call parameters of North Atlantic right whales in three habitat areas. The Journal of the Acoustical Society of America, 125(2), pp.1230-1239.

Parks, S. E., M. Johnson, D. Nowacek and P. L. Tyack. 2011. Individual right whales call louder in increased environmental noise. Biology Letters 7(1): 33 - 35.

Payne, R. and Webb, D., 1971. Orientation by means of long range acoustic signaling in baleen whales. Annals of the New York Academy of Sciences, 188(1), pp.110-141.

Price, C.S., Morris, J.A., Keane, E.P., Morin, D.M., Vaccaro, C. and Bean, D.W.W. 2017. Protected species and marine aquaculture interactions.

Ramp, C. and Sears, R. 2013. Distribution, densities, and annual occurrence of individual blue whales (Balaenoptera musculus) in the Gulf of St. Lawrence, Canada from 1980-2008. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/157. vii + 37 p.

Ramp, C., M. Berube, W. Hagen and R. Sears. 2006. Survival of adult blue whales Balaenoptera musculus in the Gulf of St. Lawrence, Canada. Marine Ecological Progress Report 319:287–295.

Ramp, C., Gaspard, D., Gavrilchuk, K., Unger, M., Schleimer, A., Delarue, J., Landry, S. and Sears, R., 2021. Up in the air: drone images reveal underestimation of entanglement rates in large rorqual whales. Endangered Species Research, 44, pp.33-44.

Redfern J V., M.F. McKenna, T.J. Moore, J. Calambokidis, M.L. DeAngelis, et al. 2013. Assessing the risk of ships striking large whales in Marine Spatial Planning. Conservation Biology 27: 292±302. https://doi.org/10.1111/cobi.12029

Redfern, J.V., Becker, E.A. and Moore, T.J., 2020. Effects of variability in ship traffic and whale distributions on the risk of ships striking whales. Frontiers in Marine Science, 6, p.793.

Reeves, R. R., and R. D. Kenney. 2003. Baleen whales, Eubalaena spp. and allies. Pp. 425–453 in: G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, ed. Wild Mammals of North America: Biology, Management, and Economics, second edition. Johns Hopkins University Press, Baltimore, MD.

Reeves, R. R., P. J. Clapham, R. L. Brownell Jr. and G. K. Silber. 1998. Recovery plan for the blue whale (*Balaenoptera musculus*). Publications, Agencies and Staff of the U.S. Department of Commerce. Paper 118. 46 pp.

Reeves, R., Smith, T.D., Clapham, P., Josephson, E., and Woolmer, G. 2004. Historical Observations of Humpback And Blue Whales in the North Atlantic Ocean: Clues to Migratory Routes and Possibly Additional Feeding Grounds. Publications, Agencies and Staff of the U.S. Department of Commerce. Paper 161. http://digitalcommons.unl.edu/usdeptcommercepub/161

Reeves, R.R., B.S. Stewart, P.J. Clapham, J.A. Powell and P.F. (illustrator). 2002. Guide to marine mammals of the world. A. A. Knopf, New York.

Rice, D.W. 1963. Progress report on biological studies of the larger Cetacea in the waters off California. Norsk Hvalfangst-Tidende 52: 181-187.

Richardson, W. J., C. R. Greene, Jr., C. I. Malme and D. H. Thomson. 1995. Marine Mammals and Noise. Academic Press, San Diego, California.

Romagosa, M., Baumgartner, M., Cascão, I., Lammers, M.O., Marques, T.A., Santos, R.S. and Silva, M.A., 2020. Baleen whale acoustic presence and behaviour at a Mid-Atlantic migratory habitat, the Azores Archipelago. *Scientific Reports*, *10*(1), p.4766.

Ross, D. 1987. Mechanics of Underwater Noise. Los Altos, CA, Peninsula Publishing.

Ross, D. 1993. On ocean underwater ambient noise. Acoustics Bulletin January/February: 5-8.

Ruppel, C.D., Weber, T.C., Staaterman, E.R., Labak, S.J. and Hart, P.E., 2022. Categorizing active marine acoustic sources based on their potential to affect marine animals. *Journal of Marine Science and Engineering*, *10*(9), p.1278.

Sadove, S. S. and P. Cardinale. 1993. Species composition and distribution of marine mammals and sea turtles in the New York Bight. Final Report to U.S. Dept. of the Interior, Fish and Wildlife Service Southern New England-New York Bight Coastal Fisheries Project. Charlestown, RI.

Savenkoff, C., Comtois, S. and Chabot, D., 2013. Trophic interactions in the St. Lawrence Estuary (Canada): Must the blue whale compete for krill?. *Estuarine, Coastal and Shelf Science*, *129*, pp.136-151.

Schiedek, D., Sundelin, B., Readman, J.W. and Macdonald, R.W., 2007. Interactions between climate change and contaminants. Marine pollution bulletin, 54(12), pp.1845-1856.

Sears, R. and J. Calambokidis. 2002. COSEWIC Assessment and Update Status Report on the Blue Whale *Balaenoptera musculus*, Atlantic population and Pacific population, in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, 38 p.

Sears, R. and W.F. Perrin. 2009. Blue whale, Balaenoptera musculus. Pages 120-124 in W.F. Perrin, B. Wursig and J.G.M. Thewissen eds. Encyclopedia of Marine Mammals, Second Edition. Academic Press, San Diego, California.

Sears, R., and W.F. Perrin. 2018. Blue Whale: Balaenoptera musculus. Encyclopedia of Marine Mammals (Third Edition). B. Würsig, J.G.M. Thewissen, and K. M. Kovacs, Academic Press: 110–114.

Sears, R., C. Ramp, A.B. Douglas and J. Calambokidis. 2013. Reproductive parameters of eastern North Pacific blue whales Balaenoptera musculus. Endangered Species Research 22: 23-31.

Sears, R., J.M. Williamson, F.W. Wenzel, M. Bérubé, D. Gendron, and P. Jones. 1990. Photographic identification of the blue whale (*Balaenoptera musculus*) in the Gulf of St. Lawrence, Canada. Reports to the International Whaling Commission, Special Issue 12:335-342.

Sears, R., F. Wenzel and J. M. Williamson 1987. The blue whale: a catalog of individuals from the western North Atlantic (Gulf of St. Lawrence). Mingan Island Cetacean Study, St. Lambert, Quebec, Canada. 27 pp.

Sergeant, D.E. 1966. Populations of large whale species in the western North Atlantic with special reference to the fin whale. Fisheries Research Board of Canada, Arctic Biological Station, Circular No. 9.

Sigurjónsson, J., and T. Gunnlaugsson. 1990. Recent trends in abundance of blue (*Balaenoptera musculus*) and humpback whales (*Megaptera novaeangliae*) off west and southwest Iceland, with a note on occurrence of other cetacean species. Reports to the International Whaling Commission 40:537-551.

Simard, Y., R. de Ladurantaye and J.-C. Therriault. 1986. Aggregation of euphausiids along a coastal shelf in an upwelling environment. Marine Ecology Progress Series 32: 203-215.

Simmonds, M.P., 2012. Cetaceans and marine debris: the great unknown. Journal of Marine Sciences, 2012(1), p.684279.

Širović, A. and Oleson, E.M., 2022. The bioacoustics of blue whales—global diversity and behavioral variability in a foraging specialist. In *Ethology and behavioral ecology of mysticetes* (pp. 195-221). Springer International Publishing.

Smith, C.R., Rowles, T.K., Hart, L.B., Townsend, F.I., Wells, R.S., Zolman, E.S., Balmer, B.C., Quigley, B., Ivančić, M., McKercher, W. and Tumlin, M.C., 2017. Slow recovery of Barataria Bay dolphin health following the Deepwater Horizon oil spill (2013-2014), with evidence of persistent lung disease and impaired stress response. *Endangered Species Research*, *33*, pp.127-142.

Southall, B., Calambokidis, J., Barlow, J., Moretti, D., Friedlaender, A., Stimpert, A., Douglas, A., Southall, K., Arranz, P., DeRuiter, S. and Goldbogen, J., 2014. Biological and behavioral response studies of marine mammals in Southern California, 2013.("SOCAL-13"). Final Project Report.

Southall, B.L., DeRuiter, S.L., Friedlaender, A., Stimpert, A.K., Goldbogen, J.A., Hazen, E., Casey, C., Fregosi, S., Cade, D.E., Allen, A.N. and Harris, C.M., 2019. Behavioral responses of individual blue whales (Balaenoptera musculus) to mid-frequency military sonar. *Journal of Experimental Biology*, *222*(5), p.jeb190637.

Southall, B., Quick, N.J., Hastie, G.D., Tyack, P.L. and Boyd, I.L., 2017. Mitigation of harm during a novel behavioural response study involving active sonar and wild cetaceans. *Journal of Cetacean Research and Management*.

Southall, B.L., Finneran, J.J., Reichmuth, C., Nachtigall, P.E., Ketten, D.R., Bowles, A.E., Ellison, W.T., Nowacek, D.P. and Tyack, P.L., 2019. Marine mammal noise exposure criteria: Updated scientific recommendations for residual hearing effects. Aquatic Mammals, 45(2), pp.125-232.

Stenson, G., J. Lien, J. Lawson and R. Seton. 2003. Ice entrapments of Blue Whales in Southwest Newfoundland: 1868-1992. In: Compte rendu de l'atelier sur le développement de priorités de recherche pour la population de rorquals bleus de l'Atlantique du Nord-Ouest, 20-21 novembre 2002. V. Lesage and M. Hammill (Ed.). Pêches et Océans Canada, Secrétariat canadien de consultation scientifique. Compte rendu 2003/031. p.15-17.

Stone, C. J. 2003. The effect of seismic activity on marine mammals in UK waters, 1998–2000. Report No. 323 of the Joint Nature Conservation Committee, Dunnet House, 7 Thistle Place, Aberdeen, Scotland.

Stone, C.J. and Tasker, M.L., 2006. The effects of seismic airguns on cetaceans in UK waters. J. Cetacean Res. Manage., 8(3), pp.255-263.

Szesciorka, A.R., Allen, A.N., Calambokidis, J., Fahlbusch, J., McKenna, M.F. and Southall, B., 2019. A case study of a near vessel strike of a blue whale: perceptual cues and fine-scale aspects of behavioral avoidance. *Frontiers in Marine Science*, *6*, p.761.

Szesciorka, A. R., Ballance, L. T., Širović, A., Rice, A., Ohman, M. D., Hildebrand, J. A., & Franks, P. J. (2020). Timing is everything: Drivers of interannual variability in blue whale migration. Scientific reports, 10(1), 7710.

Taylor, B.L., S.J. Chivers, J. Larese and W.F. Perrin. 2007. Generation length and percent mature estimates for IUCN assessments of cetaceans. National Marine Fisheries Service, Southwest Fisheries Science Center Administrative Report, LJ-07-01. 24 pp

Tetra Tech and LGL. 2020. Final Comprehensive Report for New York Bight Whale Monitoring Aerial Surveys, March 2017 – February 2020. Technical report prepared by Tetra Tech, Inc. and LGL Ecological Research Associates, Inc. 211 pp. + appendices. Prepared for New York State Department of Environmental Conservation, Division of Marine Resources, East Setauket, NY. May 18, 2020.

Thomas, P. O., Reeves, R. R., & Brownell Jr, R. L. (2016). Status of the world's baleen whales. Marine Mammal Science, 32(2), 682-734.

Tonnessen, J. N., and A. O. Johnsen. 1982. The history of modern whaling. Univ. Calif. Press, Berkeley, 798 p.

Totterdell, J.A., Wellard, R., Reeves, I.M., Elsdon, B., Markovic, P., Yoshida, M., Fairchild, A., Sharp, G. and Pitman, R.L., 2022. The first three records of killer whales (Orcinus orca) killing and eating blue whales (Balaenoptera musculus). Marine Mammal Science, 38(3).

Trumble, S.J., Robinson, E.M., Berman-Kowalewski, M., Potter, C.W. and Usenko, S., 2013. Blue whale earplug reveals lifetime contaminant exposure and hormone profiles. *Proceedings of the National Academy of Sciences*, *110*(42), pp.16922-16926.

Tyack, P.L. (2008). Implications for marine mammals of large-scale changes in the marine acoustic environment. Journal of Mammalogy, 89: 549–558.

United Nations Global Impact. 2025. "End Waste Entering the Ocean". Accessed March 2025. https://unglobalcompact.org/take-action/ocean/communication/end-waste-entering-the-ocean

van der Hoop, J., Corkeron, P. and Moore, M., 2017. Entanglement is a costly life-history stage in large whales. *Ecology and evolution*, *7*(1), pp.92-106.

Vanderlaan, A.S., Corbett, J.J., Green, S.L., Callahan, J.A., Wang, C., Kenney, R.D., Taggart, C.T. and Firestone, J., 2009. Probability and mitigation of vessel encounters with North Atlantic right whales. *Endangered Species Research*, *6*(3), pp.273-285.

Vanderlaan, A.S. and Taggart, C.T., 2007. Vessel collisions with whales: the probability of lethal injury based on vessel speed. *Marine mammal science*, *23*(1), pp.144-156.

Van Parijs, S.M., DeAngelis, A.I., Aldrich, T., Gordon, R., Holdman, A., McCordic, J.A., Mouy, X., Rowell, T.J., Tennant, S., Westell, A. and Davis, G.E., 2023. Establishing baselines for

predicting change in ambient sound metrics, marine mammal, and vessel occurrence within a US offshore wind energy area. ICES Journal of Marine Science, p.fsad148.

Weilgart, L.S., 2007. The impacts of anthropogenic ocean noise on cetaceans and implications for management. Canadian journal of zoology, 85(11), pp.1091-1116.

Weir, C.R. 2017. Developing a site-based conservation approach for sei whales Balaenoptera borealis at Berkeley Sound, Falkland Islands. Falklands Conservation report. Version 1.0. 115 pages

Wenzel, F.W., D.K. Mattila and P.J. Clapham. 1988. Balaenoptera musculus in the Gulf of Maine. Marine Mammal Science 4: 172-175.

Werth, A.J., Kahane-Rapport, S.R., Potvin, J., Goldbogen, J.A. and Savoca, M.S., 2024, February. Baleen–plastic interactions reveal high risk to all filter-feeding whales from clogging, ingestion, and entanglement. In *Oceans* (Vol. 5, No. 1, pp. 48-70). MDPI.

Winfield, Z.C., Mansouri, F., Potter, C.W., Sabin, R., Trumble, S.J. and Usenko, S., 2020. Eighty years of chemical exposure profiles of persistent organic pollutants reconstructed through baleen whale earplugs. *Science of The Total Environment*, *737*, p.139564.

Wingfield, J. E., Rubin, B., Xu, J., Stanistreet, J. E., & Moors-Murphy, H. B. (2022). Annual, seasonal, and diel patterns in blue whale call occurrence off eastern Canada. Endangered Species Research, 49, 71-86.

Womersley, F.C., Loveridge, A. and Sims, D.W., 2023. Four steps to curb ‘ocean roadkill’. *Nature*, *621*(7977), pp.34-38.

Yochem, P.K. and S. Leatherwood. 1985. Blue whale Balaenoptera musculus (Linnaeus, 1758). Pages 193-240 in S.H. Ridgway and R. Harrison eds. Handbook of Marine Mammals. Academic Press, London.

Zoidis, A.M., Lomac-MacNair, K.S., Ireland, D.S., Rickard, M.E., McKown, K.A., & Schlesinger, M.D. (2021). Large whale distribution and density in the New York Bight from monthly aerial surveys 2017-2020. Continental Shelf Research, 230, 104572. https://doi.org/10.1016/j.csr.2021.104572