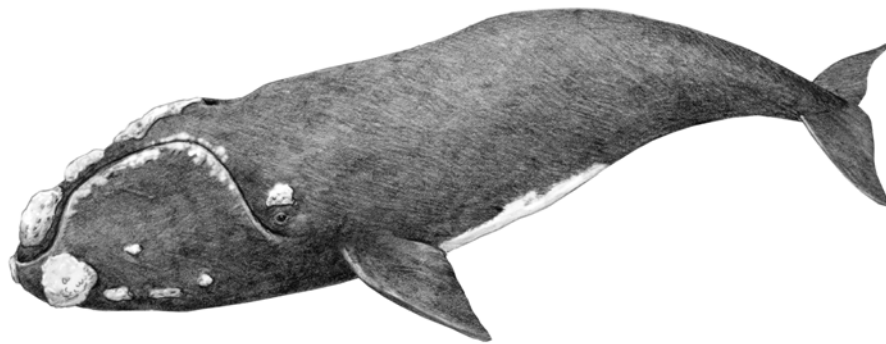


**COSEWIC**  
**Assessment and Update Status Report**

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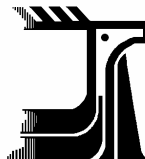
**North Atlantic Right Whale**  
*Eubalaena glacialis*

in Canada



**ENDANGERED**  
**2003**

**COSEWIC**  
COMMITTEE ON THE STATUS OF  
ENDANGERED WILDLIFE  
IN CANADA



**COSEPAC**  
COMITÉ SUR LA SITUATION DES  
ESPÈCES EN PÉRIL  
AU CANADA

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**Previous reports:**

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Gaskin, D.E. 1985. Update COSEWIC status report on the right whale *Eubalaena glacialis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 50 pp.

Hay, K.A. 1980. COSEWIC status report on the right whale *Eubalaena glacialis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 12 pp

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## COSEWIC Assessment Summary

### Assessment Summary – May 2003

**Common name**

North Atlantic right whale

**Scientific name**

*Eubalaena glacialis*

**Status**

Endangered

**Reason for designation**

The species, found only in the North Atlantic, was heavily reduced by whaling. The total population currently numbers about 322 animals (about 220-240 mature animals), has been decreasing during the last decade, and is experiencing high mortality from ship strikes and entanglement in fishing gear. A sophisticated demographic model gives an estimated mean time to extinction of 208 years.

**Occurrence**

Atlantic Ocean

**Status history**

The right whale was considered a single species and designated Endangered in 1980. Status re-examined and confirmed Endangered in April 1985 and in April 1990. Split into two species in May 2003 to allow a separate designation of the North Atlantic right whale. The North Atlantic right whale was designated Endangered in May 2003. Last assessment was based on an update status report.



**COSEWIC**  
**Executive Summary**

**North Atlantic Right Whale**  
*Eubalaena glacialis*

**Species information**

The taxonomic status of right whales (genus *Eubalaena*) worldwide has been the subject of mild controversy for over 20 years. In 2000, the International Whaling Commission's Scientific Committee, after considering genetic and morphological data, decided to retain the generic name of *Eubalaena* for right whales, and recognize three species, *E. glacialis* for the North Atlantic, *E. australis* for all southern hemisphere right whales, and *E. japonica* for the North Pacific. Right whales are large, relatively rotund whales, with square chins and a generally black coloration with occasional white belly and chin patches and no dorsal fin. They grow to about 16 m in length, with adult females averaging about 1 m larger than adult males. A strongly arched and narrow rostrum and strongly bowed lower jaws are characteristic of the species. Gray or black thickened patches of skin, called callosities, are found on the rostrum, behind the blowholes, over the eyes, on the corners of the chin, and variably along the lower lips and jaws. The callosity pattern is unique to each whale and is used by researchers to distinguish individual animals. In the field, when seen along the axis of the body, the blow is distinctively V-shaped and can reach 7 m in height.

**Distribution**

The western North Atlantic population ranges from Florida to Newfoundland and the Gulf of St. Lawrence. Right whales congregate in the summer and fall in the lower Bay of Fundy, mainly east of Grand Manan Island, and in the vicinity of Roseway Basin between Browns and Baccaro Banks on the western Scotian Shelf. They are also seen in small numbers in the summer and fall elsewhere on the Scotian Shelf and in the Gulf of St. Lawrence along the lower north shore and east of the Gaspé Peninsula. The current distribution seems to be a subset of the historical range of the species.

**Habitat**

North Atlantic right whales migrate into Canadian waters to feed. Their primary prey is the copepod *Calanus finmarchicus*, especially the larger oil-rich developmental stages (C-IV and C-V) and adults. The whales filter-feed by swimming with the mouth open at the surface (skim feeding) or at depth sieving plankton from the water through

baleen plates. Zooplankton is not distributed homogeneously, but instead usually occurs in "patches" in the water column. Copepods form dense concentrations both vertically and horizontally where tides, winds, or prevailing currents form convergences or where water parcels of different temperature, salinity, and density meet to form fronts.

## **Biology**

Data on mean longevity are not available, although back-calculation from first-birth records suggests that right whales routinely live longer than three decades. The oldest individual on record is estimated to have been 70 years old when last seen. The mean age at first parturition is currently about 10 years although one female gave birth to her first calf at age 5. No unequivocal criterion for age at sexual maturity in males is available. The age of first reproduction for males will only become known from back-calculation after analyzing the paternity of calves using genetic techniques. The sex ratio is approximately 50/50.

Right whales give birth to a single calf. In 1992, the mean interval between births was 3.67 years with a range of 2-7 years. In the 1990s, the mean calving interval increased significantly to nearly 6 years. This increase was associated with increased variability in annual calf production. At least two females have continued to produce calves over a period of 28 years, so the reproductive lifespan is at least that long. It has been estimated that 26% to 31% of the population are juveniles (< 9.6 years of age), significantly lower than the level observed in some other baleen whales, and much lower than would be expected for a growing population.

## **Population sizes and trends**

The current population size is about 322 individuals, of which roughly 222-238 are thought to be mature. In the 1980 to 1992 period, annual estimates of population size back-calculated from data on births and deaths showed steady increase from 255 individuals in 1986 to 295 in 1992. The mean net growth from one year to the next was therefore estimated at 2.5% (Knowlton *et al.* 1994). However, the population seems to have declined during the late 1990s. Fujiwara and Caswell (2001) calculated the asymptotic population growth rates from 1980 to 1995 and concluded that the growth rate declined from  $\lambda=1.03$  (SE=0.02) in 1980 to  $\lambda=0.98$  (SE=0.03) in 1995, suggesting that if the 1995 growth rate were maintained, the population would go extinct in about 200 years.

## **Limiting factors and threats**

A number of factors might account for the recent decline in reproduction and the population's generally slow rate of recovery (or, in recent years, failure to recover at all). Clearest and most certain among these are the serious injury and mortality from collisions with ships and from entanglement in fishing gear. Other hypothesized contributing factors include the genetic and demographic effects of small population

size, habitat loss and degradation, infectious disease, contaminants, marine biotoxins, an inadequacy of prey resources as a result of changes in ocean climate, and disturbance from tourism.

### **Special significance of the species**

The North Atlantic right whale was the first whale species to be commercially exploited, and it played a large role in the development of the whaling industry. As a consequence, the population was reduced to very low levels by the end of the 19<sup>th</sup> century. The population is now seriously threatened by human activities. The North Atlantic right whale has become a high-profile endangered species, sparking a large research effort and making it one of the most intensely studied mammalian species in the wild. The research, and other attempts to protect the species, depends on cross-border collaboration between Canadian and U.S. institutions and individuals. The North Atlantic right whale is an important subject of the whale-watching industry, especially in Canada's Bay of Fundy.

### **Existing protection or other status designations**

All right whales, worldwide, are protected under the International Convention for the Regulation of Whaling, implemented by the International Whaling Commission. The North Atlantic right whale is classified as Endangered in the IUCN (World Conservation Union) Red List of Threatened Animals and in the United States under the Endangered Species Act.

In Canada, right whales are protected from hunting and harassment according to the Marine Mammal Regulations under the Fisheries Act. The Department of Fisheries and Oceans is the responsible management agency. World Wildlife Fund Canada and the Department of Fisheries and Oceans jointly published the Canadian Right Whale Recovery Plan in September 2000 (WWF/DFO 2000).

### **Summary of status report**

This species is clearly at risk. Recently published models indicate that it may be on the path to extinction. Limiting factors include a low reproductive rate and a high incidence of mortality from vessel/whale collisions and entanglement in fishing gear. Age structure of the population appears to be skewed toward old animals, which is contrary to what is normally observed in a growing population. Although the prohibition on hunting is believed to have been effective for more than half a century, incidental mortality could be driving this species to extinction. Solutions to this problem will require well-coordinated, multi-disciplinary international approaches to research and management.



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

**Update  
COSEWIC Status Report**

on the

**North Atlantic Right Whale**  
*Eubalaena glacialis*

**in Canada**

2003



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## SPECIES INFORMATION

### Name and classification

The taxonomic status of right whales (genus *Eubalaena*) worldwide has been the subject of mild controversy for over twenty years. Most authors agreed that there should be two species, *E. glacialis* for the North Atlantic and North Pacific populations (so-called northern right whales), and *E. australis* for all Southern Hemisphere populations (southern right whales), with the North Atlantic and North Pacific forms sometimes considered subspecies, *E. glacialis glacialis* and *E. g. japonica*, respectively (see Schevill 1986). Rice (1998) lumped right whales and bowheads (*Balaena mysticetus*) within the genus *Balaena*, and combined all right whales in a single species, *B. glacialis*, with two subspecies, *B. g. glacialis* (North Atlantic and North Pacific), and *B. g. australis* (Southern Hemisphere). However, a 1998 International Whaling Commission (IWC) workshop recommended retaining *Eubalaena* (the right whales) as a separate genus, and noted that the IWC Scientific Committee would consider changing taxonomic status only on the basis of published papers (IWC 2001a). Rosenbaum *et al.* (2000) reviewed genetic data on right whales worldwide and concluded that three species should be recognized. The IWC Scientific Committee, after considering genetic and morphological data, decided at its 2000 annual meeting to accept Rosenbaum *et al.*'s analysis and proposed nomenclature. It was agreed to retain the generic name *Eubalaena* for right whales, and to recognize three species, *E. glacialis* in the North Atlantic, *E. australis* in the southern hemisphere, and *E. japonica* in the North Pacific (IWC 2001a:37).

Right whales were once common in temperate latitudes of all of the world's oceans. The northern and southern populations were naturally separated by the warm tropical belts in the Atlantic and Pacific Oceans. In addition, the animals in the North Atlantic and North Pacific were isolated from one another by the continent of North America.

Two species of right whale occur in Canadian waters, *E. japonica* in the Pacific and *E. glacialis* in the Atlantic. This report considers the status *E. glacialis* only; no subspecies are recognized. The common name in English is the North Atlantic Right Whale. The two common names used in French in Canada are baleine noire and baleine franche. Although COSEWIC recognizes baleine noire, baleine franche is more commonly used and has been adopted as the French common name by the Canadian Right Whale Recovery Implementation Team (September 2002).

### Description

Right whales are large, relatively rotund whales, with square chins and a generally black coloration with occasional white belly and chin patches and no dorsal fin (Figure 1). North Atlantic right whales grow to about 16 m in length, with adult females averaging about 1 m larger than adult males (Allen 1908, Andrews 1908). A blubber layer up to 20 cm thick serves for both energy storage and insulation. The head is about 25% of the total body length in adults, up to 35% in juveniles. A strongly arched, narrow rostrum and strongly bowed lower jaws are characteristic of the species.



Figure 1. Illustration of a North Atlantic Right Whale.

Gray or black thickened patches of skin, called callosities, are found on the rostrum, behind the blowholes, over the eyes, on the corners of the chin, and variably along the lower lips and jaws. The callosity pattern is unique to each right whale and is used by researchers to identify individuals (Crone and Kraus 1990, Hamilton and Martin 1999, Kraus *et al.* 1986, Payne *et al.* 1983). Callosities appear light yellow or cream colored due to infestations of cyamid crustaceans (whale lice). Callosities consist of spikes of columnar epithelial tissue, appearing barnacle-like, but no barnacles have ever been found on North Atlantic right whales. Baleen plates are black or brown, number 205 to 270 on each side, average 2 to 2.8 m in length, and are relatively narrow (up to 18 cm wide) with fine hair-like fringes facing the interior of the mouth. There are no grooves along the throat. The tail flukes are broad, measuring up to 6 m from tip to tip.

In the field, when seen along the axis of the animal, the blow is distinctly V-shaped and can reach 7 m in height. Observations of feeding, when it occurs at the surface, have led to reports of sea monsters, as these whales skim with the mouth wide open, the narrow, callosity-covered rostrum raised in the air, and the baleen partially exposed above the water.

### **Nationally significant populations**

The status of *E. glacialis* is considered the same throughout its range in the western North Atlantic, and no clearly distinct populations are apparent.

## **DISTRIBUTION**

### **Global range**

Stock structure of right whales in the North Atlantic is poorly understood. An IWC right whale workshop provisionally divided the North Atlantic, “for statistical purposes,”

into eastern and western sectors and proposed to treat the area off Cape Farewell (60-62°N, 33-35°W) separately. However, photographs of identifiable individuals in the western North Atlantic have been matched with photographs of individuals in the Labrador Basin south-southeast of Greenland and off Norway (Knowlton *et al.* 1992, IWC 2001b:66). Given what is currently known about right whale movements and distribution, it is perhaps reasonable to continue to view the whales in the eastern and western North Atlantic as separate “stocks,” while recognizing that these animals are highly mobile and sometimes move far outside their well-known habitats in the western North Atlantic (Knowlton *et al.* 1992, Reeves 2001).

The range of North Atlantic right whales historically included a large area along the east coast of North America, including waters of the Gulf of St. Lawrence and Atlantic Canada (to Labrador), east to southern Greenland, Iceland, and Norway, and south along the European coast to northwestern Africa (Schevill and Moore 1983, IWC 1986, Mead 1986, Mitchell *et al.* 1986, Brown 1986, Reeves and Mitchell 1986). Since the 1920s, sightings in the eastern North Atlantic have been sporadic — in the Canaries, Madeira, Spain, Portugal, the United Kingdom, Iceland, and Norway (e.g. Brown 1986, Martin and Walker 1997).

In the western North Atlantic, right whales were hunted in coastal waters from Florida to Labrador, including the Strait of Belle Isle and Gulf of St. Lawrence (Aguilar 1986, Reeves *et al.* 1999, Reeves 2001). They were also encountered and hunted during the summer in pelagic waters, particularly near the eastern edge of the Grand Bank and in an area directly east and southeast of Cape Farewell, the southern tip of Greenland (Reeves and Mitchell 1986).

Surveys since the late 1970s have identified five seasonally important right whale habitat areas along the east coast of North America (Figure 2). Three of these are along the U.S. seaboard (southeastern U.S., Cape Cod Bay, and the Great South Channel; Kraus and Kenney 1991).

### **Canadian range**

Two of the five known high-use habitat areas are located in Atlantic Canada (Figures 2 and 3). In the summer and autumn, right whales are observed nursing, feeding, and socializing in the lower Bay of Fundy between New Brunswick and Nova Scotia, and feeding and socializing on Roseway Basin between Browns and Baccaro Banks on the western Scotian Shelf about 50 km south of Nova Scotia (Stone *et al.* 1988, Kraus and Brown 1992, Brown *et al.* 1995). The Department of Fisheries and Oceans designated these two areas as Right Whale Conservations Areas in 1993 (Brown 1994, Brown *et al.* 1995). Both areas have been monitored annually since 1980 by researchers from the New England Aquarium (NEAq, Boston, Massachusetts).

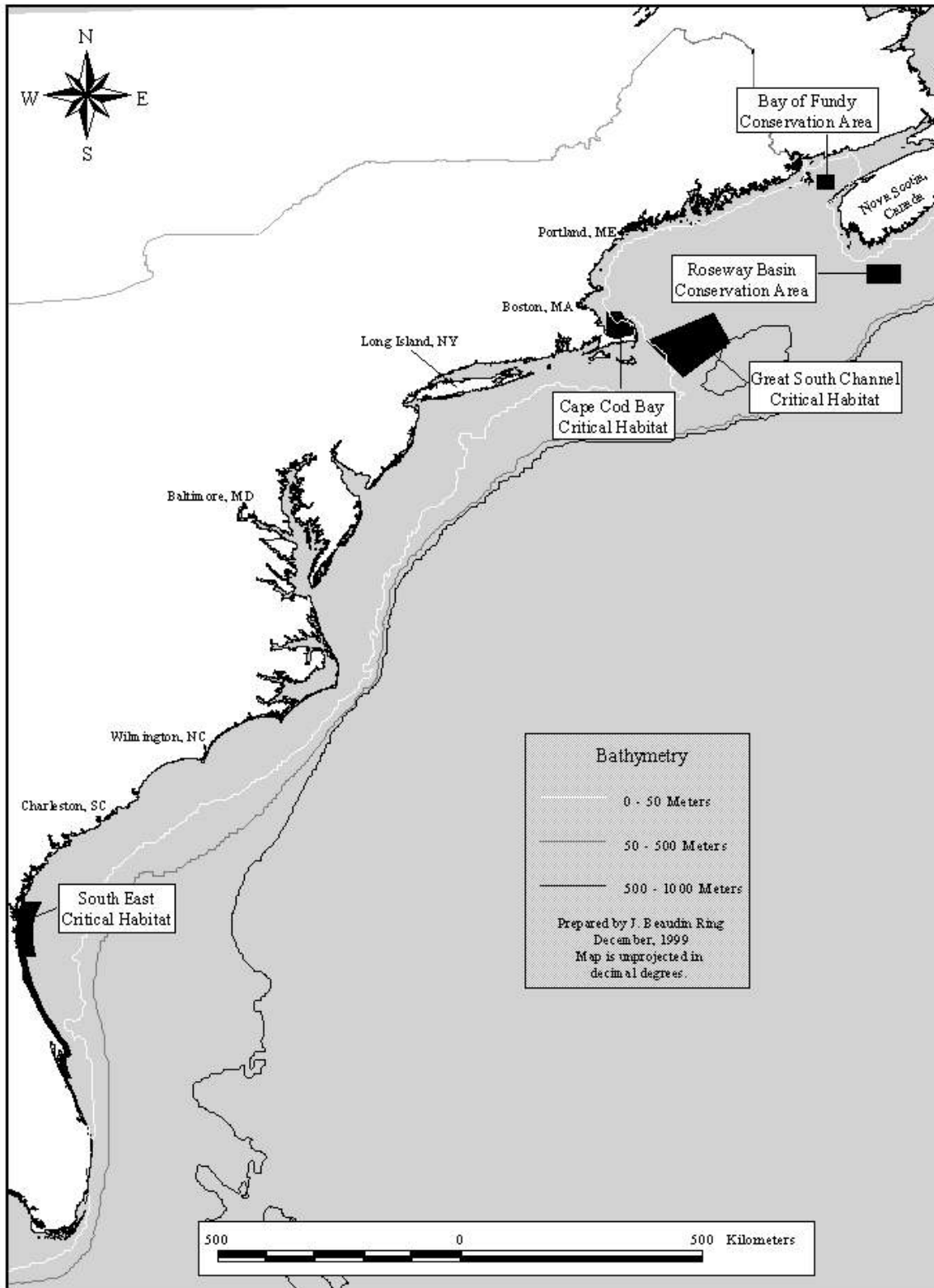


Figure 2. Known right whale habitat areas in the western North Atlantic.

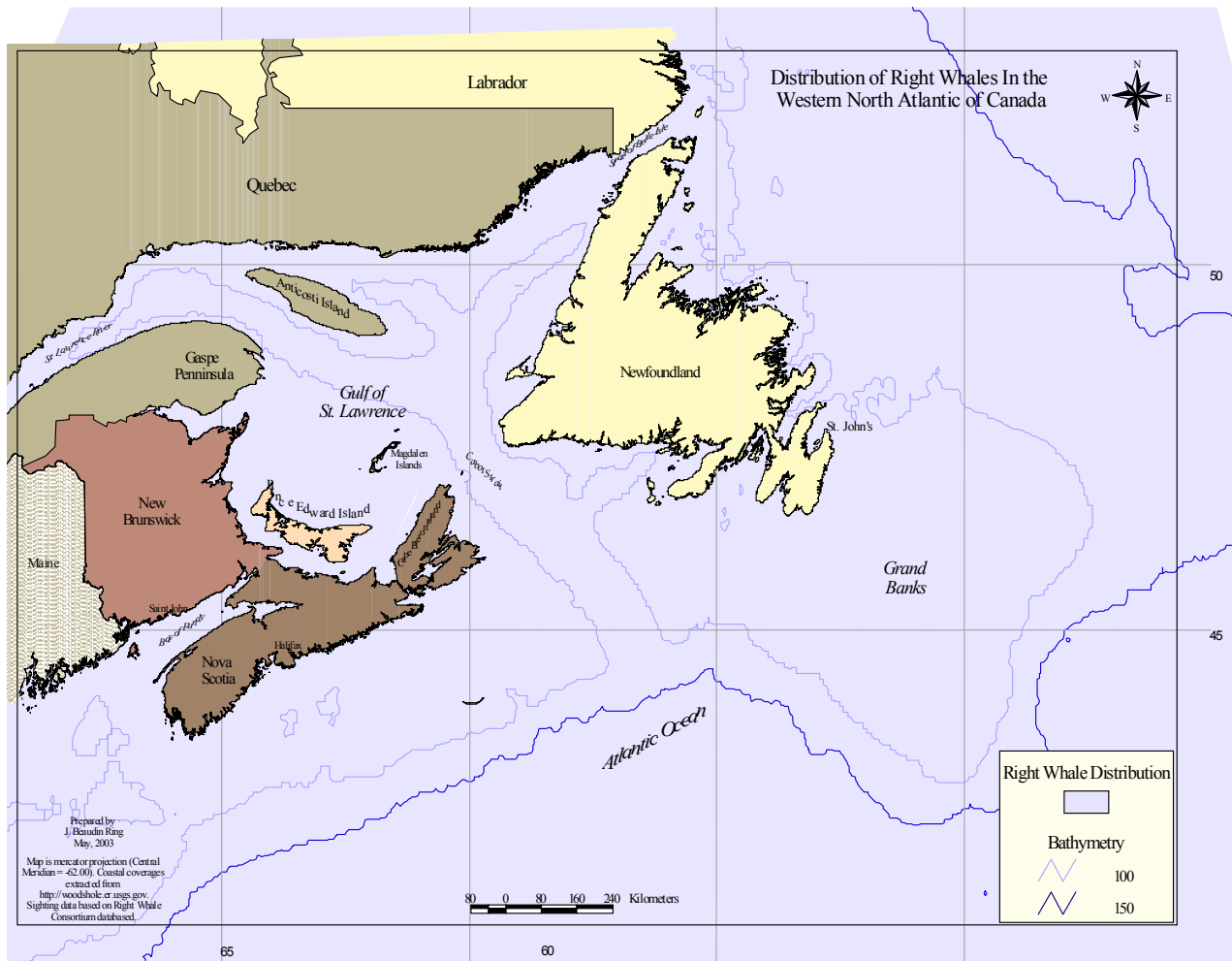


Figure 3. Distribution of right whales in the western North Atlantic off Canada (showing 200m and 2,000m contours).

In addition, right whales have been sighted in the St. Lawrence River near the confluence of the Saguenay River (R. Michaud, pers. comm. in 1998), near the Mingan Islands off the lower north shore of Quebec (R. Sears pers. comm. in 1994, 1995 and 1998), and near Percé on the Gaspé Peninsula (N. Cadet pers. comm. 1995-1998, 2000-2002). A dead right whale was found near the Magdalen Islands in the Gulf of St. Lawrence in 2001 (NEAq unpublished data), and in the same year an entangled right whale was tracked with a satellite-monitored transmitter along the eastern Scotian Shelf into the Gulf of St. Lawrence to the Magdalen Islands and back to the Scotian Shelf, thence south into the Gulf of Maine (Center for Coastal Studies, unpublished data).

It is interesting that no right whales have been sighted for more than a century in the historical whaling grounds in the Strait of Belle Isle between Labrador and Newfoundland, where the species' range is believed to have overlapped that of the bowhead whale (Aguilar 1986, Cumbaa 1986). It has generally been assumed that the balaenids hunted in summer in this region were right whales, while those hunted from late autumn through spring were bowheads (cf. Tuck and Grenier 1981, Cumbaa 1986,

Reeves and Mitchell 1986). Recent analyses of DNA extracted from bone material indicate that a very high proportion of the whales taken by the Basque whalers at Red Bay, Labrador, were bowheads rather than right whales (B. White pers. comm.). There is only limited evidence of historical whaling for right whales in three of the present-day high-use areas — the Bay of Fundy (Reeves and Barto 1985), the Scotian Shelf (see Mitchell *et al.* 1986), and the Great South Channel (Reeves and Mitchell 1986; but see Reeves *et al.* 1999). Right whale distribution may have changed over time, or, as Kenney *et al.* (2001) suggest, the current habitat-use pattern could represent that of a relict population that uses only the southern periphery of the species' former range.

As of 11 February 2003, the North Atlantic Right Whale Consortium's database contained 26,854 sightings of 438 photo-identified whales, of which 322 were thought to be alive. Of the 438 known individuals, 402 (92%) had been seen at least once in Canadian waters.

## HABITAT

### Habitat requirements

North Atlantic right whales migrate into the northern portions of their range to feed. Their primary prey is the copepod *Calanus finmarchicus*, especially the larger oil-rich developmental stages (C-IV and C-V) and adults (Murison and Gaskin 1989, Mayo and Marx 1990, Kenney and Wishner 1995, Mayo *et al.* 2001). Other small zooplankton, such as *Pseudocalanus minutus*, *Centropages* spp., and barnacle larvae, are eaten at times (Mayo and Marx 1990). The whales filter-feed by swimming with the mouth open at the surface (skim feeding) or at depth. Feeding bouts at the surface can last for hours. When feeding at depth (down to 200 m), dives lasting 20 min or longer can be repeated for hours. In the Bay of Fundy, right whales sometimes feed near to the bottom as evidenced by the fact that they surface with mud on their heads. The finely fringed baleen plates on each side of the jaw (as many as 270 plates, with maximal lengths of about 2.5 m) allow the whales to filter small zooplankton from the water. The mouth is only opened and the baleen exposed when the plankton concentration exceeds a threshold value. In the Bay of Fundy, where observations using sonar have shown whales diving to depths of 90-150 m in areas of high copepod biomass, whales did not make feeding dives unless concentrations of at least 820 copepods/m<sup>3</sup> (170 mg/m<sup>3</sup>) were present (Murison and Gaskin 1989). By comparison, right whales observed in Cape Cod Bay did not skim-feed unless concentrations of more than 1,000 zooplankton organisms/m<sup>3</sup> were present (Mayo and Marx 1990).

Kenney *et al.* (1986) estimated that a North Atlantic right whale must feed in prey patches containing energy densities of 7.57 to 2,394 kcal/m<sup>3</sup> to support its metabolic requirements. Those values are from 10 to 1,000 times greater than the densest concentration of zooplankton sampled in the vicinity of right whales in the Great South Channel. Kenney *et al.* (1986) suggested that this incongruence was due to the

scientists' inability to sample zooplankton patches as precisely as the whales are able to do. Zooplankton organisms are not homogeneously distributed, but instead usually occur in "patches" in the water column (Wu and Loucks 1995). Copepods form dense concentrations both vertically and horizontally where tides, winds, or prevailing currents form convergences or where water parcels of different temperature, salinity, and density meet to form fronts (Wishner *et al.* 1988, Kenney and Wishner 1995). Concentration may be further enhanced as the zooplankton seek preferred intensities of light or other physical factors during diurnal vertical migrations.

The four areas where North Atlantic right whales are most frequently seen feeding are among the few places where extremely concentrated patches of copepods have been documented. Three of these areas (Bay of Fundy, Roseway Basin, and Great South Channel) have deep basins (approximately 150 m deep) flanked by relatively shallow water. Copepods are concentrated there by convergences and upwellings driven by tidal and other currents. Upwelling driven by tidal currents also produces the dense patches of plankton in Cape Cod Bay, although no deep basin is present in that area.

Right whales are, therefore, highly dependent upon a narrow range of prey sizes, which occur in highly variable and spatially unpredictable patches in the Atlantic ecosystem. The four northern feeding habitats apparently have conditions that are conducive to the creation of highly concentrated patches of copepods. There is, however, substantial annual variability in copepod production, and thus in right whale abundance, in each of these areas (Brown *et al.* 2001, Kenney 2001). Right whales have adapted to this unpredictability with a large caloric buffer in the form of blubber (Moore *et al.* 2001) and an ability to travel long distances in relatively short periods of time (Mate *et al.* 1992, Slay and Kraus 1999, Kraus 2002).

## **Trends**

The number of individual right whales identified annually in the Bay of Fundy has ranged from 35 in 1983 to more than 200 in some years during the mid-1990s (NEAq unpublished data). On Roseway Basin, surveys in the 1980s and early 1990s often yielded more identifications of right whales in a given year than the Bay of Fundy; however, from 1993 through 1997 right whales were absent or extremely rare on Roseway Basin (NEAq unpublished data). This 5-year period corresponds to the years of greatest right whale use of the Bay of Fundy. Similar shifts in habitat use and abundance of right whales have also been observed in the Great South Channel off Cape Cod (Kenney *et al.* 2001).

Areas in the Gulf of St. Lawrence with opportunistic sightings (e.g., along the lower north shore of Quebec and the Gaspé Peninsula) have not been surveyed specifically for right whales. Right whales presumably converge onto areas outside the well-described core feeding areas in order to exploit dense patches of copepods. One of several examples occurred in 2001 when at least 30 right whales were observed for more than a month south of the Bay of Fundy and west of Yarmouth, Nova Scotia,



during the season when right whales are typically concentrated in the Bay of Fundy (NEAq unpublished data).

### **Protection/ownership**

The Fisheries Act and the Oceans Act are intended to protect the habitat of right whales within Canadian jurisdiction.

## **BIOLOGY**

### **Reproduction**

Female right whales give birth to a single calf. In 1992, the mean interval between births was 3.67 years (n=86) (Knowlton *et al.* 1994), with a range of 2 to 7 years. Calving intervals increased significantly in the 1990s, to a mean of nearly 6 years (Kraus *et al.* 2001, Kraus 2002). This increase was associated with increased variability in annual calf production. At least two females have had calves over a period of 28 years, suggesting that the reproductive lifespan of North Atlantic right whales is at least that long.

The mean age at sexual maturity of females is not known but the mean age at first parturition is currently about 10 years (Kraus 2002). One female gave birth to her first calf at age 5 (Knowlton *et al.* 1994). Except for post-mortem anatomical examination of the testes, no unequivocal criterion for sexual maturity in males is available. Males of all ages, including young individuals who cannot possibly be sexually mature, have been seen in courtship groups (Kraus and Hatch 2001). However, it appears that only males over 10 years of age get close enough to a female to have an opportunity for mating. The age of first reproduction for males will only become known from back-calculation after analyzing the paternity of calves using genetic techniques. Brown *et al.* (1994) used genital morphology and genetics to infer that the sex ratio in this population is approximately 50/50.

Demographic analyses suggest that 26% to 31% of the population is composed of calves and juveniles (< 9.6 years in this analysis), significantly lower than levels observed in some other baleen whale populations known to be on growth trajectories (e.g. 56-58% in Bering-Chukchi-Beaufort Seas bowheads, Zeh *et al.* 1993; 61% in eastern North Pacific gray whales, Rice and Wolman 1971) (Hamilton *et al.* 1998).

The mating system of North Atlantic right whales is not fully understood, but appears to be shaped in large part by the prolonged spacing of calves (3-5 year intervals). Such spacing means that the effective adult sex ratio is roughly one ovulating female to every four males, leading to significant competition among males for mating opportunities. Courtship is the most energetic and spectacular behaviour displayed by this species. Courtship groups (referred to as “surface-active groups”) may include 40 animals or more, as multiple males try to get close enough to mate with

the focal female (Kraus and Hatch 2001). Based upon the limited data available, it appears that the female may have intromission frequently during a courtship bout with several different males. Males appear to compete for the “alpha” positions (those next to the female), which are best for taking advantage of each mating opportunity when the female breathes (Kraus and Hatch 2001).

However, the seasonal timing and duration of observed courtship activities, from August through October, is puzzling. Calving is first observed in December in the waters off Georgia and Florida and extends through early March. The observed courtship is not consistent with Best's (1994) estimate of 12 months for the gestation period in southern right whales (*E. australis*). It is possible that courtship in the Bay of Fundy is merely “foreplay,” and that conception occurs elsewhere during December. Alternatively, either gestation is longer than 12 months, or implantation of the fertilized egg in the uterine wall is delayed, although this has never been documented to occur in cetaceans. The resolution of these questions will require better knowledge about the wintering habitats of right whales, and improved methods for evaluating pregnancy in right whales.

Most calves are born in coastal waters of the southeastern U.S. (Kraus *et al.* 1992). Since 1990, the number of calves observed each year has varied from 1 to 31, with no apparent trend. Since some cows with newborn calves are missed during the winter surveys off Georgia and Florida, complete assessment of a year's calf production requires surveys in the northern feeding areas, particularly Cape Cod Bay, the Great South Channel and the Bay of Fundy.

Mothers and calves migrate north for spring feeding in the Great South Channel and Cape Cod Bay, then to the summer nursery area in the lower Bay of Fundy, where they feed from late July to mid-October. However, Schaeff *et al.* (1993) and Malik *et al.* 1999 inferred from genetic and photo-identification data that one group of cows does not bring its calves to the Bay of Fundy each year. Therefore, another summer and fall nursery area must exist, although its location is unknown. This unidentified nursery is not in the high-use area of the Scotian Shelf on Roseway Basin because cow-calf pairs were seen there only four times in 1,059 sightings over eight field seasons (Knowlton *et al.* 1994). Knowlton *et al.*'s (1992) report of a cow and calf in the Labrador Basin south-southeast of Greenland in 1992, together with historical whaling records (Reeves and Mitchell 1986), suggest the area between Cape Farewell and Iceland as a candidate second nursery.

## **Survival**

Based on analyses of stranding, entanglement, and photographic data, Kraus (1990) and Kenney and Kraus 1993 estimated that mortality ranged between 5% and 18% during the first three years of life. Adult mortality rates are very low, probably less than 1% annually, although Fujiwara and Caswell (2001) suggest that adult female mortality rates are much higher, and are the major contribution to the current population decline (Kraus 2002).

Of 50 reliably documented right whale deaths between 1970 and 2001, five (10%) were due to entanglements in fishing gear, 18 (36%) were due to collisions with ships, and 27 (54%) were attributed to “unknown causes” or “neonatal mortality”. The only “natural” mortality currently recognized is neonatal mortality. The causes of the 14 “unknown” deaths are not known either because the carcass was not retrieved, the carcass was too decomposed to identify a causal factor, or no obvious factor was found despite a detailed necropsy.

Most of the areas heavily used by right whales in the western North Atlantic are on or near major shipping lanes serving ports in the eastern United States and Canada (Knowlton and Kraus 2001). Also, because of their coastal distribution, right whales are likely to encounter fishing gear throughout their range between Florida and Canada. More than 60% of all living whales in this population have scars indicative of entanglement at some time in their lives (Knowlton and Kraus 2001).

Data on mean longevity are not yet available, although back-calculation from first birth records suggests that right whales routinely live longer than three decades. A calf observed with its mother was killed in Florida in 1935, and the mother escaped after being photographed. The mother was photographed again in 1959 off Cape Cod, and then irregularly until the summer of 1995 when she was photographed near Georges Bank, badly wounded by lacerations from a ship's propeller. If the calf killed in 1935 was her first calf, and if she gave birth at age 10, she would have been 70 years old when last seen, making her the oldest animal of known age in this population (Hamilton *et al.* 1998).

## **Physiology**

Virtually nothing is known about the physiology of North Atlantic right whales. What is known about their physiology and anatomy is based largely upon dissections of animals killed by whalers (e.g. Andrews 1908, True 1904) and by analogy with southern right whales. Carcasses examined in the last 20 years were all in advanced stages of decomposition.

## **Movements/dispersal**

Winn *et al.* (1986) proposed a six-phase model to explain the seasonal north-south movements of right whales in the western North Atlantic. Most adult females give birth in coastal waters of the southeastern U.S. between Brunswick, Georgia, and Cape Canaveral, Florida, during the winter months (Kraus *et al.* 1986). Males and non-calving females are rarely seen in that area, and their whereabouts during the winter remain largely unknown (Kraus *et al.* 1988). They may be scattered widely along the eastern U.S. coast to at least as far north as Cape Cod Bay (Winn *et al.* 1986). There are records of adult and juvenile right whales of both sexes in Cape Cod Bay during the winter and spring, primarily feeding at or near the surface, but the number of animals observed annually accounts for less than 30% of the known population (Hamilton and Mayo 1990, Brown *et al.* 2002). There is a northward migration in the late winter and

early spring, with some animals moving along the shore. In the spring, aggregations of right whales are observed feeding and socializing in the Great South Channel east of Cape Cod, and in Massachusetts Bay (Winn *et al.* 1986, Hamilton and Mayo 1990, Kenney *et al.* 1995). Directed movements are made in June and July to the feeding grounds in the lower Bay of Fundy and on the western Scotian Shelf (Winn *et al.* 1986). In August and September the whales feed intensively in those areas (Winn *et al.* 1986). From October, a steady southward migration occurs, with some animals passing through the Gulf of Maine and off Cape Cod (Winn *et al.* 1986). Right whale aggregations are sometimes observed in the autumn on Jeffereys Ledge (Weinrich *et al.* 2000), Cashes Ledge, and Platts Bank (P. Clapham, pers. comm.) and in the spring along the northern edges of Georges Bank (Center for Coastal Studies, unpublished data).

### **Nutrition and interspecific interactions**

North Atlantic right whales feed primarily on the copepod *Calanus finmarchicus* (Murison and Gaskin 1989, Mayo and Marx 1990, Kenney and Wishner 1995, Mayo *et al.* 2001), but other small zooplankton such as *Pseudocalanus minutus*, *Centropages* spp., and barnacle larvae are also eaten at times (Mayo and Marx 1990). Their feeding activity is directed toward patches of zooplankton that are dense and compressed into layers. For example, the swimming patterns of right whales observed surface- or skim-feeding in Cape Cod Bay indicate an area-restricted foraging pattern cued by the size and density of the zooplankton patch (Mayo and Marx 1990). The dynamic variability of copepod distribution likely exerts a strong influence on the movements and distribution of right whales. Major changes have been observed in their spring and summer distribution over the last 20 years. For example, they appeared to abandon Roseway Basin in favor of the Bay of Fundy between 1993 and 1997 (NEA, unpublished data).

Mitchell (1975) speculated that the recovery of right whale populations might be inhibited by competition for calanoid copepods with sei whales (*Balaenoptera borealis*). Although there is evidence of sei whales feeding on copepods in the vicinity of right whales on the Scotian Shelf during the late 1960s and early 1970s (Mitchell *et al.* 1986), few direct observations have been made of sei whales feeding near aggregations of right whales in recent years (NEA, unpublished data). Basking sharks (*Cetorhinus maximus*) and herring (*Clupea harengus*) are prevalent in right whale feeding habitat and are additional potential competitors, judging by what is known of their diets.

### **Behaviour/adaptability**

Major changes in the regional abundance and distribution of right whales were recorded for the Bay of Fundy in 1983 (Gaskin 1991), Massachusetts Bay in 1986 (Payne *et al.* 1990), Great South Channel in 1992 (Kenney *et al.* 2001), and Roseway Basin between 1993-1997 (NEA unpublished data). Because the summer distribution of North Atlantic right whales is so tightly coupled with their primary prey, *Calanus finmarchicus*, the whales are not seen in their usual feeding areas when copepod populations there are low. Kenney *et al.* (2001) hypothesized that right whales may

return to the general area of their feeding grounds based on previous experience and then modify their foraging strategies based on environmental cues such as currents, temperature discontinuities, or salinity on various scales. Those authors proposed that the movements of right whales in the continental shelf waters of the western North Atlantic reflect adaptive responses to the distribution of their prey at many scales (see "Habitat Requirements," above).

## **POPULATION SIZES AND TRENDS**

The North Atlantic right whale population was probably even smaller in the past than it is today (Reeves *et al.* 1992; Reeves 2001). Malik *et al.* (1999) found only five matrilineages represented in the mitochondrial DNA (mtDNA) from over 200 animals sampled in the western North Atlantic population. Since mtDNA is inherited only from the mother, this suggests that the population went through a very small "bottleneck" at some time in the recent past. It is important to recognize, however, that each mtDNA haplotype could have been represented by more than one female and therefore the study by Malik *et al.* does not necessarily imply that only five female North Atlantic right whales existed at some point in the past.

The population in the western North Atlantic currently numbers about 322 animals (IWC 2001b; Kraus *et al.* 2001, NEAq, unpublished data) and appears to have been declining over the past decade (Caswell *et al.* 1999; Fujiwara and Caswell 2001). Assuming that about 26-31% of the animals are immature (see above), this suggests about 222-238 mature individuals. The eastern North Atlantic population probably numbers in the low tens of animals, at most, and is certainly too small to offer any hope of a "rescue effect" on the western population. The western population has been subject to significant anthropogenic mortality (Knowlton and Kraus 2001) and has experienced a significant decline in reproductive rates during the last ten years (Kraus *et al.* 2001). In the period from 1980 to 1992, annual estimates of population size back-calculated from data on calving and mortality indicated a steady increase from 255 in 1986 to 295 in 1992, implying a mean net annual growth rate of 2.5% (Knowlton *et al.* 1994). Fujiwara and Caswell (2001) calculated the asymptotic population growth rates from 1980 to 1995 and found that the rate had declined from  $\lambda=1.03$  (SE=0.02) in 1980 to  $\lambda=0.98$  (SE=0.03) in 1995. Those authors suggested that if the 1995 growth rate were maintained, the population would go extinct in about 200 years.

## **LIMITING FACTORS AND THREATS**

### **Ship strikes and entanglements**

Of the factors potentially depressing the growth rate of the North Atlantic right whale population, strikes by large ships and entanglements in fixed fishing gear are the most clearcut and well documented. These two factors accounted for over 46% of all documented mortality in this population between 1970 and 2001 (Knowlton and Kraus

2001). The mortality from these two factors would be particularly significant if it was biased toward females. Fujiwara and Caswell (2001) suggest that this has indeed been the case, and that the survival of females in this population is significantly lower than that of males. Given that females accompanied by calves are usually observed in coastal waters, it is plausible that adult females would be more vulnerable to the threats of ship strike and entanglement. However, known deaths in the last five years do not reflect a female bias.

## **Reproduction**

Reproduction in this population has been declining by all measures since about 1990 (Kraus *et al.* 2001, Kraus 2002, Caswell *et al.* 1999, Fujiwara and Caswell 2001). The possible reasons include food limitation (Moore *et al.* 2001), changes in habitat use (Kenney *et al.* 2001), disease and/or marine biotoxins (Reeves *et al.* 2001, R. Rolland, pers. comm.), pollutants (Woodley *et al.* 1991, Weisbrod *et al.* 2000, Reeves *et al.* 2001), genetic factors (Schaeff *et al.* 1997), and climatic variation (Kenney 2001).

## **Habitat degradation and reduction**

Reeves *et al.* (1978) hypothesized that intensive industrial use of Delaware and Chesapeake Bays by humans since the 1800s had pre-empted their use by right whales, thereby diminishing the potential recovery of the population. Not enough is known about pre-colonial use of those bays by the whales to permit an evaluation of this suggestion. Low-level pollution, ship traffic, ocean dumping, and dredging have all been invoked in recovery plans as factors that degrade habitat for right whales. There have not been any studies on the habitat requirements of right whales, other than those on prey requirements (e.g., Mayo and Marx 1990; Kenney *et al.* 1986; Wishner *et al.* 1995). Habitat discussions have tended to focus on food as the governing factor, although the absence of any evidence of right whale feeding in the southeastern U.S. suggests that at least in that area, other factors are important. Observations of courtship behaviour in the autumn in the northern feeding grounds indicate that factors other than food could also be important in those areas. If Kenney *et al.* (2001) are correct, and this remnant population of right whales is occupying only the southern portion of its potential range, then additional areas suitable for both feeding and courtship may exist north and east of Nova Scotia.

## **Whale watching and noise**

Concerns have been expressed regarding the potentially negative effects of whale watching on right whales. However, since whale watching only began in New England and southeastern Canada in the 1970s, it could not be a primary cause of the right whale population's slowness of recovery or lack of recovery. Although whale watching tourism might affect the whales by distracting them, displacing them from rich food patches, or dispersing food patches with wake or propeller wash, it is difficult to imagine that such effects are significant compared to the threats posed by large ships and fishing gear.

It has been suggested that the constant hum of shipping noise in the North Atlantic has habituated right whales to ship sounds, making them less likely to avoid oncoming vessels. It is also possible that the higher levels of ambient noise in the ocean have reduced the ability of right whales to hear mating calls over large distances, perhaps reducing mating opportunities.

### **SPECIAL SIGNIFICANCE OF THE SPECIES**

The North Atlantic right whale was the first whale species to be commercially exploited (by the Basques in about 1,000 A.D. or earlier), and it played a large role in the development of the whaling industry. As a consequence, the population had been reduced to very low levels by the beginning of the 20<sup>th</sup> century. Despite some growth in the population after it became legally protected from commercial whaling in the 1930s, it remains seriously threatened by human activities. Occurring as it does off heavily developed coastlines in most of its range, the North Atlantic right whale has become a high-profile symbol of endangered marine species, especially in the United States and Canada. Even though its present-day economic value is limited to “non-consumptive” or “low-consumptive” uses (e.g., whale-watching tourism, especially in the Bay of Fundy), this species continues to be threatened simply because of human encroachment into its habitat. Interest in the North Atlantic right whale’s survival and recovery has sparked a large research effort, making the North Atlantic right whale one of the most intensely studied mammalian species in the wild. Research and conservation efforts depend on cross-border collaboration between Canadian and U.S. institutions and individuals. Also, its protection in international waters and in the exclusive economic zones of other nations (e.g., Greenland, Iceland, Norway) must be assured if the species is to survive and recover.

### **EXISTING PROTECTION OR OTHER STATUS**

Right whales are protected internationally from hunting by the International Whaling Commission (IWC), and from commercial trade by the Convention on Trade in Endangered Species (CITES). In the United States right whales benefit from some of the strongest legislative protection measures ever enacted on behalf of rare wildlife under the U.S. Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA). Within the U.S., the National Marine Fisheries Service (NMFS) is the responsible agency for the management of right whales. In Canada, right whales are protected by the Marine Mammal Regulations under the Fisheries Act, and the Department of Fisheries and Oceans is the responsible agency for right whale issues.

In the U.S., NMFS has designated three “critical habitats”: Cape Cod Bay, the Great South Channel, and the coastal waters of the southeastern U.S between Jacksonville, Florida, and Brunswick, Georgia, out to 15 miles offshore. In Canada, the DFO has designated two “conservation areas”, one in the Bay of Fundy and one on the western Scotian Shelf (Fig. 2). Although these two areas have been officially

designated since 1993, and their boundaries are found in nautical publications and on the back of two nautical charts, there is no legislated framework that governs human activities in them.

The NMFS is issuing an updated Recovery Plan for right whales (NMFS 1991), intended to serve as a blueprint for the agency's actions under the ESA and MMPA. Implementation teams, including representatives from relevant and affected agencies at the federal and state level, have the responsibility to ensure that management actions are taken to promote the species' recovery. These teams have standing advisory boards consisting of scientists, conservationists, and industry representatives. Canada issued a recovery plan in 2000 (WWF/DFO 2000), with recommendations broadly similar to and compatible with the U.S. plan. Among the recommendations in the Canadian recovery plan that have already been implemented is relocation of the Bay of Fundy Traffic Separation Scheme to reduce the risk of collisions with right whales. This proposal by Transport Canada required the preparation of a scientific justification, thorough evaluation of the technical implications, stakeholder consultations, and approval and adoption by the International Maritime Organization (IMO). Having received IMO adoption in December 2002, the inbound and outbound lanes were scheduled to change in the summer of 2003.

Under the ESA and MMPA, the NMFS produces annual stock assessments, which include for each stock the allowable "potential biological removal" (PBR) level. The current PBR for the western North Atlantic right whale population is zero whales per year. In 2001, two right whales were killed by ships, two died from entanglements in fishing gear, two were probably neonatal deaths from natural causes, and one death occurred offshore from Nova Scotia with no diagnosis as to the cause. In 2002, eight entangled right whales were documented. One of these animals is known to have died and the other seven entanglements were judged to have been lethal. With this level of mortality, the survival of North Atlantic right whales is clearly in jeopardy and is likely to depend upon the speed with which recommendations in both the U.S. and Canadian recovery plans are implemented.

## **SUMMARY OF STATUS REPORT**

The survival of this population, and indeed the North Atlantic right whale as a species, is clearly at risk. Recently published models indicate that the population is on a trajectory toward extinction (Caswell *et al.* 1999, Fujiwara and Caswell 2001). The complexity of the right whale's biology, the inshore and coastal habits of the species, and the uncertain links between reproduction and habitat are challenging for any management strategy. The limiting factors for this population include a low reproductive rate and a high incidence of mortality from vessel/whale collisions and entanglements in fishing gear. Other factors that could be playing a role in the population's failure to recover include food limitation, habitat reduction, habitat degradation, pollution, marine biotoxins, and climate change. The estimated proportion of juveniles and calves is much lower than would be expected in a growing population. Finally, the accidental



killing of an endangered species is much more difficult to prevent than directed take by hunting. In the case of the North Atlantic right whale, the prohibition on hunting has been effective for almost 70 years, but accidental deaths from collisions with ships and entanglements in fishing gear could drive this species to extinction. The solutions to these problems are within reach, but will require well-coordinated, multi-disciplinary international approaches to research and management.

## TECHNICAL SUMMARY

### ***Eubalaena glacialis***

North Atlantic right whale

Baleine noire, Baleine franche

Bay of Fundy between New Brunswick and Nova Scotia, western and eastern Scotian Shelf Nova Scotia, Gulf of St. Lawrence, Newfoundland, Quebec and New Brunswick

<b>Extent and Area information</b>	
<ul style="list-style-type: none"> <li>Extent of occurrence (EO)(km<sup>2</sup>)</li> </ul>	North Atlantic between Florida and Norway
<ul style="list-style-type: none"> <li>specify trend (decline, stable, increasing, unknown)</li> </ul>	Unknown
<ul style="list-style-type: none"> <li>are there extreme fluctuations in EO (&gt; 1 order of magnitude)?</li> </ul>	No
<ul style="list-style-type: none"> <li>area of occupancy (AO) (km<sup>2</sup>)</li> </ul>	North Atlantic between Florida and Newfoundland and the Gulf of St. Lawrence
<ul style="list-style-type: none"> <li>specify trend (decline, stable, increasing, unknown)</li> </ul>	Unknown
<ul style="list-style-type: none"> <li>are there extreme fluctuations in AO (&gt; 1 order magnitude)?</li> </ul>	No
<ul style="list-style-type: none"> <li>number of extant locations</li> </ul>	N/A
<ul style="list-style-type: none"> <li>specify trend in # locations (decline, stable, increasing, unknown)</li> </ul>	N/A
<ul style="list-style-type: none"> <li>are there extreme fluctuations in # locations (&gt;1 order of magnitude)?</li> </ul>	N/A
<ul style="list-style-type: none"> <li>habitat trend: specify declining, stable, increasing or unknown trend in area, extent or quality of habitat</li> </ul>	Unknown
<b>Population information</b>	
<ul style="list-style-type: none"> <li>generation time (average age of parents in the population) (indicate years, months, days, etc.)</li> </ul>	~ 20 years
<ul style="list-style-type: none"> <li>number of mature individuals (capable of reproduction) in the Canadian population (or, specify a range of plausible values)</li> </ul>	222-238
<ul style="list-style-type: none"> <li>total population trend: specify declining, stable, increasing or unknown trend in number of mature individuals</li> </ul>	Declining in the late 1990s
<ul style="list-style-type: none"> <li>if decline, % decline over the last/next 10 years or 3 generations, whichever is greater (or specify if for shorter time period)</li> </ul>	Estimated decline of 2%/yr in 1995
<ul style="list-style-type: none"> <li>are there extreme fluctuations in number of mature individuals (&gt; 1 order of magnitude)?</li> </ul>	No
<ul style="list-style-type: none"> <li>Is the total population severely fragmented (most Individuals found within small and relatively isolated (geographically or otherwise) populations between which there is little exchange, i.e., &lt; 1 successful migrant / year)?</li> </ul>	No
<ul style="list-style-type: none"> <li>list each population and the number of mature individuals in each</li> </ul>	
<ul style="list-style-type: none"> <li>specify trend in number of populations (decline, stable, increasing, unknown)</li> </ul>	
<ul style="list-style-type: none"> <li>are there extreme fluctuations in number of populations (&gt;1 order of magnitude)?</li> </ul>	
<b>Threats (actual or imminent threats to populations or habitats)</b>	
<ul style="list-style-type: none"> <li>serious injury and mortality from collisions with vessels</li> <li>serious injury and mortality from entanglement in fixed fishing gear</li> <li>declining reproductive rates over the last decade</li> <li>tourism</li> </ul>	

<b>Rescue Effect (immigration from an outside source)</b>	Low
• <i>does species exist elsewhere (in Canada or outside)?</i>	Yes (a very few in eastern North Atlantic)
• <i>status of the outside population(s)?</i>	Endangered
• <i>is immigration known or possible?</i>	Unlikely
• <i>would immigrants be adapted to survive here?</i>	Presumably
• <i>is there sufficient habitat for immigrants here?</i>	Uncertain
<b>Quantitative Analysis</b>	Yes—Suggests decline of 2% per year in recent years and extinction in about 200 years

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## **BIOGRAPHICAL SUMMARY OF CONTRACTORS**

Moira Brown is the Scientific Advisor with the Canadian Whale Institute in Bolton, Ontario and a Senior Scientist and director of the right whale research program at the Center for Coastal Studies in Provincetown, Massachusetts. She was a member of the Canadian Right Whale Recovery Team and is a co-chair of the Canadian Right Whale Implementation Team and serves as a technical advisor to the U.S. right whale implementation team. Her recent research includes population biology and

demographics of right whales in Canadian waters since 1985 and Cape Cod Bay since 1997 and genetic studies since 1988. Her conservation work is most recently focused on the issue of right whales and ship collisions in Canadian waters. She is the co-chair of the Canadian Vessel/Whale working group and was instrumental in working with industry and government regulators in the amendment of the Bay of Fundy Traffic Separation Scheme.

Brown's conservation work continues to be focused on the issues faced by right whales in Canadian waters and the identification of measures to reduce the impact of human activities on their numbers. She received a B.Ed. and B.Sc. from McGill University and a Ph.D. from the University of Guelph.

Scott Kraus is the Director of Research at the New England Aquarium in Boston, Massachusetts. He was a member of the original U.S. right whale recovery team, and currently serves on the U.S. harbor porpoise take reduction team and the U.S. large whale take reduction team. Kraus serves as a technical advisor to the U.S. right whale implementation teams and a scientific reviewer for the Canadian Department of Fisheries and Oceans. He is adjunct faculty at University of Massachusetts at Boston, and has taught several years for the Massachusetts Bay Marine Studies Consortium. He produced both the first North Atlantic humpback whale catalog and the first North Atlantic right whale catalog, research publications that utilize individually distinctive markings on animals to track life history. His early research focused on expanding the application of individual photo-identification studies into population biology. He has conducted a continuous research program on North Atlantic right whales since 1980, publishing numerous papers on many aspects of right whale biology and conservation.

Kraus' recent studies are looking at methods for reducing bycatch of small cetaceans in fishing gear using acoustic "pingers". His research is increasingly focused on conservation issues faced by endangered species and habitats, and the difficulties of identifying features that animals need to survive in an increasingly urban ocean. He received his B.A. from College of the Atlantic, his M.S. in biology from the University of Massachusetts, and a Ph.D. from the University of New Hampshire.

### **AUTHORITIES CONSULTED**

The report writers do not know any source of relevant Aboriginal traditional knowledge for this species. Regular contact has been made with the DFO chair of the Canadian Right Whale Implementation Team, Mr. Jerry Conway, MASARO, Bedford Institute of Oceanography, Dartmouth, Nova Scotia. The species does not occur in a national park or marine protected area.

## **COLLECTIONS EXAMINED**

Sighting records in the North Atlantic Right Whale consortium database at the New England Aquarium, Boston, MA. have been examined. Where necessary, reference in the report to this collection of unpublished data is given as “(NEAq, unpublished data).”

## **PERSONAL COMMUNICATIONS**

Natalie Cadet – Observations Littoral Percé  
Phillip Clapham - NMFS, Northeast Science Center  
Robert Michaud – Groupe de recherche sur les mammifères marins  
Rosalind Rolland – New England Aquarium  
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