Committee on the Status of Endangered Wildlife in Canada

Comité sur le statut des espèces menacées de disparition au Canada

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STATUS REPORT ON THE STRIPED DOLPHIN *STENELLA COERULEOALBA* IN CANADA

BY

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AND

HAL WHITEHEAD

STATUS ASSIGNED IN 1993
REPORT ACCEPTED, NO STATUS DESIGNATION REQUIRED

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Status of the Striped Dolphin, Stenella coeruleoalba, in Canada

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Taxonomy

Class	Mammalia
Order	Cetacea
Family	Delphinidae
Scientific Name	Stenella coeruleoalba (Meyen, 1833)
Common Name	Striped Dolphin
Other Names:	
English	Blue-white Dolphin, Euphrosyne Dolphin
French	Dauphin Bleu, Dauphin Bleu Et Blanc, Dauphin Raye
Latin American	Del'fin Listado
Japanese	Suji Iruka
Russian	Polosatyy Del'fin or Stenella

This report reviews the biology, world-wide status and management of the Striped Dolphin (Stenella coeruleoalba), with special reference to its status in Canadian waters. This species is found in offshore waters throughout the world in warm-temperate and tropical seas. Large numbers are killed yearly in directed fisheries off Japan, and they are also incidentally caught in fishing operations around the world. Published and previously unpublished records from Canadian waters include 11 from western and 17 from eastern Canada. The Striped Dolphin appears to be at the northern limits of its normal range in Canadian waters, where no serious threats to its status exist. As such, no COSEWIC status designation is required.

Le présent rapport expose les caractéristiques biologiques du dauphin bleu, son statut mondial, et les mesures de gestion dont il fait l'objet et sa situation, particulièrement au Canada. L'espèce fréquente les eaux hauturières des mers chaudes tempérées et des mers tropicales du globe. De grands nombres sont tués chaque année dans le cadre d'une pêche sélective au large du Japon, et ils sont aussi capturés accidentellement au cours d'opérations de pêche dans toutes les mers du globe. Des données publiées et inédites (auparavant) recuillies dans les eaux canadiennnes, sot un total de 11 observations dans les eaux du Pacifique et 17 observations dans les eaux de l'Atlantique. Les eaux canadiennes, où l'espèce n'est pas menacée, semblent représenter la limite septentrionale de l'aire de répartition courante du dauphin bleu. À ce titre, l'espèce ne requiert pas une intervention de la part du CSEMDC.

Key Words: Striped Dolphin, dauphin bleu, Stenella coeruleoalba, Canada, status, cetacean, North Pacific, North Atlantic.

This review summarizes the current state of knowledge of the Striped Dolphin, Stenella coeruleoalba (Meyen, 1833), with special reference to its status and management in Canadian waters. Striped Dolphins (Figure 1) reach maximum lengths of between 2.5 and 2.7 m; males are slightly larger than females (Leatherwood and Reeves 1983; Ross 1984). Leatherwood and Reeves (1983) and Ross (1984) summarize the physical description of Striped Dolphins. Striped Dolphins and Common Dolphins (Delphinus delphis) are superficially similar, and this may make it difficult to distinguish between them at sea. Detailed descriptions of the complex pigmentation pattern of the Striped Dolphin are given by Norris and Prescott (1961), Gihr and Pilleri (1969), Fraser (1974) and Ross (1984). Pigmentation patterns appear to be highly variable, though Fraser and Noble (1970) note that these variations do not appear to correlate with age, sex, or geographical distribution. Such variations have resulted in considerable taxonomic uncertainty. In his review of the taxonomic history of Stenella coeruleoalba, Hershkovitz (1966) lists 44 historical species designations. Common names attributed to this species include the Blue-white Dolphin, Long-beaked Dolphin, Gray's Dolphin, Gray's Long-snouted Porpoise, Streaker Porpoise, Meyen's Dolphin, and the Euphrosyne Dolphin.

Distribution

The Striped Dolphin is found in all warm-temperate and tropical waters and is the most widely distributed species of the genus Stenella (Wilson et al. 1987). In the eastern North Atlantic the Striped Dolphin has been observed as far north as Britain and Denmark (Fraser 1974; Wilson et al. 1987). The species appears to become more common southward along coastal Europe (Brown 1975; Evans 1987; Collet and Duguy 1987; Duguy 1987, 1988), and is present in the Mediterranean (Morzer Bruyns 1974; Casinos and Vericad 1976; Duguy 1977; Di Natale 1983; Podesta and Notarbartolo-di-Sciara 1987). They have

been recorded along the west coast of Africa, and their presence in the Indian Ocean is well documented (Ross 1984; Leatherwood et al. 1984; Alling 1986; Wilson et al. 1987).

In the Atlantic, van Bree (1973) reports a Striped Dolphin specimen that is thought to have originated from the waters of Greenland. The species has been recorded from Newfoundland and along the U.S. east coast (Mansfield 1967; Sergeant et al. 1970; Mercer 1973; Hain et al. 1985), to Florida, as well as the Caribbean and the Gulf of Mexico (Odell and Chapman 1976; Perrin et al. 1981). There are also several records from the coast of South America from southern Brazil to northern Argentina (Brownell and Praderi 1976; Perrin et al. 1981; Wilson et al. 1987).

The Striped Dolphin is the most northerly distributed species of the genus Stenella in the North Pacific (Nishiwaki 1967). Watson (1981) notes that this species can be found as far north as the Bering Sea, but unfortunately presents no documentation. Considering the lack of documented records from the Bering Sea and the small number of records from northern parts of the North Pacific (Wilson et al. 1987) we believe it is unlikely they are found there. In the eastern North Pacific, Striped Dolphins have been reported off the coast of North America from British Columbia to the equator, including the Gulf of California (Kellogg and Scheffer 1947; Cowan and Guiguet 1952; Sampson 1970; Hubbs et al. 1973; Wahl 1977; Aguayo-L. and Perdomo-V. 1985). Au et al. (1979) describe the distribution in the eastern tropical Pacific, which between the central Mexican and northern South American coast is known to reach to 153°W. Striped Dolphins are rarely seen in Hawaiian waters (Shallenberger 1981). There do not appear to be any records as far south as Peru (Perrin et al. 1983).

In the western North Pacific, Striped Dolphins are common off Japan (Nishiwaki 1967; Miyazaki et al. 1974). There are a few records north to the southern Sea of Okhotsk (Sleptsov 1961), and south through the South Pacific to New Zealand and Australia

(Wilson et al. 1987).

Published records from within the Canadian 320 km (200 mi) extended economic zone (EEZ) are few (Cowan and Guiguet 1952; Mansfield 1967; Pike and MacAskie 1969; Sergeant et al. 1970; Mercer 1973; Wilson et al. 1987). Records are also found in unpublished reports by Hatler (1972), the Sea Education Association (1979) and Perkins et al. (1981). Jamieson and Heritage (1988) report an animal identified as Stenella sp. that was killed in an experimental fishery for Flying Squid (Ommastrephes bartrami) in offshore British Columbia waters. This animal was likely a Striped Dolphin, as other species in the genus Stenella found in the eastern North Pacific are typically tropical (Leatherwood et al. 1988). A photograph of a dead Striped Dolphin on a wharf in Chester, Nova Scotia, from 1926, can be found in Reeves and Mitchell (1987), but there are no further details as to its origin. Katona et al. (1983) state that at least one record exists for Cape Breton Island, Nova Scotia, but this does not appear to match with any record compiled here. Mercer (1973) suggests that records from Quebec, and Halifax, Nova Scotia (Tomilin 1957; Miller and Kellogg 1955) are mis-citations. Four unpublished records from the west coast, and eight unpublished records from the east coast, have also been compiled. In total, 11 records from the west coast, and 17 records from the east coast have been compiled, and are presented in Table 1, with locations shown in Figure 2. Most records are of strandings or opportunistic sightings from one research area.

Protection

International

There is no international trade known in Striped Dolphin products. If such trade were to exist, it would be regulated by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). As Striped Dolphins are listed under Appendix II

of the Convention, international trade requires export permits from the country of origin. There is no international protection for Striped Dolphins from direct or incidental takes.

National

Canada: The 1982 Cetacean Protection Regulations of the Fisheries Act of Canada of 1867 (as amended to date) provide protection for this and other species of cetaceans, from all but aboriginal hunting. "Hunting" is defined as "to chase, shoot at, harpoon, take, kill, attempt to take or kill, or to harass cetaceans in any manner", and can only be undertaken under licence. However, no provisions for regulation of incidental catches in fishing operations exist.

United States: All cetaceans are protected 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(s) and Trends

An estimated 2 300 000 Striped Dolphins are present in the eastern North Pacific (U.S. Department of Commerce 1987); the largest population estimate available for that area of any species of cetacean. Perrin (1975) notes that more than one stock may be present in the eastern tropical Pacific, with a distributional break between about 10° and 17°N latitude. Further research seems to support this population discontinuity, and Perrin et al. (1985) suggest that animals north and south of these latitudes be considered separate populations. Nishiwaki (1975) reported an estimate of 400 000 to 600 000 animals off Japan, while Kasuya and Miyazaki (1975; cited in Ellis 1989) note an estimate of between 130 000 and 180 000 for the same period and area. Kasuya (1985) concludes that the population off Japan has been declining since the mid-1940's. Forcada et al. (1990) note that the Striped and Common Dolphin are the most common small cetaceans in the

offshore waters of the eastern North Atlantic.

Habitat

The Striped Dolphin's wide pelagic distribution in the eastern tropical Pacific is related to the distinctive oceanographic features of this region (Au et al. 1979). These authors note that all evidence points to a common preference among the pelagic dolphins, particularly the Striped and Common Dolphins, for regimes of shallow thermocline, which is the major characteristic of the eastern tropical Pacific. Sightings off the northeast coast of the United States by CETAP (1982) were generally centred about the 1 000 m depth contour. In a study in Japan, Miyazaki and Wada (1978) recorded Striped Dolphins in areas where sea surface temperatures ranged from 18.2 to 30.5°C. During research on Northern Bottlenose Whales (Hyperoodon ampullatus) off the Canadian east coast, Striped Dolphins were only recorded when water temperatures exceeded 15°C, during late July and August (Table 1), although field work in the area has been undertaken during June, July, August, October and February (Whitehead, unpublished).

General Biology

Reproduction:

Striped dolphins usually produce a single calf; only one pair of twin fetuses was found in a sample of about 30 000 dolphins examined in Japan (Tobayama et al. 1970). Gestation is thought to be 12 months (Kasuya 1972). Average length at birth is about 100 cm (Kasuya 1972; Miyazaki 1977). According to Miyazaki et al. (1981), Striped Dolphins weigh about 12 kg at birth, and grow rapidly in their first two years of life. Weaning takes place at an average estimated length of 174 cm and average age of 15 months (Kasuya 1972). Estimated lengths at attainment of sexual maturity in different areas are 195-220

cm for males and 216 cm for females, with a mean age of 9 years for both sexes (range of 7-12 years for males; 5-13 years for females; Perrin and Reilly 1984). Asymptotic body weight is attained at an age of about 15 years, when males average 157.5 kg and females 135.9 kg (Miyazaki et al. 1981). The mean and minimum ages at maturity have declined in the population off Japan, likely due to exploitation (Kasuya 1985). Physical maturity is reached at 235 cm in the male, and 225 cm in the female (Miyazaki 1977). Estimates of ovulation rates of animals from the western North Pacific range from 3 to 12 times per year (Perrin and Reilly 1984). Calving interval estimates range from 1.4 years to 4.2 years. Kasuya (1985) notes that the reproductive cycle in animals off Japan has also likely shortened because of exploitation of that stock. Using counts of cemental growth layers, assuming the deposition of one growth layer group per year, Kasuya (1976) has found that animals may reach 50 years of age. From a sample of over 1 000 individuals aged using this technique, Kasuya (1985) noted one individual of each sex reaching an age of 57 years. In the same study, although sex ratio between different schools varied from about 22% females to about 73% females, the mean sex ratio of 12 schools totalling over 3 000 individuals was about 1:1.

Species Movement:

Off the coasts of Japan, Nishiwaki (1967) noted northerly movements in May through July, and southerly movements in October through December. Compared to most other species of cetaceans studied by CETAP (1982) off the NE coast of the United States, no strong seasonal changes in distribution were evident for the Striped Dolphin. As noted above, northern movements into waters off the Canadian east coast generally appear to be related to the warming of surface waters, although records from mid-winter do exist (Table 1).

Behaviour:

Groups of up to 3 000 individuals have been reported off the coast of Japan (Nishiwaki 1975). Miyazaki and Nishiwaki (1978) examined 45 schools of Striped Dolphins off the coast of Japan between 1963 and 1973 and found that 85.8% of schools had fewer than 500 individuals; the range was 8 to 2 136 individuals. They also described three different types of schools, juvenile, adult, and mixed, to which Striped Dolphins belonged at different times according to their age and reproductive condition. The average size of schools taken in the Japanese drive fisheries was 360 individuals (Nishiwaki 1975). From 114 sightings from the northeast coast of the United States, the mean estimated group size was 64.9, with a mode of 20, and a range from 1 to 500 individuals. In this area, Striped Dolphins were observed in the largest groups of all small cetacean species observed (CETAP 1982).

Food items recorded include fish, squid, and shrimp; myctophid fishes and the shrimp Bentheogennema borealis were dominant in the stomach contents of 27 individuals taken off the coast of Japan (Miyazaki et al. 1973). Feeding on anchovies and sardines in the Mediterranean has been suggested (Di Natale 1979).

Associations with seabirds, and at least nine other species of marine mammals, have been noted. These include Atlantic White-sided Dolphins (Lagenorhynchus acutus), Common Dolphins, Long-finned Pilot Whales (Globicephala melas), Risso's Dolphins (Grampus griseus), Bottlenose Dolphins (Tursiops truncatus), other species in the genus Stenella, Northern Bottlenose Whales, Sperm Whales (Physeter macrocephalus), and Minke Whales Balaenoptera acutorostrata) (Table 1; CETAP 1982; Au and Pitman 1988). Au and Pitman (1988) note that associations with birds and other species of marine mammals occurred in seven and nine percent respectively, of 139 schools observed in the eastern tropical Pacific.

Di Natale (1983) notes that Striped Dolphins have been recorded at swimming speeds up to 32 knots. Striped Dolphins are among the most acrobatic of dolphins (Figure 3), and have been reported to ride the bow waves of boats by many authors. However, Au and Perryman (1982) found that schools of Stenella, including the Striped Dolphin, exhibited an avoidance response to boats from as far away as six or more miles. It is possible that in certain areas, such as the eastern tropical Pacific where they have been pursued by tuna purse seine boats, they have learned to avoid vessels. In such areas this may result in a significant reduction in sighting probability by ship-board observers. Animals sighted off Nova Scotia in 1989 and 1990 came to the bow of the research vessel (Figure 4) and did not appear to take avoiding action. Striped Dolphins have been maintained in captivity in Japan, but little appears to be known about their captive behaviour (Defran and Pryor 1980).

Limiting Factors

A shark attack on an ailing individual has been reported (Ross and Bass 1971). Predation by Killer Whales (Orcinus orca) has not been observed (Jefferson et al. 1991), but remains have been recovered from killer whale stomach contents (Nishiwaki and Handa 1958). Although predation by False Killer Whales (Pseudorca crassidens) has not been documented, it may occur in association with tuna purse seine operations in the eastern tropical Pacific, as has been reported for other species in the genus Stenella (Perryman and Foster 1980).

A variety of parasites have been reported from this species, including the nematodes Halocercus lagenorhynchi, H. delphini, Anisakis simplex and A. typica, the trematodes Nasitrema sp., Pholeter gastrophilus, Campula rochebruni and C. delphini, the cestodes Monorygma spp., Phyllobothrium delphini, Strobilocephalus triangularis and Tetrabothrius

fosteri and the protozoan Sarcocystis sp. (Horning and Pilleri 1969; Ross and Bass 1971; Zam et al. 1971; Dailey and Brownell 1972; Dollfus 1974; Dailey and Stroud 1978; Dailey and Walker 1978; Viale 1981; Gales et al. 1985). Although presumably not detrimental to individuals, the external parasitic barnacle Xenobalanus globicipitis, as well as cyamids, have been recorded from this species (Pilleri 1970; Pilleri and Knuckey 1969; Ross 1984). The role of most parasites in mortality is generally unknown, although Nasitrema sp. has been implicated in the death of one individual off Florida (O'Shea et al. 1991). Infection by the yeast Cryptococcus neoformas has been implicated in the cause of death in an animal off Australia (Gales et al. 1985). Howard et al. (1983) note that pathogenic bacteria are probably responsible for most diseases and deaths in marine mammals. A morbillivirus has recently been implicated in the deaths of at least 400 Striped Dolphins in the Mediterranean (Domingo et al. 1990). O'Shea et al. (1991) note a pneumonia associated with the bacteria Vibrio damsela contributing to the death of a Striped Dolphin off Florida. Mass strandings have been reported for Striped Dolphins (Duguy 1987), but only infrequently (Sergeant 1982).

Striped Dolphins have been involved in the Yellowfin Tuna (Thunnus albacares) purse seine fishery in the eastern Tropical Pacific (Perrin 1975; Wahlen et al. 1988), where hundreds have been killed yearly (e.g., Chivers et al. 1990; Hall and Boyer 1990). Small numbers have also been captured in tuna purse nets and swordfish driftnets in the Mediterranean (Di Natale 1983; Notarbartolo-di-Sciara 1990), and killed incidentally in gill nets off France (Duguy and Hussenot 1982). Jamieson and Heritage (1989) reported a single Stenella sp. taken in a Canadian experimental fishery for Flying Squid in British Columbia waters in 1987. The Striped Dolphin, along with other species of small cetaceans, have long been captured in Japan in both small type whaling and local fisheries (Ohsumi 1972). Up to 20 000 Striped Dolphins have been taken annually in drive fisheries

off Japan (Nishiwaki 1975). Directed takes in Japanese coastal fisheries in recent years have been lower, ranging from 1 225 to 2 918 (IWC 1988, 1989, 1990, 1991), but the decline in catch may reflect a decrease in the population size, rather than a reduction in effort (Kasuya 1985). Aguayo-L. and Perdomo-V. (1985) report that Striped Dolphins may be taken for use as bait in a shark fishery in the Gulf of California.

The Striped Dolphin has been the subject of several detailed toxicological analyses (ie. Honda et al. 1982; Honda and Tatsukawa 1983; Honda et al. 1983; Honda et al. 1984a; Honda et al. 1984b; Tanabe et al. 1984). High levels of organochlorines have been detected in tissues taken from stranded and captured animals (Taruski et al. 1975; O'Shea et al. 1980). Significantly higher levels of mercury have been documented in Striped Dolphins compared with virtually all other species of cetaceans examined (Wagemann and Muir 1984). However, the role of contaminants in mortality is largely unknown.

Evaluation

This species appears to be only an uncommon visitor to Canadian waters. As such, it requires no COSEWIC status designation.

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Literature Cited

Aguayo-L., A., and A. Perdomo-V. 1985. Range extension. Marine Mammal Science 1(3):263.

Alling, A. 1986. Records of odontocetes in the northern Indian Ocean (1981-1982) and off the coast of Sri Lanka (1982-1984). Journal of the Bombay Natural History Society 83(2):376-394.

Au, D., and W. Perryman. 1982. Movement and speed of dolphin schools responding to an approaching ship. Fishery Bulletin (U.S.) 80(2):371-379.

Au, D.W., and R.L. Pitman. 1988. Seabird relationships with tropical tunas and dolphins. Pages 174 - 212 in Seabirds and other marine vertebrates. Edited by J. Burger. Columbia University Press, New York.

Au, D.W.K., W.L. Perryman, and W.F. Perrin. 1979. Dolphin distribution and the relationship to environmental features in the eastern tropical Pacific. Southwest Fisheries Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration Report No. LJ-79-43.

Bree, P.J.H. van. 1973. On the description and the taxonomic status of Delphinus holbellii Nilsson, 1847 (Notes on Cetacea, Delphinoidea VI). Beaufortia 20:129-134.

Brown, S.G. 1975. Relation between stranding mortality and population abundance of

smaller Cetacea in the northeast Atlantic Ocean. Journal of the Fisheries Research Board of Canada 32:1095-1099.

Brownell, R.L., Jr., and R. Praderi. 1976. Records of the delphinid genus Stenella in western South Atlantic waters. Scientific Reports of the Whales Research Institute 28:129-135.

Casinos, A., and J.R. Vericad. 1976. The cetaceans of the Spanish coasts: a survey. Mammalia 40(2):267-289.

Cetacean and Turtle Assessment Program (CETAP). 1982. A characterization of marine mammals and turtles in the mid- and North-Atlantic areas of the U.S. outer continental shelf, Final report. Contract AA551-CT8-48, Bureau of Land Management, Washington, D.C.

Chivers, S.J., R.B. Miller, and A.A. Hohn. 1990. Composition of the 1988 incidental kill of small cetaceans in the US purse-seine fishery for tuna in the eastern tropical Pacific. Reports of the International Whaling Commission 40:455-458.

Collet, A., and R. Duguy. 1987. French research on cetaceans. Pages 41-44 in The European Cetacean Society Report of the 1987 Meeting. Edited by J.W. Broekema and C. Smeenk. Hirtshals, Denmark.

Cowan, I.McT., and C.J. Guiguet. 1952. Three cetacean records from British Columbia. Murrelet 33:10-11.

Dailey, M.D., and R.L. Brownell. 1972. A checklist of marine mammal parasites. Pages 528-589 in Mammals of the Sea; Biology and Medicine. Edited by S.H. Ridgway. Charles C. Thomas, Illinois.

Dailey, M., and R. Stroud. 1978. Parasites and associated pathology observed in cetaceans stranded along the Oregon coast. Journal of Wildlife Diseases 14:503-511.

Dailey, M.D., and W.A. Walker. 1978. Parasitism as a factor (?) in single strandings of southern California cetaceans. Journal of Parasitology 64(4):593-596.

Defran, R.H., and K. Pryor. 1980. The behavior and training of cetaceans in captivity. Pages 319-362 in Cetacean Behavior: Mechanisms and Functions. Edited by L.M. Herman. John Wiley and Sons, New York.

Di Natale, A. 1979. Progress of research relating to Mediterranean cetacea. Project Cetacea, Special Report V. Annex to: Mem. Biol. Mar. Ocean. 9(1-2):1-50.

Di Natale, A. 1983. Striped Dolphin, Stenella coeruleoalba (Meyen) in the central Mediterranean Sea: an analysis of the new data. Rapp. Comm. int. Mer Medit., 28(5):201-202.

Dollfus, R.Ph. 1974. Pholeter (Trematoda Digenea) from an intestinal cyst of Stenella coeruleoalba Meyen, 1833 (Odontoceti Delphinidae). Comments on the Family Pholeteridae, R.Ph. Dollfus, 1939. List of helminths identified to date in Stenella coeruleoalba Meyen. Investigations on Cetacea 5:331-338.

Domingo, M., L. Ferrer, M. Pumarola, A. Marco, J. Plana, S. Kennedy, M. McAliskey, and B.K. Rima. 1990. Morbillivirus in dolphins. Nature 348:21.

Duguy, R. 1977. Notes on the small cetaceans off the coasts of France. Reports of the International Whaling Commission 27:500-501.

Duguy, R. 1987. Rapport annuel sur les cetaces et pinnipedes trouves sur les cotes.de France - XVI - Annee 1986. Annales de la Societe des Sciences Naturelles de la Charente-Maritime 7(5):617-639. In French with English summary.

Duguy, R. 1988. Rapport annuel sur les cetaces et pinnipedes trouves sur les cotes de France - XVII - Annee 1987. Annales de la Societe des Sciences Naturelles de la Charente-Maritime 7(6):753-769. In French with English summary.

Duguy, R., and E. Hussenot. 1982. Occasional captures of delphinids in the northeast Atlantic. Reports of the International Whaling Commission 32:461-462.

Ellis, R. 1989. Dolphins and porpoises. Alfred A. Knopf, New York.

Evans, P.G.H. 1987. Cetaceans in U.K. waters. Pages 45-46 in The European Cetacean Society Report of the 1987 Meeting. Edited by J.W. Broekema and C. Smeenk. Hirtshals, Denmark.

Forcada, J., A. Aguilar, P.G.H. Evans, and W.F. Perrin. 1990. Abstract. Distribution of common and striped dolphins in the temperate waters of the eastern North Atlantic.

Page 16 in Abstracts of the Fourth Annual Conference of the European Cetacean Society, Palma de Mallorca, 2-4 March, 1990.

Fraser, F.C. 1974. Report on Cetacea stranded on the British coasts from 1948 to 1966. British Museum (Natural History) 14.

Fraser, F.C., and B.A. Noble. 1970. Variation of pigmentation pattern in Meyen's dolphin, Stenella coeruleoalba (Meyen). Investigations on Cetacea 2:147-163.

Gales, N., G. Wallace, and J. Dickson. 1985. Pulmonary cryptococcosis in a Striped Dolphin (Stenella coeruleoalba). Journal of Wildlife Diseases 21(4):443-446.

Gihr, M., and G. Pilleri. 1969. On the anatomy and biometry of Stenella styx Gray and Delphinus delphis L. (Cetacea, Delphinidae) of the Western Mediterranean. Investigations on Cetacea 1:15-65.

Hain, J.H.W., M.A.M. Hyman, R.D. Kenney, and H.E. Winn. 1985. The role of cetaceans in the shelf-edge region of the northeastern United States. Marine Fisheries Review 47(1):13-17.

Hall, M.A., and S.D. Boyer. 1990. Incidental mortality of dolphins in the tuna purse-seine fishery in the eastern Pacific Ocean during 1988. Reports of the International Whaling Commission 40:461-462.

Hatler, D.F. 1972. The mammals of Pacific Rim National Park. Unpublished Report,

National and Historic Parks Branch, Western Region, Calgary, Alberta.

Hershkovitz, P. 1966. Catalog of living whales. United States National Museum Bulletin 246.

Honda, K., and R. Tatsukawa. 1983. Distribution of cadmium and zinc in tissues and organs, and their age-related changes in Striped Dolphins, Stenella coeruleoalba. Archives of Environmental Contamination and Toxicology 12:543-550.

Honda, K., R. Tatsukawa, and T. Fujiyama. 1982. Distribution characteristics of heavy metals in the organs and tissues of Striped Dolphin, Stenella coeruleoalba. Agricultural and Biological Chemistry 46(12):3011-3021.

Honda, K., Y. Fujise, K. Itano, and R. Tatsukawa. 1984a. Composition of chemical components in bone of Striped Dolphin, Stenella coeruleoalba: distribution characteristics of heavy metals in various bones. Agricultural and Biological Chemistry 48(3):677-683.

Honda, K., Y. Fujise, R. Tatsukawa, and N. Miyazaki. 1984b. Composition of chemical components in bone of Striped Dolphin, Stenella coeruleoalba: distribution characteristics of major inorganic and organic components in various bones, and their age-related changes. Agricultural and Biological Chemistry 48(2):409-418.

Honda, K., R. Tatsukawa, K. Itano, N. Miyazaki, and T. Fujiyama. 1983. Heavy metal concentrations in muscle, liver and kidney tissue of Striped Dolphin, Stenella

coeruleoalba, and their variations with body length, weight, age and sex. Agricultural and Biological Chemistry 47(6):1219-1228.

Horning, B., and G. Pilleri. 1969. Campula delphini (Trematoda, Campulidae) bei Delphinus delphis und Stenella styx aus dem westlichen Mittelmeer. Investigations on Cetacea 1:193-196.

Howard, E.B., J.O. Britt Jr., G.K. Matsumoto, R. Itahara, and C.N. Nagano. 1983. Bacterial Diseases. Pages 69-118 in Pathobiology of Marine Mammal Diseases, Volume 1. Edited by E.B. Howard. CRC Press, Florida.

Hubbs, C.L., W.F. Perrin, and K.C. Balcomb. 1973. Stenella coeruleoalba in the eastern and central tropical Pacific. Journal of Mammalogy 54(2):549-552.

IWC. 1988. Report of the sub-committee on small cetaceans. Reports of the International Whaling Commission 38:117-125.

IWC. 1989. Report of the sub-committee on small cetaceans. Reports of the International Whaling Commission 39:117-129.

IWC. 1990. Report of the sub-committee on small cetaceans. Reports of the International Whaling Commission 40:144-157.

IWC. 1991. Report of the sub-committee on small cetaceans. Reports of the International Whaling Commission 41:172-190.

Jamieson, G.S., and G.D. Heritage. 1988. Experimental flying squid fishery off British Columbia, 1987. Canadian Industry Report of Fisheries and Aquatic Sciences 186.

Jefferson, T.A., P.J. Stacey, and R.W. Baird. 1991. A review of killer whale interactions with other marine mammals: predation to co-existence. Mammal Review 21(4):151-180.

Kasuya, T. 1972. Growth and reproduction of Stenella caeruleoalba based on the age determination by means of dentinal growth layers. Scientific Reports of the Whales Research Institute 24:57-79.

Kasuya, T. 1976. Reconsideration of life history parameters of the spotted and striped dolphins based on cemental layers. Scientific Reports of the Whales Research Institute 28:73-106.

Kasuya, T. 1985. Effect of exploitation on reproductive parameters of the spotted and striped dolphins off the Pacific coast of Japan. Scientific Reports of the Whales Research Institute 36:107-138.

Katona, S.K., V. Rough, and D.T. Richardson. 1983. A field guide to the whales, porpoises and seals of the Gulf of Maine and eastern Canada - Cape Cod to Newfoundland. Charles Scribner's Sons, New York.

Kellogg, R., and V.B. Scheffer. 1947. Occurrence of Stenella euphrosyne off the Oregon coast. The Murrelet 28(1):9-10.

Leatherwood, S., and R.R. Reeves. 1983. The Sierra Club handbook of whales and dolphins. Sierra Club Books, San Francisco.

Leatherwood, S., C.B. Peters, R. Santerre, M. Santerre, J.T. Clarke. 1984. Observations of cetaceans in the northern Indian Ocean sanctuary, November 1980-May 1983. Reports of the International Whaling Commission 34:509-520.

Leatherwood, S., R.R. Reeves, W.F. Perrin, and W.E. Evans. 1988. Whales, dolphins, and porpoises of the eastern North Pacific and adjacent Arctic waters - A guide to their identification. Dover Publications, Inc., New York.

Mansfield, A.W. 1967. The mammals of Sable Island. Canadian Field-Naturalist 81:40-49.

Mercer, M.C. 1973. Observations on distribution and intraspecific variation in pigmentation patterns of odontocete cetacea in the western North Atlantic. Journal of the Fisheries Research Board of Canada 30:1111-1130.

Miller, G.S. Jr., and R. Kellogg. 1955. List of North American recent mammals. Bulletin of the U.S. National Museum 205:1-954.

Miyazaki, N. 1977. Growth and reproduction of Stenella coeruleoalba off the Pacific coast of Japan. Scientific Reports of the Whales Research Institute 29:21-48.

Miyazaki, N., and M. Nishiwaki. 1978. School structure of the Striped Dolphin off the Pacific coast of Japan. Scientific Reports of the Whales Research Institute 30:65-115.

Miyazaki, N., and S. Wada. 1978. Observation of cetacea during whale marking cruise in the western tropical Pacific, 1976. Scientific Reports of the Whales Research Institute 30:179-195.

Miyazaki, N., T. Kusaka, and M. Nishiwaki. 1973. Food of Stenella caeruleoalba. Scientific Reports of the Whales Research Institute 25:265-275.

Miyazaki, N., T. Kasuya, and M. Nishiwaki. 1974. Distribution and migration of two species of Stenella in the Pacific coast of Japan. Scientific Reports of the Whales Research Institute 26:227-243.

Miyazaki, N., Y. Fujise, and T. Fujiyama. 1981. Body and organ weight of striped and spotted dolphins off the Pacific coast of Japan. Scientific Reports of the Whales Research Institute 33:27-67.

Morzer Bruyns, W.F.J. 1974. On sight-records of the Euphrosyne dolphin, Stenella coeruleoalba (Meyen, 1833), in the Mediterranean. Mammalia 38(3):503-507.

Nishiwaki, M. 1967. Distribution and migration of marine mammals in the North Pacific area. Bulletin of the Ocean Research Institute University of Tokyo Bulletin 1:1-64.

Nishiwaki, M. 1975. Ecological aspects of smaller cetaceans, with emphasis on the striped dolphin (Stenella coeruleoalba). Journal of the Fisheries Research Board of Canada 32(7):1069-1072.

Nishiwaki, M., and C. Handa. 1958. Killer whales caught in the coastal waters off Japan for recent 10 years. Scientific Reports of the Whales Research Institute 13:85-96.

Norris, K.S., and J.H. Prescott. 1961. Observations on Pacific cetaceans of Californian and Mexican waters. University of California Publications in Zoology 63(4):291-402.

Notarbartolo-di-Sciara, G. 1990. A note on the cetacean incidental catch in the Italian driftnet swordfish fishery, 1986-1988. Reports of the International Whaling Commission 40:459-460.

Odell, D.K., and C. Chapman. 1976. A Striped Dolphin, Stenella coeruleoalba, from Florida. Cetology 20:1-6.

Ohsumi, S. 1972. Catch of marine mammals, mainly of small cetaceans, by local fisheries along the coast of Japan. Bulletin of the Far Seas Fisheries Research Laboratory 7:137-166.

O'Shea, T.J., B.L. Homer, E.C. Greiner, and A.W. Layton. 1991. Nasitrema sp.-associated encephalitis in a striped dolphin (Stenella coeruleoalba) stranded in the Gulf of Mexico. Journal of Wildlife Diseases 27(4):706-709.

O'Shea, T.J., R.L. Brownell, Jr., D.R. Clark, Jr., W.A. Walker, M.L. Gay, and T.G. Lamont. 1980. Organochlorine pollutants in small cetaceans from the Pacific and South Atlantic Oceans, November 1968-June 1976. Pesticides Monitoring Journal 14(2):35-46.

Perkins, J.S., P.J. Bryant, G. Nichols, and D.R. Patten. 1981. An ecological study of whales, seabirds and the marine environment of western Greenland and eastern Canada. Cruise Report No. 28. "Regina Maris". 27 June - 31 Aug 1981.

Perrin, W.F. 1975. Distribution and differentiation of populations of dolphins of the genus Stenella in the eastern tropical Pacific. Journal of the Fisheries Research Board of Canada 32(7):1059-1067.

Perrin, W.F., and S.B. Reilly. 1984. Reproductive parameters of dolphins and small whales of the Family Delphinidae. Reports of the International Whaling Commission Special Issue 6:97-133.

Perrin, W.F., E.D. Mitchell, J.G. Mead, D.K. Caldwell, and P.J.H. van Bree. 1981. Stenella clymene, a rediscovered tropical dolphin of the Atlantic. Journal of Mammalogy 62(3):583-598.

Perrin, W.F., M.D. Scott, G.J. Walker, F.M. Ralston, and D.W.K. Au. 1983. Distribution of four dolphins (Stenella spp. and Delphinus delphis) in the eastern tropical Pacific, with an annotated catalog of data sources. National Oceanic and Atmospheric Administration Technical Memorandum National Marine Fisheries Service SWFC-38.

Perrin, W.F., M.D. Scott, G.J. Walker, and V.L. Cass. 1985. Review of geographical stocks of tropical dolphins (Stenella spp. and Delphinus delphis) in the eastern Pacific. National Oceanic and Atmospheric Administration Technical Report National Marine Fisheries Service 28.

Perryman, W.L., and T.C. Foster. 1980. Preliminary report on predation by small whales, mainly the false killer whale, Pseudorca crassidens, on dolphins (Stenella spp. and Delphinus delphis) in the eastern tropical Pacific. National Marine Fisheries Service Southwest Fisheries Center Administration Report LJ-80-05.

Pike, G.C., and I.B. MacAskie. 1969. Marine mammals of British Columbia. Fisheries Research Board of Canada Bulletin 171.

Pilleri, G. 1970. Xenobalanus globicipitis Steenstrup on Delphinus delphis, Stenella styx and Tursiops truncatus of the Western Mediterranean. Investigations on Cetacea 2:248-249.

Pilleri, G., and J. Knuckey. 1969. Behaviour patterns of some Delphinidae observed in the western Mediterranean. Zeitschrift fur Tierpsychologie 26:48-72.

Podesta, M., and G. Notarbartolo-di-Sciara. 1987. The "Centre for Cetacean Studies" of the Italian Society of Natural Sciences: its founding and activities. Pages 26-27 in The European Cetacean Society Report of the 1987 Meeting, January 26-28, 1987. Edited by J.W. Broekema and C. Smeenk. Hirtshals, Denmark.

Reeves, R.R., and E. Mitchell. 1987. Cetaceans of Canada. Underwater World, Department of Fisheries and Oceans, Ottawa.

Ross, G.J.B. 1984. The smaller cetaceans of the south east coast of southern Africa. Annals of the Cape Provincial Museums Natural History 15(2):173-410.

Ross, G.J.B., and A.J. Bass. 1971. Shark attack on an ailing dolphin Stenella coeruleoalba (Meyen). South African Journal of Science 67(8):413-414.

Sampson, W.F. 1970. Stenella caeruleoalba in the northern Pacific Ocean. Journal of Mammalogy 51(4):809.

Sea Education Association. 1979. Cruise Report W-47. Scientific activities undertaken aboard R/V Westward. Woods Hole -Newfoundland - Nova Scotia - Woods Hole. 25 July - 5 September 1979.

Sergeant, D.E. 1982. Mass strandings of toothed whales (Odontoceti) as a population phenomenon. Scientific Reports of the Whales Research Institute 34:1-47.

Sergeant, D.E., A.W. Mansfield, and B. Beck. 1970. Inshore records of cetacea for eastern Canada, 1949-68. Journal of the Fisheries Research Board of Canada 27:1903-1915.

Shallenberger, E.W. 1981. The status of Hawaiian cetaceans. Final Report, Contract MMC -77/23. Marine Mammal Commission, Washington, D.C.

Sleptsov, M.M. 1961. Observations of small cetaceans in far eastern seas and NW Pacific. Trudy Instituta Morfologii Zhivotnykh 34:136-143.

Tanabe, S., H. Tanaka, and R. Tatsukawa. 1984. Polychlorobiphenyls, ΣDDT, and hexachlorocyclohexane isomers in the western North Pacific ecosystem. Archives of Environmental Contamination and Toxicology 13:731-738.

Taruski, A.G., C.E. Olney, and H.E. Winn. 1975. Chlorinated hydrocarbons in cetaceans. Journal of the Fisheries Research Board of Canada 32:2205-2209.

Tobayama, T., S. Uchida, and M. Nishiwaki. 1970. Twin foetuses from a blue white dolphin. Scientific Reports of the Whales Research Institute 22:159-162.

Tomilin, A.G. 1957. Mammals of the U.S.S.R. and adjacent countries. Volume IX. Cetacea. Israel Program of Scientific Translations, Jerusalem, 717 pages, 1967.

U.S. Department of Commerce. 1987. Marine mammal protection act of 1972. Annual Report 1986/87. U.S. Department of Commerce, Washington, D.C.

Viale, D. 1981. Lung pathology in stranded cetaceans on the Mediterranean coasts. Aquatic Mammals 8(3):96-100.

Wagemann, R., and D.C.G. Muir. 1984. Concentrations of heavy metals and organochlorines in marine mammals of northern waters: overview and evaluation. Canadian Technical Report of Fisheries and Aquatic Sciences 1279.

Wahl, T.R. 1977. Sight records of some marine mammals offshore from Westport, Washington. Murrelet 158(1):21-23.

Wahlen, B.E., R.B. Miller, and S.J. Ladiana. 1988. Composition of the incidental kill of small cetaceans in the US purse-seine fishery for tuna in the eastern tropical Pacific during 1986. Reports of the International Whaling Commission 38:403-405.

Watson, L. 1981. Sea guide to whales of the world. Nelson Canada Limited, Ontario.

Wilson, C.E., W.F. Perrin, J.W. Gilpatrick Jr., and S. Leatherwood. 1987. Summary of worldwide locality records of the Striped Dolphin, Stenella coeruleoalba. National Oceanic and Atmospheric Administration Technical Memorandum, National Marine Fisheries Service Southwest Fisheries Center 90.

Zam, S.G., D.K. Caldwell, and M.C. Caldwell. 1971. Some endoparasites from small odontocete cetaceans collected in Florida and Georgia. Cetology 2:1-11.

Author's Recommendation of Status

Based on available information, no COSEWIC status designation is required for the Striped Dolphin.

Table 1. Records of the Striped Dolphin within the Canadian 320 km (200 mi) extended economic zone (V.I. = Vancouver Island). See Figure 2 for locations.

Date	Location	Number	Type[A]	Source[B]	Temp[C]	Comments
Western Canada						
1948	Nootka Sound, V.I.	1	1	1	-	University of British Columbia UBC 2886
18 March 1958	51°45'N, 133°45'W	5-10	2	2	-	
June 1960	Long Beach, V.I.	1	1	3	-	Royal B.C. Museum BCPM 6665
23 April 1961	Lawn Pt., Campbell River, V.I.	1	3	2	-	UBC 8011
23 April 1963	Kyuquot, V.I.	1	4	2	-	UBC 9236
05 March 1972	Wreck Bay, V.I.	1	1	4	-	UBC 9470
13 March 1972	Lovekin R., Long Beach, V.I.	1	1	4,5	-	BCPM 7525, male
1975	Victoria, V.I.	1	5	3	-	BCPM 8875[D]
March 1975	Cadboro Bay, Victoria, V.I.	1	5	6	-	mandible only[D]
17 February 1983	Long Beach, V.I.	1	1	3	-	BCPM 11394, male
10 August 1987	≈48°44.3'N, 131°7'W	1	4	7	-	listed as Stenella sp., killed in squid drift net
Eastern Canada						
1926	Chester, Nova Scotia	1	6	8	-	photo of a dead animal on wharf
14 February 1964	W spit Sable Island	1	1	9	-	identification not positive
summer 1964	N. beach Sable Island	3	7	10	-	
12 January 1968	Sable Island	3	1	10	-	
1968/1969	St. Pierre Bank	1	4	11	-	caught in trawl, St. Pierre Museum
29 June 1971	47°16'N, 53°58'W	1	4	11	-	caught in salmon net
31 July 1979	41°40'N, 62°30'W	-	2	12	-	
03 August 1979	43°50'N, 58°10'W	-	2	12	-	
August 1981	44°00'N, 59°00'W	25	2	13	-	
23 July 1989	43°51.9'N, 58°55.9'W	15	2	14	15.6	w/Lagenorhynchus acutus
27 July 1989	43°33.1'N, 58°49.5'W	2	2	14	17.0	w/Delphinus delphis
04 August 1989	43°49.4'N, 58°54.6'W	20	2	14	18.6	
11 August 1989	43°48.9'N, 58°59.6'W	15	2	14	18.5	w/L. acutus, D. delphis
13 August 1989	43°50.4'N, 58°54.3'W	10	2	14	17.4	w/L. acutus, D. delphis
04 August 1990	43°50.8'N, 58°57.4'W	8	2	14	15.0	w/D. delphis
09 August 1990	43°50.8'N, 58°54.2'W	20	2	14	17.3	w/Hyperoodon ampullatus
10 August 1990	43°45.1'N, 58°57.2'W	15	2	14	19.1	w/Globicephala melas

Notes to Table 1.

[A]Type of Record: 1. Found dead on beach; 2. Sighting; 3. Skull collected, no details; 4. Caught in fishing gear, killed; 5. Skeletal parts found on beach; 6. Dead, no details; 7. Live stranded, died.

[B]Source of Record: 1. Cowan and Guiguet 1952; 2. Pike and MacAskie 1969; 3. Royal

British Columbia Museum, formerly the British Columbia Provincial Museum; 4. Hatler 1972; 5. Wilson et.al. 1987; 6. University of Victoria; 7. Jamieson and Heritage 1988; 8. Reeves and Mitchell 1987; 9. Mansfield 1967; 10. Sergeant et al. 1970; 11. Mercer 1973; 12. Sea Education Association 1979; 13. Perkins et al. 1981; 14. H. Whitehead, unpublished data.

[C]Sea surface temperature in degrees celsius.

[D]These two records from the Victoria area in 1975 may be from the same individual, as the first is represented only by a skull, and the second by a single mandible, of approximately similar sizes. Further details on these collections are unavailable.

Figure Captions

Figure 1. Striped Dolphin killed in a tuna purse-seine in the eastern tropical Pacific. Photo by O. Seth, courtesy National Marine Fisheries Service.

Figure 2. Locations of records from within the Canadian 320 km (200 mi) extended economic zone, A - Pacific coast, B - Atlantic coast. See Table 1 for details of records.

Figure 3. Striped Dolphins porpoising in the Mediterranean. Photo courtesy S. Leatherwood.

Figure 4. Striped Dolphin riding the bow wave on a research boat off Nova Scotia, 1989. Photo by H. Whitehead.

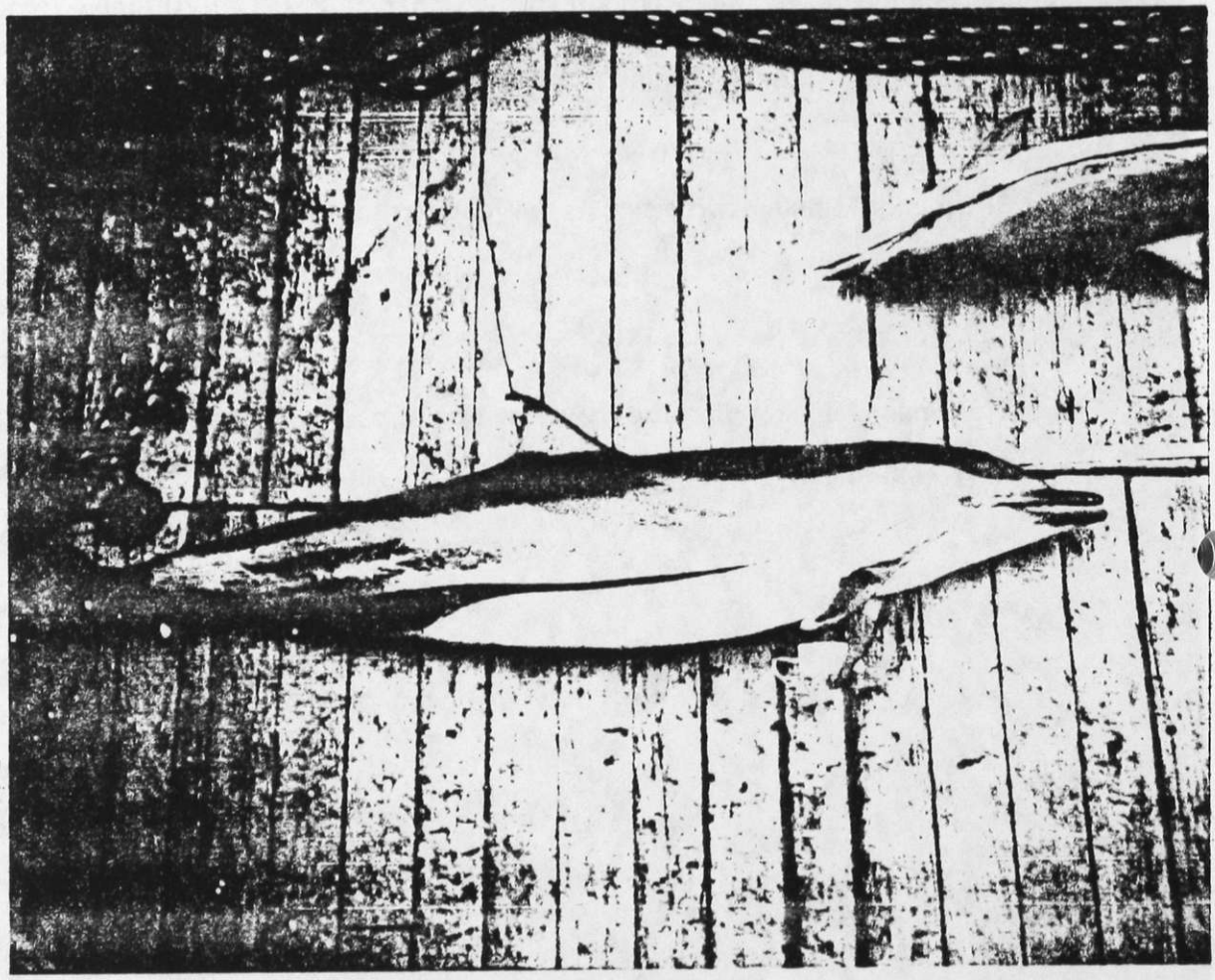

Fig. 1

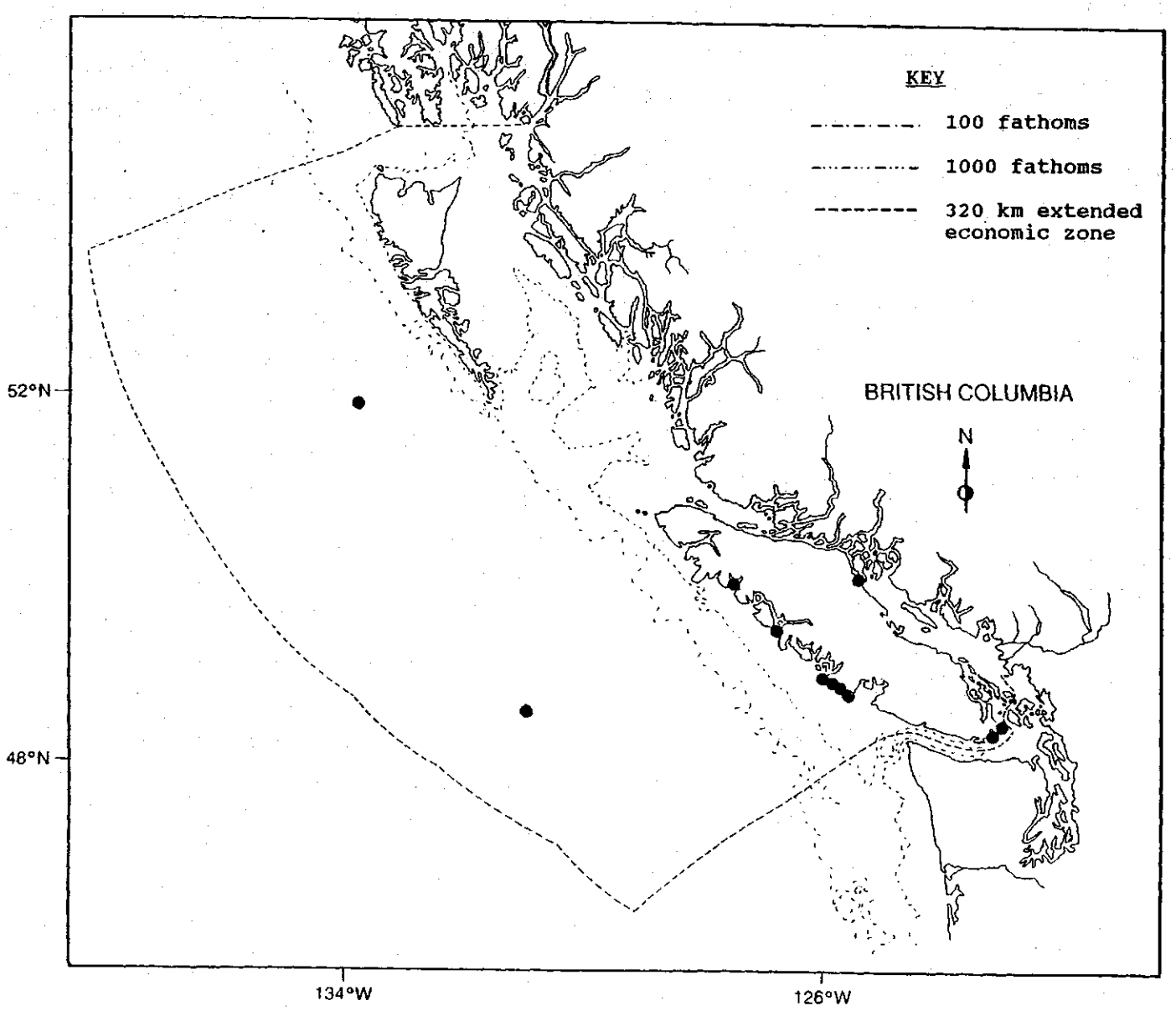
KEY
100 fathoms
1000 fathoms
320 km extended economic zone
BRITISH COLUMBIA
N
52°N
48°N
134°W
126°W

Fig 2A

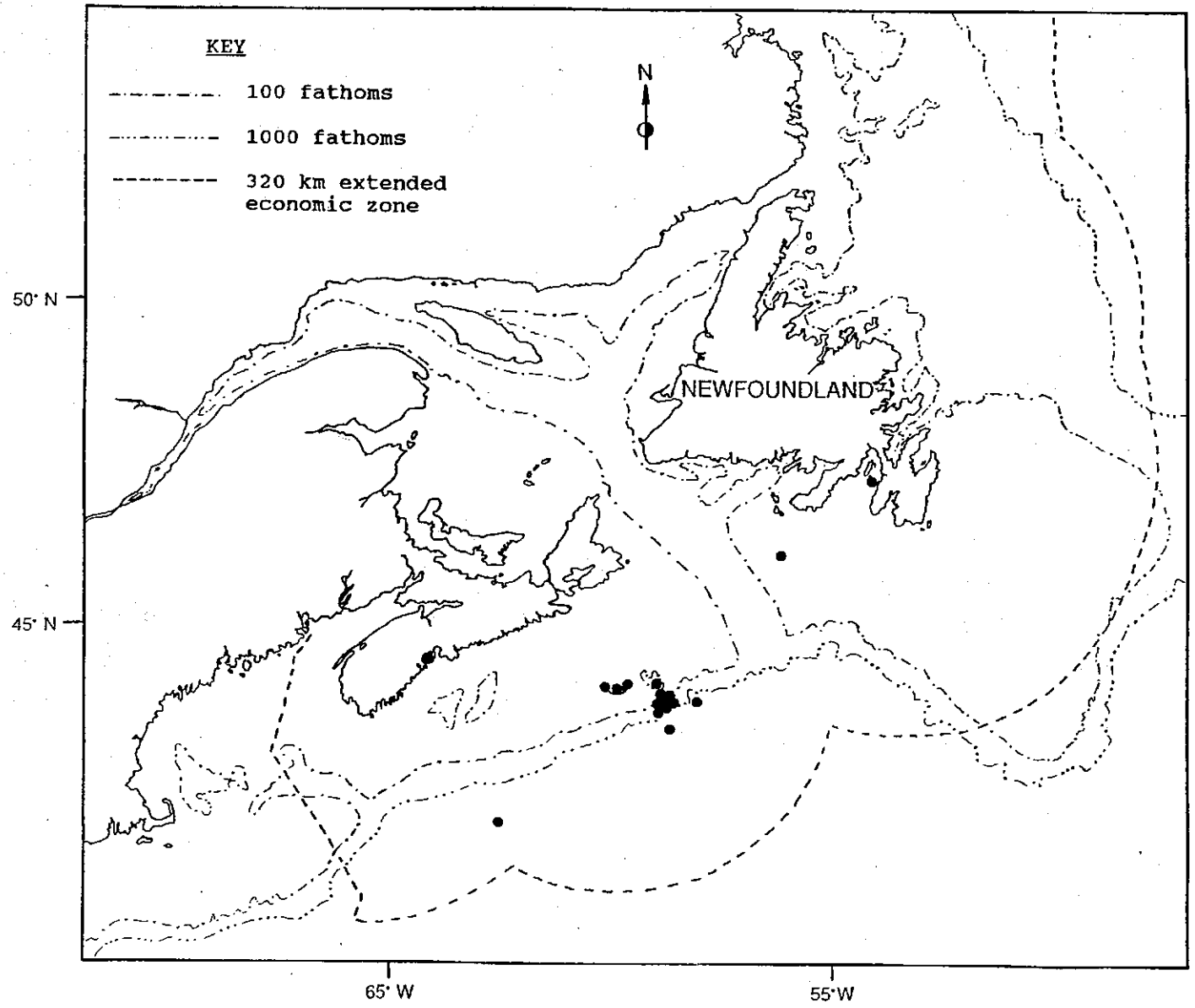
KEY
100 fathoms
1000 fathoms
320 km extended economic zone
N
NEWFOUNDLAND
50° N
45° N
65° W
55° W

Fig. 2B

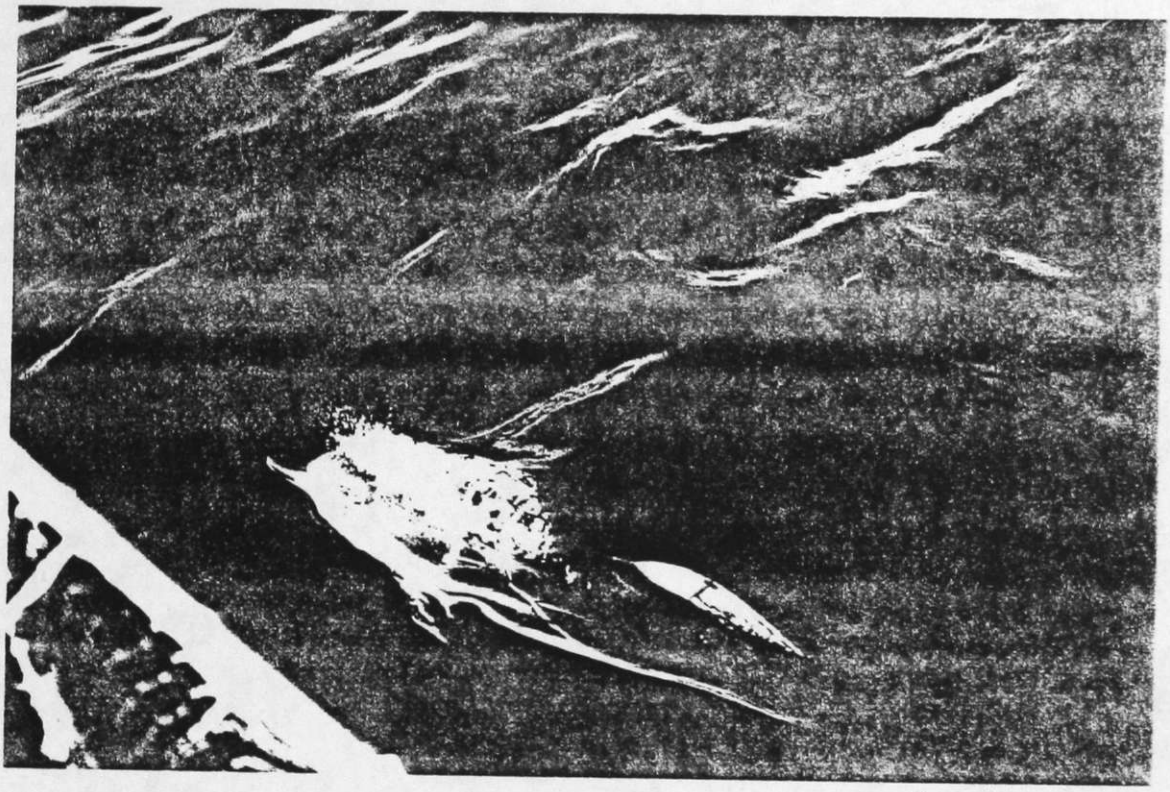

Fig 4

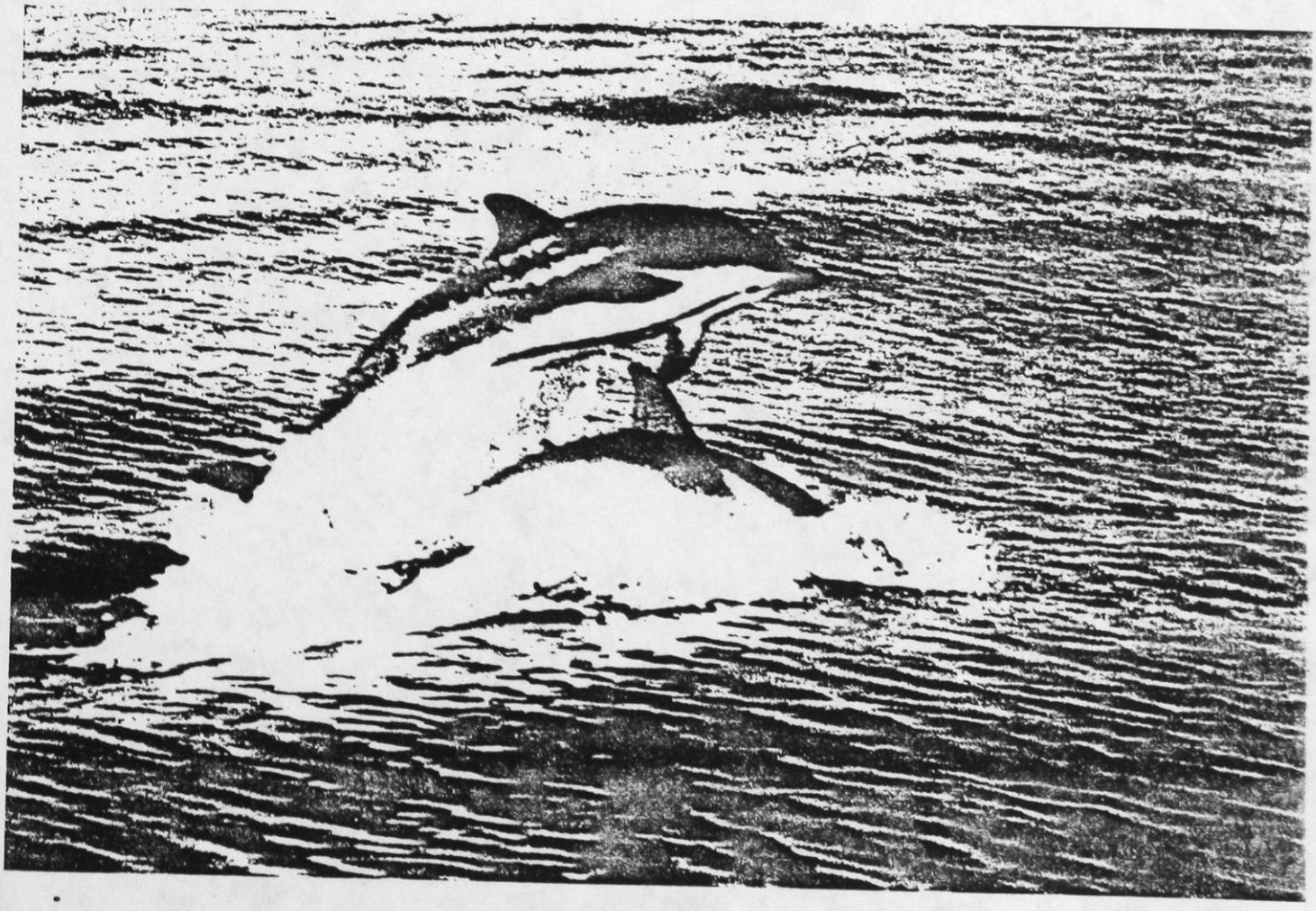

Fig 3