Significant Direct and Incidental Catches of Small Cetaceans

A REPORT BY THE SCIENTIFIC COMMITTEE OF THE INTERNATIONAL WHALING COMMISSION TO THE UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT (UNCED)

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Contents

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INTRODUCTION

Background to the Review

The Commission's Resolution

In the Resolution on Small Cetaceans (IWC, 1991a) adopted by the IWC last year, the Commission requested the Scientific Committee to commence a process of drawing together all available relevant information on the present status of those stocks of small cetaceans which are subjected to significant directed and incidental takes and on the impact of those takes on the stocks, and to provide such scientific advice as may be warranted.

The report to UNCED

The Commission also decided to present a report on the work carried out under the terms of the Resolution on Small Cetaceans to the United Nations Conference on Environment and Development (UNCED) in June 1992.

Editors' notes on the 1994 version

The present report comprises the relevant section (section 5) of the review of small cetacean stocks subjected to significant directed and incidental takes carried out by the sub-committee on small cetaceans and agreed by the full Scientific Committee and sent to the UNCED meeting. For convenience, the report follows the numbering system of the report of the sub-committee on small cetaceans published in *Rep. int Whal. Commn* 42: 178–234. Similarly the use of the word 'sub-committee' has been retained. The only changes that have been made to that report is the updating of 'In press' or 'unpublished' references where these have subsequently been published; Appendices 1 and 4 of the sub-committee report are not included as they are not relevant to the review.

Species names

The report uses English common names recognised by the IWC for small cetacean species as of October 1994. A full list of species in taxonomic order is given in Appendix 2. It should be noted that at the time of the report, only one species of common dolphin, *Delphinus delphis* was recognised. Since then two species, the short-beaked common dolphin (*D. delphis*), and the long-beaked common dolphin (*D. capensis*) have been recognised. Appendix 2 has been modified to this effect, but in most cases it is impossible to retrospectively reallocate animals assigned originally to 'common dolphin' to the two species.

5. REVIEW OF SIGNIFICANT DIRECTED AND INCIDENTAL CATCHES OF SMALL CETACEANS

Four categories of catches were identified and discussed; directed fisheries, incidental catches, deliberate incidental catches and live-capture fisheries. Information published in *Rep. int. Whal. Commn* or elsewhere, information presented to the IWC Workshop on Incidental Mortality in Passive Fishing Nets and Traps (IWC, 1994) and new information submitted to the sub-committee were reviewed. Priorities were given to those fisheries in each category where significant impacts on stocks are likely to occur. For these fisheries, previous recommendations made by the Scientific Committee, and any management response upon such recommendations were evaluated. New recommendations were made where appropriate.

The sub-committee, however, reviewed only those fisheries and stocks of small-cetaceans for which detailed information was available for consideration. It was emphasised, therefore, that while the review addresses many of the stocks which are significantly impacted by directed or incidental catches, it cannot be considered to be comprehensive, either with regard to species or to geographic regions covered. The sub-committee emphasised this problem that apply to all four categories of catches, and **recommends** that areas should be identified where there are urgent needs for basic information on status of small cetacean stocks and on impacts of any takes of those stocks. The sub-committee further **recommends** that areas should be specified where international cooperation is required (or beneficial) for developing further competence in research and management.

Problems related to pollution and habitat degradation were not addressed in the IWC Resolution on Small Cetaceans. These factors may have significant impacts on small cetaceans, in particular for those species occurring in coastal, inshore and riverine habitats. The sub-committee **underlines**, therefore, that these factors should be emphasised in a comprehensive assessment of threats to small cetaceans.

5.1 Directed fisheries[1]

5.1.1 Directed fisheries on small cetaceans in Japan

Over 20 species of small cetaceans are found in the nearshore waters around Japan. Various local fisheries for some of these species have a long history. This section

[1] Initial draft by Kasuya and Brownell.

reviews the history of exploitation for the four main small cetaceans (Dall's porpoise, striped dolphin, short-finned pilot whale, and Baird's beaked whale) hunted in Japanese waters and presents a brief review of the situation with other small cetaceans caught in direct Japanese fisheries.

5.1.1.1 *Phocoenoides dalli*

COMMON NAMES

Dall's and True's porpoise, *ishi iruka* and *rikuzen iruka* (Japanese names for *dalli* and *truei* forms, respectively), *belokrylaya morskaya svin'ya* (Russian).

DISTRIBUTION

This genus is endemic to the North Pacific basin. Its southern limits during winter are around the Boso Peninsula, near Tokyo (about 35°N) in the western Pacific and off northern Baja California, Mexico (approximately 28°N) in the eastern Pacific. The southern boundary in the central Pacific is about 39°N during summer (Jones *et al.*, 1987). In northern waters, sightings are infrequent above 62°N in the Bering Sea (Nishiwaki, 1967). In the western Pacific, these porpoises are also widely distributed in the Sea of Japan and the Okhotsk Sea (Kasuya, 1982; IWC, 1991c).

Based on the distribution of cow-calf pairs in August-September, colour pattern, body size, and geographical variation in parasite loads, the Scientific Committee proposed seven stocks of Dall's porpoises (IWC, 1991c). These are: (1) the central Bering Sea (*dalli*-type), (2) south of the Kamchatka Peninsula (*dalli*-type), (3) south of the Aleutian Islands (*dalli*-type), (4) central Gulf of Alaska (*dalli*-type), (5) northern Okhotsk Sea (*dalli*-type), (6) central Okhotsk Sea (*truei*-type) and (7) eastern North Pacific (*dalli*-type).

Understanding of the Okhotsk Sea stocks has since been refined (Miyashita, In press-b). During recent surveys the density of the *dalli*-type was low in the central Okhotsk Sea where the density of the *truei*-type (including cow-calf pairs) was high. Cow-calf pairs of *dalli*-type were concentrated to the north and south of this area of concentration of the *truei*-type in the central Okhotsk Sea (Miyashita, In press-b). The breeding ground (for the *truei*-type) south of the Kamchatka Peninsula (east of the Kuril Islands) was discontinuous with those in the Okhotsk Sea. Thus, Miyashita (In press-b) proposed three Dall's porpoise breeding stocks for the Okhotsk Sea (i.e. northern Okhotsk Sea – *dalli*-type; central Okhotsk Sea – *truei*-type; and southern Okhotsk Sea – *dalli*-type). This brought to eight the number of stocks known or postulated in the North Pacific.

PROBLEMS AND CATCH STATISTICS

This species has been hunted in Japanese waters since at least the early 1940s (Hirashima and Ohno, 1944). Porpoises are caught from two stocks (i.e. the *dalli*-type, southern Okhotsk Sea stock, and the *truei*-type, central Okhotsk Sea stock). During the 1960s and 1970s, the hand harpoon fishery in northern Japanese waters landed between 5,000 and 10,000 porpoises annually. In its early years, the hand harpoon fishery operated during winter off the Iwate coast (northern Honshu), but as the fishery started to expand, the season lengthened and the fishing ground moved into waters around Hokkaido. By 1988 the reported catch had increased to over 40,000 individuals. The Government of Japan established regulations for the hand harpoon fishery in early 1989, which resulted in a reduction of the annual catch to a total of 29,048 for that year. The estimated removals by the direct fishery from both stocks between 1986 and 1989 totalled 111,530 porpoises (IWC, 1991c). The large increases in take of this species since 1986 have been used to compensate for the shortage of whale meat due to the IWC moratorium on whaling. The increase has also been intended to compensate for the decrease in catches of striped dolphins in recent years. During the 1970s, Dall's porpoises were consumed largely in the Shizuoka area, but they are now shipped to Taiji as well. In addition to these high numbers caught and landed, other Dall's porpoises are struck and lost and therefore, probably die in this fishery. Struck and loss ratios in this fishery have been found to be highly variable by vessel, crew and area (Fujise, 1991).

The reported catches since 1963 are given Table 1. Recent catch statistics are reported as meat weight or whole animals, and the factor used to convert values for meat landed to whole animals taken is not consistent. Therefore, the Scientific Committee has expressed concern about the accuracy of the reported catches. It was also noted that meat products cannot accurately be attributed to stocks if the hunting operations are conducted in areas where both stocks occur.

Table 1

Reported landed catches of Dall's porpoises from the hand harpoon fishery in Japanese coastal waters (IWC, 1991c). Both *dalli* and *truei* types are included.

Year	Catch	Year	Catch	Year	Catch
1963	9,040	1972	5,190	1981	9,767
1964	9,440	1973	7,230	1982	12,833
1965	9,180	1974	6,470	1983	12,776
1966	7,980	1975	7,350	1984	9,764
1967	5,150	1976	9,899	1985	10,378
1968	6,020	1977	9,358	1986	16,515
1969	7,020	1978	8,426	1987	25,600
1970	8,060	1979	6,843	1988	40,367
1971	5,210	1980	6,920	1989	29,048
				1990	21,802

POPULATION ESTIMATED

Bouchet (1981) estimated that 920,000 Dall's porpoises occur in the North Pacific and Bering Sea portions of their range, excluding the Sea of Japan and Okhotsk Sea. This estimate was revised upwards to 953,000 (Turnock, 1987). The latter estimate included 212,000 porpoises in the Bering Sea stock and 741,000 porpoises in the western and central North Pacific between 150°E and 172°W. A large but unknown population(s) occurs in the eastern North Pacific.

Miyashita and Kasuya (1988) reported minimum estimates for the *dalli*-type stock in the southern Okhotsk Sea of 47,000 (plus an unknown number of animals in adjacent Soviet waters) and for the *truei*-type stock in Japanese and USSR waters of 58,000. Using porpoise sightings from 1990 surveys, Miyashita (Miyashita, In press-b) estimated the three stocks off Japan to be: 111,000 (CV=0.29), *dalli*-type, northern Okhotsk Sea stock; 226,000 (CV=0.15), *dalli*-type, southern Okhotsk stock; and 217,000 (CV=0.23), *truei*-type, central Okhotsk Sea stock.

These estimates are substantially different from the previous estimates for part of the area; so, with help from a review by Buckland the sub-committee examined the new results in some detail. The design was found to be acceptable. Although bad weather did prevent surveys from achieving uniform coverage, it did not significantly affect results. Buckland suggested that a more appropriate method of calculating variance would yield a higher variance. If the porpoises are attracted to vessels, as are Dall's porpoises in other areas, results will be biased upward; if they avoid vessels the results will be biased downward. This was not possible to assess with the data available.

ASSESSMENT AND STATUS

From data then available (catches through 1987, population estimates from Miyashita and Kasuya (1988)) the Scientific Committee concluded in 1989 that the take of Dall's porpoises in the Japanese hand harpoon fishery was clearly not sustainable (IWC, 1991b; c). In 1988 and 1989, respectively, totals of 40,367 and 29,048 porpoises were taken in this fishery. These represented 38% and 28%, respectively, of the minimum population estimates then available. Takes during the 1990 season were estimated to consist of 9,360 of the *dalli*-type and 12,442 of the *truei*-type (uncorrected for animals struck but lost). The Japanese statistics report the catch by colour type based on the area of operation for catches landed as meat (i.e. 100% *dalli*-type off Hokkaido and 90–95% *truei*-type off Sanriku). In 1990, then, the reported takes of Dall's porpoises in the Japanese harpoon fishery comprised 4.1% of the revised estimated population of *dalli*-type from the southern Okhotsk Sea stock and 5.7% of the estimated population of the *truei*-type from the central Sea of Okhotsk stock. These percentages must be increased by some amount to account for porpoises struck but lost. Estimates of the average struck-and-lost ratio ranged from 3.3% to 9.8% of those struck, depending on region (Fujise, 1991). Although some of these struck and lost animals may survive, applying the above range of struck and lost ratios suggests that 1990 takes accounted for 4.2–4.6% of the southern Okhotsk Sea stock and 5.9–6.3% of the central Okhotsk Sea stock. While these levels are very much lower than the catch rates reported for 1988 and 1989, it cannot necessarily be assumed that they are sustainable. The sub-committee in 1990 (IWC, 1991c) stated that it believed 'that allowable harvest and incidental take rates should be lower than half of the estimated value for r_{max}' and noted that 'all estimates of r_{max} presented in the submitted papers in 1990 are less than 0.10'. This implies that annual takes should be less than 5% of the estimated population size; how much less is still open to question. In addition, demographic implications of the sharp differences in age and sex structures of catches in different regions (Fujise *et al.*, 1991) must be taken into account in assessing impact.

RECOMMENDATIONS

In 1990 the highest priority recommendations of the Scientific Committee related to small cetaceans were that the planned Japanese sightings surveys be carried out and that new population estimates be developed for the stocks taken in the hand harpoon fishery (see new results in Miyashita, In press-b). It was also recommended that a plan for monitoring trends in the populations be developed. The sub-committee was pleased to receive the new estimates and **recommends** that surveys be continued as a basis for monitoring trends in population sizes for hunted stocks.

Additional recommendations in 1990 were that analyses of parasite loads in the eastern North Pacific and other areas be compared to those already studied (Walker, 1990) to help identify other possible stocks. Along these lines, it was also recommended that studies be continued or undertaken to differentiate stocks using a combination of techniques, such as differences in life-history parameters (e.g., asymptotic length), parasite and contaminant loads, reproductive seasonality, DNA and isozymes.

In 1989, the Scientific Committee recommended that catch statistics for this fishery be collected and reported on a stock-by-stock basis. Considering the possible take from the stocks off Japan, it was also recommended that the Republic of Korea be requested to report to the IWC by-catches of Dall's porpoises (and other cetaceans) in its squid driftnet fishery (IWC, 1990b).

In 1990, the Scientific Committee recommended that information on struck-and-lost rates be collected and analysed for each gear type in the Japanese harpoon fishery, to allow more accurate estimation of total mortality. It also recommended a clarification of the basis for revision of the 1986 and 1987 catch statistics (IWC, 1991c). The sub-committee was pleased to acknowledge the Japanese Government's quick response to these requests. Given that continuing problems have been identified, however, the sub-committee **advises** that there be increased effort in improving catch statistics for this fishery, and that this includes steps to distinguish the two colour types in landings of meat only. Noting the high variability in estimates currently available for struck-but-lost rates, the sub-committee **advises** that additional information be collected on these rates by area, season, vessel and other significant variables. Further, it **encourages** the continuation of steps taken to improve precision in estimates of take (Kasuya, 1991).

The sub-committee is pleased that catches have been reduced, perhaps to levels very near sustainable rates. However, given the uncertainty about the age and sex structure of catches, and pending a detailed age-structure assessment, it is again **reiterates** that catches in this fishery be further reduced.

5.1.1.2 *Globicephala macrorhynchus*

COMMON NAMES

Short-finned pilot whale, *tappa-naga* for the northern stock and *ma-gondo* for the southern stock (Japanese).

DISTRIBUTION

This species is found in tropical and warm temperate waters world wide. Short-finned pilot whales from at least two different stocks are hunted in Japanese waters (Kasuya *et al.*, 1988). The northern stock is found along the Pacific coast of northern Japan between 35°N and 43°N (IWC, 1987). Most sightings of whales in this stock during recent surveys were concentrated between 40°N and 43°N and west of 143°E (Kasuya *et al.*, 1986). Whales belonging to the southern stock were found during summer survey cruises in 1984 and 1985 in Japanese waters south of 37°N from the coast east to 125°E. No whales were seen south of 25°N or east of 152°E. This suggests that whales of the southern stock are restricted to this area off the Pacific coast of Japan. Wada (1988) reported, based on electrophoretic data, that the two stocks were genetically isolated.

PROBLEMS AND CATCH STATISTICS

Northern stock

The northern stock of pilot whales was exploited by Japanese small-type whaling vessels before World War II, but no statistics are available. During the late 1940s and early 1950s, the annual catches declined rapidly from 400 to less than 50 animals. In addition, the proportion of males in the catch declined. After a pause of about 25 years, small-type whaling on this stock resumed in 1982. Two to seven vessels have operated and landed their catch at three land stations in Ayukawa. The gunners select large whales. The total reported catch for eight seasons (1982–1990) was 700 whales (see Table 2).

Table 2

Catch statistics for northern stock of short-finned pilot whales taken by Japanese small-type whaling vessels, based on gunner's reports.

Year	No. of whales	No. of vessels	Operational-vessel days
1982	172	5	119
1983	125	7	100
1984	160	6	94
1985	62	7	77
1986	28	3	14
1987	0	0	0
1988	98	4	90
1989	50	2	78
1990	10	2	58

Since 1982, the regulations by the central government have changed several times: (1) no catch limit was set during the October-November 1982 season; (2) a quota of 175 was set for the 1983 and 1984 seasons; (3) a fixed fishing season of 255 vessel days was established for seven small-type whaling vessels during the 1985 season; (4) the government and industry decreased the fishing effort for the 1986 season to 40% of the previous season and set a quota of 50 whales from 5 October to 18 November for three vessels; (5) no whaling occurred during the 1987 season and the quota of 50 whales was carried over to the 1988 season; (6) four vessels were allowed to operate from 5 September to 30 November in 1988 with a two year quota of 100 whales; and (7) an annual quota of 50 whales was set for the 1989 and 1990 seasons and only two of the four vessels previously involved were allowed to operate from 1 September to 18 November each year.

Southern stock

In Japanese waters the southern stock has been exploited since before World War II by local fishermen in three isolated areas. Fishermen from various villages have operated a drive fishery for pilot whales along the Izu Peninsula since the early 1900s. Statistics are available since 1950. Annual catches ranged between 31 and 650 from 1950 to 1956. Statistics are incomplete between 1957 and 1971. From 1972 to the present, the annual catches have ranged from 0 to 80 whales. Today, only the fishermen from Futo (Izu Peninsula) still hunt pilot whales, but the last catch was 20 whales in 1981. Available catch records are summarised in Table 3. No catch limits are set for this fishery by the Shizuoka Prefectural government, but the Fisheries Agency requested a limit of 657 individuals of all dolphin species for the 1991 season.

Table 3

Drive fishery statistics for southern stock of short-finned pilot whales landed at Izu Peninsula, Japan.

Year	Catch	Year	Catch	Year	Catch	Year	Catch
1950	224	1958	---	1966	---	1974	0
1951	425	1959	---	1967	30	1975	0
1952	650	1960	---	1968	---	1976	0
1953	349	1961	---	1969	---	1977	73
1954	31	1962	---	1970	---	1978	80
1955	86	1963	---	1971	---	1979	0
1956	126	1964	---	1972	0	1980	0
1957	---	1965	33	1973	0	1981	20

Off Nago, Okinawa, the fishermen have hunted pilot whales in a drive fishery for a long time, but catch statistics are only available for years since 1960. Annual catches have varied from 0 to 500 animals per season (not calendar year). In 1975, the fishermen started to harpoon pilot whales from 5–7 fishing vessels. This method has replaced the traditional drive fishery in the area. The reported catches since 1960 are given in Table 4. This crossbow fishery came under regulation in 1989. A quota of 100 individuals (all species) was established for the Nago fishery with four vessels licensed for the 1991 season by the local governor.

The major pilot whale fishery is the one at Taiji (Kii Peninsula) that started in the 17th century (Kasuya and Marsh, 1984). Statistics are fragmentary for years before World War II. After the war, both small-type whaling and a drive fishery operated in the waters off Taiji. A total of 200–300 whales was taken annually between 1949 and 1951 by small-type whaling vessels. After 1951, lower catches were made and only a single small-type whaling vessel operated to meet local demand for pilot whale meat. The drive fishery started in 1969 and, since 1980, has been the only pilot whale fishery operating off Taiji. Annual catches ranged between 90 and 605 whales between 1975 and 1985. In 1982, the Japanese government placed all drive fishermen under the control of the relevant Prefectural governments (IWC, 1987). The Wakayama Prefecture (Taiji) has set an annual catch limit of 500 pilot whales since that time. Recent catch statistics are summarised in Table 5. Small-type whaling from Taiji started again on the southern stock of short-finned pilot whales in 1988 when 20 whales were caught (Kishiro and Kasuya, 1993); 3 vessels operated that year. An annual quota of 50 whales was set

Table 4

Drive and crossbow fishery for southern stock of short-finned pilot whales landed in Okinawan waters (Kasuya, In press).

Year	Catch	Year	Catch	Year	Catch
1960	243	1970	0	1980	80
1961	281	1971	165	1981	0
1962	0	1972	170	1982	5
1963	189	1973	87	1983	0
1964	318	1974	53	1984	88 *
1965	0	1975	49	1985	70 *
1966	0	1976	36	1986	82 *
1967	150	1977	301	1987	92 *
1968	150	1978	0	1988	116 *
1969	500	1979	0	1989	93 *
				1990	74 *

*Taken in crossbow fishery - crossbow and drive fisheries not seperated between 1975 and 1982.

Table 5

Catch statistics for southern stock of short-finned pilot whales taken by small-type whaling and drive fishery off Taiji, Japan, by calendar year (Kishiro and Kasuya, 1993).

Year	Harpoon	Drive	Year	Harpoon	Drive
1948	38	0	1970	108	0
1949	283	0	1971	111	24
1950	233	0	1972	60	30
1951	227	0	1973	66	52
1952	131	0	1974	65	94
1953	141	0	1975	53	410
1954	20	0	1976	14	370
1955	12	0	1977	6	170
1956	141	0	1978	13	309
1957	98	0	1979	3	87
1958	---	0	1980	0	605
1959	---	0	1981	0	476
1960	---	0	1982	0	305
1961	---	0	1983	0	378
1962	---	0	1984	0	424
1963	---	0	1985	0	589
1964	---	0	1986	0	264
1965	121	0	1987	0	294
1966	---	0	1988	20	327
1967	---	0	1989	5	71
1968	97	0	1990	8	75
1969	75	77			

for 1989 and 1990 but only 5 and 8 whales were taken, respectively. This quota was set by the Japanese Fisheries Agency.

ASSESSMENT AND STATUS

Northern stock

The provisional total estimated population size of the northern stock, based on summer surveys during 1984 and 1985, was 5,344. In 1986, the Scientific Committee expressed considerable concern that the available data suggested a decline in the northern stock (IWC, 1986b). Using data collected in September and October of 1982 through 1988, Miyashita (1993) re-estimated the population size of the northern stock to be 4,239 (CV=0.61). The annual catch of about 87 whales since 1982 represents more than 2% of the estimated present population size, but the current quota of 50 is about 1% of the estimate.

Southern stock

The estimated size of the southern population based on five cruises conducted during the summers of 1984 and 1985 was 53,000 (IWC, 1987). Based on new sighting data collected in 1986 through 1988, Miyashita (1993) revised the estimate for the southern stock of pilot whales down to 24,474 (CV=0.61). Recent total annual catches (uncorrected for any struck/lost whales) represent 1 to 2% of the estimated present population size of this stock.

RECOMMENDATIONS

In 1986, the Scientific Committee recommended that the biological monitoring programme be expanded on the northern stock and that additional vessel surveys be conducted to improve the population estimate and to collect data on the proportion of adult males present (IWC, 1986b). Additional sighting surveys were conducted by the Japanese and the results presented in Miyashita (1993). The sub-committee understands that biological materials have been collected routinely from whales landed in this fishery. It is requested that these materials be studied and reported on.

In 1986, the Committee also requested that fishing effort, sighting and catch data continue to be collected for the drive fishery along with the collection of biological materials from the catch. The Committee noted that no biological materials had been collected from the drive fishery since 1981. The Committee also suggested that investigations be initiated on stock identity of the whales taken in the three different southern fishing areas.

In 1986, the Scientific Committee felt it appropriate, from a biological point of view, that no animals be taken from the northern stock until a clearer understanding of the status of this population became available (IWC, 1986b). It recommended that if a pause in whaling was not possible, the catch should be reduced by significantly curtailing the total effort in the fishery. Japan reduced the annual catch limit from 175 whales in 1984 to 50 in 1987 and the number of vessels licenced to hunt pilot whales from the northern stock were reduced; from 6 vessels in 1984 to 2 vessels in 1989.

In 1986, the Committee also considered that the exploitation of the southern stock should not be intensified because of the recent catch levels and the fact that gross productivity of this species is low. However, effort on this stock has increased since small-type whaling on the southern stock started again in 1988. The sub-committee again **recommends** that catches from the southern stock not exceed levels prior to those in 1986.

5.1.1.3 *Berardius bairdii*

COMMON NAMES

Baird's beaked whale, *tsuchi kujira* (Japanese), *severnyi plavun* (Russian).

DISTRIBUTION

These whales are found only in the North Pacific Ocean and adjacent seas. Based on migration patterns, at least three stocks exist in the western Pacific around Japan: a western Pacific stock; a Sea of Japan stock; and an Okhotsk Sea stock (Kasuya and Miyashita, 1988).

PROBLEMS AND CATCH STATISTICS

Japanese fishermen have hunted Baird's beaked whales since at least the 17th century. Fishermen using hand harpoons from small boats operated out of Katsuyama in Chiba Prefecture (near Tokyo) until the start of the Meiji era (1867). The annual catch was only four or five whales. In 1908 *tsuchi-kujira* whaling resumed again off Chiba Prefecture from a small wooden boat with a Norwegian-type harpoon gun. After the end of World War II, coastal whaling increased, and by 1952 the Fisheries Agency of Japan had licensed 76 small-type whaling vessels. The largest catch was in 1952 when 322 Baird's beaked whales were landed (Omura *et al.*, 1955). Since 1952 the catches have declined. The Government of Japan established a national quota of 40 whales in 1983 (IWC, 1984b). The small-type whaling association divided this quota into 35 for the western Pacific and 5 for the Okhotsk Sea. In 1988 the national quota was increased 50% (from 40 to 60) as a one-year emergency increase for the small-type whaling vessels to partially replace the former catch of minke whales (IWC, 1980c). However, this higher quota was maintained in 1989 and 54 whales were landed. In 1989 one vessel with a quota of six whales did not operate in the fishery. During 1990 the quota was 54 whales and all were taken. Table 6 lists the catch of Baird's beaked whales between 1961 and 1990.

Soviet whaling operations were reported to have taken 143 whales between 1934 and 1964 off Kamchatka and the Kuril Islands. Small numbers were also taken in the eastern North Pacific and landed at various shore stations in the USA (14 whales) and Canada (135 whales) between 1934 and 1966.

A few Baird's beaked whales are known to have been caught incidentally in the Japanese salmon driftnet fishery (from both research and commercial vessels) (Ohsumi, 1975). None has been identified as incidentally taken in any of the high seas pelagic driftnet fisheries in the North Pacific (L. Jones, pers. comm.). A few have been taken in gillnets off California (California Department of Fish and Game records).

Table 6

Statistics for Baird's beaked whales taken in Japanese coastal waters.

Year	Catch	Year	Catch	Year	Catch
1961	133	1971	118	1981	39
1962	145	1972	86	1982	60
1963	160	1973	32	1983	37
1964	189	1974	32	1984	38
1965	172	1975	46	1985	40
1966	171	1976	13	1986	40
1967	107	1977	44	1987	40
1968	117	1978	36	1988	57
1969	138	1979	28	1989	54
1970	113	1980	31	1990	54

ASSESSMENT AND STATUS

Based on sightings data, Miyashita (1986) estimated that 4,220 Baird's beaked whales occurred in the western North Pacific. The most recent estimate of abundance for this species – 5,870 whales in the western North Pacific and adjacent seas (Miyashita, 1990), based on 11 surveys conducted between 1983 and 1989 (IWC, 1991c) was presented to the Committee in 1990. This new estimate included 3,950 (CV=0.28) for the Pacific coast, 1,260 (CV=0.45) for the Sea of Japan and 660 (CV=0.27) for the Okhotsk Sea. The Committee noted that the estimates of 3,950 and 4,220 whales were not statistically different from each other but that they did differ from the estimate of 2,500 from 1989 that was based on data from all months rather than just the survey data for the season of greatest abundance in coastal waters (August).

The CPUE data did not show a clear annual trend from 1947 to 1983 (Kasuya, 1984). It is not known if the population is declining or stable (IWC, 1989).

At the 1985 Scientific Committee meeting, it was noted that the national quota of 40 whales was approximately 1% of the population estimate of 4,220 (Miyashita, 1986). It is 2.4% of the 1989 estimate (2, 500). It was also noted that historically, approximately 70% of the annual catch has been males (Ohsumi, 1983). In the absence of an estimate of gross reproductive rate, the Committee did not know whether or not the population could sustain the present level of catch. During the past five years the average catch in the western Pacific by Japan has averaged about 41 whales. This is around 1% of the population size depending on the estimate used. The corresponding figures for the Okhotsk Sea stock are 8 whales and about 1.2%.

RECOMMENDATIONS

In 1990, the Committee recommended that monitoring of trends in these populations in Japanese waters continue, taking special notice about the complications to stock assessments introduced by migration of animals (IWC, 1991c).

In 1990, the Committee again noted that there was insufficient data to judge whether annual catches of approximately 60 whales are sustainable and recommended 'as in the past (IWC, 1989) that research to develop an understanding of the life history, behaviour and social system that will allow estimation of growth rate potential be continued.' It was also noted that 'this should include continued collection and analysis of data and samples from the catch'. The sub-committee noted that Japan had increased its biological sampling to 100% of the catches; the sub-committee **encourages** continuation of that level of sampling and prompt evaluation and publication of results.

5.1.1.4 *Stenella coeruleoalba*

COMMON NAMES

Striped dolphin, *suji-iruka* or *suzi-iruka* (Japanese).

DISTRIBUTION

This species is found in tropical and warm-temperate waters around the world. In Japanese waters it is associated with the advancing northern front of the warm Kuroshio Current (Miyazaki *et al.*, 1974). During the winter, the northern boundary is around 33°N; during the summer it extends to 46°N. Ohsumi (1972) and Miyazaki *et al.* (1974) suggested that all striped dolphins caught in Pacific Japanese waters belong to one stock. Recently, Kasuya and Miyashita (1989) suggested there were coastal and offshore stocks of striped dolphins off the Pacific coast of Japan.

PROBLEMS AND CATCH STATISTICS

Drive fisheries for small cetaceans have a long history in Japanese waters. The first known drive fishery operated during the Genroku Age (1688–1703), but the types of dolphins caught were not recorded. The first recorded drive fishery for striped dolphins was started by the Kawana fishermen on the Izu Peninsula on 17 December 1888 (Miyazaki, 1983). Ten villages are known to have operated the fishery in the early 1900s (Kasuya, 1985). The number has declined, and since 1984 only Futo has continued to operate. Catch statistics for the Izu area are found in Table 7.

Striped dolphins were also caught in the harpoon fishery off Taiji until 1972. Starting in 1973 a local group of fishermen formed a new drive fishery for these dolphins. Catches by this drive fishery at Taiji between 1963 and 1990 are given in Table 8. The highest catch was 11,017 in 1980. Beginning in 1982 a voluntary catch limit of 5,000 dolphins was set by the fishermen in Taiji based on advice provided by the prefectural government. In 1989 the 5,000 limit became a condition of the license. In addition, the Fisheries Agency of Japan has requested a voluntary limit of 3,100 for 1991. Striped dolphins have made up 15% – 67% of the catch at Taiji between 1982 and 1990. No catch limit has been set for the Izu Peninsula area, but the Fisheries Agency requested a limit of 657 for all species of dolphins for 1991.

Matsuoka stated that these catch limits can be achieved by adjusting the catch by releasing a certain proportion of schools driven into a bay. For example, in early 1991, when

Table 7

Catch statistics for striped dolphins landed along the Izu Peninsula. Statistics are incomplete before 1961. Data for 1942-81 from Miyazaki (1983) and 1982-1990 from Japanese Progress Reports to the IWC.

Year	Catch	Year	Catch	Year	Catch
1942	21,591	1959	21,953	1976	5,175
1943	7,763	1960	14,418	1977	4,020
1944	7,660	1961	10,569	1978	2,028
1945	7,319	1962	8,554	1979	1,300
1946	8,180	1963	8,509	1980	5,278
1947	395	1964	6,428	1981	73
1948	5,892	1965	9,696	1982	246
1949	13,441	1966	8,371	1983	40
1950	15,186	1967	3,664	1984	925
1951	11,899	1968	9,250	1985	578
1952	8,032	1969	3,130	1986	0
1953	4,028	1970	5,348	1987	0
1954	298	1971	3,315	1988	356
1955	2,552	1972	7,235	1989	102
1956	8,507	1973	6,799	1990	0
1957	2,751	1974	11,715		
1958	3,681	1975	5,996		

approximately 2,000 striped dolphins out of 7,000–12,000 sighted were driven into the bay of Taiji, only 600 of them were killed; the rest were released.

Striped dolphins have also been reported taken in gillnets and set nets in Japanese waters (Miyazaki, 1983). Between 1976 and 1981, a total of 772 striped dolphins was taken in fishing gear. Recent reports of incidental catches in various types of gear in Japanese waters are also available (Anonymous, 1990d). Watanabe (1994) has also reported catches in large-mesh drift nets during research cruises in the central North Pacific. Estimates of total catches of striped dolphins in this fishery are not yet available.

ASSESSMENT AND STATUS

The largest directed fishery (both drive and hand-harpoon) for small cetaceans in Japanese waters was that conducted on the striped dolphin, until the Dall's porpoise fishery expanded in the mid 1970s. Kasuya and Miyazaki (1982) estimated that the initial population of striped dolphins off Japan had been 320,000–340,000, but by the late 1970s it was down to between 130,000 and 180,000. At the 1982 Scientific Committee meeting, Kasuya reported that recent life-history and populations studies led him to believe that

Table 8

Catch statistics for striped dolphins landed at Taiji, Japan between 1963 and 1990. Data for 1963-1978 from Miyzaki (1980), 1979-1981 from Miyazaki (1983) and 1982-1990 from Japanese Progress Reports to the IWC.

Year	Catch	Year	Catch	Year	Catch
1963	331	1972	700	1981	4,710
1964	934	1973	727	1982	1,758
1965	642	1974	967	1983	2,179
1966	422	1975	759	1984	2,812
1967	819	1976	1,053	1985	2,639
1968	400	1977	562	1986	2,720
1969	499	1978	1,644	1987	358
1970	997	1979	2,397	1988	1,767
1971	1,717	1980	11,017	1989	1,000
				1990	682

these estimates were unreliable, for the reasons noted below.

The full statistics for the earlier years (before 1961) of the fishery on striped dolphins are not available, but in some years the catches exceeded 20,000 animals. Catch statistics from 1961 onward indicate a statistically significant downward trend in the total catches on the Izu Peninsula between 1961 and 1981, with a high of 11,715 landed in 1974 (Miyazaki, 1983). Catches of around 10,000 in the early 1960s declined to about 1,000 or less after 1980 using the same equipment (four vessels) and driving teams (Kawana and Futo). This decline occurred while the demand for dolphin meat remained high in the area. Kasuya and Miyashita (1989) reported that after the catch of striped dolphins decreased, the people in the Shizuoka area increased their use of Dall's porpoises. Kasuya (1976), Kasuya and Miyazaki (1982) and Kasuya (1985) noted that the striped dolphin population in Japanese waters has declined in abundance due to over-exploitation. Kasuya and Miyashita (1989) reported a hiatus in the density of sightings of this species at about 30°N during the summer, and suggested the possibility that there was another stock to the south of 30°N. They also identified a large number of striped dolphin sightings in the offshore water (145–160°E) between 33° and 40°N. During the same surveys, sightings of striped dolphin were scarce in the Japanese coastal waters. These data suggest that the stock of coastal striped dolphins is depleted and that the striped dolphins found offshore belong to another stock or stocks.

RECOMMENDATIONS

At the 1982 meeting, the Committee noted that the catches of these dolphins had declined over a long time period on the Izu Peninsula, that reproductive parameters had possibly changed in response to this heavy exploitation and that available analyses of CPUE were not adequate to determine the status of the stock (IWC, 1982b). Therefore, it recommended that Japan be urged to collect and analyse more detailed effort data and other relevant information on this species including:

(a) effort data in hours and days, by vessel, area, season and year;
(b) detailed oceanographic data;
(c) data on other major fisheries in the area, especially for squid, and;
(d) information on yearly changes in seasonal abundance, effort and catch.

Noting that catch limits are now voluntary, the sub-committee **advises** the establishment of mandatory catch limits on a species and stock basis, according to the status of the population.

Noting that the fisheries department has not sampled the catch of striped dolphins in ten years, the sub-committee **recommends** that Japan be encouraged to undertake a study of the age and sex composition of the catch and of reproductive parameters of the affected population.

Given reports that there have been changes in drive procedures, and total effort, the sub-committee **requests** an updated description of the drive fishery's current methods and procedure.

5.1.1.5 *Other species*

Several additional species are taken in Japanese direct fisheries (see past Japanese progress reports to the Committee, e.g. Anonymous, 1985a; 1986; 1987b; 1990d).

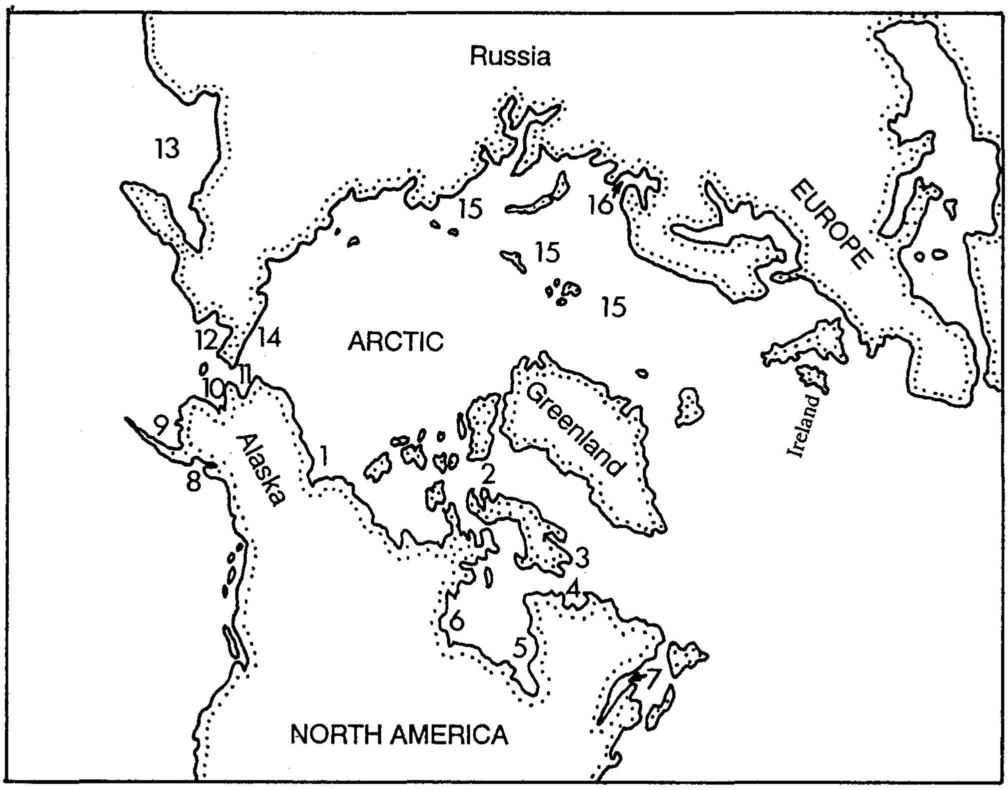

Fig. 1. White whales. Numbers refer to those in Table 9.

For example, 1,274 bottlenose dolphins were taken in drive fisheries in 1990 (SC/43/ProgRep Japan). The impacts of these takes on the populations are unknown.

5.1.2 Direct fisheries for small cetaceans in the Arctic[2]

Two species of small cetacean – the white whale and the narwhal – have distributions centred in the Arctic, and both have been exploited for centuries. In the past, commercial operations took thousands of white whales and hundreds of narwhals in some years. In recent years, most of the hunting for both species has been done by aboriginal peoples for domestic subsistence use and for the sale of muktuk and ivory. This section reviews recent developments in the exploitation of white whales and narwhals throughout their ranges, with emphasis on those areas where an immediate conservation problem is recognised or suspected.

5.1.2.1 *Delphinapterus leucas*

COMMON NAMES

White whale, beluga, belukha (Alaska and USSR), *qilaluaq* or *qaqortoq* (Greenlandic), *qilalugaq* (Inuktitut), *hvidhval* or *hvidfisk* (Denmark), *situaq* (Bering Strait Inupiat), *sisuaq* (Northern Alaskan Inupiat), *cetuaq* (Alaska mainland Yupik).

DISTRIBUTION

The white whale has a circumpolar distribution in the Arctic and subarctic, mainly north of 55°N. The world population is subdivided into at least 16 stocks that are isolated from one another to varying degrees (see Fig. 1 and Table 9). White whales tend to congregate in estuaries in summer, and the resulting aggregations have provided the basis for defining some of the stocks. Most populations are migratory, and their distribution is partly shaped by seasonal changes in ice conditions. Several stocks may mix during winter when they are excluded from the summering areas by ice (IWC, 1980c). For analytical convenience, distribution and other topics are discussed below by country. It is important to bear in mind that some of the stocks occur within the coastal jurisdictions of more than one country.

Greenland

White whales occur infrequently in East Greenland coastal waters, and those that do occur there are considered wanderers from the Svalbard area (i.e., the Barents Sea) (Dietz *et al.*, 1985).

The white whales off the west coast of Greenland belong to a stock probably shared with Canada. They ranged historically all along the coast to at least as far south as Qaqortoq (Julianehaab, *ca* 61°N), where they were hunted in winter (Winge, 1902; Degerboel and Nielsen, 1930). They now occur as far south as Nuuk (Godthaab, *ca* 64°N) only infrequently but are still abundant in outer Disko Bay and in the open pack ice along the Greenland coast south to approximately Sisimiut (Holsteinsborg, *ca* 67°N) in winter (McLaren and Davis, 1981; 1982). Surveys in 1990 and 1991 confirmed that this is the core area for white whales in winter; most animals were observed within 50km of the coast (M.P. Heide-Jørgensen, pers. comm. to Reeves, 30 April 1991).

Canada

Seven white whale stocks are provisionally recognised in Canada, based on varying degrees of difference in body sizes, catch histories and hiatuses in distribution. These are Beaufort Sea-Mackenzie Delta, High Arctic (Lancaster Sound region), Southeast Baffin (Cumberland Sound, Frobisher Bay and Lake Harbour area in Hudson Strait – see Richard and Orr, 1986), Ungava Bay, East Hudson Bay-James Bay, West-South-North Hudson Bay (=West

[2] Initial draft by R.R. Reeves.

Table 9

Status of world white whale stocks (modified from Braham, 1984). Fig. 1 shows the stock areas. Status: (A) large (3000+) and lightly or sustainably exploited; (B) large and exploited at rates that give cause for concern; (C) medium (500-3,000) and lightly or sustainably exploited; (D) medium and exploited at rates that give cause for concern; (E) small (500 or less) and vulnerable to hunting or habitat deterioration.

	Est. abundance		Est. ann. removal rate			
Centre of Summer distribution	Init.[1]	Current	Kill	(% stock size)	Refs	Status
Canada						
1. Beaufort Sea/Mackenzie Delta	--	11,500	232[2]	2.0	1,2	A
2. High Arctic/West Greenland	12,000	6,300-18,600	1,200[3]	6.5-19.0	3,4,5	B
3. SE Baffin	5,000	500	92-119	18-24	6,7	E
4. Ungava Bay	1,000	low	50+	high	8,9	E
5. E Hudson Bay/James Bay	6,600	1,864-3,874	199-203[4]	5.1-10.9	9,10	D
6. W, S and N Hudson Bay	--	25,000[5]	431-9[6]	1.7	11	A
7. St. Lawrence R.	5,000	500	0	0	12,13	E
Alaska (USA)						
8. Cook Inlet	--	300-400	10-15[7]	2.5-5.0	14	E
9. Bristol Bay	--	1,000-1,500	7-9[8]	0.5-1.0	2,15,16	C
10. Norton Sound/Yukon Delta	--	2,000[9]	155-181[8]	?	2,15,16	?
11. E Chukchi Sea	--	2,500-3,000	91-94[8]	3.0-3.8	2,15,16	?
USSR						
12. Anadyr Gulf (Bering Sea)	--	2,000-3,000	low	low	17	C
13. Sea of Okhotsk	--	25,000-30,000	low	low	18	A
14. E Siberian (W Chukchi and E Siberian Seas)	--	2,000-3,000	150[10]	5-7.5	19,20	?
15. W Siberian (Barents, Kara and Laptev Seas)	--	7,000-10,000	?	?	17	?
16. White Sea	--	500-1,000	?	?	17	?

[1]Based on cumulative catches, to be regarded as minimum estimates of pre-exploitation population size.
[2]Assumes an average catch of 123 per year in Mackenzie Delta, 1985-89, corrected on the basis of 1 killed and lost for 4 landed (ref. 21), giving an estimated total kill (ETK) of 151. Assumes an average catch of 43 (40-46) in Alaskan waters, 1987-90 (Table 4), corrected on the same basis as in Ref. 2:table 5, giving an ETK of 81.
[3]Assumes an average catch of 813 per year in West Greenland (Table 2, 1975-85); corrected on the basis of a 25% loss rate (1 killed and lost for 3 landed) (ref. 5), giving an ETK of 1084. Assumes an average catch of 87 per year in Canada, 1974-87 (Table 3); corrected on the basis of a 25% loss rate, giving an ETK of 116.
[4]Assumes that 40% of the catch in Hudson Strait and 100% of the catch on the east side of Hudson Bay is from this stock (Table 3). A loss rate of 30% of the total kill is applied arbitrarily.
[5]Combines estimates for west, south and north Hudson Bay (ref. 11).
[6]Assumes that 60% of the catch in Hudson Strait and 100% of the catch in western and northern Hudson Bay is from this stock (Table 3; and see text). A loss rate of 30% of the total kill is applied arbitrarily.
[7]Based on total kill estimate of 10 (ref. 14) and secured catch estimate 10-12 (ref. 15).
[8]Catches from Table 4, corrected for hunting loss by ETL:ETK ratio of Ref. 2:Table 5. Norton Sound loss rate may have declined in recent years with the use of aeroplanes to locate animals that sink during the hunt (ref. 21).
[9]Considered to include Kuskokwim Delta. Population estimate is not based on survey data; a single sighting of more than 2000 white whales was made near the mouth of the Yukon River in 1956 (ref. 21)
[10]Based on a guesstimate for the total annual kill at or near Sireniki in the mid-1980s (ref. 20).

References: 1. Davis and Evans (1982), 2. Lowry *et al.* (1989), 3. Reeves and Mitchell (1987c), 4. Smith *et al.* (1985), 5. Heide-Jørgensen (1990), 6. Mitchell and Reeves (1981), 7. Richard (1991), 8. Reeves and Mitchell (1987b) and Anonymous (1987), 9. Smith and Hammill (1986), 10. Reeves and Mitchell (1987a), 11. Richard *et al.* (1990), 12. Reeves and Mitchell (1984), 13. Sergeant and Hoek (1988), 14. Hazard (1988), 15. K.J. Frost (*in litt.* to Reeves, 1 April 1991), 16. Frost and Lowry (1990), 17. Yablokov (1979), 18. Ivashin (1990), 19. Ivashin (1988), 20. Burns and Seaman (1985), 21. K.J. Frost (*in litt.* to Reeves, 1 May 1991).

Hudson Bay in previous IWC reports) and St. Lawrence River. There is considerable uncertainty about the relations among the groups of whales in Hudson Bay and adjacent waters (Richard *et al.*, 1990). The delineation of stocks based on body size differences (Sergeant and Brodie, 1969) has been found by Doidge (1990) to be less useful for some stocks than was thought previously. However, white whales in Hudson Bay are consistently smaller than those in other areas studied. Preliminary attempts to use mitochondrial DNA markers to distinguish white whale stocks suggested that white whales in eastern Hudson Bay are distinct from those in the Mackenzie Delta, western Hudson Bay, Cumberland Sound and Jones Sound (Helbig *et al.*, 1989). The Beaufort Sea-Mackenzie Delta stock is shared with Alaska (USA) and possibly the USSR; the High Arctic stock probably with Greenland.

The winter and spring distribution of the Hudson Bay, Ungava Bay and SE Baffin populations is centred in Hudson Strait, the Labrador Sea and Davis Strait (Boles, 1980; Finley *et al.*, 1982; Richard and Orr, 1986), although some white whales overwinter in Hudson and James bays (Reeves and Mitchell, 1989a). Whales from several stocks may have a common wintering area. Those that summer in the Canadian High Arctic and off northwest Greenland probably winter primarily along the east side of Baffin Bay and Davis Strait in open water or unconsolidated pack ice. Some winter in the Baffin Bay North Water (Vibe, 1950; Freeman, 1968; Finley and Renaud, 1980).

Alaska (USA)

Four provisional management stocks are recognised in Alaskan waters, in addition to the Beaufort Sea-Mackenzie Delta stock shared with Canada. These are the Cook Inlet, Bristol Bay, Norton Sound-Yukon Delta and eastern Chukchi Sea stocks (Hazard, 1988; Lowry *et al.*, 1989). All the populations except the one in Cook Inlet are believed to winter mainly in the Bering Sea. The evidence for stock differences is mainly the discontinuity of summer distributions (Lowry *et al.*, 1989; Frost and Lowry, 1990). Burns and Seaman (1985) have argued that all the 'stocks' that winter in the Bering Sea comprise a single genetic population, although no direct genetic evidence is available to evaluate this argument.

USSR

White whales are widely distributed along the Soviet Arctic coast, and they have been exploited intensively in many areas (Ivashin and Mineev, 1981; Ognetov and Potelov, 1984). The estuaries of all the major rivers along the coast of Siberia are said to be visited by white whales in summer. Yablokov (1979) proposed eight stocks in Soviet waters, as follows: White Sea (2), West Siberian (Barents-Kara-Laptev seas) (2, possibly 3), East Siberian (Chukchi-East Siberian seas), Anadyr Bay (Bering Sea) and Sea of Okhotsk (2). Berzin *et al.* (1986) showed major concentrations in three areas of the Okhotsk Sea: Sakhalin-Amur, Shantar and the northern bays (Gizhiginskaya and Penzhinskaya). Five stocks are provisionally listed in Table 9, pending a more detailed justification for subdividing them.

The East Siberian and Anadyr Bay stocks probably winter mainly in the Bering Sea, where they could mix with whales belonging to the Alaskan stocks (Burns, 1984; Burns and Seaman, 1985; Hazard, 1988). Some white whales overwinter in offshore areas of the Barents, Chukchi and probably Kara seas (Belikov *et al.*, 1990).

PROBLEMS AND CATCH STATISTICS

Greenland

Preliminary summaries of white whale catch statistics for Greenland have been published by Kapel (1977; also see Kapel *in* Reeves and Mitchell, 1987b). Reported secured catches for 1975–87 are summarised in Table 10. These are consistent with the estimate of recent annual catches of 500–1,000 by Heide-Jørgensen (1990). The completeness and reliability of the Greenland catch statistics has declined in recent years as fewer hunters have participated in the reporting scheme (E.W. Born, *in litt.* to Reeves, 3 October 1985; Heide-Jørgensen,MP, 1990). The reporting system is no longer functioning reliably. High catches have been made in some years at *savssats* (ice entrapments) in Disko Bay (e.g. about 500 in February 1990 – M.P. Heide-Jørgensen, pers. comm. to Reeves, 30 April 1991). Most of the Greenlandic catch of white whales (except for *savssats*) is made in the drive fishery in Upernavik district (Heide-Jørgensen, 1990).

The demand for white whale muktuk and meat in Greenland is strong and likely to grow along with the human population. Although much of it is consumed in the villages after being shared according to local customs, some is also sold for resale in urban centres (Dahl, 1989). There are no catch limits. Local regulations and customary rules govern some aspects of the hunting (Dahl, 1990; Qujaakitsoq, 1990), but these may not be adequate in the light of changing hunt technology and consumption patterns (Dahl, 1990; Heide-Jørgensen, 1990).

Canada

White whales are protected from commercial hunting under the Beluga Protection Regulations (Fisheries Act) introduced initially in 1949 and amended many times since (Reeves and Mitchell, 1989b; Department of Fisheries and Oceans, 1990a). The St. Lawrence stock was given full protection from exploitation in 1979 and a quota of 40 whales per year (secured catch; no allowance for hunting loss) was set for Pangnirtung in Cumberland Sound in 1980. The reported catch since 1980 at Pangnirtung has exceeded the quota in some years (Richard and Orr, 1986; Cosens *et al.*, 1990). White whale products cannot be exported from the Northwest Territories (NWT) but are traded or sold within the NWT. Some is shipped to urban centres where it is sold (Reeves, unpubl. data).

Prior to 1975, there was no monitoring or reporting of catches in northern Quebec (primarily East Hudson Bay – James Bay, West-North and South Hudson Bay and Ungava Bay stocks in Tables 9 and 11). Estimates of secured catches in 13 northern Quebec communities were derived from 'harvester recall' surveys and a self-monitoring programme begun in 1975 (Boulva, 1981; Usher and Wenzel, 1987). The introduction of regular reporting from northern Quebec in the mid-1970s may give the impression of a dramatic increase in the total Canadian white whale catch, but there is no reason to believe that

Table 10

Reported white whale catches in Greenland, 1975-87, from IWC Denmark progress reports. For previous years, see Kapel (1977). Note that figures listed for 1983-85 are estimates which include an allowance for unreported catches (but not for hunting loss). The figures for 1986 and 1987 are incomplete and preliminary.

	Year												
Area[1]	75	76	77	78	79	80	81	82	83	84	85	86	87
West Greenland													
N Greenland	-	50/yr[2]	-	20	25	30	76	127	53	21	190	?	?
NW Greenland	169	89	289	148	272	291	438	346	252	348	194	244	563
CWe Greenland	105	154	108	231	195	210	198	200	100	158	50	?	?
CWw Greenland	163	799	271	221	184	202	142	113	94	194	127	114	29
SW+S Greenland	167	120	122	99	65	156	163	108	102	42	50	2	14
Total	654	1212	840	719	741	889	1017	894	601	763	611	378	606
East Greenland													
Ammassalik	2	1	1	0	0	0	0	5	0	0	0	15	76
Scoresbysund	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	2	1	1	0	0	0	0	5	0	0	0	15	76

[1]For communities assigned to each area, see Kapel (1977). [2]Annual estimate - Kapel (1983).

Note: The relatively large catches assigned to Ammassalik in 1986-87 are in error. (M.P. Heide-Jørgensen, pers. comm. to Reeves, 30 April 1991). West Greenland catches for 1988-90, as estimated by the Greenland Fisheries Research Institute, are: West Greenland - 275 in 1988, 457 in 1989 and 1,000 in 1990.

catches in northern Quebec were much different immediately before 1973–74 than since then.

A confounding aspect of the catch statistics for settlements along the coasts of northern Hudson Bay and Hudson Strait is that more than one management stock uses these areas (Finley *et al.*, 1982; Anonymous, 1987a; Richard *et al.*, 1990). Attempts to prorate catches and assign them to the different stocks are made difficult by the lack of an easily applied genetic, morphometric, behavioural or other marker.

Statistics on catches of white whales in Canada before 1972 are imprecise and incomplete. In 1972 the federal Department of Fisheries and Oceans assumed responsibility for compiling information on white whale catches (Kemper, 1980; Usher and Wenzel, 1987). Before then, the compilation of such data was idiosyncratic or unreliable. The pre-1972 data (e.g. as reported in *International Whaling Statistics* – see Reeves and Mitchell, 1987b; Strong, 1989) should be discounted or interpreted cautiously, particularly in evaluating year-to-year variability or trends through time. Although a more systematic effort has been made since 1972 to document the white whale harvest (Table 11; Strong, 1989), the problem of incomplete reporting of landed catches remains in some areas (Usher and Wenzel, 1987).

Before Canada's withdrawal from the IWC, catches of white whales and other whales were reported and published annually in the Canadian progress reports. Although a progress report has continued to be compiled and submitted annually to the IWC (Department of Fisheries and Oceans, 1990b) the most recent published report was in 1984 (Goodman, 1984). Catches are included in the Tables of reported catches worldwide published each year as part of the report of the sub-committee on small cetaceans (e.g. IWC, 1989).

Alaska (USA)

The quality and regularity of Alaskan catch statistics have improved over the past 15 years (see Seaman and Burns, 1981; Feldman, 1986; Hazard, 1988; Lowry *et al.*, 1989). K.J. Frost (*in litt.* to Reeves, 1 April 1991) reports good cooperation with hunters in obtaining accurate catch statistics for recent years (Table 12). Because of the improved reporting, comparisons of catch levels through time should be made with caution.

USSR

Catch figures provided by the USSR are difficult to interpret because little information is available concerning the hunting methods, effort, product utilisation etc. The official catch totals (e.g., Ivashin and Mineev, 1981; IWC progress reports e.g. Ivashin, 1986) presumably reflect mostly or entirely commercial catches. The totals given by Ivashin and Mineev (1981) are separated into a vessel catch in the western areas and a shore-based catch in all areas. Catches by aborigines and others for subsistence, if they occur (cf. Ivashin and Shevlyagin, 1987), may be under-reported or unreported. Burns and Seaman (1985) referred to a report received in 1985 that 25–30 white whales were taken annually at Sireniki, on the southeast coast of Chukotka. The same source confirmed that although white whales are occasionally hunted at other localities in the Bering and Chukchi seas, the average number taken is very low. The opportunistic hunt at a *savssat* in the Bering Strait region in winter 1984–85 resulted in a catch of 506 whales and an estimated 500 more dead due to 'hunger, lack of air and injuries' (Ivashin and Shevlyagin, 1987). After reviewing available information, Burns and Seaman (1985) concluded that the Soviet harvest in the Bering and Chukchi seas was on the order of 60 white whales per year in the mid-1980s. They considered it likely that 60% of the whales killed were lost (see below), indicating a total kill of about 150 per year.

Berzin (1981) implied that commercial hunting for white whales ended in the Soviet Bering and Okhotsk seas in 1963. However, the table of catches published by Ivashin and Mineev (1981) shows no catch for the Bering Sea from 1960 to 1972, then a total catch of 160 between 1973 and 1980. For the Okhotsk Sea, it shows no catch from 1960 to 1963, then a total catch of 293 between 1964 and 1969 and no catch from 1970 to 1980. Commercial catching apparently continued in the White and Kara seas through the mid 1980s (Table 13). Yablokov's (1979) summary of annual catches in Soviet waters, apparently referring to the

Table 11

Reported catches of white whales in Canada, 1974-87. See note for communities included within each statistical area.

	Year													
Area	74	75	76	77	78	79	80	81	82	83	84	85	86	87
W Arctic[1] (Beaufort Sea/ Mackenzie Delta)	128	154	154	148	129	144	85	155	126	86	142	129	157	144
E High Arctic[1]	144	60	58	61	48	86	16	158	101	106	123	121	75	58
SE Baffin[1]	200	80	171	204	93	107	74	105	66	44	51	72	65	110
Hudson Strait[2]	277	327-429	229	314	158	153	195	158	216	228	170	142	74	
Ungava[2]	92	130-163	184	194	37-38	78	60	79	58	43-45	29	32	42-44	
E Hudson Bay[2]	119	126-139	143	181	118-124	211	220	61	73	69	97	62	32-33	
W+N Hudson Bay[1]	164	94	152	191	112	105	137	211	158	196	324	263	238	238

Note: W Arctic - Aklavik, Inuvik, Tuktoyaktuk, Paulatuk, Holman; E High Arctic - Clyde River, Coppermine, Pond Inlet, Arctic Bay, Grise Fiord, Resolute, Creswell Bay, Spence Bay, Hall Beach, Igloolik, Pelly Bay; SE Baffin - Pangnirtung, Iqaluit, Lake Harbour, Broughton Island; Hudson Strait - Cape Dorset, Ivujivik, Salluit, Kangiqsujuaq, Quaqtaq; Ungava - Kangirsuk, Aupaluk, Tasiujaq, Kuujjuaq, Kangirsualujjuaq, Killiniq; E Hudson Bay - Sanikiluaq, Kuujjuarapik, Umiujaq, Inukjuak, Povungnituk, Akulivik; W and N Hudson Bay - Churchill, Eskimo Point, Whale Cove, Rankin Inlet, Chesterfield Inlet, Repulse Bay, Coral Harbour.

[1]Strong (1989), [2]Reeves and Mitchell (1989b)

1970s, indicated: 100–300 along Kanin Peninsula in trap nets; 10–15 in Onega Bay and other parts of the White and Barents seas by rifle; 200–400 in trap and gillnets and 20–50 by rifle in the Kara and Barents Seas (Yenisey and Pyasina bays); 100 or less in the Laptev, East Siberian and Chukchi seas by rifle; 20–50 in the Bering Sea by rifle; and 100 or less in the Sea of Okhotsk in seines. The total annual catch in all areas of the USSR, according to Yablokov (1979), was 550–1,015.

According to Ivashin and Mineev (1981), the commercial exploitation of white whales is regulated by catch limits, although for unstated reasons the quotas have almost always been higher than the actual catches.

Table 12

Recent landed catches of white whales in Alaska (AIBWC via K.J. Frost, in litt. to Reeves, 1 April 1991). For data from earlier years, see Seaman and Burns (1981) and Lowry *et al.* (1989). Frost (in litt. to Reeves, 1 April 1991) considers the data for 1987-90 the most complete ever available for Alaska.

Year	Beaufort[1]	E Chukchi	Norton Sd/ Yukon Del.	Kusko- kwim Del.[2]	Bristol Bay	Cook Inlet
1987	31-52	78	60-68	3-5	6	8-10
1988	67	69	200-223	13-20	5-10	12-13
1989	26-30	48-53	141-169	12	6	11-13
1990	34-35	99	85-101	0	4	10-12
4/yr ave.:	40-46	74-75	122-140	7-9	5-7	10-12

[1]Taken from the same stock as those reported for Canadian Western Arctic (Table 11).
[2]Could belong to either Norton Sound/Yukon Delta or Bristol Bay stock.

Table 13

Reported white whale catches in the USSR, 1960-88, from Ivashin and Mineev (1981) and IWC USSR progress reports. WBK - White, Barents and Kara Seas (vessel fishery); Yen - Yenisey Gulf (Kara Sea); White - White Sea; Bar - Barents Sea; Ch - Chukchi Sea; Bering - Bering Sea; Okhotsk - Okhotsk Sea; B + K - Barents and Kara Seas; Kara - Kara Sea.

	Area								
Year	WBK	Yen	White	Ch	Bering	Okhotsk	Bar	B+K	Totals
1960	2,382	324	840						3,546
1961	1,732	319	18						2,069
1962	1,143	314	21						1,478
1963	1,030	254	223						1,507
1964	2,322	253	662			94			3,331
1965	1,510	929	297			6			2,742
1966	905	35	609			35			1,584
1967		608	166						774
1968		56	30			101			187
1969		43	167			57			267
1970		67	850						917
1971		53	458						511
1972		36	518						554
1973		42	155	4	15		197		413
1974		24	146	2	17		9		198
1975		74	91						165
1976		170	302		21		38		531
1977	457	64	215		29				765
1978		19			32				51
1979		74	179		26				279
1980	60	81	75		20				236
1981									-
1982			139		53		13	73 *	278
1983			24		12		2	183 *	221
1984					33		1	300 *	334
1985			110		506	29		74 **	719
1986			172		3		3		178
1987			27		3		4		34
1988			3		5				8
	11,541	3,839	6,497	6	775	322	267	640	23,877

* Barents + Kara; ** Kara only.

Hunting loss in all areas

Estimated loss rates for white whale hunting in Greenland ranged from 14 – 19% in West Greenland south of Thule and were less than 10% for the Thule district (IWC, 1980c:appendix 4). Set nets used in Upernavik for catching white whales (Kapel, 1985) presumably cause few losses. Communal hunts using boats to drive whales or trap them in shallow water before killing them with rifles (as described by Oldendow [1935] and Dahl [1990] for the Disko Bay area and by Heide-Jørgensen [1990] for Upernavik district) also may result in relatively small losses. On the other hand, the winter and spring hunting over deep water (at *savssats* or along an ice edge) results in substantial hunting loss (Kapel, 1977). 'As a preliminary figure an overall loss rate of 25% seems reasonable for white whales' (Heide-Jørgensen, 1990).

Seaman and Burns (1981; also see IWC, 1980c, Appendix 5) reported much higher losses for white whales killed in deep water, such as when they are hunted by seal or bowhead hunters during spring, than for those killed in shallow coastal water during open-water hunts. They estimated loss rates of 60% for deep-water hunting and 20% for shallow water hunting. Their estimated total kills were based on the assumption that for all parts of Alaska, one-fourth to one-third of the white whales are taken in deep water and two-thirds to three-fourths in shallow water. Lowry *et al.* (1989) provided estimates of loss rates on a finer scale than that of Seaman and Burns (1981). They considered losses in nets (some set deliberately to catch white whales, others intended mainly to catch fish, with white whales being caught incidentally) to be negligible. Also, they estimated the loss rate for open-water hunting from boats in areas with deep, muddy water (e.g., the Yukon-Kuskokwim Delta and Bristol Bay) to be 40%. In estimating catches throughout Alaska, Lowry *et al.* (1989) applied appropriate loss rates to each harvesting situation. However, it should be noted that the loss rates applied by Burns and Seaman (1981) and Lowry *et al.* (1989) were somewhat subjective.

According to K.J. Frost (*in litt.* to Reeves, 1 May 1991) the loss rate of 20% for shallow-water hunting in parts of the eastern Chukchi Sea and Northern Sound is probably too high, particularly since small aeroplanes have been used in recent years to search these areas after the hunt to find any animals that were killed but not secured. She suggests 10% as a more appropriate estimate.

For the Mackenzie Delta, Fraker (1980) reported estimates by hunters of loss rates (percentage of killed whales that were not secured) of 32% (1973) and 27% (1977). Fraker suggested that Hunt's (1979) estimate of a 40% loss rate in the Mackenzie Delta hunt included an allowance for injured animals that escaped but eventually died from their wounds (c.f. Brodie, 1981). Fraker considered a loss rate of 33% appropriate for correcting catch statistics for this area. More recent monitoring of the Mackenzie Delta hunt has resulted in loss rate estimates of 20 to 38% of the landed catch (Strong, 1990; Weaver, 1991). Weaver (1991) attempted to account for orphaned calves by noting the number of lactating females taken, then counting their calves part of hunting mortality. The

Fisheries Joint Management Committee has funded systematic collection of data on harvest and loss in recent years. For 1985–89 the average catch was 123 (116–133) and the average number struck and lost was 28 (17–38); this would suggest 1 whale lost for every 4 landed (Alaska and Inuvialuit Beluga Whale Committee, via K.J. Frost, *in litt.* to Reeves, 1 May 1991).

For the SE Baffin region, during hunts monitored both in and outside Clearwater Fiord, the main hunting area, in 1982–84, only one instance was reported of a white whale being killed but lost (by sinking) (Orr and Richard, 1985). Most killed whales floated and thus were relatively easy to secure (c.f. Brodie, 1981). Burns and Seaman (1985) queried Orr and Richard's conclusion, noting

'In our experience, whales that sink before being harpooned or speared, would not be seen unless they were subsequently grappled, or floated to the surface, usually a day or more after death.'

Richard and Orr (1986) noted that losses were higher in hunts conducted in and near Cumberland Sound outside Clearwater Fiord. The overall loss rate for this stock may be in the order of 10–30% of the total kill (Richard, 1991a).

No data are available for the USSR. In areas where trap and gillnets have been used to capture white whales (e.g., White, Barents, and Kara seas – Yablokov, 1974; 1979; Mitchell, 1975a), the loss rate presumably has been low. However, in those areas where the whales are hunted with rifles, hunting loss must be significant (cf. Burns and Seaman, 1985; see above).

POPULATION ESTIMATES

Greenland

No independent estimate of population size for white whales in Greenlandic waters is available. Heide-Jørgensen (1990) considered the estimate by Smith *et al.* (1985) for the Canadian High Arctic stock as applicable to West and North Greenland, on the still unproven assumption that the whales found as far west as Peel Sound and Barrow Strait in summer migrate east and south in the fall to winter off West Greenland. McLaren and Davis (1981; 1982) surveyed a large area of northern Davis Strait and southern Baffin Bay in March 1981. They estimated that about 2,400 white whales were present in waters south of 70°N, north of 66°N and east of 55°30′W; their estimate made no allowance for animals that were submerged or under the ice. Surveys in 1990 and 1991 of the same area using similar methods revealed an approximately 40% decline in the number of white whales present (M.P. Heide-Jørgensen, pers. comm. to Reeves, 30 April 1991).

Canada

The stock summering in the Mackenzie Delta and eastern Beaufort Sea has been estimated recently at 11,500 (Davis and Evans, 1982).

A detailed reconstruction of the catch history in western Hudson Bay and Foxe Basin revealed no pattern of intensive exploitation and depletion that could be used for a cumulative catch estimate (Reeves and Mitchell, 1989a). The highest documented kill for any decade before 1949, when the commercial white whale processing plant at Churchill began operations, was somewhat less than 1,600 whales taken at York and Churchill, combined, in the 1880s. Richard *et al.* (1990) estimated the white whale population in western Hudson Bay as more than 23,000 in 1987. They also estimated summering populations in northern Hudson Bay of more than 700 and southern Hudson Bay of more than 1,300. These three areas have been treated as a single stock area in Table 9.

Cumulative catches indicate a minimum population in southeastern Hudson Bay (mainly summering in the Great Whale and Little Whale river estuaries) of 6,600 in the 1850s (Reeves and Mitchell, 1987c). Aerial surveys in summer 1985 produced current estimates of 1,123 (95% confidence limits 740–1,970) in James Bay and 1,124–1,904 (offshore estimate plus estuarine count) in eastern Hudson Bay south of 59°N (Smith and Hammill, 1986). The totals for southeastern Hudson Bay and James Bay are combined for an estimate of the East Hudson Bay – James Bay stock (Table 9).

At least 800–1,000 white whales summered in southern Ungava Bay during the 1870s (Reeves and Mitchell, 1987a). Systematic and coastal reconnaissance aerial surveys of Ungava Bay in the late 1970s and early 1980s suggested a remnant population of less than 50 (Finley *et al.*, 1982; Smith and Hammill, 1986).

At least 5,000 white whales summered in Cumberland Sound (SE Baffin stock) in the early 20th century, judging by the catches made in this area (Reeves and Mitchell, 1981). The most recent estimate of population size, based on aerial photographic surveys in 1985–86, is less than 500 (Richard *et al.*, 1990).

Alaska (USA)

Population estimates for all Alaskan coastal stocks were provided by Hazard (1988) and Lowry *et al.* (1989) (see Table 9). Additional surveys summarised by Frost and Lowry (1990) and Frost *et al.* (1991) gave no reason to change the earlier estimates. Surveys planned for 1991 should provide additional data for Cook Inlet and the eastern Chukchi Sea. It should be noted that there is no recent basis for the Norton Sound/Yukon Delta stock estimate; this area has never been properly surveyed for white whales (K.J. Frost, *in litt.* to Reeves, 1 May 1991).

USSR

Yablokov (1979) stated that there were no good census data from Soviet Arctic waters. He guessed that some 1,000–2,000 white whales summered in the East Siberian and western Chukchi Seas and some 2,000–3,000 in the Soviet Bering Sea. Burns (1984) assumed that at least 3,000–4,000 white whales were present in summer in offshore waters of the western Beaufort, northern Chukchi and East Siberian seas and that another 6,000-8,000 were present in coastal waters along the Asian sides of the Chukchi Sea, Bering Strait and Bering Sea, including Wrangel Island (Burns and Seaman, 1985). Gaev *et al.* (1987), as summarised by Ivashin (1990) claimed that white whales were rare in coastal waters around Wrangel Island, although Berzin (1981) cited reports of migrating herds of up to 500 white whales seen southeast of Wrangel Island in October 1960. An estimated 2,500–3,000 white whales became trapped in ice in Senjavin Strait along the eastern coast of Chukotka in December 1984 (Ivashin and Shevlyagin, 1987)

Results of aerial surveys in 1987 suggested a Sakhalin-Amur population of not more than 7,000–10,000 white whales (Popov, 1990). In addition, it was estimated that there were 3,000–5,000 white whales in the Shantar Islands area in 1987 and roughly 15,000 in the northern Sea of Okhotsk. Thus, the total estimated current population in the Okhotsk Sea is 25,000–30,000. However, the reliability of this estimate is uncertain.

Ognetov and Potelov (1984) referred to observations of a few hundred to several thousand white whales in different areas of the Kara Sea at different times, but they gave no recent population estimate for the Kara Sea stock. Judging by the large commercial catches summarised by Kleinenberg *et al.* (1968) for the Kara Sea in the 1930s (1,922 in Yenisei and Pyasina bays from 1930 to 1936; 2,092 in the Gulf of Ob from 1931 to 1935) and 1950s (743 near Dickson Island from 1953 to 1958), the Kara and Barents seas combined in the 1950s (3,664 from 1953 to 1959 by vessels of the Arkhangel'sk and Tyumen Sovnarkhozes) and near Svalbard by Norwegian vessels after World War II (3,407 from 1945 to 1960 [Lønø and Øynes, 1961]), the West Siberian stock must have been very large historically. Yablokov (1979) estimated current stock sizes of 500–1,000 for the White Sea and 7,000–10,000 for the Barents-Kara-Laptev Seas.

ASSESSMENT AND STATUS

In general, white whale stocks can be assigned to five categories: (A) large (3,000+) and lightly or sustainably exploited; (B) large and exploited at rates that give cause for concern; (C) medium (500–3,000) and lightly or sustainably exploited; (D) medium and exploited at rates that give cause for concern; (E) small (500 or less) and vulnerable to hunting or habitat deterioration. Of the 16 stocks tentatively identified (Table 9), at least 3 are in category A, 1 in B, 2 in C, 2 in D and 4 in E.

Greenland

Using annual estimates of 875–1,500 whales killed from a population of 6,300–18,600 whales (Smith *et al.*, 1985), and citing estimates of permissible exploitation rates of 2% for white whales (IWC, 1984b) and 3–4% for narwhals (Kingsley, 1989), Heide-Jørgensen (1990) concluded that the Canadian High Arctic-West Greenland white whale population is being exploited at a level above sustainable yield. White whales have virtually disappeared from the southern districts of West Greenland where large catches were made in the 19th and early 20th centuries (Kapel *in* Reeves and Mitchell, 1987b). Catches listed for South and Southwest Greenland in recent years (Table 10) indicate mainly catches made by hunters who travelled to the more northern districts for hunting (M.P. Heide-Jørgensen, pers. comm. to Reeves, 30 April 1991).

Three factors that may cause white whale catches in Greenland to increase are: the high and increasing price of muktuk, the improved technology for hunting white whales and transporting muktuk, and the expansion of freezer facilities allowing preservation of muktuk in most settlements (M.P. Heide-Jørgensen, pers. comm. to Reeves, 30 April 1991).

Alaska

Major reviews of the status of white whales in Alaskan waters have been published recently (Seaman and Burns, 1981; Hazard, 1988; Lowry *et al.*, 1989; Frost and Lowry, 1990). The Beaufort Sea/Mackenzie Delta stock shared with Canada is not considered to be in jeopardy at present (see below). Of the other four provisional stocks in Alaska, the Norton Sound-Yukon Delta stock is of greatest concern because there is no reliable stock estimate and there are substantial removals. For the other three, the stock estimates are far more current and reliable and harvest levels have been relatively stable in recent years (Lowry *et al.*, 1989; Frost and Lowry, 1990)

Aerial survey results, hunter information and reduced catch levels have been interpreted to indicate a decline in the use of southeastern Kotzebue Sound by white whales (eastern Chukchi Sea stock) (Lowry *et al.*, 1989; Frost and Lowry, 1990). Local informants have suggested that boat traffic, noise and other disturbances (Burns and Seaman, 1985; Frost and Lowry, 1990) have contributed to this decline in local availability of white whales. When this migratory stock has been surveyed farther north off Point Lay, there has been no indication of a substantial change in numbers between 1979 and 1990 (Frost and Lowry, 1990; Frost *et al.*, 1991).

Frost and Lowry (1990) concluded that the Bristol Bay stock is stable at or near its historical size. The Cook Inlet stock has been small (a few hundred) for a considerable time (at least 25 years) (Hazard, 1988).

The Alaska and Inuvialuit Beluga Whale Committee (AIBWC) was established in 1988 with the objectives of conserving white whales and their habitat and preserving traditional white whale hunting in Alaska and the western Canadian Arctic. A draft management plan has been published (Anonymous, 1990b). This plan includes provisions for ensuring full reporting of catches (including struck but lost whales), reduction of hunting loss and monitoring of populations. Harvest levels are to be based on 'the number of animals in the populations and cultural and nutritional needs.'

Canada

Exploitation of the Beaufort Sea stock within Canadian waters is managed under the Inuvialuit Final Agreement of 1984, which entrenches the preferential rights of the Inuvialuit to harvest white whales and to sell or barter the products of the harvest to other beneficiaries of the claim, and commits the Canadian federal government to a process of joint management with the Inuvialuit (Anonymous, 1984). The Inuvialuit are also represented in the AIBWC (see above). Recent reviews have concluded that this stock is large and healthy and that its rate of exploitation is within sustainable limits (Fraker, 1980; Finley *et al.*, 1987; Lowry *et al.*, 1989).

The relatively large Canadian High Arctic population is thought to be shared with Greenland (see Greenland section above). It is expected that problems associated with the management of this stock's exploitation will be a principal concern of the Greenland-Canada Joint Commission on Conservation and Management of Narwhal and Beluga (Lemche, 1991).

A scientific advisory committee within the Canadian Department of Fisheries and Oceans (DFO) stated in its prognosis for the SE Baffin stock:

> 'Pre-exploited' stock size is irrelevant to the current management decisions because unknown ecosystem changes may have altered carrying capacity, and 'historical' levels may no longer be attainable (Cosens *et al.*, 1990).

Rather than using a target level related explicitly to the minimum estimated pre-exploitation population size of 5,000, the committee recommended a target level of 'a few thousand (e.g. 3,000), to provide an adequate buffer from ... natural hazards.' To achieve the objective of allowing this limited recovery, the committee recommended complete closure of the white whale hunt in Pangnirtung and Iqaluit and a closed season from June to October in Lake Harbour. In addition, it recommended that the stock not be allowed to fall below its current level of 400–500 in the late 1980s. Richard (1991a) has predicted that continued hunting could extirpate the stock in less than a decade. However, the expected decline in the population due to hunting removals of around 100 per year during the 1980s apparently did not occur. Results of aerial photographic surveys in August 1990 were similar to those of surveys conducted in 1979–82 (Richard and Orr, 1986; P. Richard, pers. comm., 22 April 1991). In 1990, following a decision of the Nunavut Wildlife Management Board, DFO introduced annual quotas of 5 white whales each for Iqaluit and Lake Harbour and reduced the quota for Pangnirtung from 40 to 5 whales (Department of Fisheries and Oceans, 1990a; Richard, 1991a). This change provoked much controversy (e.g., Amagoalik, 1990; Anonymous, 1990b; Tinling, 1990), and the hunters in Iqaluit claimed to have taken about 60 and those in Pangnirtung more than 40 white whales in the 1990 season (Smellie, 1990a; b). The matter of SE Baffin white whale stock assessment has been referred within Canada to an independent committee for re-evaluation.

The Ungava Bay stock is severely depleted, and its conservation and recovery are a high priority (Anonymous, 1987a; Reeves and Mitchell, 1989b). Exploitation has continued in recent years (Table 11; Department of Fisheries and Oceans, 1990b), regulated at least to some degree by an informal cooperative agreement between the responsible federal agency and local or regional Inuit groups (Osherenko, 1988). It is unclear whether the community quotas and hunting ban for the Mucalic River (S. Ungava Bay) agreed in 1987 have been effective in reducing the hunting pressure on this stock.

The Eastern Hudson Bay stock is listed as 'threatened' by the Committee on the Status of Endangered Wildlife in Canada (Campbell, 1989; Reeves and Mitchell, 1989b). It continues to be hunted at levels that may exceed replacement yield (Anonymous, 1987a). An important further concern is that major hydroelectric damming and diversion projects are planned for several of the rivers used by white whales in summer (e.g. Great Whale and Nastapoka), and other large-scale industrial developments, including the impoundment of James Bay to supply fresh water to southern states and provinces, is being considered.

With respect to the Western, Northern and Southern Hudson Bay 'stocks'; the question of whether more than one stock should be recognised for the western half of Hudson Bay remains open (Richard *et al.*, 1990). If the whales summering from the Southampton Island area in the north to James Bay in the south are treated as a single population, they comprise a stock of more than 25,000. Approximately 185 white whales were taken per year by hunters in western and northern Hudson Bay (average for 1974–87 – Table 3). Whales from these areas are also hunted in Hudson Strait during autumn, winter and spring (possibly also in Foxe Basin). Arbitrarily attributing 60% of the reported or estimated catch in Hudson Strait to this stock increases the yearly average (1974–86 – Table 11) to 302–07. Applying a loss rate of 30% of the total kill, annual hunting removals in the order of 431 from this 'stock' are suggested. These calculations are necessarily very crude, but it seems safe to conclude that this stock (or these stocks) are in relatively good shape.

USSR

Without better information on population sizes and recent removals, it is impossible to make useful assessments of stocks in the Eurasian Arctic. However, despite considerable variation in the population estimates for the Sea of Okhotsk, the stock or stocks there apparently remain large (certainly in thousands or low tens of thousands). If commercial exploitation has stopped and the subsistence catch is low as implied by available information, there should be no acute conservation problem for white whales in the USSR.

RECOMMENDATIONS

The Scientific Committee (IWC, 1980a) reviewed the status of white whale stocks in 1979 and made the following recommendations as a result.

(1) That the Cumberland Sound (=SE Baffin) stock be given complete protection, that it be censused regularly to estimate population size and gross recruitment, that its relations with 'stocks' in Hudson Strait be examined and that any whales taken (should there be a hunt) be examined and sampled. As demonstrated by the work cited above, considerable effort has been devoted to stock assessment since 1979, and the catch limit has been reduced.

(2) That Canada initiate research on the stock identity and size of white whale populations hunted along the Quebec coasts of Hudson Strait and northeast Hudson Bay. Finley *et al.* (1982), Smith and Hammill (1986), Helbig *et al.* (1989) and Doidge (1990) have reported some of the relevant work conducted since 1979.

(3) That the Canadian High Arctic (summer) and West Greenland (winter) populations of white whales be provisionally managed as one stock and that Canada and Denmark (Greenland) initiate a joint research programme on this stock. Particularly, the Committee called for censuses of white whales summering in Melville Bay-Thule district and Canadian and Greenland waters of Smith Sound and Kane Basin and for analysis of the stock affinities of these whales. The Greenland-Canada Joint Commission on Conservation and Management of Narwhal and Beluga has initiated a research programme on this stock. However, no census of the specified areas has been made.

(4) That more accurate estimates be made of struck-but-lost rates in the white whale hunts of Greenland and Canada. No new data on loss rates in Greenland are available. For Canada, considerable effort has been directed at estimating loss rates in the Mackenzie Delta (Strong, 1990; Weaver, 1991; K. Frost, *in litt.* to Reeves, 1 May 1991).

(5) That the USSR provide all available data on the white whales in the Barents, White, Kara and Laptev Seas and include 'a study of the components of the Barents Sea wintering group and an assessment of the stock or stocks involved.' Some information has become available since 1979 (e.g. Berzin, 1981; Ivashin and Mineev, 1981; Ognetov and Potelov, 1982; 1984; Berzin and Vladimirov, 1986).

(6) That national research programmes on the white whales thought to winter in the Bering Sea be expanded and that a cooperative research programme be instituted by the USA, USSR and Canada. It was expected that such programmes would include documentation of catch statistics, loss rates and characteristics of the hunt and collection of biological samples for determination of vital parameters. Also, 'the temporal and spatial components of the populations should be determined, the populations censused and the inter-relationships among them identified.' No cooperative programme has been

established with the USSR to date. Several cooperative efforts between Canada and Alaska have been initiated and include sharing of harvest information, collection of samples for stock identification and vital parameters and planning further census efforts. Surveys will be conducted of the Cook Inlet and eastern Chukchi Sea stocks in 1991.

(7) That the white whale be defined as a 'whale' and listed in the IWC schedule 'so that appropriate management procedures may be discussed and implemented in the future.' No action has been taken with respect to the later part of this recommendation.

(8) That Canada provide complete catch statistics for Manitoba, Ontario and Quebec. Reporting for Quebec (mainly East Hudson Bay – James Bay, West-South-North Hudson Bay and Ungava Bay stocks) and Manitoba (West-South-North Hudson Bay stock(s)) has improved substantially over the past decade (e.g., Boulva, 1981; Gamble, 1987a; b; Reeves and Mitchell, 1989b; Strong, 1990). The white whale harvest in Ontario (southern Hudson Bay and James Bay) is negligible.

The substance of these same recommendations was reiterated in 1980 (IWC, 1981). It was noted with reference to No. 1 that a catch limit of 40 had been introduced for the Cumberland Sound stock. However, the Committee recommended that this be reduced to zero. It was noted with reference to No. 3 that the current rate of removals from the Canadian High Arctic-West Greenland stock could be 'too high for the overall population,' and this demonstrated the need for better data on population size, stock relations and removals. With reference to No. 5, it was noted that either the reported catch levels for white whales in the Barents, White, Kara and Laptev Seas (c.f. Ivashin and Mineev, 1981) were substantially above annual gross production or the current population estimates were too low. This problem highlighted the need for abundance estimates for this area.

The Scientific Committee carried out another review of white whale stocks in 1981 (IWC, 1982a, pp. 60, 121–2). The 'responsive and considerable expansion' of studies in Greenland and Canada was noted, and both governments were encouraged to continue this work, giving particular attention to stock identity, migration, abundance, calf production, collection of complete and accurate catch statistics and full collection of age and reproductive samples from the catch. Noting the 'seriously depleted status' of the Cumberland Sound, Ungava Bay and eastern Hudson Bay stocks (Finley *et al.*, 1982) and the importance to the species of 'estuarine calf-rearing grounds', the Committee recommended that all three stocks and their critical habitat be fully protected. The USA and USSR were again urged to initiate field studies to evaluate the stock structure, abundance and status of white whales summering in their waters. With respect to No. 7, the question of adding the white whale to the IWC Schedule, the Committee report noted that most members supported the earlier recommendation.

In 1982, the Scientific Committee noted that the research recommendations made in previous years had been acted upon by the USSR and Canada and that the results of research on population size, productivity and exploitation in the USSR and population size, discreteness, exploitation history and loss rates in Quebec, Hudson Strait, northeast Hudson Bay, the Canadian High Arctic and West Greenland had been reported in progress reports and the SM series (IWC, 1983a, p.161). The Committee reiterated its recommendation that the summer populations in Cumberland Sound, eastern Hudson Bay and Ungava Bay be completely protected. It also called for catch statistics and population assessment from the USA and more nearly complete catch statistics from Canada.

The Scientific Committee made three recommendations in 1982 (IWC, 1983a, p.61):

(1) that white whale catches in Alaska be 'minimised' until the uncertainty about stock identity, stock size, net recruitment and removal rates was removed;
(2) that the three depleted stocks in eastern Canada be given complete protection;
(3) that the USSR make available catch information for its white whale fishery.

In 1984, it was recommended again that the USA collect and report data on catches and loss rates (IWC, 1985, p.136). The AIBWC has been doing this since 1988 and the data are improving each year (K.J. Frost, *in litt.* to Reeves, 2 May 1991). The Alaska Department of Fish and Game reported catch figures for 1980–86 (Lowry *et al.*, 1989).

The sub-committee makes the following new **recommendations**:

(1) that the USA obtain more accurate estimates of stock size for white whales in Alaska, particularly the Norton Sound/Yukon Delta stock for which there is no reliable estimate;
(2) that more accurate and complete information be obtained on struck-and-lost rates for all areas where white whales are hunted and that methods for reducing the number of whales that are struck-but-lost be developed and implemented;
(3) that the USA, USSR, Canada and Greenland conduct genetic studies to determine the stock identity of white whales;
(4) that Greenland conduct an assessment of white whale stocks to serve as a basis for management, and that Greenland report data on white whale catches and loss rates.

The sub-committee welcomed the formation of the Canada-Greenland Joint Commission on Conservation and Management of Narwhal and Beluga and of the Alaska and Inuvialuit Beluga Whale Committee as bilateral initiatives that promise to provide intensified and coordinated research and management of shared stocks.

The sub-committee noted its continuing concern about white whale stocks in Canada that are harvested at rates above their estimated sustainable yield levels.

5.1.2.2 *Monodon monoceros*[3]

COMMON NAMES

Narwhal, *narhval* (Denmark), *killalugaq* (Inuktitut, Baffin Island), *tugalik* (Inuktitut, West Greenland), *qilaluaq qernertaq* (Greenlandic).

DISTRIBUTION

The narwhal's distribution is circumpolar north of about 65°N, but it occurs in much higher densities in Arctic waters adjoining the North Atlantic basin than in those adjoining the North Pacific. Three high-density summering areas have been identified in the eastern Canadian Arctic and off northwest Greenland: Repulse Bay and Frozen Strait, the Lancaster Sound region, and Inglefield Bay (Born, 1986; Strong, 1988). Small groups of narwhals

[3] Initial draft from R. Reeves dissertation in preparation.

summer in many other areas, including Jones Sound, Smith Sound, Melville Bay, western Baffin Bay and Davis Strait, and northern Foxe Basin. Narwhals winter mainly in the open and close pack ice of Baffin Bay and Davis Strait as far south as *ca* 64°N and in the Labrador Sea and Hudson Strait (Kapel, 1977; McLaren and Davis, 1981; 1982; Mitchell and Reeves, 1981; Turl, 1987; Richard, 1991). They rarely occur in the main body of Hudson Bay south of Southampton Island. There are few definite records from eastern Hudson Bay, but narwhals are killed occasionally on the west side of the bay as far south as Whale Cove (*ca* 62°N).

Narwhals occur in many fiords along the east coast of Greenland north from Ammassalik (Dietz *et al.*, 1985). Two offshore areas have been identified in the Greenland Sea where 19th-century whalers consistently observed narwhals, on some occasions in large numbers. These areas are centred west of Spitsbergen at 78–81°N, 05°W-10°E, and off the Greenland coast between latitudes 72–76°N (Dietz *et al.*, 1985). A possible third concentration area was identified off the northeast coast of Greenland at 79–81°N. There is no direct evidence that the narwhals in the Greenland Sea belong to a separate stock from those in Davis Strait, Baffin Bay and Smith Sound.

PROBLEMS AND CATCH STATISTICS

Greenland Sea

The narwhals in the Greenland, Barents and Kara Seas, and in the Arctic basin north of these, were exploited to some degree by European commercial whalers during the bowhead whaling era and by the Inuit of east Greenland. However, this exploitation is believed to have been light in terms of the numbers of animals killed relative to the population size.

Tomilin (1957) estimated the annual catch in Scoresby Sound as 20. Incomplete statistics for east Greenland from 1954–75 indicate annual catches ranging from 2 to 65, with a mean of about 21 (Kapel, 1977). The total reported catch in Ammassalik district during the 1970s was 141 (Dietz *et al.*, 1985). Reported catches increased during the 1980s, averaging 87 per year for Scoresbysund and Ammassalik districts, combined, from 1980 to 1987 (Table 14).

West and North Greenland

Catch statistics are provided through the Greenland Hunters' Lists of Game (Kapel, 1977; 1978; Born and Olesen, 1986; Table 14). Participation in the reporting scheme has declined during recent decades, and this has meant that a higher proportion of the reported catch is estimated rather than being an actual count (E.W. Born, *in litt.* to Reeves, 3 October 1985; Heide-Jørgensen,MP, 1990). An important shortcoming of the statistics has been the lack of reporting for Thule district (North Greenland) and in recent years the entire system of reporting catch statistics for small cetaceans in Greenland has deteriorated. Thule provided reliable estimates of the narwhal catch for only three years in the early 1960s (M.P. Heide-Jørgensen, pers. comm. to Reeves, 30 April 1991). Heide-Jørgensen (1990) estimated the recent annual catch for all of West Greenland, including Thule district, as 200–600. The Greenland Fisheries Research Institute estimated the total catch for West Greenland as 600 in 1989 and 1,200 in 1990.

Canada

Narwhal catches in Canada are underreported for a number of reasons (Finley *et al.*, 1980; Finley and Miller, 1982; IWC, 1982a; Gamble, 1987a). The tag system used to implement the national quota is most effective for monitoring the number of large, unbroken tusks that are sold. It is considerably less effective for ensuring that kills of untusked whales (females, calves and juveniles) and whales with short or significantly damaged tusks are reported. Reported catches during the 1970s and 1980s show no clear trend of increase or decrease (Table 15). The total reported catch in all years has been below the total national quota of 525 (Strong, 1989). The catch in Arctic Bay (as observed by and reported to fisheries field personnel) is strongly biased toward males (Roberge and Dunn, 1990). This bias appears to be less consistent and strong at Pond Inlet (Weaver and Walker, 1988). Discussion of the trade in tusks and other products is given in Appendix 3.

Loss rates

Acknowledging that there are no data for estimating the loss rate directly in Greenland south of Thule district, Born and Olesen (1986) assumed that it was *ca* 20%, similar to the open-water loss rate in Canada. [Born and Olesen cited as their source for the 20% figure an unpublished report by Strong *et al.* (1985) which was published in abbreviated form as Strong (1988).] Most of the hunting south of Thule is done in open water, by shooting first and then

Table 14

Narwhal catches reported in IWC Denmark progress reports. For previous years, see Kapel (1977). Note that figures listed for 1983-85 are estimates which include an allowance for unreported catches (but not for hunting loss).

	Year												
Area[1]	75	76	77	78	79	80	81	82	83	84	85	86	87
West Greenland													
N Greenland	-	150/yr[2]		-	110	120	130	118	164	135	274	115	150/yr[2]
NW Greenland	65	49	175	239	154	207	223	221	236	325	73	178	479
CWe Greenland	0	12	6	100	36	10	10	19	10	10	0	?	?
CWw Greenland	44	45	47	162	64	110	239	57	58	56	67	23	25
SW + S Greenland	7	0	9	1	3	5	19	0	0	1	1	36	1
Total	266	256	387	612	377	462	609	461	439	666	256	387	655
East Greenland													
Ammassalik	10	8	17	1	8	48	128	84	12	15	21	140	42
Scoresbysund	2	16	4	2	10	10	15	15	41	50	28	28	16
Total	12	24	21	3	18	58	143	99	53	65	49	168	58

[1] For communities assigned to each area, see Kapel (1977).
[2] Annual estimate - Kapel (1983).

Table 15

Reported narwhal catches (uncorrected for under-reporting and hunting loss) in Canada, 1974-87 (from Strong, 1989). See note for communities included within each statistical area.

	Year													
Area	74	75	76	77	78	79	80	81	82*	83	84	85	86*	87*
High Arctic	152	266	281	217	233	260	256	272	283	310	189	231	218	110
SE Baffin	-	5	16	38	28	28	68	94	99	23	69	67	38	47
N Hudson Bay/ Hudson Strait	-	-	8	-	6	31	26	40	22	11	27	16	7	24
Totals	152	271	305	255	267	319	350	406	404	344	285	314	263	181

*Strong (1989) considered the data for these years complete.

Note: High Arctic - Clyde River, Pond Inlet, Arctic Bay, Grise Fiord, Resolute, Creswell Bay, Spence Bay, Gjoa Haven, Hall Beach, Igloolik, Pelly Bay; SE Baffin - Broughton Island, Pangnirtung, Iqaluit; N Hudson Bay/Hudson Strait - Lake Harbour, Cape Dorset, Whale Cove, Rankin Inlet, Repulse Bay, Coral Harbour.

harpooning. Losses are low in Thule district, where most of the hunting is done from kayaks in open water, using a harpoon first and then killing with a rifle shot. Approximately 1 whale is lost for 20 landed in the summer hunt in Thule district (IWC, 1980b). Loss rates for hunting at *savssats* are much higher, on the order of 1 whale lost for every 2 landed (IWC, 1980b). Winter-spring hunting in Greenland generally is assumed to involve the loss of approximately 1 whale for every 4 landed (IWC, 1980b).

Nets are set for narwhals in Thule district beginning on 1 September each year. This net fishery apparently began about nine years ago after hunters noted that narwhals frequently entangled in seal nets (M.-P. Heide-Jørgensen, pers. comm. to Reeves, August 1990). The number of narwhals that are netted is unknown, except that it is small, probably less than 20 per year; the loss rate from netting is probably close to nil.

Direct observations of narwhal hunting in Canada have revealed significant hunting loss (Land, 1977; Finley *et al.*, 1980; Finley and Miller, 1982; Weaver and Walker, 1988; Roberge and Dunn, 1990). Cosens *et al.* (1990) cited a range in estimated loss rates (percentage lost of total killed) of 42–56%; thus, the estimated total of removals by hunting would be 1.72–2.27 times the landed catch. The range of 42–56% apparently is based mainly or entirely on data from Pond Inlet, which may not be representative for all catch areas. For example, at Arctic Bay, the estimated loss rates for five years with data (1983, 1986–89) ranged from 20% to 34% (Weaver and Walker, 1988). The secured catch at Arctic Bay is often as high as or higher than that at Pond Inlet (Strong, 1989). In the absence of data on loss rates from other settlements that hunt narwhals, it is impossible to decide which of the two ranges of estimates is more representative. In general, losses are highest during the ice-edge and ice-crack phases of the hunt and lowest during the open-water phase.

MANAGEMENT

In Greenland, the hunting of narwhals is regulated mainly by local legislation (Born, 1986; Qujaakitsoq, 1990).

In Canada, narwhal hunting is regulated under the Narwhal Protection Regulations (Fisheries Act) introduced in 1971 (Strong, 1988). In addition to specifying that females with calves not be hunted, waste be minimised and only high-power ammunition be used, these regulations include a national quota, allocated by community primarily on the basis of historic catch levels. The total quota is 525.

The Canada-Greenland Joint Commission on Conservation and Management of Narwhal and Beluga met for the first time in January 1991 (Lemche, 1991). This commission was established under the terms of a Memorandum of Understanding between the responsible Canadian and Greenlandic government agencies. No decisions on management were made at this session. A Scientific Working Group was charged with reviewing information on potentially shared stocks and providing advice on research and management needs. It was specified in the report that the scientific advisory group should consider knowledge from hunters in the development of its advice to the Joint Commission.

POPULATION SIZE

Greenland Sea

The only estimate is for a small part of the summer range. Larsen (1930) estimated that there were at least 176 narwhals in Scoresby Sound in September 1983, based on an aerial line-transect survey. No correction was made for animals below the surface.

Inglefield Bay

In mid-August 1984, Born (1986) counted 4,043 narwhals passing a clifftop observation site at the head of Inglefield Bay. This provides a minimum estimate for the number of narwhals summering off northwest Greenland. Additional animals apparently summer in Melville Bay (Meldgaard and Kapel, 1981) and in Smith Sound and other areas north of Inglefield Bay (Vibe, 1950).

Baffin Bay and Davis Strait

McLaren and Davis (1981; 1982) estimated that a minimum of 5,000 narwhals were present in the pack ice of northern Davis Strait and southern Baffin Bay in March 1981. This was considered an underestimate because many animals were thought to be submerged or under the ice and missed by the surveys. These wintering narwhals are considered part of the Inglefield Bay and/or the Canadian High Arctic stocks (see below).

Canadian High Arctic Stock

Smith *et al.* (1985) estimated that 13,200–18,000 narwhals summered in Lancaster Sound and adjoining waterways in 1981. This estimate was based on the results of a stratified strip-transect survey of Lancaster Sound, Barrow Strait and Prince Regent Inlet in August, and it included estimates of 2,000 and 2,117 to account for whales in two unsurveyed areas (Peel Sound and Admiralty Inlet, respectively; the former based on Smith *et al.*'s own observation of 2,022 in July 1980, the latter on Fallis *et al.* [1983]). No allowance was made for whales summering in the Pond Inlet-Eclipse Sound-Navy Board Inlet complex or along the east coast of Baffin Island. Smith *et al.* (1985) considered the estimate by Davis *et al.* (1978) of 20,000 to 30,000 narwhals in the Lancaster Sound region in 1976 to be an overestimate caused by 'the inappropriate combination of shorebased counts (Greendale and Brousseau-Greendale, 1976) with their aerial surveys.' Aerial photographic surveys of Eclipse Sound, Admiralty Inlet, Prince Regent Inlet and Peel Sound in August 1984 resulted in an estimate of 17,900 narwhals, uncorrected to account for submerged animals or for those in unsurveyed areas (Strong, 1988). Confidence limits for this estimate are 13,100–21,400 (Cosens *et al.*, 1990). It should be noted that Born (1986) and Born and Olesen (1986), citing an earlier unpublished report by Strong *et al.*, referred to an estimate of 23,700 (95% CI 18,100–29,500) for the Canadian High Arctic stock. Combining his own count with the estimate from Strong et al., Born (1986) suggested a combined Canada–Greenland High Arctic population size of at least 28,000, with confidence limits of about 22,000 to 33,500. According to J.T. Strong (pers. comm. to Reeves, 15 April 1991), the high estimate of 23,700 for the Canadian sector was released prematurely and should be ignored. A reanalysis of the 1984 aerial photographic survey data is planned (J.T. Strong, pers. comm. to Reeves, 15 April 1991).

Northern Hudson Bay Stock

Systematic photographic surveys centred in Repulse Bay and Frozen Strait in July 1982, 1983 and 1984 provided estimates ranging between 1,038 and 1,517 narwhals, with varying degrees of precision (Richard, 1991). Richard (1991) suggested that the narwhals in this area be managed as an isolated stock of about 1,300 animals.

ASSESSMENT AND STATUS

Table 16 summarises the current status of the world's narwhal stocks.

Table 16

Status of world narwhal stocks (modified from Braham, 1984).

Centre of summer distribution	Est. abundance	Est. annual kill	Removal rate (% stock size)	Refs
Barents & Kara Seas (Arctic Basin)	no estimate	none known	-	-
Greenland Sea	no estimate[1]	89[2]	unknown	-
Canadian High Arctic (Lancaster Sound region)	17,900[3]	397-568[4]	2.2-3.2	1,2
NW Greenland (Inglefield Bay)	4,043+[5]	616[6]	15[7]	-
N Hudson Bay	1,300	29-41[8]	2.2-3.2	3

[1]Larsen (1985) gave conservative estimate of 176 in Scoresby Sound, September 1983.
[2]Based on average reported catch 1978-87 (Table 1), corrected assuming 1 whale killed and lost for 4 secured (see text).
[3]The data from the 1984 survey are being reanalysed.
[4] Secured catch 290/yr (average 1976-87; Cosens *et al.*, 1990), corrected using loss rates from pooled Pond Inlet data 1982-3 (Weaver and Walker, 1988), 49%, and from pooled Arctic Bay data 1983, 1986-89 (Roberge and Dunn, 1990), 27%, as a range.
[5]Number counted in one day from a shore observation site in Inglefield Bay (Born, 1986).
[6]Based on average reported catch 1978-87 (Table 1), corrected assuming 1 whale killed and lost for 4 secured (see text).
[7]Probably an overestimate since the population estimate is an underestimate of the stock(s) hunted.
[8]Based on average reported catch 1978-87 (Table 1), corrected using the same procedures as described in footnote 3 for Canadian High Arctic stock. Note that the catches included are those from Hudson Bay and Hudson Strait only; Foxe Basin catches are assumed to be from the High Arctic stock.

References: (1) Strong, 1988; (2) Cosens *et al.*, 1990; (3) Richard, 1991.

Barents and Kara Seas

The comments by Tomilin (1957) about narwhal abundance in the areas around Franz Josef Land and Novaya Zemlya are problematical. His account suggests a significant decrease in abundance post-1930, but no basis for this impression is offered nor is any possible reason given for such a decrease. Yablokov and Bel'kovich (1974) claimed that chronicles and the discovery of bones on beaches 'testify to the former greater distribution of narwhal in the seas of the European North (White and Kara seas).' However, they did not elaborate. The statement that the narwhal 'is thought to have disappeared from the northeastern part of its range (Novaya Zemlya and Franz Josef Land), presumably because of hunting' (Anonymous, 1978) apparently is based on the reports cited above. Yablokov (1979) indicated that observations of narwhals in Soviet waters were 'rare' but speculated that there could be several thousand animals in two populations in the Soviet High Arctic. Apart from occasional kills by commercial whalers hunting bowheads in the Barents Sea during the 19th century and kills by aborigines along the Yamal Peninsula during at least the 17th century (MacRitchie, 1909), no regular hunt for narwhals in the Eurasian Arctic is documented. Their offshore, high-latitude distribution in this sector may explain, at least partially, the absence of a more detailed record. The continuing presence of small numbers of narwhals in the Barents and Kara seas (as well as in the western part of the East Siberian Sea) was noted by Belikov *et al.* (1990).

Greenland Sea

The basis for the statement that this stock was historically much larger and more widely distributed than currently (Anonymous, 1990c, p.136) is uncertain. Too little information is available about the past or present population size for narwhals in this region. Substantial recent catches, particularly in Ammassalik district (Table 14), demonstrate the need for better information on the stock(s) off east Greenland.

Canadian High Arctic

Although Cosens *et al.* (1990) indicated in their Introduction that there was no evidence of Canadian narwhal stocks being harvested at levels that could not be sustained, they concluded in their assessment of the High Arctic stock that harvests have exceeded the estimated net recruitment rate of 2–3% and that if the stock size is 17,900 as estimated, the population must be declining. Strong (1988), using similar estimates of population size and calf production, but a lower estimate of the annual kill rate, concluded that the stock was stable and that the current level of harvest could be sustained. Better information is needed about stock relations and removal rates.

Cosens *et al.* (1990) apparently did not include the two Foxe Basin communities' harvests (Igloolik and Hall Beach) in their assessment of removals from the High Arctic stock. Neither Smith *et al.* (1985) nor Richard (1991) covered Foxe Basin in their population assessment surveys. The stock affinities of narwhals hunted in northern Foxe Basin are unknown, but there is circumstantial evidence from local people suggesting that they come from the High Arctic, passing through Gulf of Boothia and Fury and Hecla Strait in late summer (P. Richard, pers. comm. to Reeves, 1 May 1991).

West and North Greenland

Annual catches of about 450 (the 1975–87 average from Table 14) would represent more than 10% of an estimated minimum stock size of 4043. However, both the catch level (incomplete reporting, no allowance for hunting loss) and the population size (based on a one-day count at a fixed location in Inglefield Bay – Born, 1986) are likely underestimates. Without improved census data and better information on stock relations of narwhals hunted in the Canadian Arctic and West Greenland, it is impossible to make a useful assessment. However, the available data are sufficient to warrant concern about the status of the stock.

Northern Hudson Bay

The combined quotas for communities in northern Hudson Bay (summering area) and Hudson Strait (wintering area) is 70, or 5.4% of the estimated stock size. Reported landed catches in most communities have been below the quota in most years (Strong, 1989), but since reporting is incomplete (Gamble, 1987a) and the quotas make no allowance for struck whales that are not secured, there is reason for concern about the impact of hunting on this stock.

RECOMMENDATIONS

The IWC Scientific Committee has made few recommendations concerning narwhals, apart from calling for their inclusion in the IWC Schedule (IWC, 1980b, p.124). In 1981, Canada and Denmark were encouraged to continue and expand research on stock identity, migration, abundance and calf production; to collect complete and accurate catch statistics; and to sample catches fully for studies of age estimation and reproduction (IWC, 1982a, p.121). Some effort toward achieving these objectives has been made by Denmark and Greenland (e.g. Born, 1986). In Canada, comprehensive research programmes have been implemented to address many of these concerns (e.g. Smith *et al.*, 1985; Gamble, 1987a; Strong, 1988; Weaver and Walker, 1988; Kingsley, 1989; Roberge and Dunn, 1990; Richard, 1991).

The sub-committee remains concerned about catch levels and loss rates in the Canadian and Greenlandic fisheries. It **recommends** particularly that more effort be made to assess stock size and removal rates for the narwhal population in the High Arctic, Baffin Bay and Davis Strait. In this regard, the sub-committee welcomes the formation of the Greenland-Canada Joint Commission on Conservation and Management of Narwhal and white whale, which is expected to implement a joint programme of research and management. The sub-committee notes with concern that the system for reporting catch statistics in Greenland has deteriorated, and recommends that such record keeping and reporting be made a high priority. In view of the substantial catches in some years in east Greenland, the sub-committee also recommends that some attention be given to stock assessment in the Greenland Sea.

(Low, 1906; Bruemmer, 1966; Hansen, 1970; Hay and Sergeant, 1976; Riewe, 1977; Treude, 1977; Durham, 1978; Kapel, 1983; Anonymous, 1985b; Ivashin, 1988; Sergeant and Hoek, 1988)

5.1.3 Direct fisheries for Globicephala melas, *in the North Atlantic*[4]

COMMON NAMES

Long finned pilot whale. Faroe Islands: *grindahvalur*; *nydingur* (large pilot whale); *leiftur* (newborn). Iceland: *marsvín*. Greenland: *nisarnaq*. Newfoundland: pilot whale; blackfish; pothead; roundhead. Norway: *grindehval*. Shetland Isles: pilot whale; blackfish; caa'ing whale. Britain: long-finned pilot whale. Sweden: *grindval*. Finland: *pallopää*; *grindvalas*. Denmark: *grindehval*. Holland and Belgium: *griend*. Germany: *grindwal*. France: *globicéphale noir*; *dauphin pilote*. Spain: *calderòn*; *caldeirò* (Galician); *cap d'olla* (Catalan). Portugal: *boca de panela*. Italy: *globicefalo*. Greece: *mavrodelphini*.

DISTRIBUTION

In the North Atlantic, the long-finned pilot whale lives in cold temperate and subarctic waters. Its general distribution is from Northwest Africa, including the Mediterranean, to the Norwegian-Barents Sea in the east and from Bermuda and Cape Hatteras at the coast of North Carolina to central parts of Greenland in the west. The North Atlantic Sightings Surveys (NASS) in 1987 and 1989 have improved our knowledge of the abundance inside the northeast Atlantic distribution area. Concentrations of pilot whales were observed especially from 2–40°W and 45–65°N, (Lens *et al.*, 1989; Bloch *et al.*, 1989; Buckland *et al.*, 1993). There is some overlap in distribution of the northerly range of the short-finned pilot whale, *Globicephala macrorhynchus*, and southerly limit of the long-finned pilot whale.

Although the pilot whale occurs north to the Barents Sea (Mitchell, 1975b), the only record from the Norwegian coast from NASS surveys was a single observation off southwestern Norway (Øritsland *et al.*, 1989; Bloch *et al.*, 1989), although they occasionally beach on the Norwegian coast (Griffiths and Øen, 1990). Elsewhere the pilot whale is commonly distributed in the western basin of the Mediterranean (Gannier and Gannier, 1990), in the Gibraltar Strait (Hashmi, 1990) and off Spain (Lens *et al.*, 1989).

Pilot whales appear to move into coastal areas following their squid prey in the summer and are more concentrated offshore in deep waters in winter (Evans, 1987). Brown's (1961) summary of observations made from ocean weather ships, merchant vessels and other ships, provides information on the oceanic range of this species as far south as 45°N in the central area of the North Atlantic, suggesting occurrence throughout the year in oceanic waters between 45°N and 50°N and probably in all longitudes from the Bay of Biscay to Newfoundland. Observations during the NASS studies tend to confirm this, indicating a greater abundance of whales, including pilot whales, in the central parts of the North Atlantic.

[4] Initial draft by D. Bloch and C. Lockyer

PROBLEMS AND CATCH STATISTICS

There is not enough information to separate North Atlantic pilot whales into discrete stocks. Previously, pilot whales were taken in the old Norse areas, including Norway, Iceland, Shetland, Orkney and Hebrides (Williamson, 1970; Joensen, 1976). Until 1972, the pilot whale was still taken in Newfoundland and until 1973 in Norway. Today, the pilot whale is only taken in the Faroe Islands and Greenland.

Between 1975 and 1987, a total catch of 487 pilot whales has been taken by small type whalers off Greenland (Table 17). The largest catch was 136 in 1977.

In the Faroe Islands, the fishery (*grind*) is opportunistic. Whales are observed either from land or from boat, and are driven on shore and killed, with entire schools taken usually. Between 1986 and 1988, 47 sightings of pods occurred (one third from land), followed by landings of 43 pods. The distance from the school to the shore ranged between 0.1 to 3.3 n.miles (Bloch *et al.*, 1990a). Traditional Faroese fishing boats are used (specialised boats or whalers have never been used). The whales are driven into suitable bays. Since November 1989, the Faroe Islands Government has restricted the use to 21 bays only.

The whales are hunted communally for food and are utilised non-commercially – the catch is shared free among the local inhabitants. Complex laws and regulations exist for the control of the catch and its utilisation. The first regulations, covering the total course of events from the initial sighting of a pod until the animals have been flensed and the beach cleaned, appeared in 1832. These have been updated several times, but the original regulations still form the backbone of today's laws (Bjørk, 1956–63).

Pilot whales have been harvested in the Faroe Islands since the Norse settlement in the 9th Century (Thorsteinsson, 1986). Hunting statistics exist back to 1584, and unbroken records exist from 1709 to the present (Joensen and Zachariassen, 1982; Bloch *et al.*, 1990b). During the period 1709–1990, 1,646 pods (235,630 whales) were harvested. The statistics show a peak periodical occurrence of whales every 110–120 years (Joensen, 1962; Joensen and Zachariassen, 1982).

In the period 1709–1990, a range of 0–4,360 whales (0–23 pods) per year were harvested, averaging 990 (6.9 pods). The maximum harvest occurred in 1941 (23 pods and 4,325 whales). In three years, 1844, 1939 and 1941, the harvest exceeded 3,000 whales; in 25 years, more than 2,000 whales were landed, while in over 95 years (a third of the time period), the annual catch exceeded 1,000 whales.

By contrast, the period 1750–1795 showed poor harvests with a total of only 13 pods comprising 2,459 whales, averaging 55 whales per year. During the years around 1900, there were occasional years with no pods landed (1890–1, 1901, 1924 and 1927). Although pods were seen during those years, attempts to beach them met with no success. In all, there were 44 years when no pods were taken (Bloch *et al.*, 1990b).

The fishery has never been managed by quota limitation. However, since 1982, a district or a whaling bay can be closed by an executive order issued by the Faroe Islands Government whenever the area in question is considered to already have an adequate supply of meat. Between 1986–1988, restrictions occurred in 4 (1986), 5 (1987) and 3 (1988) districts out of 9, and lasted for 0.5–3.5 months. So long as the pilot whale meat and blubber is used non-commercially, and only by Faroese people for local consumption, there will be an upper limit on the catch, regulated by demand.

In recent years, the Faroese Government has made limitations of the use of the gaff and spear in the fishery, in response to international concerns.

The complete pilot whale catch information is held at the Faroese Museum of Natural History in Tórshavn. There are other species taken by drive fisheries in the Faroes, including *Lagenorhynchus acutus* in some years. Catch statistics for some species are available for the past five years.

POPULATION ESTIMATE

The NASS-87 (June-August) survey of the Faroese-Icelandic area covered an area bounded by Spitzbergen and the Barents Sea in the north, the Spanish coast in the south, West Greenland in the west and the Norwegian coast in the east (Sigurjónsson *et al.*, 1989). A total of 109 sightings of approximately 4,413 animals were made onboard the four survey vessels. The sightings were concentrated southwest and west of the Faroe Islands, off the southeast coast of Iceland and in deep waters southwest and west of Iceland in the Denmark Strait; although some sightings were made west of the British Isles and Ireland, and along the East Greenland coast.

The resultant population estimates were 72,000 (CV 0.4) for the area covered by the Faroese vessel; partial population estimates for closing and passing mode are 18,950 (CV 0.5) and 12,945 (CV 0.25) whales respectively, for the areas covered by the Icelandic vessels. This gives a total 'best' estimate of close to 100,000 animals; it does not include a correction for submerged animals and assumes that all schools close to the trackline were sighted (Bloch *et al.*, 1989). When reviewing these estimates, the sub-committee discussed several factors that could bias the estimates, and noted that due to these factors, there was a greater uncertainty in the estimate than indicated by the calculated CVs (IWC, 1990b).

The area between 50–65°N and 06–45°W was covered by Iceland and the Faroe Islands during the NASS-89 survey, and a similar number of sightings of pilot whales was recorded but the data are still not fully analysed. There are no updated estimates from the other areas in the North Atlantic. However, there is an estimate of about 60,000 whales as the initial population in Newfoundland waters (Mercer, 1975), and about 13,000 whales from an aerial line-transect of a portion of the Newfoundland-Labrador area (Hay, 1982).

ASSESSMENT AND STATUS

There is no detectable evidence that the stock size of pilot whales appearing in the Faroese area has been affected by the drive fishery. The observed periodicity in the

Table 17

Catches of pilot whales in Greenland 1975-87 (Total=487). Data from Danish Progress Reports.

Year	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Catch	106	51	136	101	50	6	1	1	-	-	26	9	-

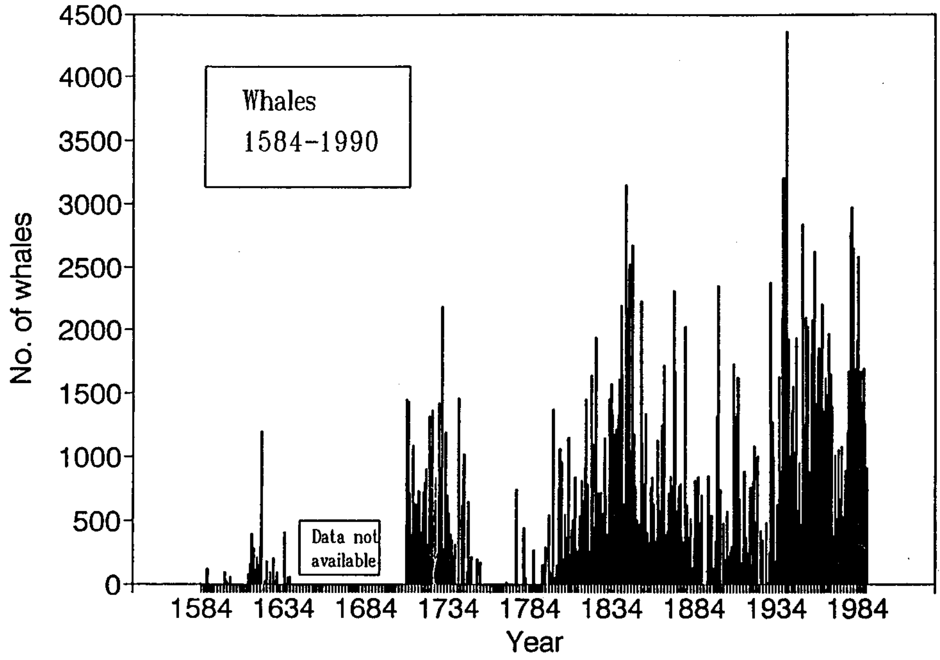

Fig. 2. Catches of pilot whales at the Faroe Islands.

occurrence of whales in the Faroese area (Fig. 2) is significantly correlated with the occurrence of the squid prey, *Todarodes sagittatus*, the presence of which is also correlated with the periodicity in the sea surface temperature (Hoydal, 1986). Any connection between the pilot whales occurring around Newfoundland in summertime and the all year round occurrence in the Faroes (Sergeant, 1986) is still not proven.

RECOMMENDATIONS

In 1985, the Scientific Committee recommended the funding of a proposal to examine the ecology of Faroese pilot whales (IWC, 1986a, p.52). Although IWC funding was not forthcoming, between July 1986 and July 1988, a comprehensive examination was undertaken of the ecology and status of the pilot whale in the Faroe Islands, under the auspices of the IWC and the United Nations Environment Programme (UNEP). The content of these examinations is outlined by Desportes (1990), and most of the results are published in Donovan *et al.* (1993).

In 1987 (IWC, 1988, p.51), the Scientific Committee noted that material being collected from the Faroese pilot whale fishery was particularly valuable for investigating the factors which determined the concentrations of organochlorine pollutants in whale tissue. These compounds are known to affect reproduction in other marine mammals. It therefore recommended that this opportunity should be brought to the attention of laboratories capable of performing standardised analyses for organochlorines and particularly for individual PCB congenors. Studies on these matters were instigated and the results are published in Donovan *et al.* (1993).

In 1989 (IWC, 1990a), the Scientific Committee made several recommendations. Concerns about past fisheries and by-catches were expressed, and in view of the fact that in the western North Atlantic the by-catch of pilot whales by foreign flag mackerel vessels in the US EEZ jumped sharply in 1988 to 140 and may have been larger in earlier years when the then larger mackerel fishery was unmonitored, it was recommended that the historical data for this fishery be examined to estimate earlier removals of pilot whales.

The existence of a past Icelandic drive fishery was confirmed (Anonymous, 1990c) and the Committee recommended that the historical data for that fishery and for strandings be obtained and reported.

Information on these matters was published in Donovan *et al.* (1993).

Several recommendations specific to the Faroese drive fishery were also made. At that time, no new information was available on population dynamics, but it was recommended that attention be given to research on this topic using the Faroese frequency-at-age data. Extensive demographic information which has been, and will be, generated by the Faroese research programme could form the basis for a valuable mathematical model of the population dynamics of pilot whales, and possibly other odontocetes. The Committee therefore recommended that such an integrated model should be developed.

The Committee recommended that stock identity be addressed by genetic comparisons being carried out between pilot whales from the Faroes and from other regions in the North Atlantic using both analyses of isoenzyme allelic frequencies and appropriate analyses of DNA. Results of such studies were presented in Donovan *et al.* (1993).

Because of the importance of information about migration to questions of stock identity and status and because the pilot whale is a species particularly suitable for radio-telemetry studies, the Committee recommended that the proposed project using satellite-linked transmitters at the Faroes to study movements, described at an earlier meeting two years previously be undertaken. This particular project, while attempted, has not met with success. No further attempts have been made or are planned.

In teeth and hard tissues, depositional anomalies may be related to stress or other external factors and it was recommended that incidence of marker lines and other anomalies in teeth of pilot whales be examined in more detail to determine possible links with oceanographic conditions, food availability and life history events. Research on this matter is continuing.

5.1.4 The Black Sea dolphin and porpoise fishery[5]

Three species of small cetacean were killed by fishermen from the four countries surrounding the Black Sea between 1870 and 1983. The common dolphin (*Delphinus delphis*) was historically the species caught in the largest numbers by the USSR, and although the limited catch statistics have generally been reported for all three species combined, it appears that the harbour porpoise (*Phocoena phocoena*) became the numerically dominant species in the catch from 1964 to the time the fishery ended in 1966 (except Turkey). The bottlenose dolphin (*Tursiops truncatus*) was of intermediate importance in the harvest. The Turkish catch reportedly consisted of 80% *Phocoena*, 15–16% *Delphinus* and 2–3% *Tursiops* in the early 1980s (Klinowska, 1991). No information is available on the composition of the earlier Turkish catches or on the Bulgarian and Romanian catches for any period. The abundance of all three species was greatly reduced by the fisheries (Zemsky and Yablokov, 1974; Smith, 1982).

DISTRIBUTION

The three species involved in the Black Sea fisheries are distributed widely, in disjunct populations, in temperate regions of the Northern Hemisphere (*Phocoena*) or the world (*Delphinus* and *Tursiops*). They are found throughout the Black Sea, reportedly moving seasonally to follow concentrations of various small pelagic fishes. For example, in the autumn they follow such prey fishes northward along the eastern Black Sea. The cetaceans formerly entered the Azov Sea, in the northeast corner of the Black Sea, along with the prey species. However, they no longer occur in that shallow sea, reportedly because it has become heavily polluted. The common dolphin historically occurred primarily in the central Black Sea, harbour porpoises and bottlenose dolphins primarily in the more coastal regions. However, sightings data suggest that there were shifts in ranges of the species in later years as the numbers of common dolphins declined. The animals in the Black Sea could move into the Mediterranean Sea, and bottlenose dolphins have been reported moving through the Bosphorous Straits. The extent of such movement is unknown, however. Tomilin (1957) presented evidence that all three cetacean species in the Black Sea differ morphologically from those elsewhere. Harbour porpoises do not occur in the eastern Mediterranean Sea at present, so those in the Black Sea are definitely an isolated stock. There is no information on the existence of separate breeding stocks within the Black Sea for any of the species. The genetics of the Black Sea dolphins and porpoise have not been studied. However, DNA-sequence comparisons with samples from other regions are presently being carried out for the common dolphin and the harbour porpoise (W. Perrin, pers. comm.).

PROBLEMS AND CATCH STATISTICS

Although the three species were harvested for many years at high levels, catch statistics are sketchy, being reported only irregularly and in total weight of the catch for all three species combined, as summarised up to 1974 by Smith (1982). The USSR catches apparently reached their maximum of 135,000 to 140,000 animals in 1938, after which they declined. The average reported catches before World War II were roughly double those for later years, despite increasing fishing effort including the use of spotting aeroplanes. During the entire fishery, catches were made by both netting (mainly USSR) and shooting (mainly Turkey), with unknown loss rates in the latter. Smith reported that during a June 1981 joint USSR-US dolphin sighting survey, there was a decreasing rate of encounter of floating harbour porpoise carcasses with increasing distance from the Turkish coast (IWC, 1983b), suggesting the continuation of a harvest by shooting in the early 1980s and an apparently high struck-and-lost rate. The decline in catches of all three species to a few thousand per year by 1964–66 prompted first seasonal restriction, then a total moratorium in the USSR, Bulgaria and Romania from 1966. Little information has been reported for years since 1974 although it is known that the harvest continued in Turkey until it was banned in 1983.

Çelikkale *et al.* (1989) and Çelikkale (1990) described recent developments in the fishery, noting especially concern within Turkey that the dolphins and porpoises posed a serious threat to the continued success of local net fisheries for the European anchovy.

Recently, illegal takes of at least two of the three species have been reported in Turkey. The causes are not known but are variously described in newspaper accounts in March and April 1991 as incidental entanglement in net fisheries, directed take to reduce competition for the European anchovy, directed take to reduce the damage to fishing nets, utilisation of an incidental catch, and directed takes for commercial marketing of fertiliser, animal feed, and oil, perhaps for cosmetics. Catches are reportedly being made in 'turbot nets', and carcasses seen on the docks are being processed by boiling in vats. There have been no official estimates of the magnitude of this recent harvest, and no confirmation of their purpose; given the lack of systematic reporting in the years before the harvesting became illegal and the illegal nature of present harvests, accurate statistical reporting should not be expected.

POPULATION ESTIMATES

Following the 1966 moratorium on industrial Black Sea dolphin/porpoise hunting in the USSR, Bulgaria and Romania, a series of aerial sighting surveys was begun by the USSR, continuing at least through the early 1980s. The methods and some of the resulting data are described in Zemsky and Yablokov (1974), and analyses of the annual variability of estimates based on these data through 1973 are presented in Smith (1982). The abundance of all three species together was estimated to be 1.5 to 2.0 million animals in the 1930s, but only 250,000 over the period 1967 to 1974. There was no apparent trend in abundance in the latter period, but variability in the estimates between years was far greater than anything reasonably compatible with the biology of the species. The largest estimates in the later period were for the common dolphin (average roughly 150,000), while the smallest estimates were for harbour porpoise (average roughly 22,000), with bottlenose dolphins intermediate (averaging roughly 85,000). These estimates are based on expanding the numbers of animals sighted assuming an effective track width of three km in which 50% of the animals present were seen. The survey tracks covered most of the Black Sea, although certain areas were missed, including that within 12 miles of the Turkish coast.

[5] Initial draft by T.D. Smith.

New surveys were conducted by Turkey in April and July of 1987 using standard line transect methods aboard four ships (Çelikkale *et al.*, 1989), and estimates for the three species combined of more than 450,000 animals obtained. The surveys were conducted seaward to 60 km, over roughly 1/6th the total area of the Black Sea, primarily along the southern coastlines. The estimates are based on assuming an effective track width of 5 km (2.5 km on each side of the vessel) and that the animals are distributed over the unsurveyed areas of the Black Sea at the same density as observed in the surveyed areas. Buckland *et al.* (1992) reviewed the statistical basis of these estimates, however, and suggested that they may be seriously biased by the use of the 'maximum effective sighting distance' as the 'effective search width', by size-biased sampling because the school sizes varied between several tens and several thousands of animals, and by extrapolating to unsurveyed areas. For example, they suggest that an estimate of just the surveyed area would be on the order of 76,000 animals, and that 'the true abundance might be substantially below the estimate of 454,440 animals, and may be well below half that estimate'. New estimates of 96,000 ±30,000, 10,000 ±3,000 and 7,000 ±3,000 for common dolphins, harbour porpoise and bottlenose dolphin, respectively, were reported in SC/43/Prog Rep USSR, but these estimates were not reviewed by the sub-committee.

ASSESSMENT AND STATUS

The populations of the three species in the Black Sea had clearly been greatly reduced by the time the fisheries closed between 1966 and 1983. While all three species continue to exist in the Black Sea, the degree of their recovery from previous depletion is not known with any precision. Based on the generally low rates of increase of cetacean populations, however, it is unlikely that they have increased to any substantial fraction of their pre-exploitation abundance in the few years that they have been protected. Further, given the reported declines in the fishery for at least one of their prey items, the recovery of the cetaceans may have been inhibited by reduced food resources. The reported Turkish takes, therefore, are of great concern, whatever their purpose.

RECOMMENDATIONS

The Scientific Committee made five recommendations concerning Black Sea dolphins in 1982 (IWC, 1983a, p.60):

(1) that better information on catch levels and species composition be made available;
(2) that the data from aerial surveys by the USSR be made available for analysis and evaluation;
(3) that a Turkish scientist familiar with the fishery be invited to participate in the next meeting;
(4) that the history of the anchovy fisheries in the Black Sea be reviewed; and
(5) that Turkey and FAO be approached concerning the sampling of the Turkish fishery to obtain biological data of various sorts.

The Scientific Committee reviewed the above recommendations in 1983 (IWC, 1984a, pp.58–9) and noted that a general FAO fishery mission to Turkey had obtained some new data on the harvest of small cetaceans. However, the requested USSR sightings data had not been obtained, nor was the invitation for a Turkish scientist to attend the Scientific Committee meeting accepted. In view of the ban on the hunting of dolphins and porpoises announced by the Turkish Government, effective mid-April 1983, the recommended sampling programme was no longer required. The Scientific Committee re-stated recommendations 2, 3 and 4.

No new data were available in 1984, and the Scientific Committee requested information from IUCN and UNEP and again expressed the desire to have a Turkish scientist attend the Scientific Committee meeting (IWC, 1985, p.53).

The paper on the anchovy fishery provided to the 1990 Scientific Committee meeting (Çelikkale, 1990) was welcomed as a partial response to recommendation 4, as was the participation of Çelikkale.

The Committee in 1990 recommended (1) that the current abundance estimates not be used as a basis for management and that they be reviewed independently; (2) that further population surveys be carried out, preferably involving at least the four nations bordering the Black Sea, and (3) that, because of the perception by fishermen in Turkey of competition by dolphins for fish, studies of feeding ecology of the small cetaceans be carried out.

The sub-committee makes two further **recommendations** below.

(1) An evaluation of alternate possible causes for the declines in the anchovy fishery in Turkey should be made, including fishery resource surveys to monitor abundance and collection of specific catch and fishing effort statistics. The seasonal distribution of the anchovy population and the small cetaceans should be more fully described. Because the fish populations migrate throughout the Black Sea, similar information should be obtained in all countries surrounding the Black Sea, including information on possible incidental take or directed take of cetaceans.
(2) The actual reasons for the reported takes of dolphins and porpoises in Turkey should be determined, and accurate statistics should be collected. Steps should be taken to ensure that these takes are reduced given the poor present understanding of the status of these populations. If the takes are motivated by perceived threats to the anchovy fishery, these threats should be further evaluated. If the takes are motivated by the commercial value of the products, these markets should be documented, and the existence of alternate sources of raw materials investigated. If the takes are incidental to commercial fishing operations, the causes of the entanglements should be determined, and steps taken to reduce the incidental take through education and possible changes to gear and fishing practices. Bulgaria, Romania and the USSR should also be encouraged to provide similar information.

5.1.5 The Peruvian small cetacean fishery[6]

Several species of small cetacean are taken by a variety of artisanal fisheries in Peruvian coastal waters and used for human consumption (Read *et al.*, 1988; Van Waerebeek and Reyes, 1990a). In Peru, the distinction between directed and incidental catches is blurred because small cetaceans possess commercial value, so all catches of dolphins and porpoises have been retained. Three species are commonly taken by these fisheries: dusky dolphin (*Lagenorhynchus obscurus*), Burmeister's porpoise (*Phocoena spinipinnis*), and common dolphin (*Delphinus delphis*).

[6] Initial draft by A. Read.

DISTRIBUTION

The dusky dolphin occurs in cold-temperate waters along both coasts of South America and in presumably separate populations off southern Africa and New Zealand. On the Pacific coast of south America, it is distributed in coastal waters from Huacho, Peru (11°S) to southern Chile (Gaskin *et al.*, 1987). Burmeister's porpoises also occur in the cool waters of the coastal upwelling zone in Peru, extending from Paita (5°S) to the Beagle Channel in Chile and in the coastal waters of the Atlantic into southern Brazil (IWC, 1991c). Their entire range appears to be limited to coastal waters of South America. Common dolphins are widely distributed in pelagic and coastal waters throughout the world oceans, extending south in the Pacific to at least 40°S (Aguayo, 1975). Nothing is known about seasonal movements or stock structure of these three species in Peruvian waters.

PROBLEMS AND CATCH STATISTICS

Two sets of catch statistics describe the numbers of dolphins and porpoises captured in Peruvian waters. Official government statistics, compiled by the Ministerio de Pesqueria (MIPE), report the weight of all small cetaceans landed annually in Peruvian ports from 1966 to the present. Reported landings were at fairly low levels until the early 1970s, when catches rose dramatically (Read *et al.*, 1988). Recent annual landings have decreased from a peak of 1,408 tonnes in 1979 to 426 tonnes in 1989 (Van Waerebeek and Reyes, 1990b). Unfortunately these data are not collected on a species-by-species basis, so it is difficult to estimate the total number of individuals taken.

Estimates have also been made of the actual number of small cetaceans landed at several ports in central Peru since 1985 (Read *et al.*, 1988; Van Waerebeek and Reyes, 1990a; b). In the small port of Pucusana (12°S), the estimated total kill of small cetaceans has increased from 175 in 1985 to 2,320 in 1989 (Van Waerebeek and Reyes, 1990b). The majority of this catch is comprised of dusky dolphins, captured intentionally in a drift net fishery during the winter months (Read *et al.*, 1988). Comparison of these estimates with the published statistics show that the MIPE data are accurate for Pucusana, where small cetacean carcasses are weighed, but highly inaccurate for other ports where weights are estimated by port officials (Van Waerebeek and Reyes, 1990b).

Read *et al.* (1988) estimated the total number of dolphins and porpoises captured in Peruvian waters by combining official MIPE statistics on landed weights with data on species composition and mean weight of each species collected at Pucusana. These authors reported an approximate catch of 10,000 dolphins and porpoises during 1985, although they cautioned that this estimate depended on the accuracy of MIPE records and the extrapolation of species composition from central Peru to the remainder of the coastline.

A particularly troubling aspect of the situation in Peru is the recent development of the directed fishery for small cetaceans. Early reports of utilisation of small cetaceans in Peru (Mitchell, 1975a) indicated that the capture of these animals occurred incidentally to other fishing operations. In recent years, the majority of landed dolphins and porpoises have been deliberately captured, mostly in the directed net fishery for dusky dolphins (Read *et al.*, 1988), although a large catch of common dolphins was taken by harpoon in 1987 (Van Waerebeek and Reyes, 1990b). It has been suggested that this direct exploitation was initiated in the early 1970s following the collapse of the industrial anchoveta fishery in 1972 (Read *et al.*, 1988). The commercial value of incidentally captured dolphins and porpoises presumably stimulated deliberate catches of these animals, particularly after the demise of the lucrative anchoveta fishery.

POPULATION ESTIMATES

There are no population estimates for any species of small cetacean in Peruvian waters.

ASSESSMENT AND STATUS

It is not possible to assess the status of small cetaceans in Peru, because estimates of total kill and abundance are lacking. The catch of dusky dolphins is known to be large, however, numbering in the thousands, and is thus cause for concern. In 1990, the IWC Workshop on Mortality of Cetaceans in Passive Fishing Nets and Traps expressed concern for this population of dusky dolphins (IWC, 1994). Notwithstanding the increase in catches at Pucusana, Van Waerebeek and Reyes (1990b) noted a negative trend in MIPE national landing statistics between 1979 and 1990, and suggested that this reduction in catches might indicate an unsustainable exploitation of declining populations. The Peruvian government reportedly closed the directed fishery for small cetaceans in November 1990, but the Scientific Committee had no detailed information about this closure and its effects.

RECOMMENDATIONS

Research is required to provide reliable estimates of total fishing mortality for each species in Peruvian waters. The sub-committee **recommends** that this be achieved by modifying existing MIPE data collection procedures to record the number of individuals of each species landed rather than total weight. Estimates of abundance of affected species and elucidation of stock structure are also urgently required to assess the impact of directed and incidental takes on affected populations, and the sub-committee **recommends** such studies to be undertaken.

The IWC Workshop (IWC, 1994) recommended that the Government of Peru collect and report catches of cetaceans at all ports, by species and number as well as weight. It also recommended that alternative fishing methods be sought to reduce marine mammal mortality without affecting fishery yields and that technological programmes to this end be established. If the incidental and directed kills continue, it is vital that an effort be made to assess the dolphin population(s), to at least obtain a minimum estimate of abundance.

5.1.6 The Sri Lankan small cetacean fishery[7]

Large catches of small cetaceans have been reported around Sri Lanka. Although some dolphins may have been harpooned by Sri Lankan fishermen at least as long ago as the late nineteenth century (Leatherwood and Reeves, 1989), the current situation appears to have developed along with the rapid expansion of use of synthetic gillnets, which were introduced in the 1950s and are now the fishing method of choice in most fishing areas of the country. Initially, incidentally gillnetted cetaceans may have been discarded by most fishermen, or retained for personal use by only a few. However, as uses were identified and markets established for flesh of small cetaceans, those animals incidentally caught began to be retained and practices were gradually expanded to include deliberate

[7] Initial draft by R. Reeves.

taking (Leatherwood and Reeves, 1989). These developments may well have been fuelled by rapidly increasing human populations and declining availability of some other traditionally sought marine resources (Amarisiri and Joseph, 1985; Joseph, 1985). At present, dolphins are taken mostly in gillnets and by hand harpoons and are used for human consumption and as bait in longline fisheries. The taking of dolphins in Sri Lanka is now widespread and apparently growing (Leatherwood and Reeves, 1989).

SPECIES INVOLVED

The following species of small cetaceans, in approximately descending order of importance (i.e. numbers landed), have been identified in Sri Lanka since 1982: *Stenella longirostris*, *Grampus griseus*, *S. attenuata*, *S. coeruleoalba*, *Tursiops truncatus*, *Kogia simus*, *Feresa attenuata*, *Pseudorca crassidens*, *Globicephala macrorhynchus*, *Peponocehala electra*, *Lagenodelphis hosei*, *K. breviceps*, *Steno bredanensis*, *Orcinus orca*, *Mesoplodon sp.*, *Delphinus delphis* and *Ziphius cavirostris* (Leatherwood and Reeves, 1989). Catches also include a few large cetaceans (*Physeter catodon, Balaenoptera physalus and Megaptera novaeangliae)* and dugongs (*Dugong dugon*) (Leatherwood and Reeves, 1989). Most of the species involved in the Sri Lankan fisheries have pantropical or cosmopolitan distributions.

ESTIMATED CATCHES

The Sri Lankan National Aquatic Resources Agency (NARA) recently estimated that approximately 12,950 small cetaceans are caught in gillnets and others (no estimate) are harpooned annually in Sri Lanka (Dayaratne and de Silva, 1990). Methods used to estimate mortality were not presented in sufficient detail to warrant critical evaluation. Leatherwood (1994) reexamined data on fishing effort and dolphin catches in Sri Lanka from 1984–1986 originally presented in Leatherwood and Reeves (1989), and estimated that at least 8,042–11,821 small cetaceans were taken annually, depending on the assumptions used; he regarded even the highest of these figures as a substantial underestimate. In fact, data do show clearly that takes of small cetaceans are very large in Sri Lanka but are inadequate to permit calculation of reliable estimates with appropriate measures of confidence. With the kind and quality of data currently available

'All attempts to estimate mortality of cetaceans in Sri Lankan fisheries ... are compromised in significant ways ... The best (one) could do was to calculate a series of estimates using conservative assumptions and present the basis and details for those estimates in sufficient detail that they can be recalculated as more information becomes available' (Leatherwood and Reeves, 1989,p.47).

POPULATION STATUS

Although small-scale aerial and vessel surveys have helped describe distribution, relative abundance and behaviour of cetaceans in some areas of Sri Lanka (e.g. Alling, 1986; Leatherwood and Reeves, 1989), there is virtually no information available on stock identity, size or status for any species. Even if there were, data on fishing effort and catches of small cetaceans are inadequate to reliably define any trends in catches of small cetaceans. Therefore, it is not possible to assess effects of removals on the populations involved.

RECOMMENDATIONS

A well-established system for collecting statistics on fish catches exists in Sri Lanka. Observers in fish-landing sites record fishing effort and catches daily or weekly; these data are regularly compiled for each of the 14 fish-landing districts and reported to a national data centre. Catches of cetaceans are not routinely included in catch reports; they are available for only a few sites regularly visited by officials. By training local fisheries officers in identification of cetaceans and making reporting of cetacean catches a routine part of their duties, Sri Lankan authorities could use the existing fisheries reporting system to assess magnitude of catches. Biological studies of caught specimens, as have been initiated by NARA, combined with extensive surveys of the fishing grounds and adjacent EEZ, are then needed to assess effects of catches on affected populations.

It is already illegal to take cetaceans in Sri Lanka (Leatherwood and Reeves, 1989). However, pressures from increasing human populations and economic problems in the country are defining government policies favouring expansion of resource harvesting. As favoured status, and thus full protection, for cetaceans is unlikely, a conservative management programme is needed. To succeed, this programme must educate fishermen and field workers about differences between reproductive potentials of fishes and marine mammals, and thus consequences of overfishing the latter, and provide for careful monitoring and regulation of takes.

The IWC Workshop (IWC, 1994), in addition to a variety of recommendations applicable to Sri Lanka as one of many nations with large cetacean by-catches, recommended that new fisheries not be initiated and that existing fisheries not be expanded until after evaluation of their effects on non-target species.

5.1.7 Platanista minor[8]

COMMON NAMES

Indus susu, Indus river dolphin, *bhulan* (Pakistan)

DISTRIBUTION

This dolphin formerly inhabited the Indus River system, from upstream as far as Attock to downstream below Hyderabad. The historic distribution included the major tributaries of the main channel: Ravi, Sutlej, Chenab and Jhelum (Reeves, 1991). The present distribution is much less extensive (Fig. 3). A few dolphins may survive upstream of Chashma Barrage and below Sukkur Barrage, but most of the population is downstream of Chashma Barrage and upstream of Sukkur Barrage. They are now absent from the tributaries above Panjnad Barrage (Khan and Niazi, 1989).

Upstream movement through barrages is very unlikely to occur, and downstream movement, while possible, is probably only sporadic (Reeves *et al.*, 1991). The extant population is divided into five isolated subpopulations (Khan and Niazi, 1989).

PROBLEMS AND CATCH STATISTICS

No official statistics of any kind appear ever to have been kept on dolphin catches in the Indus system. Information about takes is limited to what can be learned from the literature on scientific collections and live captures, totalling at least 6 and 11, respectively, since 1968 (Herald *et al.*, 1969; Pilleri, 1970a; b; 1972; Pilleri *et al.*, 1976).

[8] Initial draft by R.R. Reeves and R.L. Brownell, Jr.

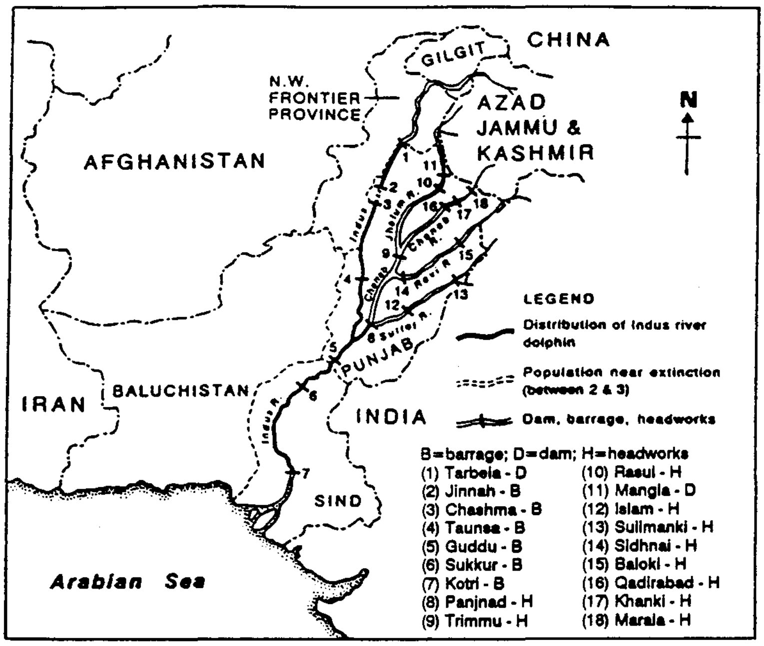

Fig. 3. Distribution of the Indus river dolphin.

Although the river dolphin has been legally protected in Sind province since 1972, the Punjab province since 1974 and the Northwest Frontier province since 1975 (Atkins, 1989), there have been reports of continued killing (Pilleri and Zbinden, 1974; Pilleri and Bhatti, 1978; Reeves, 1991). There is no reported regular incidental mortality in fishing gear or from boat collisions. However, fishing with gillnets, throw nets and various other gears takes place, and some motor traffic occurs, throughout much of the area inhabited by the dolphins.

The most serious conservation problem for this species is the loss of suitable habitat, including the partitioning of the metapopulation by barrages. All the barrages are being considered for retrofitting to produce hydroelectric power. The pressure is strong in Pakistan for intensified agricultural and industrial development, and the demand for water will certainly continue to grow.

POPULATION ESTIMATE

Counts of dolphins in the Sind Dolphin Reserve between Sukkur and Guddu barrages, carried out by the Sind Wild Life Management Board since the late 1970s, suggest a stable or increasing subpopulation there (Khan and Niazi, 1989). The most recent counts suggest a population size on the order of 400–450 dolphins. Because the details of survey methodology are unavailable, however, it is difficult to judge the validity of this estimate.

In the Punjab, counts by the Punjab Wildlife Research Centre between 1987 and 1990 indicate a subpopulation of about 100–110 in waters below Taunsa and Panjnad barrages and above Guddu Barrage (Chaudhry and Chaudhry, 1988; Chaudhry and Khalid, 1989; A.A. Chaudhry and U. Khalid, pers. comm. to Reeves, May 1990). The subpopulations in the Punjab and Northwest Frontier province upstream of Chashma Barrage and in Sind downstream of Sukkur Barrage range from a few to 10–20 individuals (Khan and Niazi, 1989; Chaudhry and Khalid, In press). Although the counts for the Punjab reported by Chaudhry and colleagues are substantially higher than those reported by Khan and Niazi (1989), there is no reason to suppose that the population has increased. Khan and Niazi's counts were made in discrete portions of the area (see Niazi and Azam, 1988), whereas Chaudhry *et al.* attempted 100% coverage.

ASSESSMENT AND STATUS

The Indus River dolphin is critically endangered because of its restricted distribution and low population size. The subpopulation between Sukkur and Guddu barrages receives some protection, and its distribution and population size are monitored regularly by the Sind wildlife authorities. The same is true of the subpopulation between Taunsa, Panjnad and Guddu barrages, although since this area lacks explicit status as a dolphin reserve, policing efforts may be less effective. Even if protection from direct exploitation were complete, which it probably is not (Reeves, 1991), the deterioration of habitat is likely to continue.

RECOMMENDATIONS

International support is urgently needed for developing a programme of field research that addresses immediate management problems. Research should include (1) continued regular monitoring of population size and distribution, (2) noninvasive efforts to identify and track the movements and activities of individual dolphins, (3) estimating calf production and calf mortality, (4) identifying limiting habitat parameters, (5) precisely mapping and monitoring existing utilised and vacant habitat along the full length of the river, (6) determining and quantifying the cause(s) of mortality generally, determining whether the subpopulations are increasing or decreasing and projecting future trends in the subpopulations. Potential reserve areas need to be surveyed and appropriate reports and recommendations prepared. The advisability and feasibility of creating ways to allow mixing of the artificial subpopulations should be studied, perhaps as a component of the hydroelectric development work being supported with foreign capital (Reeves *et al.*, 1991).

Enforcement and strengthening of existing protective laws and creation of additional reserves should be high priorities. International support may be needed to ensure adequate staffing, training and equipping of wardens. Further withdrawals of water from the main river channels for irrigation, power plant cooling or any other domestic or industrial use should be minimised. The Government of Pakistan and the international aid agencies involved in supporting development projects in the Indus basin should be made aware of the river dolphin's precarious status, required to assess the likely impact of the projects on dolphins and dolphin habitat, and encouraged to make every effort to reduce or eliminate any deleterious effects.

5.2 Incidental catches

5.2.1 *Phocoena sinus*[9]

COMMON NAMES

Vaquita, Gulf of California harbour porpoise

DISTRIBUTION

This porpoise is endemic to the warm-temperate waters of the upper Gulf of California. It has the smallest geographic range of any marine cetacean. A few sightings from farther south in the Gulf have not been confirmed. (Silber, 1990; Vidal, In press).

PROBLEMS AND CATCH STATISTICS

The vaquita has been incidentally caught in the gillnet fishery for totoaba (the large sciaenid fish *Totoaba macdonaldi*) since the mid-1920s (Vidal, In press). The fishery peaked in the 1940s and declined as the totoaba was depleted. The totoaba became fully protected in 1975, but the fishery has continued at lower levels, both as a legal experimental fishery and illegally. In addition, the vaquita is taken incidentally in gillnets in a growing shark fishery and a fishery for sierra (*Scomberomorus* sp.) and in shrimp trawls. The historical levels of incidental catches are impossible to reconstruct because of lack of information on fishing effort and vaquita catch rates. Records are available for 85 vaquitas taken incidentally since 1985 (Vidal, In press). This undoubtedly represents a very small proportion of the total mortality from fishing operations. The available information suggests that 30–40 vaquitas are killed each year (IWC, 1991c). Most recently, 13 vaquitas have been caught in the totoaba fishery during February and March this year (O. Vidal, pers. comm., 1991; not included in Vidal, In press).

POPULATION ESTIMATE

The size and status of the vaquita population are unknown. Extensive surveys by Silber (1990) and co-workers 1986–89 resulted in sightings of only 110 individuals in all surveys combined. Considering the scarcity of sightings relative to survey effort, the few individuals per sighting, and the very limited geographic range of the species, there can be no doubt that the population is very small, perhaps in the low hundreds (IWC, 1991c).

ASSESSMENT AND STATUS

The vaquita is the most endangered marine cetacean. The relatively high incidental catches and the difficulties and costs of enforcing long-term conservation measures quickly lead to the conclusion that the vaquita is in immediate danger of extinction (IWC, 1991c).

RECOMMENDATIONS

Because of the precarious status of the single population of this species, the Scientific Committee in 1990 (IWC, 1991b) recommended that further action be taken to stop the major cause of entanglement by fully enforcing the closure of the totoaba fishery and reconsidering the issuance of future permits for experimental totoaba fishing, that immediate action be taken to stop the illegal shipment of totoaba (also and endangered species) across the US border, and that a management plan for the long-term protection of this species and its habitat be developed and implemented. The plan should include: (1) an evaluation of other fisheries that take or may take vaquitas; (2) investigation and implementation of alternative methods of fishing or other economically viable activities to prevent further incidental mortality; (3) education of the local fishermen and general public to increase awareness of the vaquita's dangerous situation; (4) monitoring of the status of the population of vaquitas; and (5) studies of the population biology of the species.

5.2.2 *Lipotes vexillifer*[10]

COMMON NAMES

Baiji, Chinese river dolphin

DISTRIBUTION

The species is presently restricted to the lower and middle Yangtze River, from the mouth to Yichang below the Three Gorges, where it occurs in small scattered groups over a distance of more than 1,000 km (Ridgway, 1966). It formerly occurred in other rivers and in the lakes feeding into the Yangtze.

PROBLEMS AND CATCH STATISTICS

The decline of the baiji is due to several causes: (1) habitat degradation (through depletion of fish stocks, development for water conservation and irrigation, and riverbank development, including explosion during construction), (2) increased river traffic resulting in deaths due to collisions with vessels, and (3) harmful fishing practices (Peixun and Yuanyu, 1989). The harmful fishing practices include the use of illegal bottom snaglines ('rolling hooks') and electrofishing. In 1984, in the section of the river from Honghu to Wuhu, 7 baiji were killed in explosions, 10 in illegal fisheries and one in electrofishing. Incidental kill data are not available for the entire length of the range of the species or for more recent years.

POPULATION ESTIMATE

The total number of baiji is estimated at 300 (Peixun and Yuanyu, 1989). This estimate is based on surveys conducted in 1985 and 1986. The density of dolphins per km of river searched ranged from 0.09 to 0.39. Further population surveys are planned.

ASSESSMENT AND STATUS

There is no estimate of original population size, but the range has contracted in historical times. The decline is thought to have been particularly steep during the last 35 years, as the Yangtze Valley has become industrialised and the river itself more heavily used (Perrin and Brownell, 1989).

RECOMMENDATIONS

The Workshop on Biology and Conservation of the Platanistoid Dolphins at Wuhan, People's Republic of China, in 1986 made a series of recommendations concerning conservation and management (Perrin and Brownell, 1989).

[9] Initial draft by W.F. Perrin.

[10] Initial draft by W.F. Perrin.

(1) Further efforts should be made to eliminate or reduce the use of the 'rolling hook' fishing gear in the regions of high dolphin density.
(2) Procedures should be developed to ensure that dolphins are absent or removed from the area before explosives are used in river-bank construction.
(3) All the proposed and additional natural reserve areas should be established along the river, with commitment of sufficient resources for effective enforcement of protective regulations.
(4) The two proposed semi-natural reserves at Shishou and Tongling should be constructed and the health of the captured dolphins placed in them monitored closely. Hydrologic surveys of the probable effects of high-dam construction on both sites should be carried out. Before dolphins are placed in the reserves, thorough studies of levels of contaminants in the water, bottom sediments and food fish should be completed. Seasonal change in the quantity and nutritive quality of the food fish should also be analysed. Finless porpoise should not be placed in the reserves; they may compete with the baiji for food in the situation of decreased species diversity of food fishes.

Since the workshop, several of these recommendations have been acted on. A patrol vessel has been put in service to enforce the ban on the use of 'rolling hooks'. An additional natural reserve has been established, and construction of the semi-natural reserve at Tangling has nearly been completed. An environmental study of the site of the proposed semi-natural reserve at Shishou has been carried out.

In addition the sub-committee **recommends** that monitoring of the population status should be continued.

5.2.3 Tursiops truncatus *on the Natal South Coast of South Africa*

COMMON NAMES

Bottlenose dolphin, *stumpneusdolfyn* (Afrikaans)

DISTRIBUTION

The bottlenose dolphin is found in tropical and temperate coastal waters around the world and in offshore waters in some regions (e. g. the eastern tropical Pacific: Scott and Chivers, 1990). In South African waters, the South Natal Coast population is apparently resident in a range approximately 30–40 km long (Ross *et al.*, 1989). Roughly 80–90% of dolphins seen in aerial surveys were within one km of the shore.

PROBLEMS AND CATCH STATISTICS

Approximately 20 dolphins die annually in anti-shark gillnets (Cockcroft, 1990; IWC, 1994). Most of the kill is made up of lactating females and their calves.

POPULATION ESTIMATE

Ross *et al.* (1989) estimated the population at 219–249, although some assumptions and factors in the assessment probably cause this to be an underestimate. They suggested a need for offshore aerial surveys, more detailed data on home range and daily movement patterns to assist in assessing the reliability of the aerial survey estimates, a means for estimating percentage of schools missed on the trackline, and mark-resighting studies of individual schools. Some of these problems were addressed in a series of surveys flown along the north coast of Natal in 1989 (Cockcroft *et al.*, 1991), from which it was estimated that the probability of seeing a dolphin group was 0.31 (approximate confidence limits 0.15, 0.46).

ASSESSMENT AND STATUS

The population may have been under pressure from the shark nets since 1952 (Ross *et al.*, 1989). The original size of the population is unknown. Although population size has been estimated as 219–249, the results of Cockcroft *et al.* (1991) suggest that this might be a substantial underestimate. Even so, the annual take of about 20 may be more than can be sustained, and it is likely that the population is declining (IWC, 1994).

RECOMMENDATIONS

Research needed to improve the population estimate is described above. The IWC Workshop (IWC, 1994) recommended that the killing of bottlenose dolphins in Natal waters be reduced immediately and that an immediate reassessment of deployment of the anti-shark nets be carried out. Information is also needed on relationships among contiguous stocks or herds of bottlenose dolphins.

5.2.4 Stenella coeruleoalba *in the Mediterranean Sea*[11]

COMMON NAMES

Striped dolphin (English), *delfín listado* (Spanish), *dauphin bleu et blanc* (French).

DISTRIBUTION

The striped dolphin is found in tropical and temperate waters worldwide. It is one of the most abundant cetacean species in Mediterranean waters. Its distribution extends over both the eastern and the western basins, although it appears to reach higher densities in the latter. It prefers deep waters and is usually found beyond at least 5–10 miles of the coast with the highest densities being probably reached in open waters.

PROBLEMS AND CATCH STATISTICS

Because of their pelagic habits, striped dolphins do not usually interact with coastal and artisanal fisheries. The major problems appear to be pollution, incidental catches in offshore drift nets.

(i) Pollution

This is probably the most acute long term problem for the population. Western Mediterranean striped dolphins are amongst those mammals in which the highest concentrations of organochlorine pollutants have ever been detected. The blubber of specimens stranded on the Mediterranean coast of France showed concentrations averaging 267 ppm for PCBs and 344 ppm for DDTs (Alzieu and Duguy, 1979) and free-ranging striped dolphins off Spain carried levels averaging 326 ppm of PCBs and 165 ppm of DDTs (Aguilar and Perrin, 1988). Concentrations of heavy metals, especially mercury, are also known to be extremely high (Viale, 1978; 1981; Sanpera *et al.*, unpub. data). Although no studies to establish the impact of these pollutant levels on the population have been carried out, it is well documented that some pollutants, especially organochlorines, depress reproductive rates, produce alterations in skeletal development, and depress the immune system of mammals (Luster and Faith, 1979; Nicholson and Moore, 1979).

[11] Initial draft by A. Aguilar.

In 1990 an epizootic process broke out in the western Mediterranean and produced thousands of deaths of striped dolphins. The ultimate cause was found to be a morbillivirus infection, although levels of PCBs in diseased dolphins were found to be higher than in the healthy population, suggesting that individuals carrying high pollution loads were more susceptible to the disease. Also, abnormal weather conditions that decreased water productivity in the region (and subsequent lack of food for the dolphins) may have also played a role by weakening the dolphins and facilitating the infection and spreading of the disease (Aguilar and Raga, 1990).

(ii) Catches

The striped dolphin is seldom caught in coastal gillnets, bottom trawlers or long-line fishing (Duguy *et al.*, 1983). However, the recent development of pelagic gillnet fisheries in Italian, Spanish and African Mediterranean waters produced considerable by-catches of this species in the late 1980s (Magnaghi and Podesta, 1987; di Natale, 1990; di Natale and di Sciara, 1990). Large-scale drift nets were temporarily banned in 1990 in Italy and strictly regulated in Spain in 1991. However, some limited drift net operations by foreign flag vessels in the southern Mediterranean still remain totally unregulated. The Government of Italy is reportedly considering whether the temporary ban instituted last year will be continued. Very recent, and as yet unconfirmed, information indicates that Italian vessels may be permitted to restart driftnetting in 1991 [*The ban was lifted – Ed*]. Reliable quantification of past and current incidental kills of striped dolphins in the Mediterranean is not available. Illegal directed kills of striped dolphins also occur in France, Italy, southern Spain and northern Morocco at least (Duguy *et al.*, 1983; Aguilar, unpub. data; di Natale, 1990).

POPULATION ESTIMATE

The Mediterranean population of striped dolphins appears to be independent of that inhabiting North Atlantic waters, although some limited mixing through the Gibraltar Straits probably exists (Aguilar and Perrin, 1988). No reliable population estimate for the Mediterranean population of striped dolphins is available. In the western basin it has been suggested that the species may have expanded in the last decades to occupy the ecological niche of the common dolphin, a species in clear recession (due to unknown causes), at least in the northern fringe of the western Mediterranean (Viale, 1985).

ASSESSMENT AND STATUS

Because of lack of reliable information of population abundance, population trends and biological parameters, the status of the species in the Mediterranean can not be assessed. However, the pressure of human activities, especially through pollution, incidental catches and decrease of prey abundance is undoubtedly adversely affecting the population.

RECOMMENDATIONS

IWC (1994) recommended that actions similar to the ban instituted by Italy should be encouraged elsewhere in the Mediterranean, and that international co-operation and action by the General Fisheries Council for the Mediterranean (GFCM) are required to ensure that large scale driftnet fisheries do not restart from other nations, or that reflagging for the purpose of continuing the fishery does not occur. A second recommendation was that wherever possible the consequences of banning drift nets for the fishermen involved should be studied, the economic impacts on the fishing community appraised and the subsequent development of alternative fishing methods monitored.

The sub-committee **recommends** that research efforts should be devoted to:

(i) monitoring pollutant levels, especially organochlorines and heavy metals, and assessing their effect on population parameters such as reproductive rates, body and skeletal growth, and immunological strength;
(ii) monitoring incidental and direct catches and identifying the fishing gear and areas in which the highest mortality occur;
(iii) determining population size, structure and stock identity, and estimating local abundance, especially in the regions affected by the 1990 epizootic;
(iv) monitoring fishing and anomalous natural mortality through examination of stranded animals. This will also permit continued monitoring of the health status of the population through necropsy.

The sub-committee also **recommends** that management measures should be adopted to ensure the enforcement of existing laws to restrict harmful fishing operations, and the reduction of pollutant shedding into Mediterranean waters.

5.2.5 Phocoena phocoena *in the western North Atlantic*[12]

COMMON NAMES

Harbour porpoise, common porpoise, *marsouin commun, pourcil*, (French); puffin' pig.

DISTRIBUTION

Distributed primarily in temperate and subarctic waters of the Northern Hemisphere, in the western North Atlantic, the distributional limits of this species are Upernavik (72°N) and northern Florida (28°N) (Gaskin, 1984; Polacheck *et al.*, In press). The vast majority of sightings have been made over the continental shelf, although harbour porpoises are occasionally found in deep waters further offshore (Stenson and Reddin, 1990). Gaskin (1984) suggested the existence of four stocks in the western North Atlantic based on indirect evidence from patterns of distribution and seasonal movements. From north to south, these proposed stocks are: (1) western Greenland, (2) eastern Newfoundland and Labrador, (3) Gulf of St. Lawrence, and (4) Bay of Fundy, Gulf of Maine and southwestern Scotian Shelf. Porpoises in all four stocks exhibit seasonal migrations and are common in inshore waters only during the summer months (Gaskin, 1984).

PROBLEMS AND CATCH STATISTICS

Harbour porpoises have been subjected to both directed hunting and incidental catches in commercial fisheries throughout their range. Aboriginal hunters in western Greenland took between 400 and 900 porpoises per year between 1900–50 and between 600 and 1,200 from 1950–87 except for the period 1968–71 when the catch was between

[12] Initial draft by A. Read.

1,300 and 1,500 (Kapel, 1977 and Danish Progress Reports to the IWC). It should be noted, however, that the reliability of the Greenlandic hunting statistics has been deteriorating during recent years. Harbour porpoises were also hunted in the Gulf of St. Lawrence (Laurin, 1976) and Bay of Fundy (Leighton, 1937; Prescott and Fiorelli, 1980) until recently (Gaskin, 1984). There are no reliable records of direct exploitation of this species in the waters of Newfoundland and Labrador.

Large numbers of harbour porpoises have been killed in salmon gillnets off the western coast of Greenland for several decades (Lear and Christensen, 1975). Foreign vessels were estimated to have taken approximately 1,500 porpoises in 1972 (Lear and Christensen, 1975) and the catch of the domestic fleet may have been almost as large (Kapel, 1977). No recent data exist on the numbers of porpoises killed in this fishery, although foreign vessels have been excluded since 1976 (Kapel, 1977). There is, however, reason to believe that the number of porpoises killed in this fishery has decreased since 1975 as the salmon quota has gone down from 2,000 tonnes in 1972 to around 800 tonnes in the most recent years (Lear and Christensen, 1975; Larsen, pers. comm.).

In Newfoundland and Labrador, harbour porpoises are killed in salmon gillnets, cod traps and groundfish gillnets. In 1980, 100 fishermen in Newfoundland reported taking 243 harbour porpoises in gillnets (Lien *et al.*, 1987). It is not possible to extrapolate a total catch from these data, because sampling was not proportional to fishing effort and no estimates of total effort are available. Nevertheless, the total annual incidental catch of harbour porpoises in this region probably numbers in the low thousands (Lien *et al.*, 1987).

Fontaine *et al.* (1992) sent questionnaires to 968 coastal fishermen in the Gulf of St. Lawrence and asked them how many porpoises they encountered in their nets during 1988. One-third of the fishermen responded, reporting that they caught 623 porpoises, mostly in groundfish gillnets. It is not known whether or not the respondents were representative of the entire fishing community, but it is clear that the incidental catch of harbour porpoises in the Gulf of St. Lawrence is substantial.

Harbour porpoises are also captured by bottom tending gillnets and herring weirs in the Bay of Fundy and Gulf of Maine (Smith *et al.*, 1983; Read and Gaskin, 1988). The largest incidental catches in this area are recorded by the groundfish gillnet fisheries. Reported kills by fishermen from the western Bay of Fundy and data on observed kill rates in the Gulf of Maine, combined with information on gillnet effort, suggest that the incidental catches are substantial, and it is has been suggested that recent takes are on the order of 300 to 800 animals per year (IWC, In press). However it is not currently possible to extrapolate observed kill rates for the Gulf of Maine to obtain an accurate estimate of total takes for this area because of the non-representative sample of vessels from which kill rate data were obtained and problems with spatial/temporal resolution in the gill net effort data (Smith *et al.*, 1990). In addition, no information is available on possible kills in the eastern Bay of Fundy and the western Scotian Shelf. There are a few confirmed reports of incidental catches from fixed gear in waters south of Cape Cod during winter months (Polacheck *et al.*, In press). Current efforts by the US National Marine Fisheries Services (NMFS) are directed at improving estimates of incidental catches by placing observers aboard gillnet vessels in the Gulf of Maine (Payne *et al.*, In press).

POPULATION ESTIMATES

No reliable population estimates are available for harbour porpoise stocks in Greenland, Newfoundland and Labrador, or the Gulf of St. Lawrence. Aerial surveys in the Gulf of Maine resulted in a minimum abundance estimate of 3,541 ±1,486 (Winn, 1982). Kraus *et al.* (1983b) performed a shipboard survey of the inshore waters of the Gulf of Maine and estimated harbour porpoise abundance at 7,956 ±1,327. The results of an experiment on census techniques indicated that aerial and shipboard surveys both under-estimate actual harbour porpoise density because only a small proportion of individuals are at the surface when the survey vessel passes (Kraus *et al.*, 1983a). Application of *ad hoc* correction factors derived from this experiment suggests that actual abundance was at least 15,000 when these surveys were performed. It was noted that these surveys may have missed a substantial proportion of the range of the population in this area, so that this may still be a considerable underestimate of the true population size (IWC, 1991c). A comprehensive census of harbour porpoises in the Bay of Fundy and Gulf of Maine is planned by NMFS during the summer of 1991.

ASSESSMENT AND STATUS

A lack of accurate data on the magnitude of directed and incidental mortality prevents definitive assessments of the status of harbour porpoises in Greenland, Newfoundland and Labrador, and the Gulf of St. Lawrence. Preliminary evidence, however, suggests that incidental catches are large in these areas and are thus cause for concern. Two recent reviews (IWC, 1991c; 1994) have concluded that the incidental catch of harbour porpoises in the Bay of Fundy and Gulf of Maine is unlikely to be sustainable. These reviews both recommended that steps be taken immediately to reduce the incidental mortality of harbour porpoises in this region. At the present time, harbour porpoises are listed as 'threatened' in eastern Canada by the Committee on the Status of Endangered Wildlife in Canada (Gaskin, 1989). A status review of this species in the United States is currently being performed by NMFS.

RECOMMENDATIONS

In 1990, the Scientific Committee (IWC, 1991c) recommended that research be undertaken to (1) improve understanding of harbour porpoise stock identity, (2) estimate abundance for all stocks, and (3) refine estimates of the magnitude of directed catches and incidental mortality for all stocks. Also to, (4) conduct a joint US-Canada comprehensive sighting survey in the Bay of Fundy, Gulf of Maine and adjacent waters. Each of these research initiatives will require a substantial investment of time and resources. In addition, research should address degradation of the coastal habitat of this species and the effects of contaminants on the condition of particular stocks. Research is underway for these recommendations in the Bay of Fundy and Gulf of Maine. Further, more general, recommendations on harbour porpoise research were made by the Scientific Committee in 1990. These are summarised in Item 5.2.7 below.

The large kills of harbour porpoises in commercial fisheries, combined with substantial uncertainty regarding many aspects of the biology of this species, led the Scientific Committee to recommend that levels of incidental mortality be reduced throughout the range of the species.

5.2.6 Phocoena phocoena *in the eastern North Atlantic*[13]

COMMON NAMES

Harbour porpoise (English), *bruinvis* (Dutch), *Schweinswal* (German), *marsvin* (Danish), *tumlare* (Swedish), *nise* (Norwegian and Faroese), *muc mhara* (Irish), *Marsouin* (French), *Marsopa* (Spanish).

DISTRIBUTION

Although recent surveys show an offshore, oceanic occurrence of the harbour porpoise, this species is primarily distributed in coastal waters of the temperate and subarctic zone throughout the Northern Hemisphere, with a population occurring as far south as Senegal in the East Atlantic (IWC, 1991c). The extensive shallow waters of the North Sea are probably the most important habitat for harbour porpoises in the Northeast Atlantic.

PROBLEMS AND CATCH STATISTICS

The sub-committee on small cetaceans expressed concern for the status of the stock when it reviewed available information in 1990, and listed incidental catches, depletion of prey populations, pollution and human disturbances as possible threats to porpoise populations in these areas (IWC, 1991c).

Most countries in the region have legislation protecting the harbour porpoise. The only reported directed catches of harbour porpoises are small takes in the Faroe Islands, and these takes are likely to have a negligible effect on the stock. Habitat degradation and incidental catches in fishing gear have been proposed as more significant threats to harbour porpoises in this region.

The seasonal migration of porpoises through the Danish Belt Seas into the Baltic is well known (Möhl-Hansen, 1954). This migration through shallow and narrow waters gave rise to the long history of the Danish harvest of porpoises. This historical hunt is described by Kinze (in prep), who mentions six major catching sites. The most important site was the northern Little Belt, which was operative in the period from 1357 to 1892 and in the years 1916–19 and 1941–44. The overall annual take for this site may have been about 1,000 animals, with a minimum total take of 47,432 animals from 1827 to 1892. According to Kinze, this hunt continued for about five centuries. However, in the 1880s the annual catches increased and may have initiated the decline of the 'Baltic population' of porpoises. The relative importance of these takes compared with other negative influences on the Baltic population is unknown.

Clausen and Andersen (1988) collected 149 porpoises mainly from coastal gillnet fisheries in Danish waters during 1980 and 1981. They also noted the existence of further catches in wreck nets worked further offshore in the southern North Sea. They proposed a total catch of several thousand by Danish vessels in the North Sea. Kinze (1990a) reported the capture of 152 porpoises in Danish fisheries, mainly in the Skagerrak, between 1986 and 1989. One vessel, from a fleet of 15 similar vessels at Hantsholm, was monitored individually in 1988 and 1989. An annual catch rate of 30 porpoises was recorded, which lead Kinze to speculate that this fleet may take around 450 per year. Further catches are reported in gillnets in Danish waters.

Further incidental takes in the order of tens to a few hundreds are reported from most other countries in the region (e.g. Northridge, 1988; Kremer and Schulze, 1990; Northridge and Lankester, 1990; Benke *et al.*, 1991). About 100 porpoises were recorded incidentally caught in a six-week period in 1988 by a drift net fishery for salmon in Norwegian coastal waters. The use of salmon drift nets was prohibited in Norway after the 1988 fishing season. Other Norwegian gillnet fisheries are known to catch porpoises, but less so than the former drift net fishery for salmon (Bjørge and Øien, 1990). Since the summer of 1988, a systematic scheme for collecting incidentally caught porpoises in Sweden has resulted in the collection of 178 individuals to December 1990, most of which came from gillnets in the Kattegat and Skagerrak (Lindstedt, 1990).

POPULATION ESTIMATES

The only estimates of population size based on survey results, are those of Bjørge and Øien (1990), who reported an estimated abundance of harbour porpoises in the Lofoten-Barents Sea area of 10,994 (CV 0.2381), and in the northern North Sea of 82,619 (CV 0.2165). There is little information on population trends in this area. In the Baltic Sea it is clear that harbour porpoise abundance has declined during this century (Andersen, 1982; Skora *et al.*, 1988; Määttänen, 1990). In the North Sea the situation is far from clear. The relatively large number of porpoises found in the central and northwestern North Sea gives no reason to neglect the possibility of a depletion of porpoise populations in neighbouring areas. Evans (1990) has reported declines in porpoise abundance in three separate areas in the Shetland Islands on the basis of boat surveys carried out locally in the early and late 1980s. Such results are difficult to interpret when so little is known of population distribution.

The stock identity of porpoises in the eastern North Atlantic is not well understood. A non-metric analysis of a large series of harbour porpoise skulls suggested the existence of several population units in this region (Kinze, 1990b), and a study based on isoenzyme electrophoresis indicated distinct Dutch and North Sea populations (Andersen, 1990).

ASSESSMENT AND STATUS

Although no single fishery is known to have a dramatically high incidental catch of porpoises (except for the possible large take in some Danish fisheries reported by Clausen and Andersen (1988)), the species is taken incidentally throughout the region, and there is a fear that the overall incidental catches could be above the sustainable level for the total population in the area. Although no reliable information is available at present on the population structure in the North and Baltic Seas, indications of distinct sub-populations exist. Taking into account the uneven distribution of fisheries, the impact of bycatches on any distinct sub-population may be more significant than overall takes on the total population in the northeast Atlantic region.

RECOMMENDATIONS

At its 1990 meeting, the Scientific Committee recommended, as a high priority, that incidental kills of harbour porpoises in gillnets should be reduced throughout their range (IWC, 1991c). Possible ways to reduce incidental kills include gear modifications, gear conversions, area or season closures and other restrictions in the fisheries.

The importance of determining harbour porpoise stock identities was also highlighted by the Scientific Committee in 1990 and it recommended that studies on stock identity should be undertaken through an integrated approach that

[13] Initial draft by A. Bjørge.

includes a combination of pollutant levels, calving areas, non-metric variation, DNA allozymes and other types of research that may contribute to stock discrimination.

The Committee also recommended:

(1) that the methodology for these different approaches be standardised so that results are comparable;
(2) that where distribution extends beyond the boundaries of a single country, available samples and data should be pooled from as many potential sub-populations as possible, across national boundaries, and be analysed together;
(3) that for the northeastern Atlantic the information on potential stocks, distribution, and other relevant data be synthesised in an attempt to produce a clearer picture of the stock identities in that region;
(4) that abundance be estimated for populations where no such estimates exist, and especially for those for which there is or may be a large incidental kill;
(5) that such studies consider the possibility that apparent declines in abundance may result from geographic shifts in distribution. Trends in abundance should be monitored on the basis of systematic surveys;
(6) that dedicated sightings surveys should be conducted in the North and Baltic Seas;
(7) that attention should be given to estimating g(0) for harbour porpoise surveys;
(8) that behavioural studies of free ranging harbour porpoises should be made to gain knowledge of habitat requirements in order to provide a framework for establishing management plans for the species and its habitat;
(9) that tissues of stranded and incidentally killed harbour porpoises should be collected and analysed in order to monitor their contaminant levels;
(10) that monitoring of pollutants be integrated with research on reproductive biology and other population parameters to increase the understanding of the possible effects of contaminant loads on the condition of the populations (this was considered especially important in the northeast Atlantic region);
(11) that a high priority be given to monitoring, as well as reducing, levels of incidental mortality in all fisheries;
(12) that when questionnaire and interview methodology is used to investigate or monitor incidental catches, studies of reliability and scaling of reported take estimates should also be included.

An additional recommendation is that all countries of the northeast Atlantic region should implement a recording scheme for incidental captures of harbour porpoises in their waters.

5.2.7 *High Seas driftnet fisheries*

5.2.7.1 *North Pacific*

Driftnet fisheries in the North Pacific Ocean include the following: (1) Japanese salmon drift gillnet fishery, (2) Japanese, Taiwanese and Korean drift squid gillnet fishery and (3) Japanese and Taiwanese large mesh drift gillnet fishery for tunas and billfishes. The major small cetaceans taken in these fisheries are the northern right whale dolphin, *Lissodelphis borealis*, Pacific white-sided dolphin, *Lagenorhynchus obliquidens* and Dall's porpoise *Phocoenoides dalli*. Other small cetaceans that are known or likely to be taken included common dolphin, *Delphinus delphis*, striped dolphin, *Stenella coeruleoalba*, bottlenose dolphin, *Tursiops truncatus*, Risso's dolphin, *Grampus griseus*, spotted dolphin, *Stenella attenuata*, pygmy killer whale, *Feresa attenuata*, pygmy sperm whale, *Kogia* spp. and ziphiids. The three major species are reviewed in turn below.

Lissodelphis borealis[14]

COMMON NAMES

Northern right whale dolphin; *semi-iruka* (Japanese); *severnyi kitovidnyi del'fin* (Russian).

DISTRIBUTION

The northern right whale dolphin is a cold-temperate water species endemic to the North Pacific Ocean. In the eastern North Pacific, it has been sighted from about 32° to 58°N (Fig. 4; Leatherwood and Walker, 1979; Kajimura and Loughlin, 1988). In the western North Pacific, the southern limit is as far south as 35°N from September to June (Kasuya, 1971) and about 40°N in the remainder of the year (Fig. 4); the northern limit is the southern Kurile Islands (Sleptsov, 1952; Klumov, 1959). The southern boundary in the central North Pacific is about 35°N (Fig. 4). Their temperature range is about 8° to 24°C, although the majority of the sightings have been in temperatures of 11°to 17°C (Fig. 4; Dohl *et al.*, 1983). Based on sightings

[14] Initial draft by L.L. Jones and E. Miller.

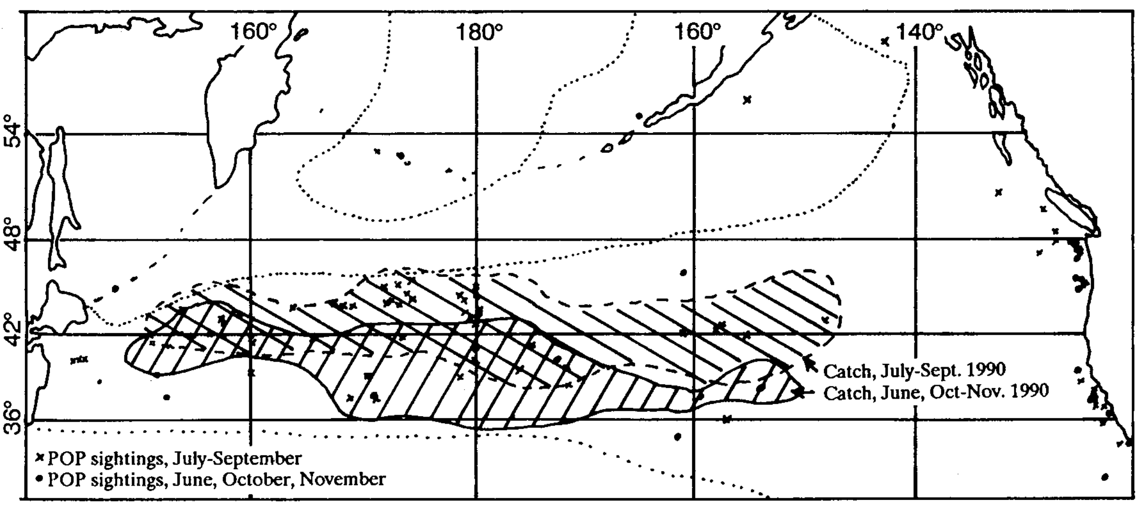

Fig. 4. Sightings of *Lissodelphis borealis* (1958–89) and high seas driftnet catch areas in 1990.