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Status of northern bottlenose whales

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ABSTRACT

The northern bottlenose whale, *Hyperoodon ampullatus*, is a beaked whale found only in the northern North Atlantic. It is a deep-diver, primarily using waters >500m deep. Whaling was concentrated in six centres of abundance: the Scotian Shelf; northern Labrador and southern Baffin Bay; around Iceland, east Greenland and the Faeroes; Andenes, Norway; Møre, Norway; and Svalbard. Although northern bottlenose whales are sometimes found in intervening waters and in other parts of the northern North Atlantic, these potentially represent distinct populations. There is genetic and other evidence that the Scotian Shelf and Baffin-Labrador populations are distinct, that Iceland and Baffin-Labrador may be linked, but no other genetic data on population structure. Northern bottlenose whale population sizes are hard to estimate because of the whales' deep-diving and ship-seeking behaviour. The Scotian Shelf population numbers about 163 animals and has been fairly stable since 1988. The sizes of other populations are unknown. Sightings are fairly frequent off Iceland, the Faeroes and Svalbard, but the animals are rarely seen in surveys covering the two population centres that the whalers used off mainland Norway, or in the Baffin-Labrador area. There are strong indications that a catch of about 65,000 northern bottlenose whales principally between 1872-1972 depleted the population. The principal threats that the species currently faces are interactions with fisheries and anthropogenic noise.

INTRODUCTION

The northern bottlenose whale, *Hyperoodon ampullatus* (Forster 1770), is a beaked whale, family Ziphiidae, found only in the northern North Atlantic. Its only congener, the southern bottlenose whale, *Hyperoodon planifrons*, lives in the Southern Ocean. No subspecies are recognized. The northern bottlenose whale is a sturdy, medium-sized (7-9m) whale, with a beak and falcate dorsal fin. It has a pronounced forehead, bulbous in the case of females and immatures, and squared off, and often white, in the case of mature males. Mature males are also larger than females (ca. 1m, Benjaminsen and Christensen 1979). Colour ranges from chocolate brown (from diatom films) to light grey. Northern bottlenose whales have one pair of teeth, at the tip of the lower jaw, but these usually only erupt through the gums in older males.

The northern bottlenose whale is found primarily in deep waters, and is quite rarely sighted, even on well-planned surveys. During the extensive 2007 TNASS surveys of the northern North Atlantic, the northern bottlenose was the twelfth most frequently sighted species (NAMMCO 2009). The northern bottlenose whale is among the most accomplished, and perhaps the deepest, diver of all mammals, descending regularly to depths greater than 800m for periods lasting up to 70 minutes (Hooker and Baird 1999). Northern bottlenose whales are also renowned for their inquisitiveness, and unlike other beaked whale species, will frequently approach vessels (Mead 1989), a characteristic used to full advantage during whaling by the placement of additional harpoons at the rear of whaling ships.

Much of the information on the biology of the northern bottlenose whale comes from two sources: analyses of specimens killed by Norwegian whalers (e.g. Benjaminsen 1972, Christensen 1973, Benjaminsen and Christensen 1979), and studies of living individually photoidentified animals off the Scotian Shelf and particularly in a submarine canyon called the Gully (e.g. Gowans *et al.* 2001, Hooker *et al.* 2002, Wimmer and Whitehead 2004).

LIFE HISTORY AND PREDATION

Females become sexually mature at 8-13 years old and males at 7-9 (Benjaminsen and Christensen 1979). Whaling data suggest that females give birth to single offspring about every 2 years after a gestation of about 12 months (Benjaminsen and Christensen 1979), although observations of calves of the Scotian Shelf population indicate a reproductive rate that is lower than this: in the Gully between 1988-1999, only 6% of 3,113 sightings of northern bottlenose whales close enough to the research vessel to be photoidentified (<~100m) were recorded as first-year calves (H. Whitehead, unpublished data). The life span is at least 37 years (Christensen 1973). The generation time can be estimated at about 15.5 years, which is the mean age of 26 females older than the mean age of sexual maturity killed by whalers in the Davis Strait (data from Christensen 1973).

Norwegian whalers saw killer whales (*Orcinus orca*) attacking northern bottlenose whales, and noted scarring from previous attacks (Jonsgård 1968a; Jonsgård 1968b).

DISTRIBUTION AND POPULATION STRUCTURE

Northern bottlenose whales are found in deep waters of the northern North Atlantic (>approximately 500m), north of about 40^{o}N (Figure 1). However, apart from the population found along the Scotian Shelf, and sporadic sightings in the Azores, they are rarely seen south of 55^{o}N. Whaling for the northern bottlenose whale was concentrated in six general areas across the northern North Atlantic (Figure 1): (i) Scotian Shelf, Canada with the population focused on the submarine canyon called the Gully; (ii) northern Labrador and southern Baffin Bay, Canada; (iii) around Iceland, east Greenland and the Faeroes; (iv) Andenes, Lofoten Islands, off northern mainland Norway; (v) Møre, off southwestern Norway; and (vi) Svalbard (Spitzbergen), Norway (Mead 1989). These all potentially represent distinct populations, although bottlenose whales are sometimes found in suitable habitat between these areas of concentration (Benjaminsen and Christensen 1979 see below), and in other parts of the northern North Atlantic. For instance, there have been a number of sightings along the edge of the Canadian shelf between the Scotian Shelf and northern Labrador, off the British Isles, in the deeper waters of the Bay of Biscay and off the Azores (Clarke 1981, Mead 1989, Reeves *et al.* 1993).

Dalebout et al. (2006) used 10 microsatellites and 434bp of the mitochondrial DNA (mtDNA) control region sequence to compare animals from three of these population centres: the Scotian Shelf (n=34, all biopsy samples from the Gully collected 1996-2003), off Baffin-Labrador (n=127, from 124 teeth collected between 60^{o}N - 63^{o}N in 1971 during Norwegian whaling and two biopsy samples in 2003), and Iceland (n=23 from teeth collected during Norwegian whaling in 1967). The differentiation of the Scotian Shelf and Baffin-Labrador populations was confirmed by both microsatellites (F_{ST}= 0.0243, $P<$ 0.0001) and mtDNA (Φ_{ST}= 0.0456, $P<$ 0.05). Dalebout et al. (2006) estimated that fewer than two individuals per generation move between these areas. There was significant differentiation in both genomes for both males and females. For microsatellites, the differentiation (as indicated by F_{ST}) between the animals from the Scotian Shelf and the Baffin-Labrador populations was similar for males and females. The Icelandic samples appeared distinct from those of the Scotian Shelf (microsatellites: F_{ST}= 0.0276, $P<$ 0.0001; mtDNA: Φ_{ST}= 0.0315, P=0.12), but not from those from Baffin-Labrador (microsatellites: F_{ST}= 0.0000, P=0.40; mtDNA: Φ_{ST}= -0.0150, P=0.72).

There is additional evidence that the Scotian Shelf and Baffin-Labrador population centres represent separate stocks. The mean length of 451 photographically measured living animals (with some resampling of individuals) and 25 directly measured whaled animals from the Scotian Shelf was 0.7m shorter than the mean length of 127 animals taken by whalers off Labrador (Whitehead *et al.* 1997b, Whitehead *et al.* 1997b). Scotian Shelf animals seem to mate and give birth around August (Whitehead *et al.* 1997a), whereas the modal breeding season off Labrador is April (Benjaminsen 1972). There are no photoidentification matches between the 9 animals photoidentified off Labrador and in southern Baffin Bay, and the extensive photoidentification catalogue for the Scotian Shelf which contains a large proportion of the population there (H. Whitehead and T. Wimmer, unpublished). In a pollutant analysis (see below), 3 animals sampled from the Baffin-Labrador population had significantly higher scores for expression of CYP1A1 (a biomarker for exposure to some contaminants including polycyclic aromatic hydrocarbons) compared with 33 animals sampled off the Scotian Shelf (MANOVA, $p<0.001$), but measured blubber contaminants in the whales from Labrador were substantially and significantly lower than those of animals sampled off the Scotian Shelf (Hooker *et al.* 2008). Finally, the methodology of the mark-recapture estimation of the size of the Scotian Shelf population using photoidentifications (Whitehead and Wimmer 2005) means that if there was much interchange between the Scotian Shelf and the Baffin-Labrador populations, the resulting estimate would include animals in both populations. However, the estimate is not large, which implies that if there were frequent exchange of animals between them, then the Baffin-Labrador population, in spite of its large range, must be very small indeed.

Thus, there is good evidence that the Scotian Shelf and Labrador-Baffin population centres contain largely distinct stocks, and indications of linkages between Labrador-Baffin and Iceland. We know of no other evidence of potential stock relationships between the population centres for this species.

BEHAVIOUR AND SOCIAL STRUCTURE

Long recognized as deep divers, whalers reported that some harpooned individuals could dive for over 2 hours (Gray 1882). Over 30 hours of dive data from time-depth recorders deployed in the Gully showed that dives to >800m for 30-40 mins were routine, with a maximum depth of 1450 m and maximum duration of 70 mins (Hooker and Baird 1999). After a long dive, whales sometimes remain at the surface for 10 mins or more, blowing regularly, although frequently this surface period is characterized by short, shallow dives (<100 m) preceding or interspersing time at the surface. Occasionally whales may remain near the surface for periods of up to an hour or more.

Their social structure appears generally similar to that of coastal populations of bottlenose dolphins (*Tursiops* spp.) (Gowans *et al.* 2001): at the surface they form labile groups of about 1-5 animals containing any mix of age and sex classes; females possess a loose network of relationships while there are strong bonds between pairs of males. Aggressive behaviour is rare, although head-butting between mature males has been observed (Gowans and Rendell 1999). Vocalisations include high frequency (ca. 24 kHz) echolocation clicks (Hooker and Whitehead 2002).

The northern bottlenose whale is likely highly adapted to its deep-diving lifestyle, but there have been no studies of this. The inquisitiveness of the species, as well as its social structure, may be related to the consistent use of what are, by cetacean standards, small ocean areas (Gowans *et al.* 2001). A consequence of their tendency to approach vessels is that bottlenose whales were easily captured by whalers.

MOVEMENTS AND MIGRATIONS

The available evidence suggests that the Scotian Shelf population does not make seasonal migrations. Rates of acoustic detection of the animals on “pop-up” hydrophones placed in the Gully are similar in all 12 months (H. Moors pers. comm.), and there are photoidentification matches of individuals between seasons (Whitehead *et al.* 1997b). Animals move between the three large canyons on the eastern Scotian Shelf (the Gully, Shortland Canyon, Haldimand Canyon, which are arranged along the shelf edge at intervals of about 50km) but show individual preferences for particular canyons (Wimmer and Whitehead 2004). Little is known about the movements of Baffin-Labrador animals or whether they make seasonal migrations. However, there have been sightings of northern bottlenose whales in the Baffin-Labrador area in winter, perhaps indicating a lack of consistent seasonal migration (Reeves *et al.* 1993). Migratory movements are also unclear in the northeastern Atlantic (Benjaminsen and Christensen 1979). Catch rates and sex ratios varied seasonally in the different northeastern Atlantic locations, indicating migrations (Benjaminsen 1972). Gray (1882) suggested that whales moved northward in spring and southward in autumn. Increased stranding frequency on the shores of Europe in late summer and autumn suggest southward migration (Fraser 1953) but alternative explanations such as inshore movement following a food source are equally plausible. In addition, animals were caught in substantial numbers off Scotland in June (Thompson 1928) and are seen in the Azores, one of their most southerly locations, in summer (Clarke 1981).

HABITAT AND FOOD

Northern bottlenose whales occur in deep (>500m), northern waters of the North Atlantic, generally with depths between 800-1,500m, along the continental slope (Benjaminsen and Christensen 1979, Reeves *et al.* 1993, Wimmer and Whitehead 2004). These water depths seem to coincide with their dive depths (Hooker and Baird 1999), perhaps indicating that the whales often forage near the bottom. The northern bottlenose whales of the Scotian Shelf are most commonly sighted in three large canyons, the Gully, Shortland Canyon and Haldimand (Wimmer and Whitehead 2004).

While northern bottlenose whales are known to eat various deep-water fishes and squids, they particularly favour deep-water squids of the genus *Gonatus* (Mead 1989). In consequence, they have a particularly narrow ecological niche compared with other deep-diving mammals (Whitehead *et al.* 2003). In the more northern parts of the range, including the Baffin-Labrador habitat, their primary food is *Gonatus fabricii* (Mead 1989) whereas in more temperate waters of the Scotian Shelf it is *G. steenstrupi* (Hooker *et al.* 2001).

POPULATION SIZE

The behaviour of northern bottlenose whales complicates some standard methods used for estimating population size. Catch-per-unit-effort methods were compromised by attraction to whaling vessels and "standing-by" behaviour toward wounded companions (see Mead 1989). Raw population estimates from visual ship surveys will be negatively biased because of the animals' long dives, and positively biased because of their attraction to boats (Reeves *et al.* 1993). The former can potentially be corrected using data on diving behavior (Hooker and Baird 1999); the latter is much more problematic, especially as the degree of attraction may vary with many factors including location, season, and the type and speed of the survey vessel. Aerial surveys only face the deep-diving bias, but this lowers the sighting rate so that population estimation may not be feasible, even with large, well-planned surveys (Lawson and Gosselin 2009). NAMMCO (2009) concluded that the total of 50 aerial and shipboard "Sightings made during [the large scale and well-planned 2007] T-NASS will be reported as distribution data only because there are not enough points for an abundance estimate". Mark-recapture methods using photoidentifications can provide quite precise estimates, but heterogeneity in identification rates and the lack of reliable identification marks on some animals should be incorporated (Whitehead and Wimmer 2005). This is a promising species for acoustic surveying, but greater knowledge of their vocalizations is needed.

Scotian Shelf

Using photoidentification data collected between 1988-2003 in the Gully, and a model that incorporates heterogeneity in identifiability and correcting for animals that have no reliable marks, Whitehead and Wimmer (2005) estimated that the Scotian Shelf population contained 163 adult and immature animals (95% confidence interval 119-214). An updated analysis, after adding data collected in 2006-2009, gave an estimate of 164 adult and immature animals (95% confidence interval 121-214). The best population models (minimum AIC) fit to the full 1988-2009 photo-identification data sets did not include a trend parameter, indicating a stable population. If a trend parameter was added to the model, the estimated population trend was +2.1% per year (95% confidence interval -1.6%/year to +6.3%/year). This trend estimate is almost identical to that generated from the 1988-2003 data set (Whitehead and Wimmer 2005).

Baffin-Labrador

A number of sightings of northern bottlenose whales have been made in the Baffin-Labrador area (Reeves *et al.* 1993, Herfst 2004, MacDonald 2005), and the animals are frequently mentioned as being observed by fishermen working in the area. However, systematic TNASS aerial surveys in 2007 encountered northern bottlenose whales only once in the flights off Labrador (5,363 km flown south of Cape Chidley, the northern tip of Labrador), compared with 9 encounters off eastern and southern Newfoundland (17,998 km flown) and 3 off the Scotian Shelf (9,111 km flown) (Lawson and Gosselin 2009). Similarly, extensive boat surveys in 2003 and 2004 through the major areas of sightings and catches off Labrador and in the Davis Strait encountered very few animals (Herfst 2004, Compton 2005), with a much lower encounter rate than in the canyons of the Scotian Shelf (Table 1). The longer 2003 survey used the same boat, methods and personnel as have been used for surveys of the Scotian Shelf canyons, and it was carried out in better weather than is usual on the Scotian Shelf. A brief survey on a fisheries research vessel in southern Baffin Bay/Davis Strait in 2004 was more productive, with 6 encounters in 25.5 hours of effort, although all but two of these encounters occurred while the vessel was fishing, and northern bottlenose whales are attracted to fishing vessels in the area (MacDonald 2005). Thus the status of the Baffin-Labrador population is uncertain.

Iceland and Faeroes

There have been shipboard surveys for cetaceans in the waters surrounding Iceland in 1987, 1989, 1995, 2001 and 2007. Based on 86 sightings of the northern bottlenose whales in 1987 and 1989 Gunnlaugsson and Sigurjonsson (1990) estimated a population size of 4,925 (CV 0.16) off Iceland and 902 (CV 0.45) off the Faeroes. Pike et al. (2003) estimated 27,900 (CV 0.67) for the 1995 survey and 28,000 (CV 0.22) for that in 2001. We know of no estimate from the 2007 data in which 26 animals were sighted in the general area of Iceland. These estimates are biased downwards because of the long dives behavior of the whales, and upwards because of ship attraction. While they could be corrected for diving behavior using information on diving behavior (Hooker and Baird 1999), and this has been attempted (NAMMCO 1993), correction for ship attraction is much harder, and perhaps impossible to do with any rigour. Thus these ship survey estimates have little validity. Only one bottlenose whale was sighted on the aerial portion of the 2007 Icelandic survey (NAMMCO 2009).

Despite these problems with the abundance estimates, the survey results show that numbers of bottlenose whales live in the waters off Iceland and the Faeroes.

Norway (Andenes and Møre)

Information on northern bottlenose whales sightings off Norway will be presented at the SC meeting by Øien and colleagues. Northern bottlenose whales are very rarely sighted in the two areas of concentration off mainland Norway identified by the whalers (Figure 1) (no mentions of sightings in Norwegian Progress Reports 2004-2010; see also http://arcticwhaletours.com/?p=952).

Svalbard

Northern bottlenose whales are sighted from time to time in the Svalbard region (http://arcticwhaletours.com/?p=952). For instance, in the Small Management Area ES, which includes the northern Norwegian Sea, the Greenland Sea and the Svalbard area west of 28ºE and north of 73ºN, during 2008 12 northern bottlenose whales were sighted over 2,780 nautical miles of ship survey (2009 Norway Progress Report).

WHALING

We summarize the history of whaling for northern bottlenose whales in Table 2. For more detailed information, see, for instance, Benjaminsen (1972) and Reeves et al. (1993).

There has been a drive fishery in the Faeroe Islands that has taken occasional bottlenose whales for many centuries. Bloch et al. (1996) found reports of 811 whales being taken between1584-1993. The whaling continues. In 2007, 3 northern bottlenose whales were taken in the Faeroes (Faeroe Island progress report to NAMMCO 2009), and 7 in 2008 (Faeroe Islands progress report to NAMMCO 2010).

Scottish whalers began to hunt northern bottlenose whales in 1852, and commenced in earnest about 25 years later (Mead 1989). The Scots mostly whaled in the northwestern Atlantic especially in the Davis Strait (Reeves *et al.* 1993). However the hunt for bottlenose was soon taken over by Norwegians, whom, it is estimated, took about 57,500 whales between 1882 and the late 1920's from whaling grounds in the northeast Atlantic (Reeves *et al.* 1993). The Norwegians restarted bottlenose whaling in the late 1930s as part of their North Atlantic hunt for several species of small whale. They caught bottlenose whales across the eastern North Atlantic particularly in the four northeastern Atlantic centres of concentration shown in Figure 1 (Benjaminsen 1972). Between 1969-1971 the Norwegian whalers turned their attention to the Baffin-Labrador population killing 818 animals (Christensen 1975, Reeves *et al.* 1993).

Between 1962 and 1967, 87 northern bottlenose whales were taken from the Scotian Shelf area by whalers based in Blandford, Nova Scotia (Reeves et al. 1993). It is unknown whether the population has recovered from this depletion. Genetic analyses detected no signal of a population bottleneck in this population (Dalebout et al. 2006).

After the end of whaling in 1971, there was scientific dispute, especially at the Scientific Committee of the IWC, as to whether or not the hunt had depleted the species substantially across its range (Christensen *et al.* 1977, Holt 1977, Mitchell 1977). Clearly during the second phase of Norwegian whaling, effort moved consistently away from the home bases of the whalers, catch numbers peaking in 1938-1941 off Andenes, 1954-1957 off Møre and Svalbard, 1962-1965 off Iceland, and 1969-1971 off Labrador (Benjaminsen 1972). This is a classic signal of overexploitation (Mitchell 1977), but Christensen et al. (1977) argued that the western expansion can be explained by factors other than overexploitation of the eastern populations.

THREATS

Northern bottlenose whales seem to face two principal threats: bycatch/ entanglement in fishing gear, and ocean noise. In both cases the threat is actual, but the extent of harm is uncertain. There are also some concerns about the effects of contaminants.

There are reports of northern bottlenose whales interacting with fisheries off Iceland (Iceland Annual Progress Report 2009), but especially in Baffin-Labrador waters. Animals in the Baffin-Labrador population frequently interact with offshore trawling and longlining operations (MacDonald 2005). Fisheries and Oceans Canada has collected many photographs, personal communications and observer reports of northern bottlenose whales associated with fisheries for Greenland halibut (*Reinhardtius hippoglossoides*) off northern Labrador and in the western Davis Strait (J. Lawson pers. comm.). Some fishermen complain that these whales are taking the bait or catch off the lines (perhaps exacerbated by fishermen apparently feeding bait or bycatch to nearby northern bottlenose whales) (J. Lawson pers. comm.). Several fishermen claimed they were "driven from the fishery" by whale depredation, despite the use of rapid location changes or "decoy vessels" to try to lure groups of northern bottlenose whales away from actively fishing vessels (J. Lawson pers. comm.). Lawson (pers. comm.) notes that Greenland fishermen also taking Greenland halibut, but working on the opposite side of the Davis Strait, do not report similar whale depredation.

Since the early 1980's Fisheries and Oceans Canada has collected 8 records from the At-Sea Observer program (5 from the Scotian Shelf area; and 3 from Newfoundland/Labrador) of entanglement of northern bottlenose whales in long-lines and otter-trawls, both benthic and pelagic, set for swordfish (*Xiphius gladius*), silver hake (*Merluccius bilinearis*), Greenland halibut and squid (Department of Fisheries and Oceans 2009). (The silver hake and squid fisheries are no longer active.) Some of these animals were cut free, and may have survived. Others died. One dead adult was brought to the surface entangled by the caudal peduncle in gillnet gear for Greenland halibut in 2008 (J. Lawson pers. comm.). Additionally a northern bottlenose whale was observed severely entangled and injured in long-line gear in the Gully in 1999 (Gowans *et al.* 2000), and one died from entanglement in fishing gear off Iceland during 2008 (Iceland Annual Progress Report 2009). Additional entanglements have almost certainly gone unreported, but their frequency and severity are unknown. In an analysis of markings on 100 photographs of the melons (foreheads) of the Scotian Shelf animals, Mitchell (2008) found only one example of marks indicating entanglement, and one of vessel collision. This might suggest that entanglement is not a severe problem, although one death per year caused directly or indirectly by entanglement would exceed the estimated PBR (0.3) for the Scotian Shelf population (Harris *et al.* 2007).

Anthropogenic noise in the ocean is generally increasing and seen as a threat to cetaceans. Noise can have a range of deleterious effects on marine mammals, including death from stranding, permanent and temporary threshold shifts in hearing ability, masking of important sounds (from conspecifics, prey, predators and the environment, as well as the returns from their own echolocation), displacement and behavioural disturbance (Cox *et al.* 2006, Nowacek *et al.* 2007). However, research into the effects of anthropogenic noise on cetaceans rarely examines long-term, population-level effects, and has produced apparently contradictory results (Nowacek *et al.* 2007, Weilgart 2007). Thus the effects of ocean noise on northern bottlenose whales are extremely uncertain.

The noise sources of most concern for northern bottlenose whales are geophysical seismic surveys, which are sporadically intense in their habitat. The most likely effects of seismic activity on northern bottlenose whales are probably displacement from preferred habitat and disruption of foraging. A variety of cetacean species have been found to move away from seismic surveys (Stone 2003), and the presence of seismic pulses negatively affects the foraging effectiveness of another deep-diving species, the sperm whale, *Physeter macrocephalus* (Miller *et al.* 2009).

Seismic exploration activity has been sporadic but sometimes intense in the habitat of the northern bottlenose whale. It has been of most concern for the Scotian Shelf population (Department of Fisheries and Oceans 2009). The Gully, as a marine protected area, no longer has seismic exploration, but the sounds of surveys outside the Gully can reach into it (McQuinn and Carrier 2005). Northern bottlenose whales were sighted in the Gully during a 2003 seismic survey being carried out approximately 50km away, during which received noise levels from the survey were about 135-140dB re 1µPa SEL (Gosselin and Lawson 2005, McQuinn and Carrier 2005). Other important habitat for Scotian Shelf northern bottlenose whales, especially Shortland and Haldimand canyons, are subject to seismic surveys. Heavy seismic exploration activity occurred in the area of Haldimand canyon between 1999-2003. Shortland and Haldimand canyons have been recommended as Critical Habitat in the proposed Recovery Strategy for the Scotian Shelf population (Department of Fisheries and Oceans 2009), and this could eventually lead to measures that limit the exposure of the whales to noise from seismic surveys. Seismic surveys off Labrador have so far been generally south of the principal habitat of the Baffin-Labrador population. There has been intense seismic exploration activity in the waters off the United Kingdom (detailed at https://www.og.decc.gov.uk/environment/opachr.htm) and in the waters off Norway (see http://www.pdp.diskos.com/). Off Norway, seismic exploration has been particularly frequent over the old Møre whaling grounds, quite frequent in the general area of Svalbard, and relatively rare off Andenes.

Beaked whales are known to strand and die in response to the use of military sonars and other naval activities (Cox *et al.* 2006, Weilgart 2007). Seismic operations are also occasionally implicated (Weilgart 2007). While Cuvier's beaked whale (*Ziphius cavirostris*) is the species most often involved in strandings linked to military sonar, there is a record of one northern bottlenose whale in a mass stranding off the Canary Islands (Weilgart 2007). The habitat of northern bottlenose whales is sufficiently far from populated coasts that most strandings are unlikely to be detected and reported. The mechanisms by which loud sound causes the death of whales are not clear. However, Houser et al. (2001) and Hooker et al. (2009) suggest that, because of their repetitive long and deep dives, northern bottlenose whales may be particularly susceptible to acoustically triggered physiological damage through nitrogen accumulation in the blood and tissues, although northern bottlenose whales may be less at risk of such damage than

Cuvier's beaked whales (Hooker *et al.* 2009).

Overall contaminant levels in northern bottlenose whales from both the Scotian Shelf and Baffin-Labrador populations were similar to those in other North Atlantic odontocetes (Hooker *et al.* 2008). However, among the Scotian Shelf animals there were significant increases in 4,4'-DDE and *trans*-nonachlor in 2002-2003 relative to 1996-1997, an interval during which the Sable Offshore Energy project developed near Sable Island, about 30 km from the Gully (Hooker *et al.* 2008). An analysis of photographs of marks on the melons of the Scotian Shelf whales found an increase over this period in the prevalence of those marks that have been associated with skin disease in other odontocetes (Mitchell 2008). It is not clear whether the increases in these marks and in contaminant levels were in any way related to the industrial activity of the Sable Offshore Energy Project. Contaminant concentrations have been reported for one bottlenose whale in the eastern Atlantic, a juvenile male which stranded in the North Sea in 1976 (Harms *et al.* 1978). This animal contained much higher quantities of PCBs and somewhat higher quantities of DDTs than animals sampled in the Gully (37,100 ng/g total PCBs and 14,200 ng/g total DDT based on wet weights, which, given 50% lipid recorded by Hooker et al. 2008, would result greater values converting to lipid weights). However, there may be problems with such comparison, given recent advances in analytical techniques and variation in lipid solubility (Hooker et al. 2008).

LEGAL PROTECTION AND DESIGNATED STATUS

The northern bottlenose whale is listed as a "Protected Species" by the International Whaling Commission with a catch limit of zero, and as "Data deficient" by IUCN. The species is also listed on Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The Scotian Shelf population is considered Endangered under the Canadian Species at Risk Act, and the Baffin-Labrador population was listed as of Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in May 2011. The Government of Canada will now decide whether or not to accept COSEWIC's listing as the official status under the Species at Risk Act.

The Gully, the focus of distribution of the Scotian Shelf bottlenose whales, was made a marine protected area in 2004 with the habitat of the whales forming its core area (Macnab 2005). Shortland and Haldimand canyons are considered Critical Habitat for this population and so may receive some protection (Harris *et al.* 2007). Most of the coastal waters of Svalbard (to about 22km from shore) are also marine protected areas, and may provide protection for some bottlenose whale habitat, especially to the west of the islands.

SUMMARY

Although there was some controversy (Christensen *et al.* 1977), there was quite good evidence by the late 1970's that the catch of about 65,000 northern bottlenose whales between about 1872-1972 depleted the population (Mitchell 1977): whaling effort moved away from the whalers' home base, the value of the product rose, but the production declined. Furthermore the whalers took over half of today's Scotian Shelf population (Whitehead and Wimmer 2005). There are signs that in some areas populations have not recovered much, if at all. The species seems scarce in the Baffin-Labrador area and is rarely seen in areas of former concentration off mainland Norway. The signs are better off Svalbard, Iceland and the Faeroes where sightings are fairly common. The whales are consistently found in the canyons along the Scotian Shelf, but the population there is small and increasing slowly, if at all. The species is involved in fishery interactions that are sometimes harmful to the animals, and may be threatened by the effects of underwater noise and chemical contaminants.

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Table 1. Rates of detecting northern bottlenose whales in scientific boat-based sighting surveys conducted by H. Whitehead laboratory (Dalhousie University) and on "pop-up" hydrophone recorders deployed at depths of about 1,000 m for periods of months (H. Moors; Dalhousie University/DFO).

	Sighting rate encounters/hr (effort in hrs) (Herfst 2004, Wimmer and Whitehead 2004, Compton 2005)	Rate of hearing northern bottlenose whale clicks/min (H. Moors pers. comm.)
The Gully	0.50 (1,450)	35.0
Shortland Canyon	0.29 (114)	22.9
Haldimand Canyon	0.14 (94)	26.6
Other Scotian Slope waters	0.00 (154)	9.7*
Labrador-Baffin	0.03(321)	-

* Mean of values from 2 stations about 25 km east and west of the Gully

Table 2. Approximate numbers of northern bottlenose whales caught by different hunts in different population centres of the North Atlantic (from Benjaminsen 1972, Reeves *et al.* 1993, Bloch *et al.* 1996).

Whalers	Dates	Scotian Shelf	Labrador-Baffin	Iceland	Faeroes	Andenes, Norway	Møre, Norway	Svalbard
Faeroe Islands	1584-1993				811			
U.K.	1850-1892		~ 1,669					
Norway	1883-1926			<		~57,500		>
Norway	1938-1969			~2,150		~200	~700	~1,700
Canada	1962-1967	87						
Norway	1969-1971		818					

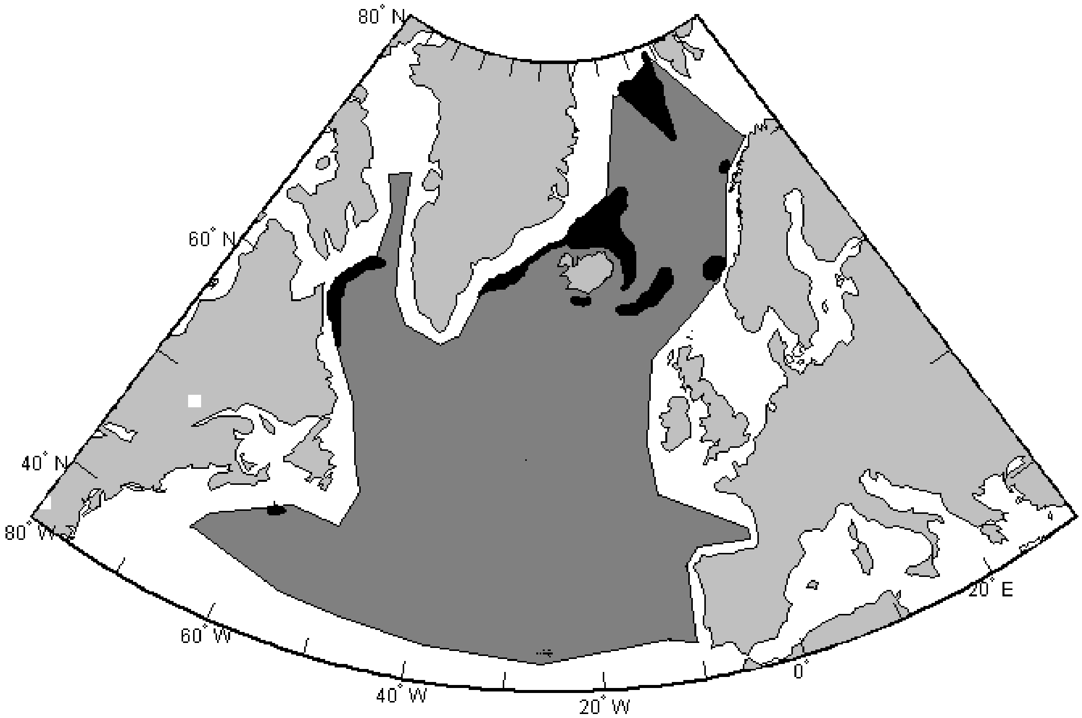

Figure 1. Approximate global distribution of northern bottlenose whales (dark grey) with major areas of whaling for this species indicated in black.