COMMITTEE ON THE
STATUS OF ENDANGERED
WILDLIFE IN CANADA

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COMITÉ SUR LE STATUT
DES ESPÈCES MENACÉES
DE DISPARITION AU
CANADA

OTTAWA (ONT.) K1A 0H3
(819) 997-4991

STATUS REPORT ON THE LONG-FINNED PILOT WHALE *GLOBICEPHALA MELAS* IN CANADA

BY

D. NELSON

AND

J. LIEN

STATUS ASSIGNED IN 1994
NOT AT RISK

REASON: THE POPULATION FREQUENTING CANADIAN WATERS WAS REDUCED EARLIER IN THE CENTURY BY DRIVE FISHERIES AND RECOVERY IS SLOW DUE TO INCIDENTAL ENTRAPMENTS, POLLUTANTS AND DEPLETION OF PREY SPECIES; HOWEVER, THERE ARE NO IMMEDIATE THREATS TO THE POPULATION.

OCCURRENCE: COASTAL WATERS OF NEWFOUNDLAND, QUEBEC, NOVA SCOTIA, NEW BRUNSWICK, AND PRINCE EDWARD ISLAND (ATLANTIC OCEAN).

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CSEMDC - Un comité de représentants d'organismes fédéraux, provinciaux et privés qui attribue un statut national aux espèces canadiennes en péril.

Committee on the Status of Endangered Wildlife in Canada

Comité sur le statut des espèces menacées de disparition au Canada

JUNE 1990

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STATUS REPORT ON THE LONG-FINNED PILOT WHALE *GLOBICEPHALA MELAS* IN CANADA

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STATUS ASSIGNED IN 1994
NOT AT RISK

Status Of The Long-finned Pilot Whale, *Globicephala melas*, In Canada

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Nelson, D., and J. Lien. 1993. Status of the Long-finned Pilot Whale, *Globicephala melas*, In Canada. Committee on the Status of Endangered Wildlife in Canada (COSEWIC), Canadian Wildlife Service, Ottawa, Ontario.

The Long-finned Pilot Whale, *Globicephala melas*, is a mainly pelagic species widely distributed in the cold temperate waters of the North Atlantic and the Southern Hemisphere. It regularly migrates in summer to Canadian inshore waters following spawning squid. Drive fisheries from 1947 to 1971 seriously depleted numbers of *Globicephala melas* off Newfoundland. Mass strandings represent a major known source of natural mortality for this species. The effects of incidental entrapments, pollutants, and fisheries for prey species remain relatively unknown, but these factors have the potential for limiting this species. *Globicephala melas* has recently been used in satellite tracking and DNA fingerprinting studies, and is a common subject in the study of mass strandings. There are few reliable recent population estimates for *Globicephala melas*, but even optimistic recovery forecasts based on drive fisheries in Newfoundland would produce a present population substantially lower than pre-whaling numbers. Given that there are no immediate threats to the population a COSEWIC status designation would not seem to be warranted at this time.

Le globicéphale noir, *Globicephala melas*, est une espèce plutôt pélagique retrouvée un peu partout dans les eaux froides tempérées de l'Atlantique nord et de l'hémishphère austral. En été, il migre régulièrement vers les eaux côtières canadiennes à la recherche de calmars. La chasse par rabattage effectuée de 1947 à 1971 en a décimé les effectifs dans les eaux côtières de la Terre-Neuve. Les échouages en masse sont une importante cause connue de mortalité, par contre, les incidences de la capture accidentelle, d'élements polluants et de l'exploitation des espèce-proies demeurent relativement mal connues. Elles ont toutefois un potentiel comme facteurs limitatifs de l'espèce. *Globicephala melas* a souvent été l'objet d'études de repérage par satellite et d'identification de l'ADN, ainsi que des échouages en masse. De telles études promettent d'approfondir nos connaissances des petitis cétacés. Aucune prévision démographique récente fiable n'est disponible en ce qui concerne *Globicephala melas*, mais même des prévisions optimistes quant au rétablissement des effectifs décimés par la chasse par rabbatage effectuée dans les eaux de Terre-Neuve ne donneraient qu'un effectif nettement inférieur à l'abondance pré-exploitation. Puisque elles ne sont pas des menaces immédiates une désignation de statut par le CSEMDC n'est pas justifié à ce moment-ci.

Key Words: Long-finned Pilot Whale, *Globicéphale noir*, *Globicephala melas*, *Globicephala melaena*, toothed whales, Odontoceti, Cetacea, marine mammals.

The Long-finned Pilot Whale, *Globicephala melas* (Traill, 1809), is variously known as the Northern Pilot Whale, Atlantic Pilot Whale, Pothead, Blackfish, Calling Whale, and Caa'ing Whale. It has often been cited as

GLobicephala melaena, although *Globicephala melas* is the more taxonomically correct form of the name (Rice 1989).

The species is characterized by a bulbous forehead, a falcate dorsal fin with a long base located far forward on the body, a slight beak, and sharply pointed pectoral flippers that may reach one-fifth of the body length (Figure 1). It is slate-grey to black in colour, although pale or albino individuals are sometimes observed (Sergeant and Fisher 1957; Hain and Leatherwood 1982; Bloch 1994). An anchor-shaped patch of greyish-white on the throat extends into a grey stripe along the underside which expands around the navel and surrounds the genital area (Sergeant and Fisher 1957). Other markings may include a variable grey saddle behind the dorsal fin and a grey or white streak behind the eye, both of which may be more common in Southern Hemisphere populations (Scott 1942; Sergeant and Fisher 1957; Davies 1960; Aloncle 1972; Aguayo 1975). Young animals are lighter in colour overall, and the saddle and eye blaze, if present, apparently become evident after 3-5 years of age (Starrett and Starrett 1955; Sergeant and Fisher 1957; Bloch et al. 1994).

Globicephala melas can be distinguished from the closely-related short-finned pilot whale, *Globicephala macrorhynchus*, by differences in range, size, external markings, length of pectoral flippers, size of tail flukes, tooth count, and skull characteristics (Fraser 1950; Yonekura et al. 1980; Leatherwood and Reeves 1983; Bloch et al. 1994). Most differences are not entirely reliable, however, as there is some overlap in range and physical characteristics (Leatherwood et al. 1976; Van Bree et al. 1978; Yonekura et al. 1980; Casinos 1981; Powers et al. 1982; Nores and Perez 1988; Bloch et al. 1994). The teeth may provide the best distingushing characteristic: those of *Globicephala*

macrorhynchus are generally fewer (7 to 9 instead of 10 to 12 in both jaws) and larger (Sergeant 1959).

Globicephala melas shows marked sexual dimorphism. Males can reach lengths of approximately 620 cm and weights of 3 tons, while females are approximately 18 to 25% smaller (Sergeant 1962; Martin et al. 1987; Kasuya et al. 1988b; Desportes 1990; Bloch, 1994). Males also have longer flippers and longer and wider flukes than females, and more often have the eye-streak marking (Bloch et al. 1994).

Distribution

Globicephala melas is widely distributed in cold temperate waters of the North Atlantic and southern oceans (Figure 2). The northern and southern forms, which are widely separated geographically and may vary in coloration, are sometimes regarded as subspecies: *Globicephala melas melaena* in the north, and *Globicephala melas edwardi* in the south (Davies 1960; Aguayo 1975; Mitchell 1975a; Van Bree et al. 1978).

The northern population ranges from Greenland, Iceland, the Barents Sea, and possibly the Baltic sea in the north, to Cape Hatteras in the west, and northwest Africa (including the Mediterranean) in the east (Sergeant and Fisher 1957; Mitchell 1975a; Leatherwood & Dahlheim 1978; Evans 1980; Nores and Perez 1988).

In the eastern Atlantic, *Globicephala melas* appears to be rare in Italian waters, on the coasts of the Netherlands and Belgium, and the east coasts of Britain and Ireland (Evans 1980). It may or may not be present in the North Sea (Leatherwood & Dahlheim 1978; Evans 1980).

In the western Atlantic, it is numerous in the region of Georges Bank, Scotian Shelf, outer Laurentian Channel, and Grand Bank from July - December, but is absent from inshore Labrador waters during summer (Sergeant 1979). *Globicephala melas* is found throughout the Gulf of St. Lawrence, although it seems to be more abundant in the southern portion of the Gulf and along the west coast of Newfoundland (Sergeant and Fisher 1957; Sergeant et al. 1970; Dunbar et al. 1977; Sears et al. 1981; Sears 1982).

Globicephala melas is common off the east coast of the U.S., although abundance varies greatly. They are found along the shelf break from Cape Hatteras to the eastern tip of George's Bank (Hain et al. 1981). In summer, they move from the shelf edge onto George's Bank and into the Gulf of Maine (Hain et al. 1981; Powers et al. 1982), although they are present on George's Bank throughout the year. Sightings are most common in the southern New England mid-shelf and shelf-break in fall and winter (Powers et al. 1982).

In the Southern Hemisphere, *Globicephala melas* occurs mainly north of the Antarctic Convergence in the cold currents (Humbolt, Falkland, and Benguela) associated with the West Wind Drift (Mitchell 1975a; Leatherwood & Dahlheim 1978; Van Bree et al. 1978; Guiler et al. 1987; Miyazaki and Kato 1988).

Long-finned Pilot Whales inhabited the Sea of Japan until the 12th century, although there is no recent evidence of them in the Bering sea or North Pacific (Kasuya 1975; Kasuya et al. 1988a). Sometimes, individuals of *Globicephala macrorhynchus* taken off the coast of Japan are mistakenly identified as *Globicephala melas* (Ohsumi 1975; Kasuya et al. 1988a).

Globicephala melas appears to be distributed continuously across the North Atlantic (Brown 1961; Leatherwood & Dahlheim 1978). Separate stocks have yet to be conclusively distinguished, although there is some evidence that the western

and eastern North Atlantic populations are distinct. Eastern animals appear to be slightly larger, and although the population around Newfoundland was depleted by a drive fishery in the 1960s, the eastern population showed no corresponding decline in numbers (Sergeant 1962; Mercer 1975; Mitchell 1975a,b; Moore et al. 1979; Martin et al. 1987; Bloch, 1994). Declines were also not observed in areas near Newfoundland, such as Nova Scotia (Sergeant 1982). This may indicate the presence of subpopulations within the western North Atlantic.

Although there is incomplete census data, Andersen (1988) hypothesized a parapatric distribution between the east and west Atlantic, resulting in a limited exchange of genes between the two areas. Further, differences in the types of parasties carried by pilot whales from the Faroe Islands, the western Mediterranean, eastern North Atlantic waters near France, and Newfoundland, suggest that individual whales may not routinely move between any of these regions (I.W.C. 1990a). However, recent increases in mass strandings reported from both sides of the Atlantic suggest the possibility of a continuous distribution across the North Atlantic (D.E. Sergeant, McGill University, Main Road, Hudson, Quebec; personal communication).

In the eastern Atlantic, enzyme variation within and between schools of whales caught in the Faroes may imply some degree of reproductive isolation among schools (Andersen 1988). Further, differing concentrations of the elements mercury, cadmium, and selenium found among Faroese whales suggests the existence of at least two sub-populations (Jean-Caurant 1987; Julshamn et al. 1987). Faroese pilot whales have been historically classified into one of two types depending upon the shape of the dorsal fin, but these differences are now attributed to yearly variations in blubber thickness (Andersen 1988; Bloch et al. 1994).

In waters of the British Isles, there is some evidence of at least two separate populations; a northerly one which may be part of the stock centered on the Faroes, and a more southerly one (Evans 1980).

Protection

International

Pilot whales are listed on Appendix I of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES).

National

Canada: All whaling, except aboriginal, is prohibited in Canadian waters under the Marine Mammal Regulations the Fisheries Act of 1867 (as amended to date). Hunting can only be undertaken under license.

United States: Protection is afforded under the Marine Mammal Protection Act of 1972 as well as by the Packwood-Magnuson Amendment of the Fisheries and Conservation Act, and the Pelly Amendment of the Fisherman's Protective Act.

Population Size and Trends

There are inadequate estimations of abundance for the entire northern or southern population of Long-finned Pilot Whales.

Western Atlantic

A drive fishery existed at Cape Cod from the mid-1700s to the 1920s, with the mean annual catch in the 1800s on the order of 2000 to 3000 animals (Mitchell 1975b; Mead 1979).

Although *Globicephala melas* was exploited to some extent in Newfoundland even before the 1900s, it became the target species of organized drive fisheries from 1947 to 1971, which took approximately 54 000 animals within this time span (Mercer 1975; Sergeant 1982). Most whales were captured in Trinity Bay and Bonavista Bay, with fewer in Conception Bay and Notre Dame Bay (Sergeant 1962; Mercer 1975).

The population in eastern Newfoundland waters is thought to have numbered 50 000 to 60 000 at the onset of the fishery, and was apparently decimated by the hunt. A peak kill of 10 000 whales in 1956 gave way to a steady decline, until annual catches numbered in the low hundreds (Mitchell 1974; Mercer 1975; Sergeant 1982). The whales were usually herded by boats into shallow bays and killed with lances, although a few hundred were harpooned annually by crews on whaling vessels (Sergeant 1962). In 1971, the company which processed the animals reported to the Department of Fisheries that "Potheads" were virtually commercially extinct in Newfoundland (J. Lien, Memorial University Ocean Sciences Centre, St. John's Newfoundland; personal communication). The drive fishery ended when commercial whaling on the Canadian Atlantic coast was banned by the Government of Canada on December 22, 1972 (Mercer 1975). There is no evidence of depletion in any other stocks of *Globicephala melas*.

Some authors feel that the Newfoundland population may be recovering (Mitchell 1975a; Sergeant 1982), however, there is little new information on the status of the Newfoundland population. The most recent estimates for northeastern populations yield 4000 to 12 000, and sightings are relatively infrequent (Hay 1982; Lynch 1987; I.W.C. 1990b; Lien 1980; Lien et al. 1980; Lien, unpublished data). It is unlikely that recovery is complete. If one assumed a Newfoundland population of 4000 animals in 1972, present numbers

estimated from an optimistic 6% net recruitment rate would only be around 12 000 animals.

Eastern Atlantic

Statistics on the non-commercial pilot whale drive in the Faroe Islands have been found dating as early as 1584, and an unbroken record exists from 1709 to the present (Bloch et al. 1990a). The annual catch between 1709 and 1989 varied from 0 to 4325 whales, with an average of 988 whales caught per year (Bloch et al. 1990a). In 1987, an estimate of 100 000 whales was made for waters east of Greenland, with the most animals occurring southwest of the Faroe Islands (Desportes 1990). There is no evidence of depletion, although uncertainties in abundance numbers and reproductive rates make assessments tentative (I.W.C. 1990a). Hunting techniques in the Faroe Islands are similar to those that were utilized in the Newfoundland drive fishery (Bloch et al. 1990b).

Small numbers of animals have been taken in Norway, West Greenland, Iceland, Scotland, and Ireland (Christensen 1975; Kapel 1975; Mitchell 1975a,b; O'Riordan 1975; Sergeant 1979; I.W.C. 1990b). Population estimates for eastern Atlantic waters yield approximately 100 000 whales, although there is uncertainty in this number (I.W.C. 1990b).

Habitat

Globicephala melas is a pelagic species which inhabits deep water throughout most of the year, although at times it moves inshore in pursuit of prey (Leatherwood & Dahlheim 1978; Sergeant 1979; Sergeant 1982; Dawson et al. 1985; Martin et al. 1987). Knowledge of habitat use by *Globicephala melas* is fragmentary for most seasons and for offshore areas. Satellite tracking data

indicate an affinity for shelf edges (B. Mate, Marine Sciences Center, Oregon State University, Newport Oregon; personal communication).

General Biology

Reproductive Capability

The breeding season of Long-finned Pilot Whales around Newfoundland lasts from May to November, with the maximum number of births occurring in mid-August (Sergeant 1962). A summer breeding season is also found for pilot whales in the Mediterranean. The whales begin to congregate in July and calve by late September. In the Faroes, the average conception date is around June (Evans 1980; Amos and Dover 1990; Desportes 1990). Some animals breed sucessfully year-round, however (Desportes 1990).

A single calf, approximately 180 cm in length and weighing 100 kg is born after a gestation period of about 16 months (Frazer and Huggett 1959, 1973; Sergeant 1962; Martin et al. 1987; Bloch, 1994). Twins appear rarely (Bloch, 1994). Lactation can last 2.5 years or longer, although weaning and tooth eruption begin at around 6 months of age (Sergeant 1962; Martin et al. 1987; I.W.C. 1988; Desportes 1990; Bloch, 1994). Some whales taken in the Faroes were found to have milk in their stomachs, even though they were over four years old (Desportes 1990). Females can be both lactating and pregnant (I.W.C. 1988; Bloch, 1994).

Male pilot whales show a rapid rate of growth until sexual maturity is reached at about 12 years of age, and 4 to 5 meters in length (Sergeant 1962; Martin et al. 1987; Kasuya et al. 1988b; Bloch 1994). Growth may be most rapid in the first 2 to 3 years of life (Martin et al. 1987; Kasuya et al. 1988b). After sexual maturity is reached, the growth rate for males slows, and may cease

at about 20 to 25 years of age (Sergeant 1962; Kasuya et al. 1988b; Bloch 1994). Females show a growth pattern similar to males, although they generally grow a bit slower (Sergeant 1962; Kasuya et al. 1988b; Desportes 1990; Bloch 1994). Females mature at 6 to 13 years and a length of 3 to 4 m (Sergeant 1962; I.W.C. 1988; Kasuya et al. 1988b; Bloch, 1994). Males live up to 50 years, while females can live longer than 60 years (Kasuya et al. 1988b; Desportes 1990; Bloch, 1994).

One calf is produced about every three or four years (Sergeant 1962; Desportes 1990). At least three ovulations can occur in females during one breeding cycle (Sergeant 1962). Annual pregnancy rate is approximately 30%, (Perrin and Reilley 1984; Bloch, 1994), and annual calf production is estimated at 10 to 13% (Sergeant 1962; Harrison 1969; Martin et al. 1987; Desportes 1990). A high reproductive capacity is retained at all ages, with some females surviving to a post-reproductive phase (Sergeant 1962; Martin et al. 1987; Kasuya et al. 1988b; Desportes 1990). This phase can actually begin quite early - one female examined in the Faroes was sexually senile at 28 years - possibly as a result of ovarian exhaustion (Kasuya et al. 1988b; Desportes 1990).

The annual mortality rate of males from age 1 to 8 is about 5.8%, while for females it is 4.5% (Sergeant 1962). Kasuya et al. (1988b), examining the same data as (Sergeant 1962), estimated the mortality rate of males under 25 years of age to be about 7%, while for females it is much lower at 2%. In young calves the sex ratio is approximately equal, but the difference in mortality rates results in a declining percentage of males as cohorts age; the overall sex ratio at maturity being one male to two or three females (Sergeant 1962; Martin et al. 1987; Kasuya et al. 1988b; Desportes 1990; Bloch, 1994). A higher percentage of females than males within a pod is reported from many sources (Sergeant et al.

1970; McLeod 1981; Crespo et al. 1985; Dawson et al. 1985; Martin et al. 1987; Amos and Dover 1990; Bloch, 1994), although occasionally, mostly-male or all-male pods are found (Sergeant 1962; Geraci and St. Aubin 1977; Amos and Dover 1990; Desportes 1990). The higher rate of male mortality may result through intraspecific fighting among males (Bloch, 1994).

Species Movement

Canadian Waters: Around Newfoundland, pilot whales show a marked seasonal variation in distribution. They generally arrive on the Grand Banks in June and remain until late autumn (Sergeant 1962; Mercer 1975; Lien et al. 1980; Lynch 1987) Maximum abundance in summer appears to be along the southeast coast of Newfoundland: they are not as commonly seen in the inshore waters of the Maritime provinces of Canada or southwards, although they are present (Mercer 1975; Leatherwood & Dahlheim 1978; Hain et al. 1981; Powers et al. 1982; Gaskin 1983).

Summer inshore movements of pilot whales around Newfoundland are coincident with the arrival of the Short-finned Squid (*Illex illecebrosus*), which prefer water temperatures in the range of 5 to 15°C. (Frost and Thompson 1933; Sergeant and Fisher 1957; Lien and Aldrich 1982).

Pilot whales are often sighted in June, and again in October - November, along the continental slope from the entrance of the Gulf of Maine northward to the Laurentian Channel, the southwest edge of the Grand Bank, and the channel between the eastern edge of this bank and Flemish Cap (Sergeant 1962; Lynch 1987). They appear to be absent from this zone in winter (Sergeant 1962).

There have been other widespread summer sightings offshore from New England, Nova Scotia, Iceland, in the Labrador Sea, and over oceanic depths east of the Grand Bank (Sergeant and Fisher 1957; Brown 1961; Mercer 1973, 1975; Boles

1980; Haycock and Mercer 1985; Sigurjonsson and Gunnlaugsson 1989). They may be found off the coast of Cape Cod as early as May (Starrett and Starrett 1955). Apparently, Long-finned Pilot Whales occur only north of 55°N latitude in the summer months, on both sides of the Atlantic (Brown 1961).

Pilot whales migrate outside the Continental Shelf in winter, and are then known to inhabit areas on and east of the Grand Bank in North Atlantic Current waters (Sergeant and Fisher 1957; Sergeant 1962). There have also been winter sightings off New England and Greenland (Sergeant and Fisher 1957; Brown 1961; Mercer 1967, 1975; Parsons 1981).

Other Areas: In West Greenland and Iceland, pilot whales generally stay offshore (Sergeant and Fisher 1957; I.W.C. 1990a). In European seas, this species occurs numerously between Iceland, the Norwegian coast and Great Britain in the summer, with its maximum concentration around the Faroe Islands (Sergeant and Fisher 1957; Leatherwood and Dahlheim 1978; I.W.C. 1990a). They are known to pursue squid into Icelandic fjords, and their presence in Faroese waters appears to be related to prey distribution and changes in water temperature (Grimpe 1933; Saemundsson 1939; Bloch et al. 1990a).

There is little evidence to support any strong north-south migrational patterns in the Northern Hemisphere, although a seasonal movement of Southern Hemisphere whales into Antarctic waters has been postulated (Guiler et al. 1987; Martin et al. 1987).

Behaviour

Feeding: In Newfoundland coastal waters, *Globicephala melas* subsists mainly on Short-finned Squid, although Northern Cod (*Gadus morhua*) are common prey when

squid are less plentiful (Sergeant 1962; Mercer 1975). Other organisms known to be taken in the western Atlantic include the amphipod *Gammarus locusta* and the squids *Loligo pealii* and *Gonatus fabricii* (Sergeant and Fisher 1957; Mercer 1967). When squid is abundant, it has been estimated that food intake may be 3 to 6% of body weight, or as much as 41 kg per day (Sergeant 1962).

Although *Illex illecebrosus* is considered to be the main food item for Long-finned Pilot Whales in the western North Atlantic, individuals of consumable size are only available in the summer months (Mercer 1975). Prey species for the remainder of the year are not known, although oceanic squids (including other species of Ommastrephids) and oceanic fishes are probably candidates (Mercer 1975). Pilot whales have been known to consume Turbot, *Reinhardtius hippoglossoides,* in the winter (Mercer 1967).

Saemundsson (1939) considered *Ommastrephes sagittatus* to be the most commonly ingested squid in northern European waters, although pilot whales feed mainly on the squid *Todarodes sagittatus* off the Faroe Islands (Moore et al. 1979; Desportes 1990; Bloch 1994). Generally, prey species taken in Faroese waters are shoaling, oceanic, mid-water organisms (Desportes 1990). Other squids taken in eastern waters include *Gonatus fabricii*, *Eledone* sp, *Teuthowenia* sp, *Taonius* sp, *Architeuthes* sp, and *Histioteuthis* sp (Evans 1980; Desportes 1990; Bloch, 1994). Fish prey include Blue Whiting (*Micromesistius poutassou*), Northern Cod, Horse Mackerel (*Caranx trachurus*), flounder (Pleuronectidae), and Turbot (Sergeant 1962; Evans 1980; Bloch, 1994). Fish and other organisms become more prevalent in the diet of pilot whales when squid are scarce (Desportes 1990; Bloch, 1994). Schools of pilot whales are known to associate strongly with mackerel shoals off southwestern England (Evans 1980). There is also a

correlation between herring numbers and pilot whale catches for the Faroes, which may result from squid concentrating to feed on the herring (Evans 1980).

Pilot whales apparently feed in a group, as the degree of digestion of squid in stomachs is always the same in groups driven ashore (Sergeant 1962). *Globicephala melas* has been observed feeding in groups and forming circle patterns which may indicate "herding" of squid (Weilgart 1985).

Social Behaviour: Pelagic groups of *Globicephala melas* generally consist of about 20 animals, although they may concentrate inshore in much larger numbers sometimes exceeding 200 animals (Sergeant and Fisher 1957; Clarke 1962; Sergeant 1962; Evans 1980; Hay 1982; Weilgart 1985; Amos and Dover 1990). In Newfoundland, groups that are driven ashore or mass strand are generally larger than pelagic assemblages; the mean being 85 animals (Sergeant 1962, 1982). It is speculated that changes in group size may reflect varying behaviours such as feeding, migration, or reproduction, although pod sizes may also be underestimated when observed at sea (Sergeant and Fisher 1957; Sergeant 1962; Evans 1980; Weilgart 1985; Martin et al. 1987).

Schools generally contain animals of various sizes and both sexes (Sergeant 1962; Amos and Dover 1990; Bloch, 1994). The social structure of *Globicephala melas* has yet to be conclusively determined, although there is evidence of a matrilineal pod organization (Amos and Dover 1990; I.W.C. 1990a; Desportes 1990). Further, because there is usually more than one mature male in a pod, a multi-male, polygynous mating system seems likely (Sergeant 1962; Martin et al. 1987).

Males probably move frequently between pods; spending only a few months in any particular group (Amos and Dover 1990; Desportes 1990). This movement may

begin when the males reach sexual maturity, during which time segregation into separate pods is possible (Kasuya et al. 1988b). All-male or mostly-male herds are rarely observed, however, and there is no evidence that this species is generally segregated (Sergeant 1962; Martin et al. 1987; Amos and Dover 1990; Bloch, 1994).

Globicephala melas is a highly social species, and strong social bonds are often cited to explain mass stranding (Kritzler 1952; Geraci and St. Aubin 1977; Norris and Dohl 1980). Its social nature is also reflected in a rich vocal repertoire, which includes a variety of whistles ranging from 0.5 to 5.0 Khz in frequency, double clicks, and the ability to produce two totally different signals simultaneously (Schevill 1964; Busnel and Dziedzic 1966; Taruski 1979; Herman and Tavolga 1980). Signature whistles and dialects may also exist (Taruski 1979; McLeod 1982).

Sound production is known to vary with behavioural and environmental context (Taruski 1979; Weilgart and Whitehead 1990). Simplest sounds are emitted during periods of minimal activity such as resting behaviour, while more complex sounds occur when behaviour is vigorous and energetic, and involves more complex coordination within the group (Taruski 1979; Weilgart and Whitehead 1990). Differences in calling rate between large and small schools have also been observed (Taruski 1979).

In the summer of 1987, an immature pilot whale was tracked for 95 days in the western North Atlantic through the use of a satellite-monitored radio tag (Mate, personal communication). Information obtained indicated that virtually all deep dives occurred either just before sunset or at night, and coincided with the nocturnal rise of prey items. Since few deep dives were recorded during the day, it was thought that the whale was probably feeding on surface shoaling fish

at these times, if it fed at all. The highest swimming speeds were also found at night, suggesting fast prey-chasing or searching. Daily movements of up to 234 km were observed, with a mean of 80 km per day. The average number of dives in a 12 hour period varied from 636 to 1433, reflecting changes in the animal's activity patterns. Swimming speeds averaged 3.3 km/h over the entire period, while speeds above 16 km/h could be maintained for periods exceeding three hours. Surface resting activity, sometimes of up to 15 minutes, was most common during the first three hours of sunrise (Mate, personal communication).

This species has been observed to form mixed groups with Bottlenose Dolphins (*Tursiops truncatus*), White-beaked Dolphins (*Lagenorhynchus albirostris*), Atlantic white-sided Dolphins (*Lagenorhynchus acutus*), Killer Whales (*Orcinus orca*), and Tuna, Thunnus thynnus (Sergeant and Fisher 1957; Aloncle 1972; Leatherwood et al. 1976; Leatherwood and Dahlheim 1978; Evans 1980; Sears 1982; Bloch, 1994). On occassion, single stray Narwhals, *Monodon monoceros*, have been found associating with groups of *Globicephala melas* (Lien and Barney 1991).

Behaviours such as spyhopping and lobtailing have been observed in pilot whales, while breaching may occur when groups are feeding (Weilgart 1985; Leatherwood et al. 1976). They are not known to ride bow waves (Leatherwood et al. 1976).

Limiting Factors

Parasites

Although not a serious limiting factor, parasites are common in this species. External parasites include the Whale Louse, *Isocyamus delphini*, which infests crevices in the skin and old wounds, and *Conchoderma auritum*, found on

the teeth and gums, usually of older animals (Sergeant 1962; Martin et al. 1987; Balbuena and Raga 1991). The Whale Louse apparently infests mature males more heavily than other classes, possibly due to differences in behaviour of the males (Balbuena and Raga 1991).

Internal parasites include the nematode *Anisakis simplex* which may originate in the stomach from ingested squid, in the nasal passages and middle ear sinuses, and *Crassicauda carbonelli* infesting the penis; also the trematodes *Leucasiella delamurei* and *Odhneriella subtila* from the small intestine, and *Phyllobothium delphini* embedded in the blubber of older animals (Sergeant 1962; Raga and Balbuena 1988, 1990; Balbuena et al. 1989).

Some parasites, such as the trematode *Pholeter gastrophilus* and the nematode *Anasakis simplex* show a decline in older animals, which could suggest that heavy infestation could be a cause of mortality (Desportes 1990).

Infections

The influenza A virus, originating from avian sources, is known to be transferrable to pilot whales (Hinshaw et al. 1986; Chambers et al. 1989). *Streptococcus equi*, an equine pathogen rarely isolated from other animal species, has been found in *Globicephala melas* (Higgins et al. 1980).

Pollutants

Organochlorines and heavy metals have been documented in the tissues of *Globicephala melas* (Taruski 1975; Wagemann and Muir 1984; Muir et al. 1988). Martin et al. (1987) reported higher levels of PCBs in pilot whales stranded along British coasts than have been found in any other populations of this species. Mercury levels in consumable parts of Faroe pilot whales are known to

approach or exceed safe limits (Andersen et al. 1987). Contaminants may be transfered from females to their young during pregnancy and lactation (Desportes 1990).

The effects of these pollutants have yet to be determined. However, high concentrations of heavy metals have been suggested as a possible cause for stranding, and high levels of polychlorinated biphenyls have been associated with reproductive failure in other marine mammals (Muir et al. 1988).

Predation

Pilot whales often bear scars, especially on trailing edges of flippers, dorsal fin, and flukes (Sergeant 1962; Martin et al. 1987). Tooth scars, common on adult males, may attest to play or fighting for pod dominance rather than by attempted predation (Martin et al. 1987; Bloch, 1994). Sergeant (1962) found no evidence of predation by Killer Whales or sharks for pilot whales around Newfoundland, although Killer Whales are known to prey on them in other areas (Katona et al. 1988). Sucker marks have also been observed, and are probably made while the whale is feeding on squid (Sergeant 1962; Martin et al. 1987; Bloch, 1994).

Mass Strandings

Globicephala is the genus that most frequently mass strands. Such strandings sometimes involve entire pods (Geraci and St. Aubin 1977; Evans 1980; Sergeant 1982). Mass strandings of Long-finned Pilot Whales have been recorded from Ireland, Britain, France, Spain, New Zealand, South America, New South Wales, the Netherlands, Greenland, Newfoundland, Nova Scotia, Cape Breton Island, Sable Island, Prince Edward Island, Magdalen Islands, Miquelon Island, and Cape

Cod (Starrett and Starrett 1955; Dawbin 1964; Sergeant et al. 1970; O'Riordan 1975; Husson and Van Bree 1976; Mead 1979; Sergeant 1979; Wood 1979; Nores and Perez 1982; Sergeant 1982; Crespo et al. 1985; Dawson et al. 1985; Sheldrick 1989; Kingsley, unpublished data). Table 1 lists reported mass strandings for eastern Canadian waters between 1957 and 1990.

A rough estimate of annual mortality due to mass strandings in Newfoundland from 1975 to 1980 is about 1% of the population, and mass strandings seem to be increasing (Sergeant 1982). Recently, pilot whales have begun to strand almost yearly around Cape Cod (Sergeant, personal communication). Sheldrick (1979) and Brown (1975) report an increase of pilot whale strandings on the British coast beginning in 1947, although their data included single-stranded animals. A more recent study suggests that British mass strandings have increased since about 1982 (Sheldrick 1989). Further information is needed to estimate the effect of mass strandings on pilot whale populations. It is possible that mass strandings represent the main source of coastal mortality for this species (Sergeant 1982).

Incidental Catches

Incidental catches of *Globicephala melas* in fishing gear have been frequently observed (Lien and Aldrich 1982; I.W.C. 1990a; Donovan & Perrin 1990; Kraus et al. 1990; Northridge 1990; Stenson and Reddin 1990). Catches often involve younger and smaller animals which cause little damage to the fishing gear. Because of this, there is a tendency to under-report catches (Lien and Aldrich 1982; Lien et al. 1994). Further, in some jurisdictions where there are regulatory problems stemming from incidental catches, fishermen may try to avoid reporting animals that have been caught (Prescott et al. 1980).

Lien and Aldrich (1982) investigated incidental catches of *Globicephala melas* in Newfoundland during 1983, a year of high squid abundance. The whales were commonly found in traps set for squid, although they also became caught in groundfish and herring gillnets. Of 43 animals reported entrapped, 87% died as a result of the entrapment. It was suggested that entrapments were probably more likely to be reported by fishermen in 1983 because they occurred in a small area and were considered a major problem in the fishery. Since 1983, inshore abundance of *Globicephala melas* has been quite low, and it is probable that isolated entrapments would not be reported (Lynch 1987; Lien et al. 1994).

Other

The exploitation of prey species by various fisheries may have an impact on populations of Globicephala melas , although such effects have yet to be documented for this species (Lowry and Frost 1985).

Special Significance of the Species

The Faroese Fishery

The non-commercial pilot whale hunt, or "grind" is an integral part of the traditions and culture of the Faroe Islands (Olafsson 1990). In recent years a high level of controversy has surfaced which involves ethical, ecological, and animal-welfare issues (Gibson-Lonsdale 1990; Joensen 1990; Olafsson 1990). In addition, high concentrations of mercury found to be present in consumable tissues has raised significant health questions (Andersen et al. 1987, Olafsson 1990).

The pilot whale fishery of the Faroes does offer an excellent opportunity for studying the biology and social structure of these animals, as statistics

have been kept as far back as 1584, and represent information about entire pods of whales (Desportes 1990; Bloch, 1994). A newly-developed technique which may prove invaluable for answering questions about population biology is that of DNA fingerprinting, which can accurately assess paternity of individual animals (Amos and Dover 1990). DNA fingerprinting is a more accurate method for examining population structure than the use of coded tags or naturally occurring markings, because these offer only indirect evidence about breeding systems (Kaufman et al. 1987; Amos and Dover 1990). At the present time, data are being gathered with this technique from the Faroese fishery which will eventually provide information concerning individual movement between pods, age at first breeding, length of time spent within pods, and the relatedness of individuals within pods (Amos and Dover 1990).

The Phenomenon of Mass Stranding

As *Globicephala* is the genus that most frequently mass strands, *Globicephala melas* is a common subject for the study of this phenomenon (Geraci and St. Aubin 1977; Evans 1980; Sergeant 1982; Kirschvink 1990). No conclusive evidence yet exists as to the causes of mass strandings. Parasitism has been suggested as a possible factor (Dailey et al. 1979; Wood 1979; Morimitsu et al. 1986), yet it appears that mass-stranded animals are generally not diseased or highly parasitized (Geraci 1979; Hall and Schimpff 1979; Ridgway 1979; Sergeant 1979; Wood 1979; Sergeant 1982; Morimitsu et al. 1986). Other speculations include confusion due to lack of familiarity with inshore waters, disturbances to the echolocation system because of an area's underwater topography, problems in attention, anomalies in geomagnetism, or general stress from any number of

possible sources (Geraci and St. Aubin 1979; Wood 1979; Dawson et al. 1985; Kirschvink 1990).

As mass strandings of Odontocete species apparently occur where the animals are abundant, a better understanding of the phenomenon could provide evidence on the state of various populations (Sergeant 1979; Sergeant 1982).

Satellite Tracking

The development of satellite-monitored radio tracking represents another important breakthrough in the study of whale behaviour. A feasible monitoring system was first used in 1987 to record the behaviour a pilot whale for 95 days in the western North Atlantic (Mate, personal communication). The pilot whale is a useful model for tracking studies because it is found in a variety of environments, its trophic niche is typical of many odontocetes, and it is easily captured (Mate, unpublished data. At the present time, satellite systems are still under development; they may eventually provide information including stock separation, energetics, acoustics, and the identification of critical habitats (Mate 1989).

Evaluation

Globicephala melas is widespread, and although numbers are considerably lower than prior to commercial whaling, they still relatively abundant in the North Atlantic. Although there may be several sub-populations in Canadian waters which are somewhat distinct, exact relationships are unclear. It is known that *Globicephala melas* off Newfoundland was severely depleted by drive fisheries which ended in 1971. There have not been systematic efforts to assess populations and their recovery since that time. Even optimistic estimates would

indicate that numbers are still low and well below pre-whaling population size. Mass strandings represent a major known source of natural mortality for this species. The effects of incidental entrapments, pollutants, and fisheries for prey species remain relatively unknown, but these factors have the potential for limiting this species. Although this sub-population would meet the criteria for a COSEWIC designation of vulnerable, if considered without regard to other North Atlantic populations, there is no evidence that the population is distinct and discrete. Therefore, since the species is widespread and relatively abundant throughout the Western North Atlantic such a designation cannot be made since Western North Atlantic populations would not seem to be at risk, although numbers have not recovered to pre-whaling levels.

Acknowledgements

Bob Campbell of Fisheries and Oceans is acknowledged for his patience - he is truly a tolerant editor who can ignore deadlines almost as well as the authors. World Wildlife Fund (Canada) and Medtronic provided financial assistance to Dawn Nelson while we wrote this manuscript. D.E. Sergeant made helpful suggestions, and although we did not follow all of them, his criticisms helped improve drafts of the manuscript. We are grateful to Dora Bloch for her helpful guidance. Thanks also go to Michael Kingsley for providing a summary of Canadian mass strandings.

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Table 1. Mass strandings of *Globicephala melas* for eastern Canadian Waters between 1957 and 1990. All reported strandings of more than one animal are listed (Kingsley, unpublished data).

Year	Date	No.	Locality	Remarks	Source
1957	4 Aug	12 +	Cow Head, NF	all died	Sergeant et al. 1970
1959	2 Oct	18	Sable Island, NS	refloated on later tide	Sergeant et al. 1970
1960	1 Aug	58	Port Maitland, NS	all died	Sergeant et al. 1970
1967	24 Dec	15	Glace Bay, Cape Breton Island, NS	all died	Sergeant et al. 1970
1975	28 Sep	300	Charleston, Bonavista Bay, NF	200 whales towed out, many smaller whales restranded, approx 125 died	Mitchell 1977
1976	26 Dec	130 +	Sable Island, NS	116 examined	Geraci & St. Aubin 1977
1978	17 Sep	63	Miquelon Island	scattered over 1 mile of sandy beach	Mitchell 1980
1978	19 Sep	99	Pte aux Allouettes Miquelon Island	dead in two tight groups	Mitchell 1980
1978	29 Sep	ca. 70	Musgrave Harbour, Bonavista Bay, NF	fishermen towed many into deep water, approx. 54 died	Mitchell 1980
1979	14 Jul	135	Point aux Gaul, NF	all died	Lien 1980
1980	18-19 Oct	75	Point Leamington, NF	all died	Lien 1980
1980	25 Oct	18	Grand Beach, NF	all died	Lien 1980
1980	9-18 Nov	52	Bedeque Bay, PEI	all died	Mitchell 1982
1981	31 Aug	39	Little Burnt Bay, Notre Dame Bay, NF	all died	Lien & Aldrich 1982
1981	4 Sep	2	Chance Cove Trinity Bay, NF	both died	Lien & Aldrich 1982
1981	4 Sep	5	Branch St. Mary's Bay, NF	all died	Lien & Aldrich 1982
1981	6 Sep	27	George's Bay, NS	13 died, remainder released	Loch 1983
1981	8 Sep	70	Port Hood, George's Bay, NS	25-30 died	Loch 1983

Table 1 cont'd.

Year	Date	No.	Locality	Remarks	Source
1981	13 Oct	13	Magdalen Islands	all died	Loch 1983
1981	27 Jul	23	Grand Bank, NF	12 unbeached themselves, 11 died	Lien et al. 1982
1982	18 Aug	3	Bonavista, NF	2 unbeached, 1 died	Lien et al. 1982
1982	13 Aug	14	Pinkney's Pt., Yarmouth NS	12 released, 2 died	Goodman 1984
1990	9 Aug	2	Cheticamp, NS	ca. 40 whales attempted to strand but were successfully repelled, 2 died	Tom Kiely, *in litt.*, 10 Aug 1990
1990	15 Sep	2	Sturgeon Bay, PEI	female & young moved to deeper water, female restranded on 16th, euthanized	R.P. Johnston, DFO Charlottown, in litt., 19 Sep 1990
1990	ca. 30 Sep	2	S. Lakevale, NS	males, dead when found	Kingsley, *pers comm.*

List of Figures

Figure 1. Long-finned Pilot Whale, *Globicephala melas*, (Drawing by D. Nelson, approximately 1/50 life size).

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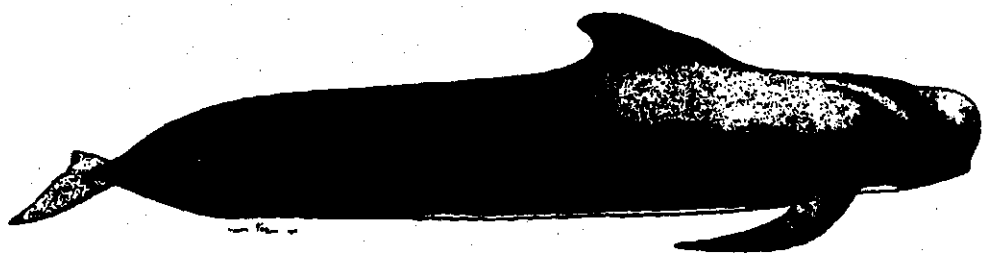

Figure 1. The long-finned pilot whale, *Globicephala melas* (Drawing by D. Nelson)

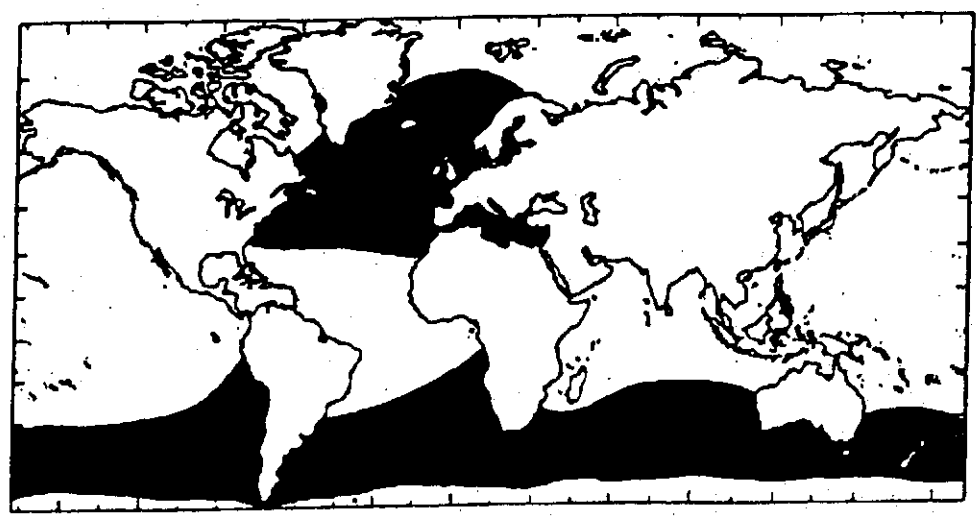

Figure 2. Range of *Globicephala melas*