Status of the Dwarf Sperm Whale, *Kogia simus*, with Special Reference to Canada*

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The Dwarf Sperm Whale, *Kogia simus*, has been recorded in tropical and warm temperate waters world-wide. This species is rarely observed at sea, and little is known of its biology. Insufficient information is available to classify its world-wide status, though they are infrequently taken directly and indirectly in various fisheries. In Canada, the only confirmed record is of a single stranded animal from Vancouver Island, British Columbia, though they are likely found in Canadian waters more frequently. There are no obvious threats to its status in Canadian waters where the species is not at risk.

Le cachalot nain, *Kogia simus*, est répandu dans les eaux tropicales et tempérées chaudes du monde. On observe cette espèce peu souvent en mer et on en connait très peu sur sa biologie. Il n'y a pas assez d'information pour classifier son statut mondial, mais de temps en temps ils sont directement et indirectement attrapées dans les pêches diverses. Il n'y a qu'un seul enregistrement authentique au Canada d'une baleine échouée sur la côte de l'île Vancouver en Colombie-Britannique, bien qu'il soit probable qu'il puiss être plus répandu. Il n'y a aucunes menaces manifestes à son statut dans les eaus canadiennes où l'espèce n'est pas en péril.

Key Words: Dwarf Sperm Whale, Cachalot nain, *Kogia simus*, Physeteridae, status, Canada, Cetacea.

Two species are recognized in the genus *Kogia*, the Pygmy Sperm Whale, *Kogia breviceps* (Blainville 1833), and the Dwarf Sperm Whale, *Kogia simus* (Owen 1866). Little is known about either species. This report summarizes the current state of knowledge of *Kogia simus*, with special reference to its status and management in Canadian waters, by request of the Fish and Marine Mammal Subcommittee of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Description

Sometimes considered as a distinct family Kogiidae (e.g., Nishiwaki 1963; Klinowska 1991), *Kogia* is most commonly recognized under the subfamily Kogiinae within the family Physeteridae (e.g., Handley 1966; Barnes 1973). Numerous scientific names were given to these whales at both the specific and generic level until Hector (1878) encompassed all species under the single name *Kogia breviceps*. Although subsequent works listed more than one species (e.g., Yamada 1954), only a single species was recognized by most authors until Handley's (1966) review of cranial, skeletal, and external characteristics, which confirmed the existence of two species. This nomenclature was further supported by taxonomic comparisons by Ross (1978).

These past taxonomic uncertainties often make it difficult or impossible to accurately determine the species described in early accounts (e.g., Edmondsun 1948; Manville and Shanahan 1961). As a result, reviews of earlier records for distribution, numerical, and/or other data on either species are often hampered with some degree of uncertainty. Other reports provide sufficient descriptive and/or morphometric details to enable an accurate specific determination to be made (e.g., Schulte (1917), *Kogia breviceps*; Enders (1942), *Kogia breviceps*); such determinations appear in some of the more recent literature (e.g., van Bree and Duguy (1967) in reviewing Weber (1923) — *Kogia simus*; Raun et al. (1970) in reviewing Caldwell et al. (1960) Galveston specimen — *Kogia simus*; Raun et al. (1970) in reviewing Gunter et al. (1955) Mustang Island specimen — *Kogia breviceps*; Aitken (1971) in reviewing Hale (1959) — *Kogia simus*; Gallagher and van Bree (1980) in reviewing Hale (1963) Fremantle specimen — *Kogia simus*; Omura and Takahashi (1981) in reviewing Hirasaka (1937) — *Kogia simus*; Ross (1978) in reviewing Allen (1941) Virginian female — *Kogia simus*; Nagorsen (1985) in reviewing Yamada (1954) — all *Kogia simus*).

Adult Dwarf Sperm Whales range from 2.0 to 2.7 m in length and weigh between 136 and 272 kg (Handley 1966; Ross 1978). Numerous authors have commented on the "shark-like" appearance of *Kogia*, having a squarish head, protruding snout, and a small, narrow underslung jaw ending well posterior to the snout (Figure 1). Body shape is also sometimes described as "porpoise-like", being very robust and tapering rapidly to the tail, which is marked by a median notch between the flukes. A high dolphin-

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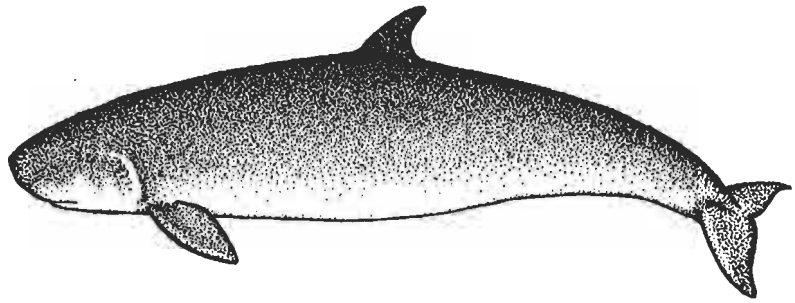

FIGURE 1. Dwarf Sperm Whale. Illustration by Pamela Willis.

like dorsal fin, strongly falcate, is positioned midway along the back. The crescentic blowhole is situated slightly left of center in alignment with the eye. The presence of two or more short throat grooves may be characteristic of the species (Leatherwood and Reeves 1983; Leatherwood et al. 1988; Caldwell and Caldwell 1989; Jefferson et al. 1992); however, until examination for this feature becomes standard practice, it will remain unknown whether it is ever absent. Seven to 12 (rarely 13) pairs of thin, sharp, posteriorly-curved teeth, lacking enamel, are present in the lower jaw and up to three pairs may be found in the upper (Handley 1966; Ross 1978). No sexual dimorphism has been reported in either kogiid species (Handley 1966; Ross 1978). Detailed body measurements are given in Ross (1978) and Chantrapornsyl et al. (1991) and are summarized in Nagorsen (1985).

Colouration fades from dark blue-gray or black along the dorsal surface (including the dorsal fin and dorsal surface of the flukes) to a lighter gray along the flanks, broken only by the dark gray dorsal surface of the pectoral flippers, fading to dull white or pink on the ventral surface. A pale crescent or bracket-shaped mark (often termed "false gill" or "bracket mark"), appears between the eye and insertion of the flipper and appears to be characteristic of the genus (Hubbs 1951; Yamada 1954; Ross 1978). A second lightly-pigmented process ascending just anterior to the bracket mark has been observed on some Dwarf Sperm Whales, creating a dark "island" between the two marks (Yamada 1954). Rarely described, this feature is apparent in some photographs of stranded individuals (e.g., Leatherwood et al. 1988, Figure 252, Japan specimen; Caldwell and Caldwell 1989, Figure 4(C), Florida specimen). Variability among individuals is also apparent in the degree of extension of white ventral colouration up into a ridge or "island" just anterior to the eye (Yamada 1954).

The *Kogia* skeleton exhibits a number of unique characteristics. The skull has the shortest (proportionally) rostrum among extant cetaceans, it lacks an independent jugal, has a pronounced supracranial basin and sagittal septum, and is asymmetrical, having a left naris considerably larger than the right (Handley 1966; Nagorsen 1985). All cervical vertebrae are fused together, the costal cartilages are unossified, the sternum is reduced to three elements, and the scapula is low and porpoise-like (Handley 1966; Nagorsen 1985). Vertebral counts of the Dwarf Sperm Whale vary from 50 to 57 (cervical = 7, thoracic = 12 - 14, lumbar-caudal = 29, 35-37) (Owen 1866; Allen 1941; Yamada 1954; Hale 1959; Pinedo 1987). Nagorsen (1985), in reviewing vertebral and rib counts by several authors, states that it is not clear whether these different counts reflect individual variation or a loss of bones during preparation of the skeleton. The small nature of the terminal vertebrae of *Kogia* has been noted by several authors (e.g., Allen 1941; Hale 1962), and Allen (1941) states that these are easily lost and that caudal counts for the majority of his specimens are subject to error. If the lower counts are indeed due to incomplete skeletal preparation, then differences in vertebral count between the two species of *Kogia* may become apparent with the acquisition of new specimens, as has been proposed by Omura et al. (1984). A phalangeal formula of I 2, II 5, III 4, IV 4, and V 2 was given by Owen (1866). Hyoid apparatus anatomy and function is reported by Reidenberg and Laitman (1994). Detailed descriptions of the skull and/or skeleton are provided by Owen (1866), Hirasaka (1937), Yamada (1954), Ross (1978), Gallagher and van Bree (1980) and Nagorsen (1985).

Several characters to distinguish between the two species have been described since Handley's (1966) synopsis (Table 1). Height and position of the dorsal fin are the most common diagnostic features used in species determination, particularly from photographs or measurements (e.g., Raun et al. 1970; Robineau and Rancurel 1981; Sylvestre 1988a), although Sylvestre (1988a) questions the reliability of these characters, and Ross (1978) states that caution should be used in using the latter due to the relatively small differences in the posi-

TABLE 1. Distinguishable, partially distinguishable, and potentially distinguishable characteristics of *Kogia simus* and *Kogia breviceps*. Measurements apply to adult specimens, other characters apply regardless of age. Modified from (A) Handley 1966, (B) Ross 1978, (C) Leatherwood and Reeves 1983, (D) Omura et al. 1984, (E) Leatherwood et al. 1988, and (F) Jefferson et al. 1992.

Character	*Kogia simus*	*Kogia breviceps*	Source(s)
Distinguishing Characters			
Total Length	≤2.7 m	>2.7 m	A, B
Weight	136-272 kg	318-408 kg	A
Dorsal Fin	high (>5% TL), near center, anterior insertion generally <50% TL	low (<5% TL), posterior to back, anterior insertion >50% TL	A,B
Mandibular Teeth	7-12 (rarely 13) pairs	12-16 (rarely 10 or 11) pairs	A, B
Maxillary Teeth	0-3 pairs	none	A, B
Condylobasal Length	<323 mm	>333 mm	A, B
Mandibular Symphysis	short (<51 mm) and ventrally level	long (>64 mm) and ventrally keeled	A, B
Dorsal Cranial Fossae	cupped posteriorly and sub-symmetrical	not cupped posteriorly; left fossa longer and narrower than right; elongated	A, B
Dorsal Sagittal Septum (near vertex)	least breadth generally <20 mm; narrow, near-vertical walls, often pinched posteriorly	least breadth >20mm; broad, slopes gradually into cranial fossae	A, B
Snout Length (tip to blowhole)	7.5-10.1% of total length	10.4-12.8% of total length	B
Partially Distinguishing Characters			
Tooth Length, Diameter	shorter, proportionally more slender than *Kogia breviceps*. Unlikely to exceed 30 mm length, 4.5 mm diameter. Teeth 20-30 mm long generally have >60% pulp cavity closure	longer, proportionally wider than *Kogia simus*. May exceed 30 mm in length, 4.5 mm diameter. Teeth 20-30 mm long have <60% pulp cavity closure	B
Potentially Distinguishing Characters			
Throat Grooves	2 or more	none	C, E, F
Vertebral Number	55-57	52-54	D

tion of anterior insertion. Ross (1978) also detected overlap between the two species in the position of the foramen magnum relative to skull height, precluding this feature as a distinguishing character as stated by Handley (1966). Anatomical differences between the two species are described by Yamada (1954), Handley (1966), and Ross (1978).

Like the Sperm Whale (*Physeter macrocephalus*), *Kogia* have a spermaceti organ associated with the right, smaller diameter, naris, situated between the narial passages and posterior to the large fatty melon. Nasal tract and spermaceti organ structure is described by Schenkkan and Purves (1973). Melon and blubber lipid composition is described in Litchfield and Greenberg (1974), Litchfield et al. (1975), and Karol et al. (1978).

A structure apparently unique to *Kogia* is a sac which expands from the lower intestine near the anus, filled with a dense, dark, reddish-brown fluid resembling chocolate syrup (Benham 1901; Caldwell and Caldwell 1989). *Kogia* appear to release the fluid, which produces a dense red cloud in the water, when stressed (Yamada 1954; Scott and Cordaro 1987; Caldwell and Caldwell 1989) (see *Behaviour* under **General Biology**, below).

A detailed description of Dwarf Sperm Whale anatomy is provided by Ross (1978). Detailed anatomy of a *Kogia* sp. (not easily determinable to species due to characters shared by both) is provided by Benham (1901). No anatomical observations appear to be available on fetal *Kogia simus*, although Kernan and Schulte (1918) and Schulte and Smith (1918) provide anatomical details of a fetal *Kogia breviceps*.

Distribution

Knowledge of the distribution of both *Kogia* species is imprecise, as it is derived largely from stranded specimens. Sightings of *Kogia* at sea for which species identifications are made occur infrequently. It has been suggested that there may be no reliable characters with which the species may be distinguished at sea (Leatherwood and Reeves 1983; Leatherwood et al. 1988); recent sighting records

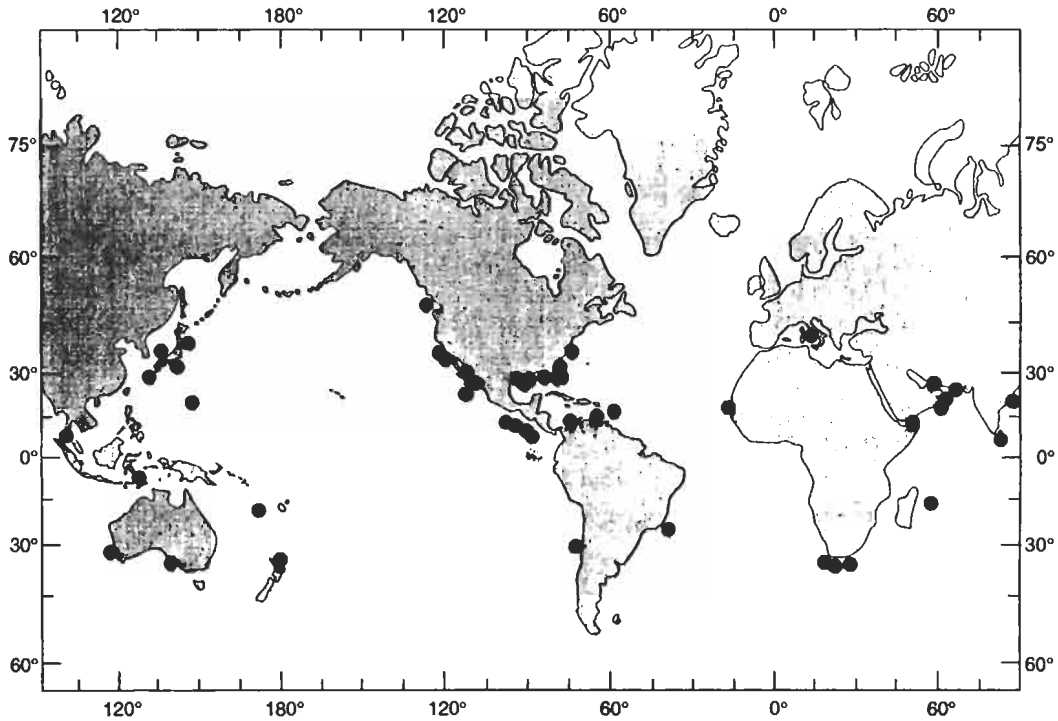

FIGURE 2. General localities of *Kogia simus* records based primarily on stranding and catch data. Each symbol represents one or more record or non-specific locality. (Modified after Nagorsen 1985: Figure 5; and Caldwell and Caldwell 1989: Figure 2.)

indicate that in some instances differentiation is possible (e.g., Wade and Gerrodette 1993). Their consideration as a single species until fairly recently makes precise range determination additionally problematic.

Both species occur in tropical and temperate waters world-wide, with the Dwarf Sperm Whale potentially preferring slightly warmer waters (Caldwell and Caldwell 1989) (Figure 2). In the North Pacific, records of *Kogia simus* have been obtained from Guam, Mariana Islands (Kami and Lujan 1976), Japan (Hirasaka 1937; Yamada 1954; Sylvestre 1988a), Vancouver Island, Canada (Nagorsen and Stewart 1983), California, United States (Roest 1970; Jones 1981), Mexico (Rice 1978) including the Gulf of California (Aurioles et al. 1993; Breese and Tershy 1993), and off Central America (Scott and Cordaro 1987). South Pacific records include New Caledonia (Robineau and Rancurel 1981), New Zealand (Brabyn 1991) and off central Chile (Crovetto and Toro 1983). Ninety-five sightings of Dwarf Sperm Whales were recorded south of 24°N during surveys in the Eastern Tropical Pacific (ETP) (Wade and Gerrodette 1993). Western North Atlantic and Gulf of Mexico stranding records include Virginia (Allen 1941), Florida (Zam et al. 1971; Odell et al. 1985; Candela 1987), Georgia (Caldwell et al. 1971; Candela 1987), Louisiana (Jefferson 1995), and Texas (Caldwell et al. 1960; Jefferson 1995) in the United States. No records appear to exist from eastern Canada. Sightings within the continental slope region of north-central Gulf of Mexico are provided in Mullin et al. (1991) and Jefferson (1995) provides a historical review of Gulf of Mexico sightings and strandings. Caribbean records include St. Vincent Island (Caldwell et al. 1973), Colombia (Vidal and Findley 1989), and the Netherlands Antilles (Debrot and Barros 1992). The only eastern North Atlantic records consists of a single stranding off Senegal, Africa (Maigret and Robineau 1981). A single individual stranded in the Mediterranean off Italy (Baccetti et al. 1991). The only published record from the South Atlantic is of a stranding in southern Brazil (Pinedo 1987). Indian Ocean specimens have been reported from Oman (Gallagher and van Bree 1980; Gallagher 1991), Pakistan (de Silva 1987), India (Owen 1866), Sri Lanka (Leatherwood 1985; Leatherwood and Reeves 1989; *see* review by de Silva 1987), Thailand (Chantrapornsyl et al. 1991), Indonesia (Weber 1923), western Australia (Hale 1963), and South Africa (Ross 1978; Klages et al.

1989), and are summarized in Chantrapornsyl et al. (1991). A Southern Ocean record of two stranded Dwarf Sperm Whales is from near Adelaide, South Australia (Hale 1959). The relative paucity of eastern and South Atlantic records may reflect a lack of observer effort (Gunter et al. 1955; Ross 1978; Caldwell and Caldwell 1989).

Protection

International

The Dwarf Sperm Whale is listed under Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora 1973 (CITES) (*see* Birnie 1982). This listing regulates the international trade of listed species and products derived from them between members and non-members of the convention via an export permitting system. At present there does not appear to be any international trade in Dwarf Sperm Whale products. The International Whaling Commission (IWC) regulates the taking of whales in accordance with the current Schedule provisions; however, due to a lack of consensus on behalf of the members of the Commission, it is unclear whether "whale" refers to all cetaceans or only certain species (Klinowska 1987, 1991), so coverage of the Dwarf Sperm Whale under the Commission's mandate is a matter of debate.

National

Canada: Until they were repealed in 1993, the Cetacean Protection Regulations of the Fisheries Act of Canada of 1867 protected all cetacean species from "hunting". "Hunting" was defined as "to chase, shoot at, harpoon, take, kill, attempt to take or kill, or to harass cetaceans in any manner", and could only be taken under licence. Aboriginal "hunting"; however, could be undertaken without licences. The Cetacean Protection Regulations were replaced with the Marine Mammal Regulations of the Fisheries Act in early 1993. These regulations appear to provide no more or no less protection, by stating only that "no person should disturb a marine mammal except when...under the authority of these Regulations". No provisions exist for regulation of incidental catches in fishing operations. Canada is not currently a member of the IWC, having withdrawn in 1982 (IWC 1982).

United States: All cetaceans are protected through the Marine Mammal Protection Act of 1972 (as amended to date), as well as through 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

There is insufficient information to accurately classify the world status of the Dwarf Sperm Whale (Klinowska 1991). World-wide population size of either species of *Kogia* is unknown. The only abundance estimate of *Kogia simus* is 11 200 (CV = 0.294, upper and lower 95% bootstrap CL = 7700, 16 200) for the ETP; this is likely an underestimate, possibly by as much as one half (Wade and Gerrodette 1993).

Although sometimes reported as rare (e.g., Handley 1966; Sylvestre 1983), several authors have noted that *Kogia* are difficult to detect and are likely much more common than sighting records would suggest (Caldwell and Caldwell 1989; Chantrapornsyl et al. 1991; Jefferson et al. 1992). Au and Pitman (1988), using 20 and 25 power binoculars, noted the difficulty in seeing *Kogia* in other than calm sea conditions during biological surveys in the ETP. The subtle surface behaviour, deep water distribution, small group size and at least occasional skittishness (see *Behaviour* under **General Biology**, below) of both species likely give an erroneous impression of rarity (Enders 1942; Jefferson et al. 1992; Baird unpublished data).

There is no information available on stock identity. No detailed study on geographic variation in either species has been undertaken. Yamada (1954) states that there are pigmentation differences between Japanese kogiids and those from American coasts; however, the occurrence of a Dwarf Sperm Whale from Florida with pigmentation similar to those described by Yamada (see Caldwell and Caldwell 1989, Figure 4C) demonstrates that such marking is not limited to Japanese specimens.

Habitat

Dwarf Sperm Whales inhabit deep waters in temperate and tropical regions; although typically offshore, sighting records from nearshore areas in the southwestern Gulf of California exist (Aurioles et al. 1993; Baird unpublished data). Identification of prey species (mainly squid) obtained from the stomachs of stranded individuals from various areas suggest that the Dwarf Sperm Whale occurs primarily along the continental shelf and slope in the epi- and meso-pelagic zones (Fitch and Brownell 1968; Ross 1978; Candela 1987; Klages et al. 1989). Although the diets of both *Kogia* species overlap, the relative contribution of prey types suggests that *Kogia simus* occurs farther inshore than *Kogia breviceps*, with the former foraging upon smaller squid and shallower depths than the latter (Ross 1978; Candela 1987; Klages et al. 1989; Aurioles et al. 1993). Ross (1984) suggested that younger animals utilize the outer section of the shelf and upper portion of the slope, while adults occur in deeper waters.

General Biology

Reproduction/Life History

Based on examinations of corpora activity and analysis of length data of females with fetuses or small calves, Ross (1978, 1984) identified several

sexually mature females and estimated a length at sexual maturity of between 210 - 220 cm. Bossart et al.'s (1985) and Caldwell and Caldwell's (1989) subsequent examinations of ovary activity in two and one other females, respectively, agree with Ross' estimate. Six males examined by Ross (1978) were identified as sexually mature based on testes dimension, tubule diameter, and presence of sperm. Published data on four other males led Ross (1978) to suggest a length at sexual maturity of between 210 - 220 cm; 210 cm was also the minimum length at male sexual maturity found by Bossart et al. (1985), based on evidence of spermatogenesis, and is supported by Caldwell and Caldwell's (1989) examination of testes and sperm production in three males. Based on the extent of fusion of vertebral epiphyses to the bodies of the centra in both his sample specimens and those from the literature, Ross (1978; 1984) found length at physical maturity to vary considerably between individuals, occurring between 210 - 270 cm. Age at sexual maturity is unknown; Ross (1978) attempted aging Dwarf Sperm Whales based on tooth growth layers but was unsuccessful as growth increments form more than once annually, and groups of increments did not cluster in a manner suggestive of annual increments. Longevity is unknown. Comparisons of calf and fetal lengths led Ross (1978) and Pinedo (1987) to estimate length at birth at 1 m. Observations of pregnant females with calves in both species of *Kogia* suggest that females may become pregnant in successive breeding seasons (Allen 1941; Ross 1978). Pinedo (1987) lists records of fetal and juvenile Dwarf Sperm Whales, and plots Southern Hemisphere records of body length against date, suggesting that mating occurs in summer and birthing in early summer. She estimates a gestation period of about 9.5 months. Comparisons of calf lengths versus time of year suggest that the calving season may last over five months (Ross 1978; Nagorsen 1985; Chantrapornsyl et al. 1991). Using data provided by Ross (1978) and Caldwell and Caldwell (1989), measurements of testes from sexually mature males yielded variable lengths ranging between 9.8 - 22.2 % total body length. The nine mature males and eight mature females recorded as strandings led Ross (1978) to suggest a sex ratio approximating 1:1, assuming each sex demonstrates equal longevity and probability of stranding. Detailed descriptions of the gonads may be found in Ross (1978).

Movements

Seasonal differences in stranding records for certain areas have led numerous authors to suggest the possibility of seasonal movements (e.g., Allen 1941; Gunter et al. 1955; Sylvestre 1988b) however, no conclusive evidence is available due to small sample sizes, actual or potential biases in effort, and other potential seasonal influences (e.g., weather). Odell et al. (1985) observed that the stranding seasonality of *Kogia* in Florida followed the annual inshore/offshore signal of the Gulf Stream, with the number of strandings increasing as the stream moves farther offshore. They suggest that individuals may follow prey into short-term meanders of the stream over the shelf but are unable to return to familiar waters once the meanders dissipate. A review of Sri Lankan catch records by Chantrapornsyl et al. (1991) revealed increased catches in the summer months, which they suggest may be a reflection of increased fishing effort; a summer increase in catches off Japan was attributed to migratory movements by Yamada (1954); however, no information on seasonal distribution of fishing effort was provided. No seasonal differences are apparent for the Gulf of Mexico (Jefferson 1995), the southwest Gulf of California (Aurioles et al. 1993; Baird, unpublished data), or South Africa (Ross 1978).

Feeding

The most commonly recorded prey of Dwarf Sperm Whales are cephalopods. Remains (primarily beaks) have been recovered from stranded animals from Japan (Fitch and Brownell 1968), western Canada (Nagorsen and Stewart 1983), California (Jones 1981), Florida, Georgia (Candela 1987), western Africa (Maigret and Robineau 1981), South Africa (Ross 1978; Klages et al. 1989), and southern Brazil (Pinedo 1987). Identified cephalopod prey include members of the families Histioteuthidae, Enoploteuthidae, Gonatidae, Lycoteuthidae, Cranchiidae, Octopoteuthidae, Chiroteuthidae, Onychoteuthidae, Ommastrephidae, Mastigoteuthidae, Brachioteuthidae, Loliginidae, Vampyroteuthidae, Sepiidae, and Octopodidae (Ross 1978; Jones 1981; Nagorsen and Stewart 1983; Candela 1987; Pinedo 1987). Ross (1978) examined stomach contents of 24 Dwarf Sperm Whales, all of which stranded prior to 1976 in South Africa, and found sepiids to be the most common prey type; whereas Klages et al. (1989) found *Lycoteuthis* and *Histioteuthis* to be the most common prey taken between 1975 and 1987 in their analysis of 33 *Kogia simus* stomach contents. Enoploteuthids were the most abundant prey in animals from Florida and Georgia, followed by histioteuthids, ommastrephids, and loliginids (Candela 1987). *Histoteuthis atlantica* and *Histoteuthis macrohista* predominated the beaks found in a specimen from southern Brazil (Pinedo 1987). *Loligo vulgaris* and *Octopoteuthis* sp. were significant prey species on the eastern African coast but insignificant in the south and west (Klages et al. 1989). Fish are represented less often in stomach contents. Fitch and Brownell (1968) provide a detailed species list of otoliths taken from three Dwarf Sperm Whales off Japan, representing 18 species from seven families (Argentinidae,

Congridae, Gonostomatidae, Macrouridae, Moridae, Myctophidae and Sternoptychidae). Otoliths and jaws of several fish species were recorded by Ross (1978) (*Photichthys argenteus, Chauliodus* sp., *Stomias boa*, an unidentified gempylid, *Nansenia* sp., *Melamphaes* sp., *Benthodesmus* sp., *Sudis* cf. *hyalina*, stomiatoids cf. *Chauliodus*, a possible macrourid, *Lampanyctus* spp., *Myctophum* spp. *Scopelopsis multipunctatus*, and several unidentified myctophids), and a single pair of *Porichthys* sp. otoliths were found in a Brazilian specimen (Pinedo 1987) . Other occasional prey include crustaceans such as shrimp and crab (Fitch and Brownell 1968; Ross 1978; Maigret and Robineau 1981; Nagorsen and Stewart 1983; Pinedo 1987; Klages et al. 1989). Analysis of the hyoid apparatus in all the Physeteridae indicate powerful suction feeding (Reidenberg and Laitman 1994).

Analysis of prey items suggests that feeding occurs at a range of depths. The stomachs of two Dwarf Sperm Whales off Senegal, West Africa, contained shrimp which typically occur between 500 - 1300 m (Maigret and Robineau 1981). Examination of prey items of three specimens from Japanese waters indicated habitual feeding at depths greater than 250 m; 3 species of bottom-dwelling fish (Macrouridae), which are typically found in waters 450 - 1500 m deep, were present in all three specimens (Fitch and Brownell 1968). The majority of squid prey found in South African *Kogia simus* were sepiids (Ross 1978), which typically occur within 100 m of the surface (Roeleveld 1972), and in other animals benthic fish and crab have been identified (e.g., Jones 1981), indicative of bottom feeding (Gaskin 1982).

Behaviour

Observations of wild *Kogia* suggest they typically form small groups of one to four, with occasional groups of up to ten reported (Palmer 1948; Yamada 1954; Handley 1966; Ross 1984; Au and Pitman 1988). Wade and Gerrodette (1993) calculated a Dwarf Sperm Whale mean group size of 1.7 (coefficient of variation = 0.07) during marine mammal surveys in the ETP, and Au and Pitman (1988) calculated a mean group size of 2, standard deviation = 1, based on 30 observations of unidentified *Kogia* during surveys in the same region.

The surface behaviour of *Kogia* is poorly known due to the paucity of sightings. Both species appear to be slow-moving, rarely engaging in rapid or boisterous surface activity (Allen 1941; Handley 1966). They are typically observed floating at the surface with the back of the head and anterior dorsal surface exposed, much in the same manner as sperm whales (Yamada 1954; Leatherwood and Reeves 1983; Caldwell and Caldwell 1989; Breese and Tershy 1993). Usually all or some of the dorsal fin is exposed as well (Baird, personal observation). The blow of both species is rarely visible, and upon diving, *Kogia* typically sink vertically, rather than rolling at the surface and exposing the tail stock (Leatherwood et al. 1988; Baird, personal observation). Surface behaviour of *Kogia simus* and/or unidentified *Kogia* in recent surveys in the Gulf of California typically consisted of continuous resting at the surface for approximately one minute (J. Barlow, Southwest Fisheries Science Centre, P.O. Box 271, La Jolla, California 92038, personal communication). The animals would then simply disappear, but would often reappear after a very brief dive (less than three minutes) for another similar period of surface resting.

Allen (1941), Palmer (1948), and Yamada (1954) all mention accounts describing the ease with which *Kogia* could be harpooned, being quite approachable. Such records have presumably led to descriptions such as "easy to approach" (Katona et al. 1993; referring to *Kogia breviceps*) and "apparently oblivious to approaching vessels" (Caldwell and Caldwell 1989; referring to both species). Whalers in the Lesser Antilles, however, describe *Kogia* as being elusive and wary, being difficult to approach and catch (Reeves 1988). Similarly, one of us (RWB) found Dwarf Sperm Whales difficult to approach in the southwestern Gulf of California, frequently observing them through binoculars but rarely being able to approach within 200 m. Records of cetacean responses to survey platforms recorded in the north-central and western Gulf of Mexico showed Kogia to respond negatively to the ship (73%, 11/15 sightings) and to change their behaviour in response to the survey airplane in 40% (12/30) of sightings (Lynn et al. 1995). Recent observations of *Kogia simus* and/or unidentified *Kogia* in the Gulf of California also found them to be difficult to approach, both with a large ship and out-board launches (J. Barlow, personal communication). The fact that they are rarely sighted may result in part due to a general inapproachability, whereby animals may descend beneath the surface in response to an approaching vessel before being detected. The difficulty with which *Kogia* are observed at sea suggests that a close approach is likely often necessary before the unaided eye can detect them. Even with the advantage of binoculars, detection can be difficult in other than calm sea conditions (e.g., Au and Pitman 1988). More observations at sea are required before the approachability of either species can be accurately determined.

Breese and Tershy (1993) recorded four dive times for a Dwarf Sperm Whale in the central Gulf of California to the nearest minute: 14, 43, 19 and 30. A recent survey in the Gulf of California recorded 59 dive intervals of *Kogia simus* and/or unidentified *Kogia* (J. Barlow, personal communication). The median dive time was 8.6 minutes and the median surface time was 1.2 minutes, but

dives of up to 25 minutes and surface periods of up to three minutes were fairly common. Longer dive times (up to 53 minutes) were recorded but were probably the result of one or more missed surfacings.

Analysis of lung volume and mechanics of a stranded *Kogia breviceps* suggested capability of high expiratory flow rates at reduced lung volume, which may function to prevent decompression sickness (Bergey 1983); similar form and function may occur in *Kogia simus*. Examination of the structure and function of the eye in *Kogia simus* suggests capability in low light such as would occur at depth (Dawson 1980).

Associations with other species of marine mammals or with seabirds appear to be extremely infrequent; we could find no such records in the literature. Groups of *Kogia* were observed 30 times during biological surveys in the ETP, none of which involved seabird associations (Au and Pitman 1988). In the ETP, two *Kogia simus*, presumed to be mother and calf, were accidentally encircled in a purse seine net set for Yellowfin Tuna (*Thunnus albacares*) associated with Spotted Dolphins (*Stenella attenuata*) and Spinner Dolphins (*Stenella longirostris*), but at no time prior to or during the set did they appear to be associated with the dolphins (Scott and Cordaro 1987). About 30 observations of Dwarf Sperm Whales in the southern Gulf of California revealed no evidence of seabird or other associations (Baird, unpublished data).

As noted, *Kogia* expel a reddish-brown cloud of fluid from the anus when apparently disturbed or threatened (Yamada 1954; Scott and Cordaro 1987; Caldwell and Caldwell 1989; Aurioles et al. 1993). Both stranded animals and *Kogia* caught in fishery operations have been observed to engage in this behaviour, often termed a "startle response", which may serve to temporarily conceal the animals or operate as a decoy (Scott and Cordaro 1987). The cloud produced may cover an area of 100 square meters (Scott and Cordaro 1987), and is often interpreted as feces or blood (Yamada 1954; Caldwell and Caldwell 1989).

We found nothing published on sounds produced by *Kogia simus*. Observations of captive animals suggest that neither species is particularly vocal (Caldwell and Caldwell 1989; Thomas et al. 1990). Recent attempts at recording Dwarf Sperm Whale sounds in the Gulf of California confirm these impressions (Steve Dawson, personal communication). Thomas et al. (1990) recorded a low frequency "cry" from a captive *Kogia breviceps* and echolocation signals have also been recorded from captive *Kogia breviceps* (Caldwell et al. 1966; Caldwell and Caldwell 1987). Caldwell and Caldwell (1989) suggest that similar sounds are likely produced by *Kogia simus*.

Limiting Factors

Data on natural mortality are scarce. *Kogia breviceps* has been preyed upon by Killer Whales (*Orcinus orca*) off St. Vincent, Caribbean, as has *Kogia* (not identified to species) in the Indian Ocean (Perrin 1982). Substantial scarring on some stranded Dwarf Sperm Whales is suggestive of shark attacks (Caldwell and Caldwell 1989), and scars attributed to the White Shark (*Carcharodon carcharias*) were found on a stranded *Kogia breviceps* in northern California (Long 1991). A variety of internal parasites have been recorded from stranded *K. simus*, but none have been positively linked to mortality (c.f. Roest 1970; Zam et al. 1971; Ross 1978; Caldwell and Caldwell 1989). Myocardium lesions and hepatic change consistent with heart failure was found in several stranded adult *Kogia* of both species (Bossart et al. 1985). Pneumonia has also been observed in stranded *Kogia* (Caldwell and Caldwell 1989). To the authors' knowledge no toxicology studies have been carried out on *Kogia simus*; analysis of heavy metals in an Argentinian *Kogia breviceps* revealed high cadmium concentration relative to other marine mammals studied (Marcovecchio et al. 1990; Marcovecchio et al. 1994), but it is unknown what role such elevated levels may have in mortality.

Kogia are infrequently taken by fisheries, both as direct catches and as bycatch. Both species have been killed accidentally in Sri Lanka (Leatherwood 1985; Leatherwood and Reeves 1989), and both directly and incidentally in Japanese fisheries (Yamada 1954; Handley 1966; Fitch and Brownell 1968; Omura et al. 1984; Sylvestre 1988a). *Kogia simus* and unidentified *Kogia* have been occasionally deliberately killed in small whaling operations in the Lesser Antilles (Caldwell et al. 1973; Reeves 1988), and probably still are (Reeves 1988). *Kogia* have been hunted in Indonesia (Weber 1923) but there is no evidence of takes in recent years (Barnes 1991). Two Dwarf Sperm Whales were incidentally encircled in a tuna purse seine set in the ETP (Scott and Cordaro 1987). Two *Kogia* were taken by fishermen in Hawaii, one by spearing and one taken by baited hand line (Edmondson 1948); kangaroo ligaments were found in the stomach of a South Australian specimen, presumably taken as fisherman's bait (Hale 1962).

Ingestion of plastic items could potentially lead to intestinal blockage. Plastic items have been found in the digestive tracts of both species; a Dwarf Sperm Whale stranded off Senegal, West Africa had part of a ball-point pen in the latter portion of the intestine, apparently present for some time (Maigret and Robineau 1981), and Ross (1978) found a plastic bag in the stomach of a South African specimen. A young male *Kogia breviceps* stranded in Texas had a plastic garbage can

liner, a bread wrapper, a chip bag, and two additional pieces of plastic in its forestomach and fundic stomach (Tarpley and Marwitz 1993). Caldwell and Caldwell (1989) suggest that plastic may resemble squid and be mistakenly consumed. Allen (1941) states that wounds apparent on an adult female *Kogia simus* and a presumed yearling male stranded south of Cape Henry, Virginia, resulted from propeller collisions. Caldwell and Caldwell (1989) suggest that a few *Kogia* are likely injured or killed from boat collisions; however, such events are probably very rare.

Special Significance of the Species

There is insufficient information to accurately classify the world status of the Dwarf Sperm Whale (Klinowska 1991). The world status of the other member of the genus, the Pygmy Sperm Whale, is also poorly known.

Evaluation

Only one record of this species exists from Canadian waters. With the difficulty of spotting this species at sea, individuals may be regularly occurring in some areas off Canada's coasts but is likely rare or uncommon at best. No serious threats to its status in Canadian waters are apparent, but there is insufficient scientific information on which to base a COSEWIC status designation.

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A record of this species from eastern Canada is mentioned in Lucas and Hooker (1997). On 30 September 1996 a 226 cm long male *Kogia simus* was found dead on the south beach of Sable Island, off Nova Scotia (approximately 44°N, 60W). Photos measurements, and tissue samples from this animal were collected (Lucas and Hooker 1997), and details will be presented by Lucas et al. (in preparation).

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