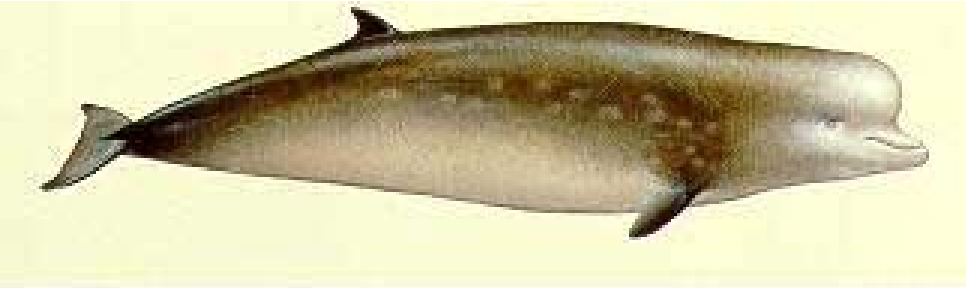
COSEWIC
Assessment and Update Status Report

on the

Northern Bottlenose Whale
Hyperodon ampullatus

Scotian Shelf population

in Canada



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ENDANGERED
2002

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE
IN CANADA

COSEPAC
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AU CANADA

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Northern Bottlenose Whale *Hyperoodon ampullatus* (Scotian Shelf population) was formerly listed as Northern Bottlenose Whale *Hyperoodon ampullatus* (Gully population).

For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment Canada
Ottawa, ON
K1A 0H3

Tel.: (819) 997-4991 / (819) 953-3215
Fax: (819) 994-3684
E-mail: COSEWIC/COSEPAC@ec.gc.ca
http://www.cosewic.gc.ca

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COSEWIC
Assessment Summary

Assessment Summary – November 2002

Common name
Northern Bottlenose Whale (Scotian Shelf population)

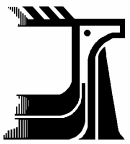
Scientific name
Hyperoodon ampullatus

Status
Endangered

Reason for designation
This population totals about 130 individuals and appears to be currently stable. Oil and gas development in and around the prime habitat of this population poses the greatest threat and will likely reduce the quality of their habitat. However, there is little information as to how this species is, or is not, affected by oil and gas development activities.

Occurrence
Atlantic Ocean

Status history
The Northern Bottlenose Whale was given a single designation of Not at Risk in April 1993. Split into two populations in April 1996 to allow a separate designation of the Northern Bottlenose Whale (Scotian Shelf population). Scotian Shelf population designated Special Concern in April 1996. Status re-examined and uplisted to Endangered in November 2002. Last assessment was based on an existing status report with an addendum.



COSEWIC
Executive Summary

Northern Bottlenose Whale
Hyperoodon ampullatus
Scotian Shelf population

Description

The northern bottlenose whale is a 6-9 m member of the beaked whale family. It is a brownish-grey animal with a pronounced beak, a bulging forehead, and a robust body.

Distribution

The northern bottlenose whale lives only in the northern regions of the North Atlantic, principally in the waters off Norway, Spitzbergen, Iceland, Greenland and Labrador. Northern bottlenose whales are sighted consistently, throughout the year, at the entrance of the Gully, a submarine canyon on the edge of the Scotian Shelf. This is the most southern concentration of northern bottlenose whales, and evidence suggests that the Gully population is largely or totally distinct from the animals found at higher latitudes.

Population Sizes and Trends

Northern bottlenose whales were whaled heavily throughout their range between 1850-1973, and this whaling is thought to have reduced the population considerably. The catch included 87 animals killed in or near the Gully during the 1960's. Currently about 210 animals habitually use the Gully. We do not know whether this population is growing, shrinking, or stable.

Habitat

Northern bottlenose whales live in deep (greater than 1,000m) and usually cold waters. Particular concentrations are often found near areas where the ocean floor is especially steep, such as the Gully.

General biology

Northern bottlenose whales become sexually mature at about age ten. Adult females give birth to 3.5 m young once every two years or so after a gestation period of about one year. Males are larger than females and distinctive because of their flat,

white, foreheads. Northern bottlenose whales may dive to over 1,000 m for more than an hour and principally feed on deep-water squid and fish. They are social animals, forming groups of 2-12, and there seem to be some long-term companionships between members of the same sex. They make a variety of social sounds and loud, ultrasonic clicks, which are probably used to find food. Northern bottlenose whales are the most curious of all whales, frequently approaching stationary vessels.

Limiting factors

The Gully seems to be very important for the small population of bottlenose whales that live south of Nova Scotia. The principal threat to these animals is the possibility of exploitation of the oil and gas fields on the Scotian Shelf close to the Gully. The noise, chemical pollution, and other disturbance of such activities might lead the whales to abandon of Gully, potentially endangering the population.

Protection

National legislation and international conventions protect northern bottlenose whales from hunting. Several initiatives have been undertaken to protect the Gully population:

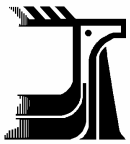
The oil company, Lasmo, which is exploiting the Cohasset-Panuke field 110 km to the west of the Gully, has declared a "tanker exclusion zone" including the Gully, so that shipping associated with the development does not interfere with the whales.

The Department of Fisheries and Oceans has designated a "Whale Sanctuary" in the Gully for the northern bottlenose whales. Mariners are asked to avoid the Gully, or transit it cautiously.

The establishment of a Marine Protected Area in the Gully is being considered by the Canadian Wildlife Service, the Department of Fisheries and Oceans, Parks Canada, World Wildlife Fund Canada and other organizations.

Conclusions

The small population of northern bottlenose whales that uses the Gully is the only population of any beaked whale species anywhere in the world in which individual living animals have been identified and are the subjects of long-term study. These animals live at the southern extreme of the species' range, seem to be largely or totally distinct from the populations further north, appear to be non-migratory, and spend an average of 57% of their time in a small core area at the entrance of the Gully, which has seafloor relief that is unique in the western North Atlantic. These characteristics make the population particularly sensitive to human activities. Development of the oil and gas fields on the Scotian Shelf close to the Gully would threaten the bottlenose whales.



COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) determines the national status of wild species, subspecies, varieties, and nationally significant populations that are considered to be at risk in Canada. Designations are made on all native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fish, lepidopterans, molluscs, vascular plants, lichens, and mosses.

COSEWIC MEMBERSHIP

COSEWIC comprises representatives from each provincial and territorial government wildlife agency, four federal agencies (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biosystematic Partnership), three nonjurisdictional members and the co-chairs of the species specialist groups. The committee meets to consider status reports on candidate species.

DEFINITIONS

Species	Any indigenous species, subspecies, variety, or geographically defined population of wild fauna and flora.
Extinct (X)	A species that no longer exists.
Extirpated (XT)	A species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A species facing imminent extirpation or extinction.
Threatened (T)	A species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Not at Risk (NAR)**	A species that has been evaluated and found to be not at risk.
Data Deficient (DD)***	A species for which there is insufficient scientific information to support status designation.

* Formerly described as “Vulnerable” from 1990 to 1999, or “Rare” prior to 1990.
** Formerly described as “Not In Any Category”, or “No Designation Required.”
*** Formerly described as “Indeterminate” from 1994 to 1999 or “ISIBD” (insufficient scientific information on which to base a designation) prior to 1994.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list.

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Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

Update
COSEWIC Status Report

on the

Northern Bottlenose Whale
Hyperoodon ampullatus

Gully population

in Canada

Hal Whitehead[1]
Annick Faucher[1]
Shannow Gowans[1]
Stephen McCarrey[2]

1996

[1]Department of Biology
Dalhousie University
Halifax, NS
B3H 4J1
[2]Department of Zoology
University of Tasmania
P.O. Box 252C
Hobart 7001
Australia

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INTRODUCTION

A population of approximately 213 Northern Bottlenose Whales, *Hyperoodon ampullatus*, uses the Gully, a prominent submarine canyon on the edge of the Scotian Shelf. These animals use the Gully throughout the year. Approximately 57% of the population reside in a 20 km x 8 km core area at the entrance of the canyon at any time. The Gully animals seem to be largely or totally distinct from the population seen off northern Labrador: they are smaller and appear to breed at a different time of year. This is the only population of beaked whales in the world that is the subject of long-term research on individually identified animals. Threats to the population include commercial shipping, fishing and oil and gas developments. One oil and gas discovery of commercial interest, the Primrose field, lies about 5km from the core area of this population. The population is vulnerable because of its small size, location at the extreme southern limit of the species' range, and year-round dependence on a small and unique sea area. It is threatened by plans for the development of the oil and gas fields close to the Gully.

In this report we evaluate the status of the population of Northern Bottlenose Whales, *Hyperoodon ampullatus* (Forster, 1770) whose members are found in the Gully, a submarine canyon on the edge of the Scotian Shelf. The Northern Bottlenose Whale is a 6 to 9 m member of the beaked whale family (Ziphiidae) resident only in the northern regions of the North Atlantic. Its closest relative is the Southern Bottlenose Whale (*Hyperoodon planifrons*) of the southern oceans. Bottlenose whales seen in the tropical Pacific may be *Hyperoodon planifrons* or an unnamed species (Klinowska 1991). The biology of the Northern Bottlenose Whale was reviewed by Benjaminsen and Christensen (1979) and Mead (1989). The general status of the species in the North Atlantic was described by Reeves, Mitchell and Whitehead (1993).

DISTRIBUTION AND STOCK IDENTITY

Northern Bottlenose Whales are present consistently, throughout the year, in a 20 km x 8 km "core area," at the entrance of the Gully, a submarine canyon on the edge of the Scotian Shelf (Faucher and Whitehead 1991; Reeves, Mitchell and Whitehead 1993; Figure 1). They are also sighted, more rarely, off the edge of the Scotian Shelf to the east and west of the Gully (Figure 1), and there are very occasional reports from the edge of the U.S. Shelf (Reeves, Mitchell and Whitehead 1993). During the Canadian Patrol Frigate Shock Trials in November 1994, Northern Bottlenose Whales were observed twice and heard once near the detonation site (42° 05'N 61° 20'W), 110 km from the Shelf Break and 200 km from the Gully (Parsons 1995; Figure 1).

The Gully is the southernmost area in the western North Atlantic where Northern Bottlenose Whales are found on anything other than on a very occasional basis. The nearest other region where the species may be consistently sighted is off northern Labrador, 1400 km to the north.

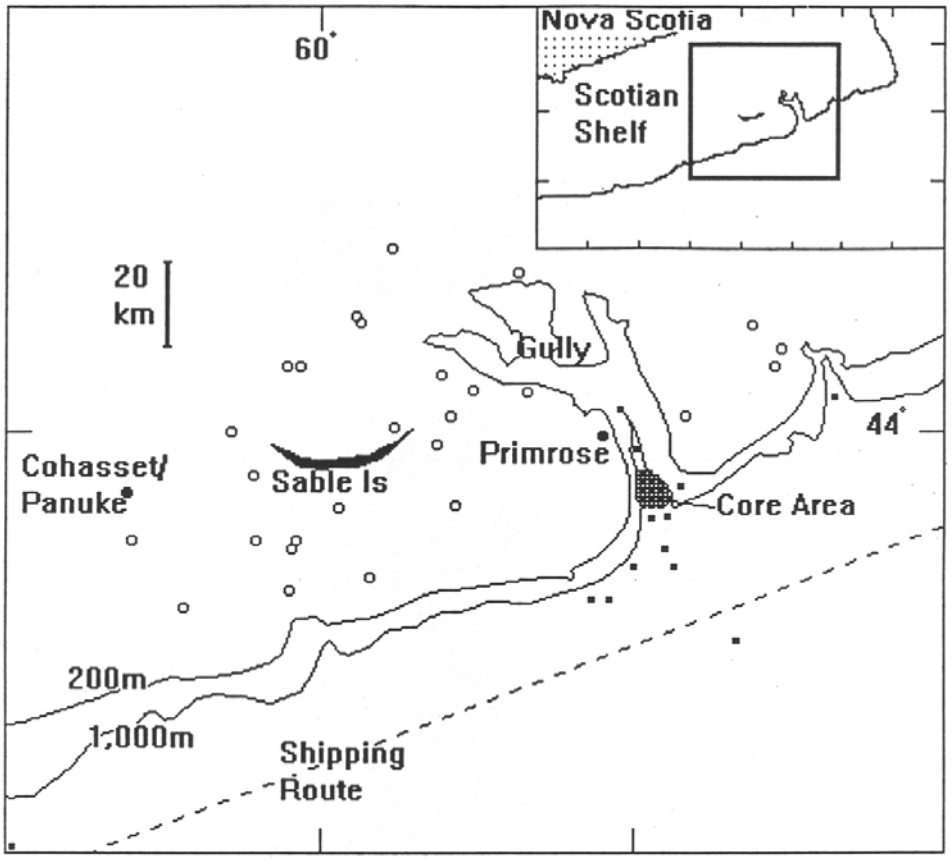

Figure 1. The Scotian Shelf, showing the Gully,oil and gas discoveries from Wade et al. (1989) (circles,the Cohasset/Panuke and Primrose fields are filled), major shipping route (dashed line), the core area of the Northern Bottlenose Whale population (shaded), and additional sightings and catches of the species (■) from Reeves,Mitchell and Whitehead (1993), the Sea Education Association and our own sightings. The site of the Canadian Patrol frigate Shock Trial at which Bottlenose Whales were sighted is marked on the inset by a '+'.

Analysis of photographic identifications of individual whales suggests that the animals in the Gully at any time are about 57% of a population numbering about 213 animals (Table 1; see below). The geographic range of this population is unknown but, based on the pattern of sightings, we suspect that it is principally the slope waters south of Nova Scotia. If the Gully animals are an integral, freely mixing part of the population off northern Labrador, then the total population numbers only about 213 animals—unlikely given the numbers and geographical spread of recent sightings in northern waters (Reeves, Mitchell and Whitehead 1993).

Table 1. Estimates of population parameters for individually identifiable Bottlenose Whales with distinctive long-term marks in the Gully from high quality photographs using the likelihood methods of Sandland and Kirkwood (1981) and Whitehead (1990). Approximate 95% confidence intervals were estimated from ranges of parameter values with minimum support functions less than 2.0 (Edwards 1972). Population sizes for the individually identifiable animals with clear marks are uprated to estimates for all animals (given in bold) using the proportion of animals with clear, identifiable marks, 29%.

Number of identified individuals	66	74
Estimates Using Years As Units		
Total Population Size	60 (**209**)	65 (**226**)
(95% c.i.)	50-79 (**174-275**)	51-94 (**178-328**)
Mortality+Emigration (from total population)+Mark Change Rate	0.10/year	0.15/year
(95% c.i.)	0.00-0.21	0.02-0.26
Estimates Using Months As Units		
Total Population Size	61 (213)	61 (213)
Gully Population Size	32 (111)	37 (129)
Emigration Rate From Gully	0.52/month	0.38/month
Immigration Rate To Gully	0.54/month	0.59/month
Mortality+Emigration (from total population)+Mark Change Rate	0.10/year	0.16/year

The population analysis (Table 1) does not rule out occasional migrations of animals between the northern (Labrador-Davis Strait) areas and the Gully. The estimates of mortality+emigration+mark change are about 12% per year, and have wide confidence limits (Table 1). We have no objective means of allocating the 12% between these three possible causes. Much of the 12% could be due to mark change. No other estimates of mortality are available for Northern Bottlenose Whales, although mortality is believed to be about 6% per year in the Sperm Whale (*Physeter macrocephalus*), the species most ecologically similar to the Northern Bottlenose for which data are available (Rice 1989). Thus we can only conclude from the population analysis that emigration rates from the Gully population, and immigration rates into it, are probably less than about 10% per year and may be negligible.

Additional evidence that the Northern Bottlenose Whales in the Gully are largely distinct from those off Labrador comes from an examination of length distributions (Figure 2). The photographically measured animals in the Gully are about 0.7 m shorter than those caught off northern Labrador. The same effect is true for the two sexes—the Labrador population is 0.55 m larger for all males, 0.94 m for females. Some of the difference could be due to differential selection by the whalers and our photographic measurement methods. However, this cannot account for all the difference: about 10% of the Labrador population were greater than 8.5 m long, but animals this large were virtually absent from the Gully (Figure 2). It is possible that only young animals visit the Gully. However, we do see distinctive mature males as well as females with calves, and a 6.15 m male with 5 growth layers in its teeth which stranded in the Bay of Fundy, and was thus likely from the Gully population, lay below the growth curve for animals caught in Labrador (Mitchell and Kozicki 1975), further evidence that the Gully population are smaller than those from Labrador.

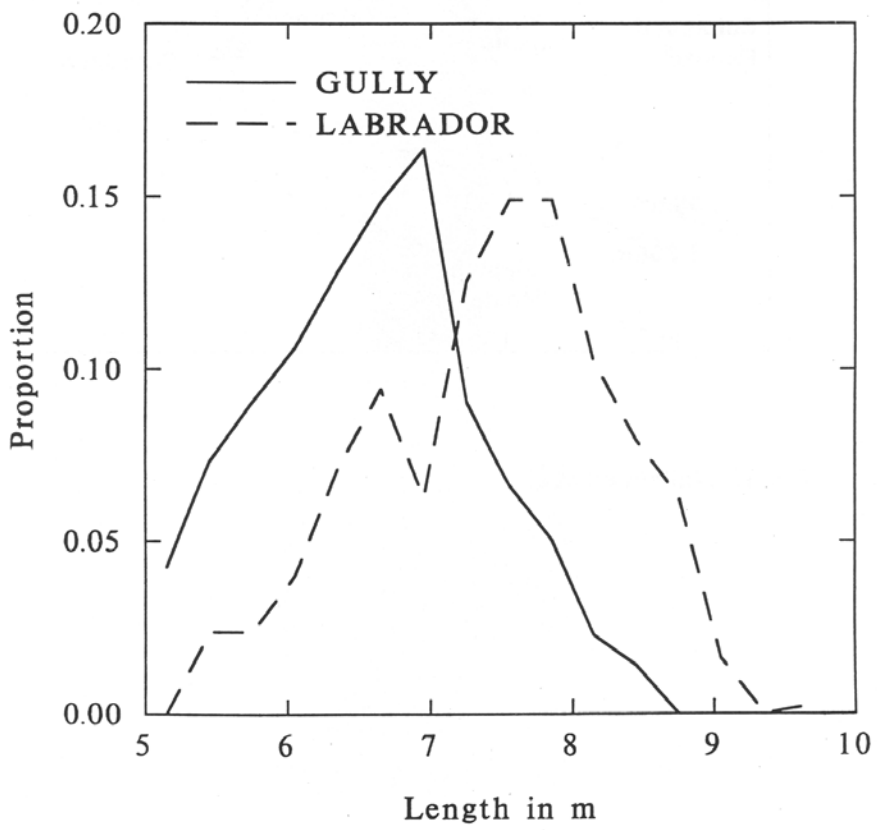

Figure 2. Length distributions for the Bottlenose Whales caught off Labrador (n=127) (Christensen 1975), and measured photographically in the Gully using the method of Gordon (1990) (n=451—some animals were measured several times).

Our observations also indicate that the Bottlenose Whales of the Gully may be on a different breeding schedule than the Labrador population, which mates and gives birth in April (Benjaminsen 1972):

In the Gully, we have 5 high-quality measurements (probably representing 2 calves) of 3.0 to 3.3 m in August, and none between 3.3 to 4.0 m. Mead (1989) suggests 3.5 m for the mean length at birth of the populations studied in northern waters. Thus, even allowing for smaller animals in the Gully, the 3.0 to 3.3 m calves observed in the Gully in August were likely recently born.

The gestation period of Bottlenose Whales is about 12 months so that mating and calving occur at the same time of year (Benjaminsen and Christensen 1979). In the Gully, the proportion of mixed groups of males and females rises through June-August (proportion of groups with both adult males and females: 10% June; 17% July; 28% August), consistent with an August mating/parturition season.

PROTECTION

National legislation and international conventions protecting Northern Bottlenose Whales from hunting are described by Reeves, Mitchell and Whitehead (1993). Neither now, nor in the near future, is the population in the Gully likely to be subject to whaling.

Several initiatives have been undertaken to protect the Gully population:

- In 1990, the oil company Lasmo, which was beginning exploitation in the Cohasset-Panuke field 110 km to the west of the Gully, declared a "tanker exclusion zone" including the Gully, so that shipping associated with the development does not interfere with the whales.
- The Department of Fisheries and Oceans has designated a "Whale Sanctuary" in the Gully for the Northern Bottlenose Whales and, in the Canadian Notices to Mariners Annual Edition (1994), published guidelines for the behaviour of vessels within the sanctuary. Shipping companies have been asked (by letter) to avoid the area, and many have agreed to do so.
- The establishment of a Marine Protected Area in the Gully is being considered by the Canadian Wildlife Service, the Department of Fisheries and Oceans, Parks Canada, World Wildlife Fund Canada and other organizations and individuals (Amirault 1995).

POPULATION SIZES AND TRENDS

High-quality photographic identifications (from 1988 to 1995) of individual Bottlenose Whales with clear long-term markings (nicks on the dorsal fin) have been used to examine the size and structure of the population using the Gully. The analysis uses the maximum-likelihood mark-recapture techniques described by Sandland and Kirkwood (1981) and Whitehead (1990). Estimates were calculated separately for identifications using photographs of the left and right sides of the dorsal fin and surrounding areas, and with calendar years and calendar months as time units.

Several population models were tried. Those which produced the best fit to the data (i.e. no parameters could be removed without significantly worsening the fit of the data to the model) had the following characteristics (Table 1, Figure 3):

- there are, at any time, about 35 photographically identifiable whales with clear long-term marks in the Gully;
- these are a part of a larger population which habitually uses the Gully containing approximately 61 photographically identifiable whales with clear long-term marks;
- animals move into the Gully from the other parts of the population's range (probably the waters of the Scotian Shelf) at a rate of about 0.55/month;
- animals move from the Gully to the other parts of their range at a rate of about 0.45/month;

- animals die, emigrate from the range of the population that habitually uses the Gully (e.g. to northern Labrador), or change their marks at a rate of 0.12/year. This disappearance of animals from our marked population is why the number of identified animals is greater than the population estimate in Table 1.

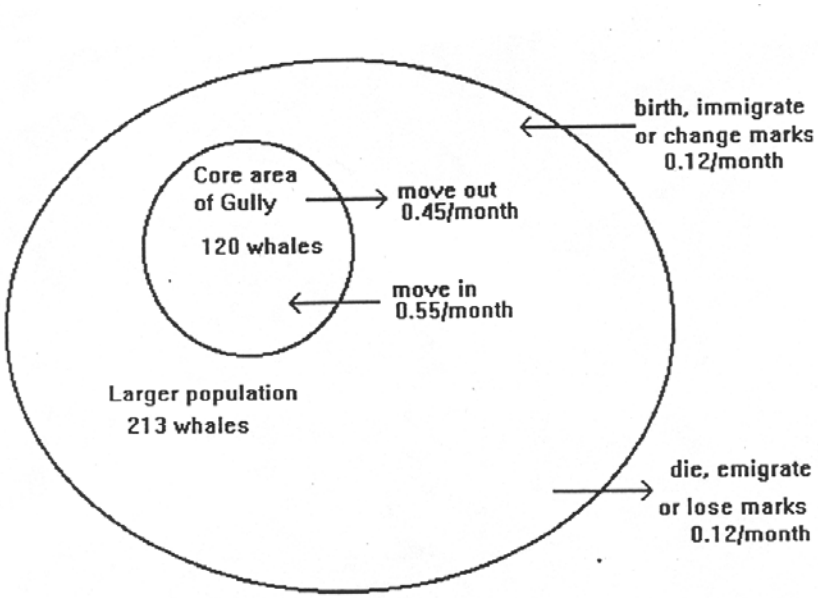

Figure 3. Representation of the population organisation of the Bottlenose Whales that use the Gully as suggested by mark-recapture analysis of individual identification photographs (Table 1).

As about 70% of the population that habitually uses the Gully are identifiable (Faucher and Whitehead 1991), and 41% of these animals have clear long-term marks, about 29% of the population is represented in the population analysis summarized in Table 1. Therefore the results summarized in Table 1 suggest that the animals in the Gully at any time constitute about 57% of a total population numbering approximately 213 animals, with an approximate 95% confidence interval of 172-278. Unfortunately, there are insufficient data to make a meaningful examination of trends in population size with time.

Eighty-seven Northern Bottlenose Whales were taken by whalers working from Blandford, Nova Scotia between 1962-1967 (Reeves, Mitchell and Whitehead 1993). The great majority of these seem to have been killed in, or near, the Gully (Reeves, Mitchell and Whitehead 1993). Assuming that the population size is now somewhere between its levels immediately before and after this whaling, a 29 to 41% reduction in numbers during the whaling period is indicated.

HABITAT

The habitat of the Bottlenose Whales south of Nova Scotia is the waters near the edge of the continental shelf which are greater than 1000 m deep, but the overwhelming focus of their distribution is the 20 km x 8 km core area at the entrance of the Gully. In terms of relief, and penetration into the shelf, the Gully is the most prominent canyon in the western North Atlantic. The whales are never seen in waters less than about 800 m deep, even though such depths are within a few km of their core habitat.

Protection of this core habitat is likely to be essential for the survival of the population.

GENERAL BIOLOGY

The general biology of Northern Bottlenose Whales was described by Benjaminsen and Christensen (1979), Mead (1989) and Reeves, Mitchell and Whitehead (1993).

LIMITING FACTORS

The size of the population that uses the Gully is small, about 210 animals. This is well below the 2000 beneath which IUCN (International Union for the Conservation of Nature) classifies cetacean species as Endangered (Klinowska 1991). However, the Gully Bottlenose Whales, although apparently largely or totally distinct from the populations in more northern waters, are not (as far as we know) a different species. It seems likely that the population is naturally small, limited by available habitat in the area to the low hundreds.

The Gully population is at the extreme southern limit of the species' range in the western North Atlantic. This likely limits the potential for alternative suitable habitat in nearby sea areas.

The proximate threats to these animals from humans are principally:

- collisions with ships. Each year a number of whales are found dead in the waters off Nova Scotia following collisions with shipping (J. Conway, personal communication), although there are no known reports of Bottlenose Whale fatalities.
- acoustic pollution. Whales communicate and sense their environment largely through the acoustic channel. Noise affects the behaviour and movement of whales; it has the potential to interfere with feeding or mating, or cause physiological damage (Richardson et al. 1991; Committee on low-frequency sound and marine mammals 1994).
- fishing gear. Entanglement in fishing gear (that in active use as well as discarded, abandoned or lost gear) is a major threat to many cetacean

populations (Cooke 1991). A number of the Bottlenose Whales in the Gully show evidence of encounters with fishing gear (e.g. Fig. 4).

- marine debris. Entanglement in floating debris, such as plastic bags and discarded strapping, is a source of mortality for many marine animals, including cetaceans (Cooke 1991). The Gully has a high level of such pollution (Dufault and Whitehead 1994).
- chemical pollution.

Figure 4. Northern Bottlenose Whale.

The most obvious sources of these dangers are commercial shipping, fishing activity and petrochemical exploration and exploitation. Explosions and loud underwater sounds made for naval and scientific purposes may also pose a threat (Richardson et al. 1991; Committee on low-frequency sound and marine mammals 1994).

Ships may collide with the whales, are a source of acoustic pollution, and can contribute to marine debris and chemical pollution. The major east-west trans-Atlantic shipping route lies about 30 km south of the Gully core area (Figure 1). Commercial ships (excluding fishing vessels) transit the core area of the Bottlenose Whales about once per day (H. Whitehead, unpublished data). This rate may have decreased somewhat since the Department of Fisheries and Oceans' guidelines were published in the Notices to Mariners, and requests for avoidance were sent to shipping companies.

The shallow areas bordering the Gully were heavily dragged for groundfish, while midwater draggers take Redfish (*Sebastes* sp.) from within the core area. Fishing vessels, especially while dragging, are extremely noisy (H. Whitehead, personal observation). They may entangle whales in their active, lost or discarded gear, and are sources of other marine debris. The crash of groundfish stocks during the last few years has considerably reduced fishing activity in the area of the Gully. Harpooning and long-lining for Swordfish (*Xiphius gladius*) also takes place in the core area but this is less obviously harmful.

Oil and gas have been found in commercially exploitable quantities on the Scotian Shelf bordering the Gully. One find, the "Primrose" field, lies about 5 km from the core area of the Bottlenose Whales (Figure 1). The only current exploitation in the area is at the "Cohasset/Panuke" condensate fields (Figure 1). These are 110 km from the Gully, and their exploitation probably poses little threat to the bottlenose whales. In the next few years, a consortium of oil companies led by Mobil Oil Canada plans to exploit some of the gas discoveries around Sable Island, the closest of which, the "Venture" field, is about 45 km from the core area of the bottlenose whales in the Gully.

Oil and gas exploitation has the potential to harm the Bottlenose Whales directly through the noise of the drilling and other operations, spills and discarded material, but also indirectly because of an increase in shipping traffic. Noises associated with offshore oil and gas production disturbed the behaviour of Bowhead Whales (*Balaena glacialis*) to ranges of about 3-11 km (Richardson, Wursig and Greene 1990). It is not known how sensitive the Bottlenose Whale is to acoustic disturbance but the most ecologically similar species for which there are any data, the Sperm Whale, is especially easily disturbed by sound (e.g. Watkins and Schevill 1975; Watkins, Moore and Tyack 1985). Bottlenose Whales have particularly weak social sounds (Winn, Perkins and Winn 1970) which might suggest vulnerability to acoustic disturbance.

The most important limiting factor for the population of Bottlenose Whales in the Gully is likely the pattern and method of development of these oil and gas fields.

SPECIAL SIGNIFICANCE OF THE POPULATION

Our research on the Northern Bottlenose Whales in the Gully is unique: it is the only long-term study of any beaked whale population, anywhere in the world--these are the only living ziphiids to be individually identified. There are no known locations at all comparable to the Gully in terms of the potential for studies of beaked whale populations. In the near future, most of what is known about the natural behaviour of living beaked whales is likely to come from the Gully.

The population is not only amenable to research: two film crews have visited the Gully and have successfully filmed the whales; and local tourist operators are making plans to bring limited numbers of whale watchers to the Gully.

Unusual biological features of the Bottlenose Whale include their maxillary crests, their deep and prolonged dives, the types of sounds produced, and pronounced curiosity towards boats (Mead 1989; Reeves, Mitchell and Whitehead 1993).

EVALUATION

The population of Northern Bottlenose Whales in the Gully is small, about 213 animals, at the southern extreme of the species' range, and largely or totally distinct

from the larger populations further north. The animals seem to be non-migratory, spending an average of 57% of their time in a 20 km x 8 km core area, which is bathometrically unique in the western North Atlantic. These characteristics make the population particularly sensitive to human activities. Thus the population should be, at the least, considered vulnerable.

The development and exploitation of the oil and gas fields on the Scotian Shelf is approaching the Gully, threatening the Bottlenose Whales and other inhabitants of the Gully, which include exceptional numbers of some other cetacean species (Gowans and Whitehead 1995). With exploitation of the Primrose field, the core area of the Bottlenose Whales in the Gully may be abandoned, endangering the population. The current plans for progressive development of the oil and gas fields near the Gully suggest that this population should be designated vulnerable.

ACKNOWLEDGEMENTS

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Addendum to the status of the northern bottlenose whale,
Hyperoodon ampullatus
(Scotian Shelf population*)

Hal Whitehead and Tonya Wimmer
Department of Biology
Dalhousie University
Halifax
Nova Scotia B3H 4J1

*Previously called “Gully population”

Date: November 2002

INTRODUCTION

The status of the northern bottlenose whale (*Hyperoodon ampullatus*), a beaked whale (family Ziphiidae) of the North Atlantic, was assessed for COSEWIC by Reeves *et al.* (1993), and no listing was given. A subsequent report on the population that uses the waters of the Gully, a submarine canyon off the Scotian Shelf, led to this population being placed in the Special Concern category in 1996 (Whitehead *et al.* 1997a). Since these reports, substantial new information has been published on the Gully population, and industrial development in the area has accelerated rapidly, potentially threatening the population. Consequently, the listing of this population needs reassessment.

DIET

Analyses of fatty acids, stable isotopes and the stomach contents of animals stranded in the region all suggest that the principal food of the northern bottlenose whales off the Scotian Shelf are adult squid of the genus *Gonatus* (Hooker et al. 2001). These animals tend to live at or near the bottom at depths of the order of 1,000 m.

DISTRIBUTION AND STOCK SEGREGATION

The northern bottlenose whale is only found in the northern North Atlantic, with population centres off Iceland, Norway, the Davis Strait/northern Labrador and Nova Scotia (Reeves *et al.* 1993; Fig.1). Whitehead *et al.* (1997a, b) considered it likely that the bottlenose whales that use the Scotian Shelf are “largely or totally distinct” from those off northern Labrador, based on the results of a population model, and differences in length distribution and apparent breeding seasons between the two areas.

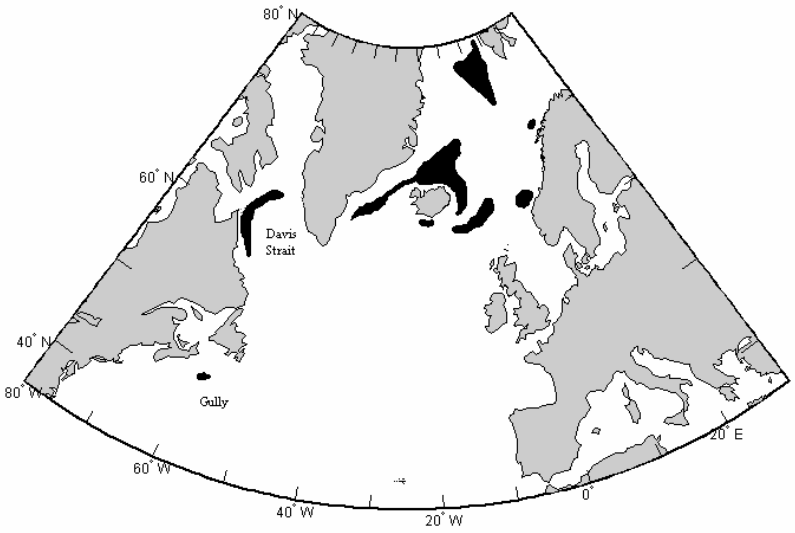

Figure 1. North Atlantic showing primary distribution of northern bottlenose whales.

New genetic results confirm this. The distribution of mtDNA control region haplotypes of the Scotian Shelf population is significantly different from that of the animals in the nearest other population centre, 1,400 km to the north, off northern Labrador (exact test, P=0.008; F_{ST}=0.118, P=0.024; Φ_{ST}=0.145, P=0.007; Dalebout *et al.* 2001). Of the four mtDNA haplotypes identified from the total population, one was found only in the Gully, and one off northern Labrador (and Iceland) but not in the Gully, the other two were common to the Gully and Labrador. The exchange of females between the two populations is estimated at less than five per generation. A more precise estimate is constrained by the small sample sizes currently available and the fact that the Labrador sample is from teeth collected by whalers which do not provide sufficient quality DNA for many analyses (Dalebout *et al.* 2001).

About 34% of the Scotian Shelf population is in the Gully at any time (Gowans *et al.* 2000), but until recently it was unclear where these animals were, when not in the Gully. Sightings in U.S. EEZ waters are very rare despite relatively greater effort than in Canadian waters (R. Kenney, pers. comm). There have been occasional sightings and catches in the deep waters off Nova Scotia outside the Gully (Reeves *et al.* 1993; Parsons 1995; Whitehead *et al.* 1997a) as well as off the Grand Banks of Newfoundland (G. Stenson, pers. comm.). From these sources we know of 4 sightings from the Grand Banks off Newfoundland (G. Stenson, pers. comm. and DFO Scotia-Fundy, Fisheries Observer Program), 39 from off the Scotian Shelf (DFO Scotia-Fundy, Fisheries Observer Program), excluding the Gully, Shortland and Haldimand canyons (1992-2001) and 2 from US waters (R. Kenney, pers. comm.).

A survey along the 1,000 m contour from east of New Jersey to south of Newfoundland conducted during the summer of 2001, and additional research in 2002, (T. Wimmer unpublished) suggested that they spend much of the time when not in the Gully inside Shortland and Haldimand canyons (Fig. 2), which lie about 50 km and 100 km to the east of the Gully. These three canyons were the only locations in which the animals were seen during the entire survey. Seven of the 14 animals photographically identified (based on preliminary examination of prominently marked individuals) in Shortland and Haldimand canyons during the summer of 2001 had previously been identified in the Gully. Studies in the Gully (Hooker *et al.* 2002b) and elsewhere (Reeves *et al.* 1993) suggest that the northern bottlenose whales' primary distributions in the western North Atlantic are near the 1,000 m contour.

POPULATION SIZE AND TRENDS

The Scotian Shelf population has been assessed using mark-recapture methods applied to photoidentification records collected between 1988-1999 (Gowans *et al.* 2000). The best-fit mark-recapture model gave a population estimate of about 130 individuals (95% CI ~107-163). This is down from the 230 previously estimated (Whitehead *et al.* 1997b), but this is because of improved methodology, not a population decline. The Scotian Shelf population seems to have been stable in numbers between 1988-1999 with an estimated trend of -0.28%/yr (95% CI~ -4.0%/yr to +3.5%/yr)

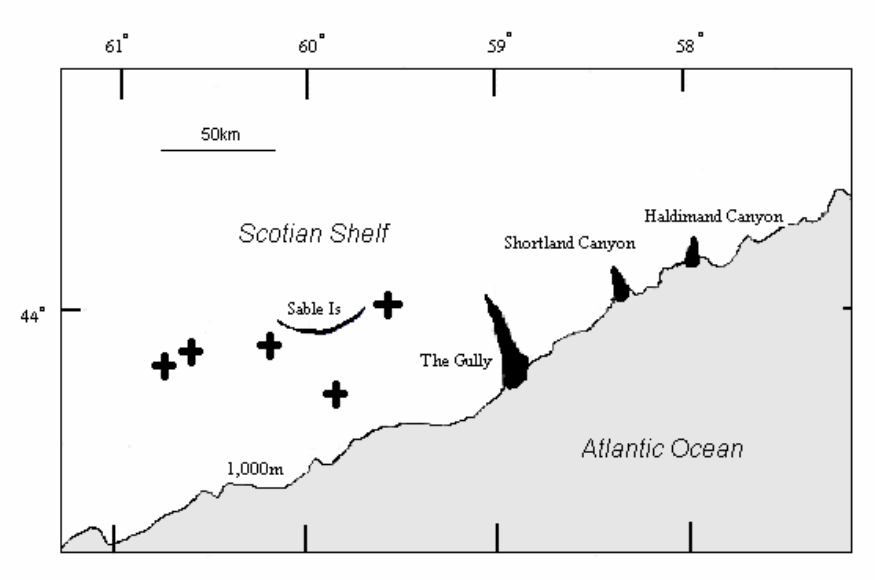

Figure 2. Primary habitat of northern bottlenose whales in submarine canyons on the edge of the Scotian Shelf ("+" denotes site of current petroleum production platform).

(Gowans *et al.* 2000). The estimate of mortality plus mark change plus final emigration from the population was estimated to be 13%/yr (95% c.i. 9.5-17.5%/yr; Gowans *et al.* 2000).

Threats

Between 1962 and 1967, 87 northern bottlenose whales were captured by Canadian whalers, mainly from the vicinity of the Gully (Reeves et al. 1993). The most obvious current threats to the Scotian Shelf population of northern bottlenose whales would seem to come from entrapment in fishing gear and the outputs of oil and gas exploration and exploitation which are prominent in the offshore waters of the eastern Scotian Shelf and increasing in extent.

Entrapment in fishing gear

On 21 August 1999 one juvenile bottlenose whale was observed entangled in long-line gear, almost certainly fatally, in the Gully (Gowans *et al.* 2000). It had the line wrapped tightly around its flukes, so that it could not swim, and around its beak, so that it could not feed. In 2001 another juvenile was reported entangled on the edge of the southern Grand Banks through the Fishery Observer Programme (M. Schowell, pers. comm.). The latter was cut free and probably survived, at least in the short term. A number of animals in the Scotian Shelf population show marks consistent with escape from entrapment in fishing gear (Whitehead *et al.* 1997a). The long-line fishery for swordfish (*Xiphius gladius*) and tuna in the Gully and other shelf waters persists, but

mostly takes place after the summer field study of bottlenose whales is over, so if there is substantial mortality from this cause it would probably go unnoticed by cetacean scientists.

Hydrocarbon exploration

Oil and gas exploration is spreading over the outer eastern Scotian Shelf, and very recently, and rather unexpectedly, into the deeper waters off it (Fig. 3). Included in the leased areas is much of the water at around 1,000 m deep which is thought to be the bottlenose whales' preferred habitat (Hooker 2002b; Reeves *et al.* 1993). Seismic surveys, the most prominent element of hydrocarbon exploration, are being frequently carried out over much of the area, including the deeper waters. Seismic pulses were heard on 18% of the 292 2-min hydrophone listening stations along the 1,000 m contour of the Scotian shelf in 2001 (T. Wimmer, unpublished). The seismic activity on the Scotian Shelf is prominent in the acoustic background off the Bahamas, and along the mid-Atlantic Ridge (Clarke 2002; NMFS and USN 2001), thousands of km away. Seismic pulses have become an important part of the environment of the Scotian Shelf. The Gully is not being explored at present because of respect for the DFO Sable Gully Pilot Marine Protected Area "Area of Interest" by the Canada Nova Scotia Offshore Petroleum Board (which regulates hydrocarbon exploration and exploitation on the Scotian Shelf), although the Gully has no legal protection. Shortland and Haldimand canyons are very close to leased areas (Fig. 3), and currently have no protection.

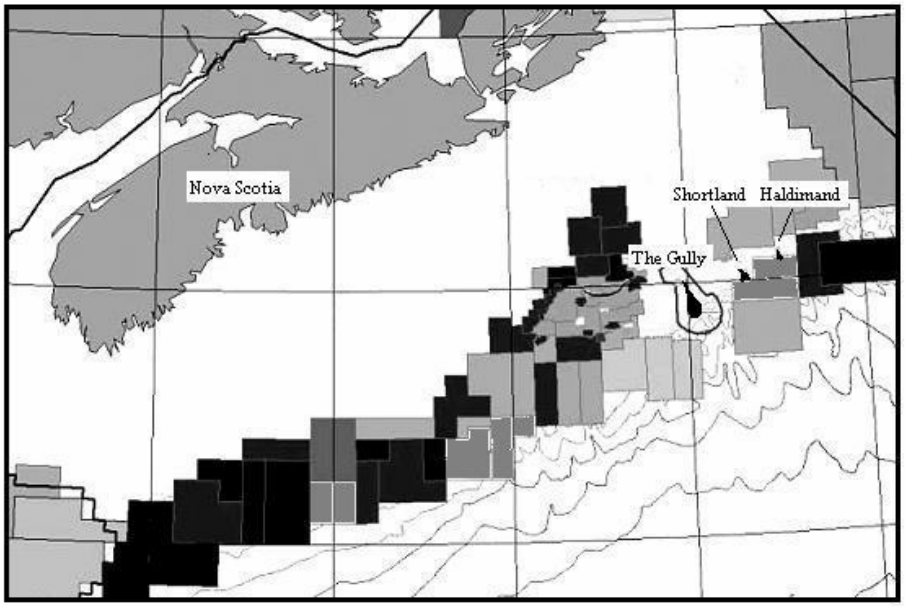

Figure 3. Oil/gas exploration leases on the Scotian Shelf (from Canada-Nova Scotia Offshore Petroleum Board website: http://www.cnsopb.ns.ca/Maps/map2001.html).

The effects of the noise from oil and gas exploration (especially seismic noise) on northern bottlenose whales are not clear (LGL and Malme 1998, p. 151). Studies of other species have produced mixed, but sometimes disturbing, results. For instance, western Pacific grey whales (*Eschrichtius robustus*) off Sakhalin Island, Russia, showed decreased densities, and changes in blow rates and movement patterns in the presence of operational seismic vessels at ranges of 30-35 km (Wursig *et al.*, 1999). Bowhead whales (*Balaena mysticetus*) avoided seismic vessels at similar ranges (Richardson *et al.* 1995, p. 298). Off Scotland, several cetacean species were found to change their distributions and behaviour in the presence of seismic activity (Stone 1997, 1998, 2000 & 2001). Sperm whales (*Physeter macrocephalus*) have been noted changing their behaviour in response to seismic activity at ranges of several hundred kilometres (Bowles *et al.* 1994), and leaving areas as seismic activity commenced (Mate *et al.* 1993), although some other studies, including one in the northern Gully (McCall Howard 1999), did not find any obvious changes in the behaviour or distribution of sperm whales in response to seismic activity. These inconsistencies may result from state-dependent responses: animals responding strongly in certain situations (e.g. when migrating) but not in others (e.g. when breeding or feeding). In some ways (such as the possibility of physiological damage) the lack of a response to a threat may be more dangerous than a clear response (e.g. displacement from the affected area). It is important to note both that all these results come from studies of short-term responses which may or may not translate into population-level effects, and that population-level effects from a stressor may occur with little obvious short-term response (e.g. Harrington and Veitch 1992).

However, loud noise (and seismic exploration produces very loud sounds at ca. 262 dB re 1 μPa at 1 m; LGL and Malme 1998, p. 21) can be fatal to members of other beaked whale species (e.g. Balcomb & Claridge 2001; NMFS and USN 2001)—the ziphiidae may be particularly vulnerable to noise pollution—and there are a number of routes by which it can affect the population biology of cetaceans, including damage to organs, displacement from important habitat, changes in behaviour, and masking of important sounds (Richardson *et al.* 1995). Theoretical studies suggest that bottlenose whales, because of their deep-diving behavior, may be particularly at risk from non-auditory physiological damage from underwater noise (Houser *et al.*, 2001).

Lawson *et al.* (2000, p. 64) state that a 10 km buffer zone around the “Area of Interest” for the Sable Gully Marine Protected Area is “thought to be conservative” for northern bottlenose and sperm whales However, given the lack of any quantitative information on the hearing abilities of the northern bottlenose whales (Lawson *et al.* 2000, p. 42) or how they react to sound or are affected by it (Lawson *et al.* 2000, p. 42), this statement seems to us scientifically indefensible in the case of this species.

Currently, as shown in Fig. 2, commercial hydrocarbon exploitation is taking place from a network of wells in shallow waters around Sable Island (gas, Sable Offshore Energy), as well as the Cohasset-Panuke field to the west of Sable Island (oil). The closest current production platform is 40 km from the bottlenose whales’ Gully habitat, and others lie 15 km from the 1,000 m contour to the west of the Gully (Fig. 2). Like exploration, hydrocarbon production is noisy, with sounds from the drilling process, the

rigs themselves, supply vessels, and pile-driving during construction. The effects of these noises on bottlenose whales are unknown.

Drilling has other outputs, including toxins, especially if oil-based drilling muds are used. Recent results show that there is active sediment transport from Sable Island Bank into the deeper waters of the Gully through "feeder canyons" (Fader & Strang, In Press). This could introduce toxic residues from the Sable Offshore Energy operation into the deep-water ecosystem of the Gully on which the bottlenose whales seem to depend (Hooker *et al.* 2001, 2002a).

The Canada Nova Scotia Offshore Petroleum Board in August 2002 released a "Strategic Environmental Assessment of Potential Exploration Rights Issuance for Eastern Sable Island Bank, Western Banquereau Bank, the Gully Trough and the Eastern Scotian Slope." It concludes that in the waters around the Gully and in Shortland and Haldimand canyons "the issuance of exploration rights can be considered." Thus there are prospects for rapidly increasing oil and gas exploration and development in the whales' primary habitat.

Contaminants

Preliminary analyses of the blubber of bottlenose whales biopsied in the Gully in 1996-1997, before major industrial development in the area, showed levels of PCBs and DDT comparable to those found in other large toothed whales of the North Atlantic, and expression of the cytochrome P4501A was very low, indicating little recent exposure to petroleum hydrocarbons (Whitehead *et al*. 1998). Pollutant levels in samples collected since the industrialization of the area have yet to be analyzed.

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