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Maritimes Region

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Science Advisory Report 2020/008

ASSESSMENT OF THE DISTRIBUTION, MOVEMENTS, AND HABITAT USE OF NORTHERN BOTTLENOSE WHALES ON THE SCOTIAN SHELF TO SUPPORT THE IDENTIFICATION OF IMPORTANT HABITAT

Surfacing northern bottlenose whales (top, photo credit: H. Moors-Murphy) and dorsal fin image from photo-identification study (bottom, photo credit: Whitehead Lab, Dalhousie University).

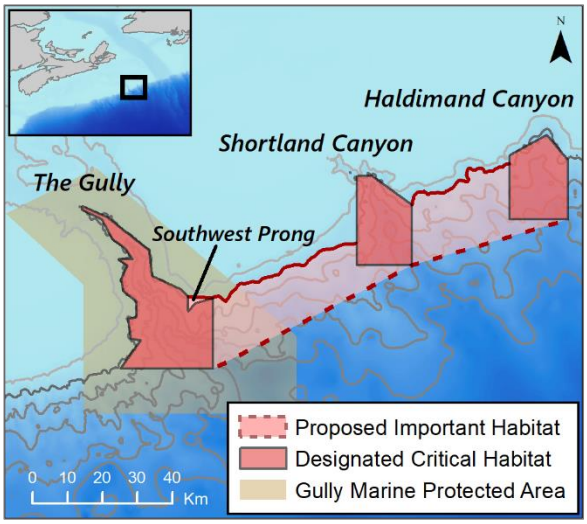

Figure 1. Map of currently designated Critical Habitat for northern bottlenose whales and proposed important habitat in inter-canyon areas on the eastern Scotian Shelf.

Context:

The Scotian Shelf population of northern bottlenose whales was listed as Endangered under Canada's Species at Risk Act (SARA) in 2006. A Recovery Strategy first produced in 2010 identified partial critical habitat for the population, encompassing three submarine canyons along the eastern edge of the Scotian Shelf. Recognizing that habitat requirements for northern bottlenose whales are not fully understood, the Recovery Strategy included a Schedule of Studies to identify additional important habitat areas and refine our understanding of the biophysical features and attributes of habitat that support feeding and social functions for the population. Year-round passive acoustic monitoring occurring since 2012 and visual and acoustic surveys during summer months since 2001 (including photographic identification efforts) have provided new data on the presence and movement patterns of northern bottlenose whales in areas outside of the Gully, Shortland and Haldimand canyons. The Species at Risk Program has requested Science advice on the importance of inter-canyon areas for northern bottlenose whales on the Scotian Shelf, based on new information gained from passive acoustic monitoring efforts and other recently collected data and analyses. Questions to be addressed include:

- *How does species presence in the inter-canyon areas compare to that within the canyons?*
- *What are the biophysical functions, features, and attributes of the inter-canyon habitats for northern bottlenose whales?*

- *What are the spatial extents of the areas that support the above habitat properties?*
- *What are the activities likely to destroy the functions, features, and attributes of the inter-canyon habitats?*

This Science Advisory Report is from the February 11-15, 2019, National Marine Mammal Peer Review Committee (NMMPRC) February 2019 Biannual Meeting. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

SUMMARY

- The Endangered Scotian Shelf population of northern bottlenose whales consists of fewer than 150 individuals, primarily occupying the eastern edge of the Scotian Shelf. The Gully, Shortland, and Haldimand canyons have been designated as critical habitat for the population.
- Stationary passive acoustic recorders deployed over two years (2012–2014) showed northern bottlenose whale presence and foraging activity in inter-canyon areas throughout the year.
- Vessel-based surveys occurred in summer months over six years between 2001 and 2017 with limited visual and towed-array acoustic effort in inter-canyon areas. Though no northern bottlenose whale sightings occurred, there were acoustic detections during these surveys in inter-canyon areas over multiple days/years.
- Photo-identification studies (2001–2017) showed that some individuals were found in all three canyons, and that individuals typically remained in the Gully for 10–25 days and regularly moved among the three canyons.
- These results indicate that inter-canyon areas function as foraging habitat and movement corridors between canyons and, thus, are important habitat for the population. The areas identified as important habitat can be delineated by the 500 m depth contour and straight lines connecting the southeast corners of the existing critical habitat areas.
- Within the Gully, the highest densities of sightings occurred on either side of the bathymetric feature known as the Southwest Prong, and individuals have been observed moving outside the critical habitat boundary to cross over this feature. This is likely an important area for movement of individuals and habitat connectivity within the Gully and with the inter-canyon areas.
- The features and attributes of the inter-canyon habitat are similar to those of the canyon habitat areas, and include deep water, steep topography, access to prey, an adequate acoustic environment to support foraging and movement, and adequate space to allow the unimpeded movement of individuals.
- Risks to the inter-canyon habitat areas are similar to those identified for canyon habitat areas, and likely include acoustic disturbance, changes to food supply, environmental contamination, and alteration of biological or physical oceanographic conditions. Due to the importance of the inter-canyon areas as movement corridors, physical obstruction preventing movement may also pose a risk to habitat function.
- Analyses presented here were focused on inter-canyon areas and there may remain additional important habitat for the population that has not yet been identified.

BACKGROUND

Northern bottlenose whales (*Hyperoodon ampullatus*) inhabit offshore waters in northern regions of the North Atlantic Ocean. They are typically observed in deep waters (>500 m) along the continental shelf edge.Off eastern Canada, two populations have been identified. The Scotian Shelf population consists of fewer than 150 individuals and is listed as Endangered under the *Species at Risk Act* (SARA). The distribution of the Scotian Shelf population appears to be highly concentrated around three submarine canyons that have been the focus of most research effort: the Gully, Shortland, and Haldimand canyons. Deep-water squid from the genus *Gonatus* likely constitute their primary prey, but little is known about the abundance and distribution of *Gonatus* species off eastern Canada.

The Scotian Shelf northern bottlenose whale Recovery Strategy, produced in 2010 and amended in 2016, identifies partial critical habitat for the population as areas encompassing the Gully, Shortland and Haldimand canyons (Figure 1, Fisheries and Oceans 2016). Stationary passive acoustic monitoring, vessel-based visual and acoustic surveys, and movement modelling analyses using photo-identification data provide new information on the distribution, habitat use and movements of northern bottlenose whales on the eastern Scotian Shelf. These data were examined to determine the importance of inter-canyon areas (the slope area between the Gully and Shortland Canyon and between Shortland and Haldimand canyons) to Scotian Shelf northern bottlenose whales.

ANALYSIS

Distribution and Seasonal Presence in Inter-Canyon Areas

Information on year-round occurrence of northern bottlenose whales was collected from 2012 to 2014 using stationary passive acoustic monitoring at one site within the Gully (Midgul), and two inter-canyon sites: GulSho, located between the Gully and Shortland Canyon, and ShoHald, located between Shortland and Haldimand canyons. Bottom-mounted recorders were deployed at each site and acoustic recordings were analyzed for the presence of northern bottlenose whale echolocation clicks, which are produced during foraging dives and may be detected at ranges of up to a few kilometers away. Clicks were detected on 100% of recording days in the Gully, and on 25% (GulSho) and 43% (ShoHald) of recording days at the inter-canyon sites, indicating that these areas are frequently utilized as foraging habitat by northern bottlenose whales. A seasonal pattern in monthly click detection rates was observed, with the highest rates occurring in spring and lowest rates in summer and fall (Figure 2). It is not clear whether this seasonal variation reflects a change in the density or distribution of whales, or a change in foraging activity occurring in the vicinity of the recorders.

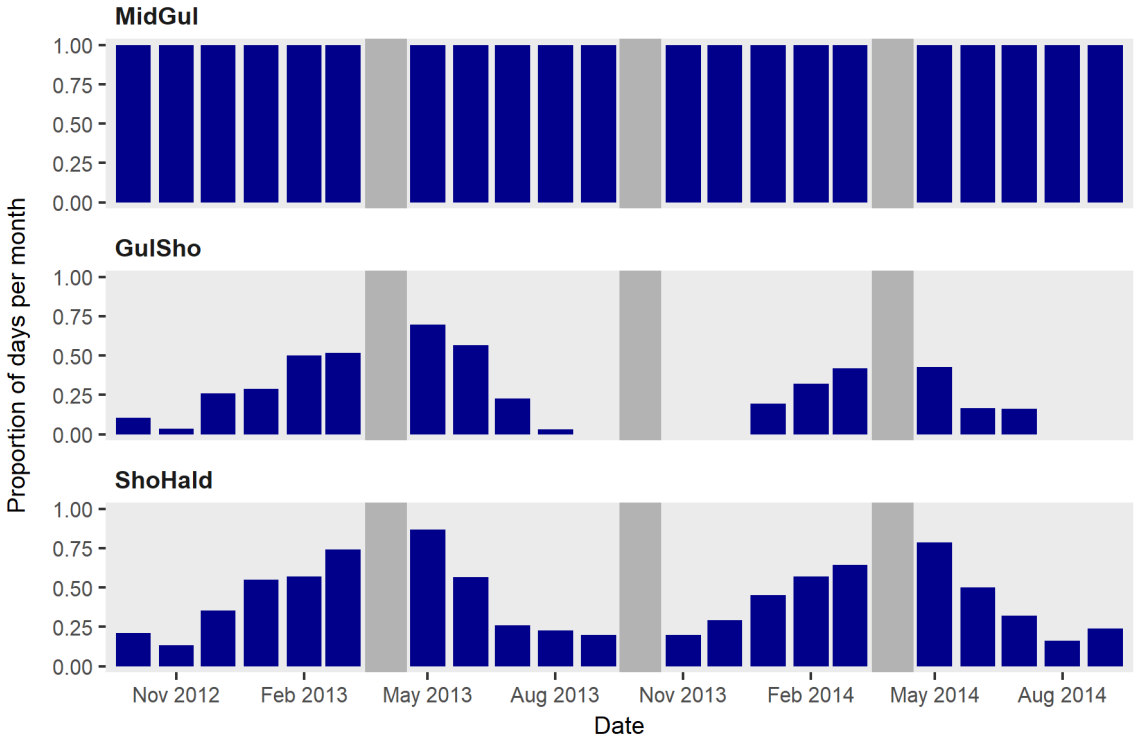

Figure 2. Proportion of days per month with northern bottlenose whale acoustic detections at each stationary recording site from October 2012 to September 2014; months with fewer than 10 recording days are omitted from plot (grey shaded bars).

Vessel-based surveys in the Gully have been part of an ongoing northern bottlenose whale research program since 1988. Survey effort was expanded to include Shortland and Haldimand canyons in six years (2001, 2002, 2011, 2015, 2016, and 2017; Figure 3). Surveys occurred during the summer months and primarily focused on the three canyon areas. Since 2001, there were 265 northern bottlenose whale sightings in the Gully, 83 in Shortland Canyon and 53 in Haldimand Canyon across 82 survey days. There were no sightings in inter-canyon areas; however, there was very limited visual survey effort outside the canyons. Within the Gully, the highest density of sightings occurred near the Southwest Prong of Banquereau Bank, a shallow feature located on the eastern side of the Gully critical habitat area (Figure 3). Some individuals have been observed moving outside the critical habitat boundary and crossing over the shallow waters of the Southwest Prong, likely to access deeper areas within the Gully on either side of this feature as well as the deeper inter-canyon area.

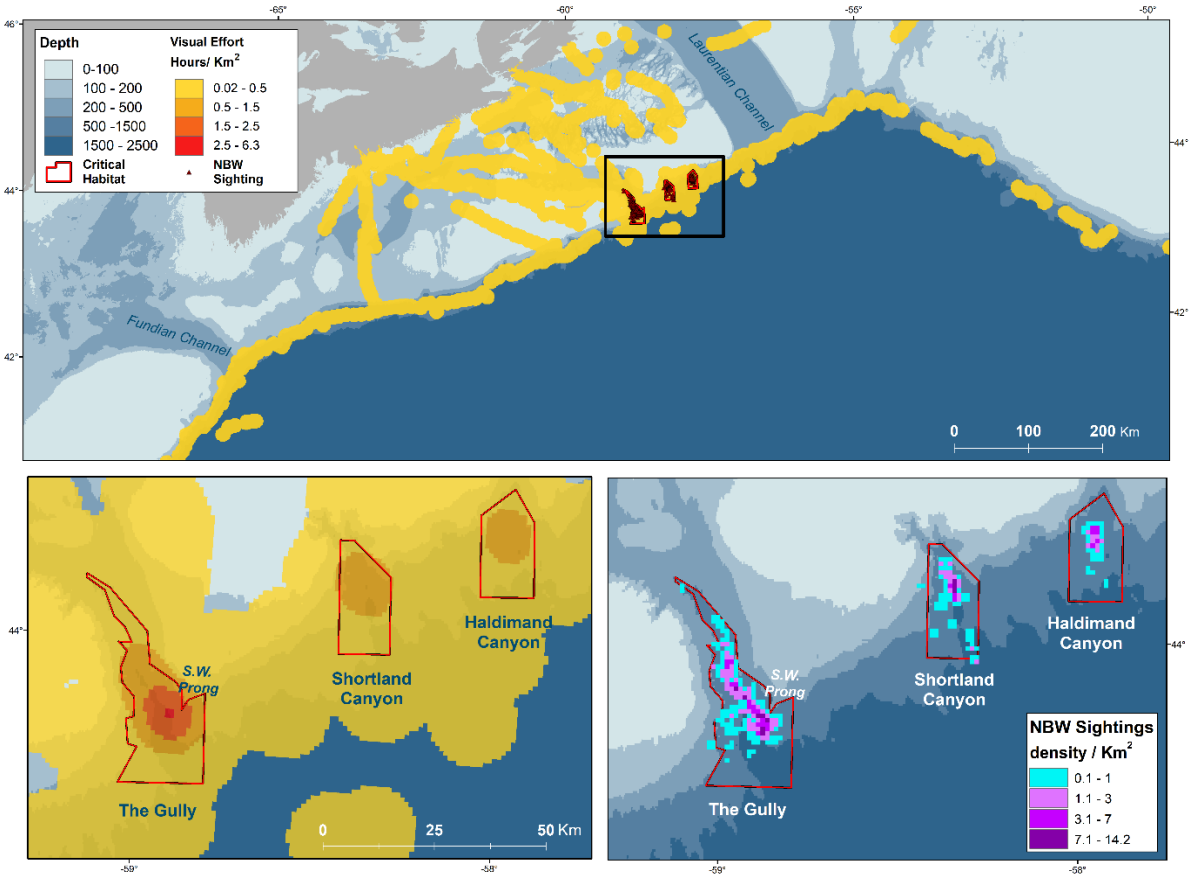

Figure 3. Map of visual survey effort per km^2 in 2001, 2002, 2011 and 2015–2017. Red indicates higher effort and yellow indicates lower effort, based on observation time during daylight hours with visibility greater than 1 km and Beaufort sea state of 4 or less. Locations of northern bottlenose whale (NBW) sightings and survey effort are shown on the upper map; the density of survey effort (left) and NBW sightings (right) in and around the canyons are shown on the lower maps. Red outlines delineate the boundaries of the currently designated critical habitat areas.

Acoustic recordings were collected during vessel-based surveys from 2015–2017 using a towed hydrophone array (Figure 4). Acoustic recording effort was more extensive than visual effort conducted during the same surveys, since it was possible to collect acoustic recordings at night and across a wider range of weather conditions. Most detections of northern bottlenose whale clicks occurred within the canyons, reflecting higher survey effort in those areas. There were also click detections outside the critical habitat areas, extending as far as the Fundian Channel and beyond the mouth of the Laurentian Channel, with most occurring in areas between the canyons and within 50 km of critical habitat boundaries. Detections occurred between and just outside the canyons on 4 consecutive survey days in 2015, 1 day in 2016, and 1 day in 2017, and were generally clustered along the 1000 m depth contour. There were no acoustic detections in offshore waters deeper than approximately 2000 m.

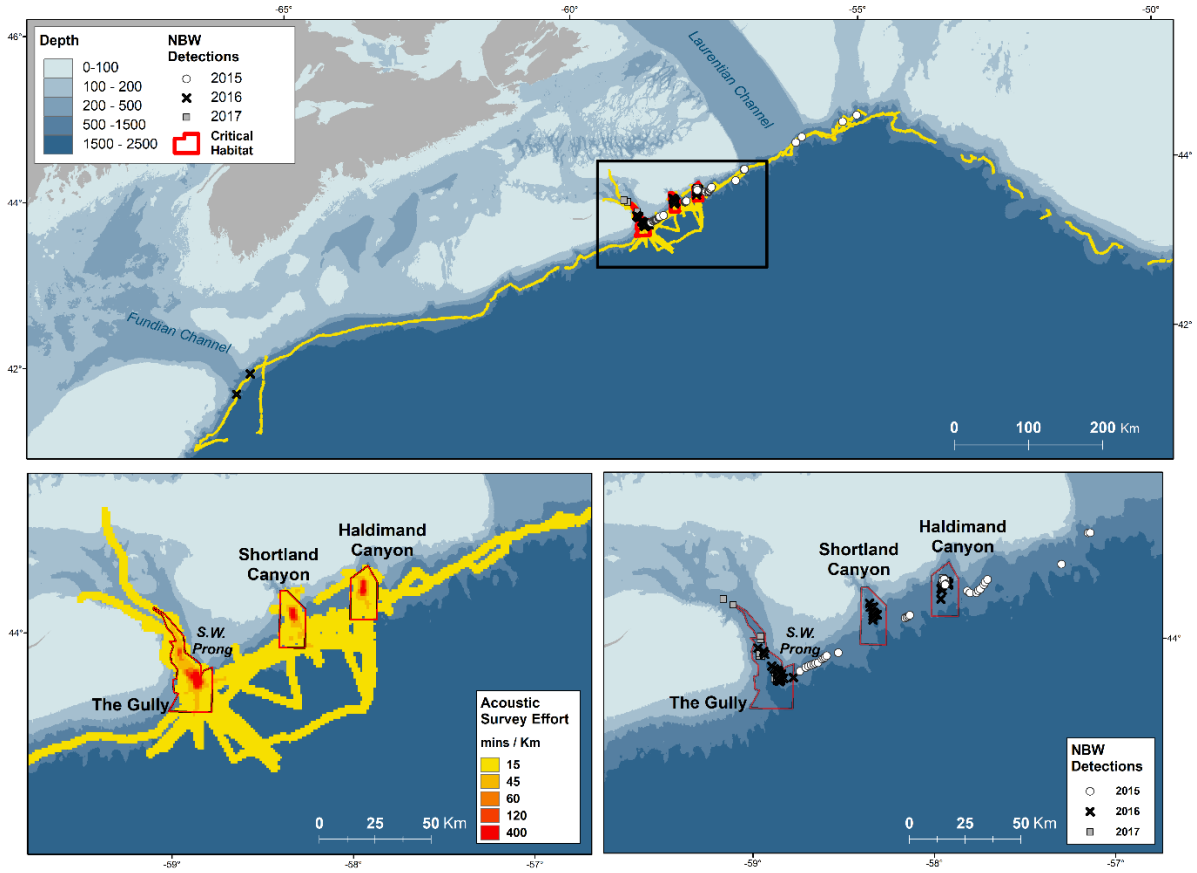

Figure 4. Map of acoustic survey effort per km² in the study area from 2015–2017. Confirmed northern bottlenose whale (NBW) detections are represented by symbols based on survey year, and shown with total acoustic survey effort on the upper map; the density of acoustic survey effort (left) and locations of NBW detections (right) in and around the canyons are shown on the lower maps. Red outlines delineate the boundaries of the currently designated critical habitat areas.

Residency and Movement Patterns

Analysis of photo-identification data provided insight into residency and movement patterns of northern bottlenose whales on the eastern Scotian Shelf. Photo-identification data have been collected in the Gully since 1988 and more recently in Shortland and Haldimand canyons (2001 to 2017). Models were used to estimate the probability of re-identifying individuals, either in the same area or a different area. Data collection effort varied between canyons, with 53 days of photo-identification effort occurring in the Gully, 13 in Shortland Canyon, and 9 in Haldimand Canyon. Despite the more limited effort in Shortland and Haldimand canyons, several individuals were identified in all three canyons, indicating that individuals move among the canyons. The typical residency period in the Gully was estimated to be 10–25 days. Model results suggest that average residency periods in the other canyons are shorter than in the Gully, but there is considerable uncertainty around the estimates for the other canyons. Further studies, including increased photo-identification effort in areas other than the Gully will help to improve the precision of these estimates.

Overall, movement modelling analyses indicated a consistent rate of movement into and out of the Gully, on the order of one individual per day. The Gully is the most highly utilized habitat area, but all three canyons are visited by individuals in the population. These results highlight the strong degree of connectivity between the canyons. Movement modelling results are consistent with other evidence that the Scotian Shelf population is not confined to this area.

Importance of Inter-Canyon Areas

Based on the evidence provided above, the inter-canyon areas located between existing critical habitat areas are considered important habitat for the Scotian Shelf northern bottlenose whales (Figure 1). Individual northern bottlenose whales are known to move between the canyons, and the inter-canyon areas function as important movement corridors. Year-round passive acoustic detections indicate that northern bottlenose whales also regularly forage in these areas. The inter-canyon areas identified as important habitat in Figure 1 are bounded by the 500 m depth contour, also used to delineate the upper boundary of the existing critical habitat areas, and a straight line connecting the southeast corners of the existing critical habitat areas. This area encompasses the depths where most northern bottlenose whale sightings and acoustic detections occur, as well as the most direct route between canyons and the sites where foraging activity was detected between canyons. In addition, the area encompassing the Southwest Prong bathymetric feature located on the eastern side of the Gully is identified as important for the movement of northern bottlenose whales between existing critical habitat areas on either side of this feature and to the inter-canyon area.

Characteristics of Inter-Canyon Habitat and Risks to This Habitat

The biophysical features and attributes of the inter-canyon habitat are similar to those of the canyon habitat areas, and include deep water (>500 m), steep topography, access to sufficient quantity and quality of prey (deep-water squid), an adequate acoustic environment to support foraging and movement, and adequate space to allow for unimpeded movement of individuals. Risks to the inter-canyon habitat areas (i.e. activities that may potentially lead to destruction of the habitat) are also similar to those described for the currently designated critical habitat areas, likely including acoustic disturbance, changes to food supply, environmental contamination, and alteration of biological or physical oceanographic conditions. In addition, due to the importance of these areas as movement corridors, physical obstructions (e.g. high densities of fishing gear or vessels) that could prevent movement may also pose a risk to habitat function.

Sources of Uncertainty

Passive acoustic monitoring provides year-round information on the presence of northern bottlenose whales at specific recording sites. As monitoring was only conducted within the Gully and at two inter-canyon sites during the 2012–2014 recording period, it is not possible to measure click detection rates within Shortland and Haldimand canyons or compare these two canyons to the inter-canyon sites. The Gully is known to be a particularly high-use habitat area relative to the other canyons, and it should not be considered representative of all canyon areas. Based on an earlier, more limited passive acoustic monitoring study, click detection rates within Shortland and Haldimand canyons are expected to be more comparable to those found at the inter-canyon sites rather than the detection rates occurring in the Gully.

Passive acoustic monitoring results represent a minimum estimate of presence due to recording schedules and because only echolocating whales are detected (whales present but not echolocating remain undetected). The number of individuals present cannot be estimated using acoustic detections.

Sighting records reflect the highly uneven spatial and temporal distribution of survey effort, and it is not possible to compare the relative importance of inter-canyon areas to the canyons based on these data. Future visual surveys with more effort in daylight hours and during periods of good visibility in inter-canyon areas as well as other non-canyon areas would provide further information on habitat use by the population. Photo-identification data collection occurred only during the summer months; therefore, residency and movement patterns during other times of the year remain unknown. However, because northern bottlenose whales were acoustically detected in inter-canyon areas throughout the year, and the highest click detection rates actually occurred during non-summer months, it is assumed that they move between canyons year-round.

The boundaries of the important habitat areas identified in this paper were suggested based on limited available information on the spatial extent of these habitats. More data are needed to determine whether these boundaries fully encompass important inter-canyon habitat areas, particularly the deeper boundary represented by the dashed line in Figure 1.

CONCLUSIONS AND ADVICE

The inter-canyon areas located between the existing Gully, Shortland Canyon and Haldimand Canyon critical habitat areas are important habitat for Scotian Shelf northern bottlenose whales. Similar to canyon critical habitat, northern bottlenose whales are present year-round in the inter-canyon areas, which function as foraging habitat and movement corridors. Figure 1 offers a suggested delineation of these important habitat areas. The features and attributes of the inter-canyon areas are presumed to be similar to those of the canyon habitat areas, as are the risks to these habitats. Physical obstruction may pose an additional risk to the function of habitat in these areas as important movement corridors.

OTHER CONSIDERATIONS

The full extent of important habitat for Scotian Shelf northern bottlenose whales remains unknown. The analyses presented here were designed to assess the importance of inter-canyon areas located between designated critical habitat, but additional important habitat for the population may exist outside these areas. Further research is needed to ensure that all important habitat required to support recovery of the population has been identified, as well as to improve our understanding of the habitat requirements of the species. Passive acoustic monitoring efforts have recently been expanded to include other areas along the Scotian Shelf. When available, these datasets will provide new insight into the seasonal presence and foraging activities of northern bottlenose whales.

In addition to the Scotian Shelf population, a distinct population of northern bottlenose whales inhabits the Davis Strait-Baffin Bay-Labrador Sea region. Documented sightings have recently occurred off Newfoundland. No clear genetic links or photo-identification matches have been made between the Scotian Shelf population and northern bottlenose whales off Newfoundland or in more northern waters, and the population structure of northern bottlenose whales off eastern Canada is not fully understood. Further studies are underway to address broader questions regarding population structure and connectivity.

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SOURCES OF INFORMATION

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Fisheries and Oceans Canada. 2016. Recovery Strategy for the Northern Bottlenose Whale, (*Hyperoodan ampullatus*), Scotian Shelf population, in Atlantic Canadian Waters [Final]. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa. vii + 70 pp.

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