

## Annex H

### Report of the Sub-Committee on Small Cetaceans

**Members:** Perrin (Convenor), Aguilar, Andersen, Arnason, Asper, Baird, Barlow, Bjørge, Bloch, Braham, Brownell, Buckland, Cawthorn, Christensen, da Silva, DeMaster, Desportes, Donovan, Ford, Fujise, Gunnlaugsson, Hall, Heyning, Hiroshima, Hohn, Inagaki, Jean-Caurant, Johnson, Joyce, Kasamatsu, Kasuya, Kato, Kock, Lens, Lockyer, Lyrholm, Martin, Mate, Michaelis, Moore, Nakamura, Odell, Øien, Reilly, Sanpera, Scott, Sigurjónsson, Smith, Stoker, Swartz, Vikingsson.

#### 1. ELECTION OF CHAIRMAN

Perrin was elected Chairman.

#### 2. APPOINTMENT OF RAPORTEURS

Martin, Smith, Buckland and Heyning assisted the Chairman as rapporteurs.

#### 3. ADOPTION OF AGENDA

The adopted agenda is given in Appendix 1.

#### 4. REVIEW OF AVAILABLE DOCUMENTS

The following documents contained information relevant to the work of the sub-committee: SC/41/SM1-33; O 4, 5, 7, 12, 17, 20, 22, 25, 26, 27, 33; SHMi14 and 17; SC/40/O 30 Revised; and the national Progress Reports. Sigurjónsson generously distributed to the members of the sub-committee copies of the proceedings volume for the 1987 Workshop on North Atlantic Killer Whales in Provincetown, Massachusetts (Sigurjónsson and Leatherwood, 1988).

#### 5. REVIEW OF EXPLOITED POPULATIONS OF PILOT WHALES

##### 5.1 North Atlantic populations of *Globicephala melas*

The sub-committee reviewed information on North Atlantic pilot whales in 1987 (*Rep. int. Whal. Commn* 38:117-9) and noted a number of areas where substantial information was being developed. The sub-committee discussions this year focused on several of these areas, especially on information derived from recent extensive sampling of the Faroese drive fishery.

The sub-committee wishes to recognise the very great effort and cooperation that have made the international research programme in the Faroes possible and productive and wishes to thank the participants in the programme for the large number of papers and progress reports submitted here.

##### 5.1.1 Stock identity

The long-finned pilot whale is widely distributed in the North Atlantic: in the Central Atlantic (Brown, 1961), from Cape Hatteras north on the western side and on the eastern side from Northwest Africa north to Greenland (SC/41/SM5 and 10). Little information is available on the degree of exchange of animals in different regions of the Atlantic. SC/41/SM28 describes different parasite fauna composition between animals from the Faroe Islands, the eastern North Atlantic near France and the western Mediterranean and notes that a different parasite composition had been described for whales from the earlier Newfoundland pilot whale fishery (Sergeant, 1962). It was noted that the overall degree of parasite infection increased with age and was higher for males. However, the differences that were noted between regions could occur due to diet differences and were not thought to be necessarily an indication of genetic separation. On the other hand, the permanence of scars caused by particular species of nematodes, and the fact that cysts of the type encountered for some cestodes persist for the life of the whale (which is only an intermediate host) suggest that individual pilot whales do not routinely move between the three regions studied or between Newfoundland and eastern Atlantic waters.

SC/41/SM17 examined differences between pods driven in the Faroese fishery using starch-gel electrophoresis on three polymorphic enzymes. An earlier paper (Andersen, 1988) demonstrated a difference between one pod captured at a northern locality and six others taken elsewhere, prompting speculation of the existence of more than one stock. The larger sample now available demonstrates considerable variation between pods, with no obvious geographical or seasonal pattern, and the sub-committee concluded that there is currently insufficient evidence to demonstrate the existence of more than one stock in the area. It was recommended that comparison be made between this and other regions in the North Atlantic in order to put into context the degree of genetic variability found in the Faroese catch.

Statistically significant differences in cadmium levels between pods have been found in a study of heavy-metal contamination (SC/41/SM21).

The sub-committee concluded that no new information on stock structure had been obtained to date using the new genetic analytical procedures discussed at the 1987 meeting (various analyses of DNA). However, the sub-committee noted that samples of tissues from pilot whales killed in a western Atlantic mackerel fishery are potentially available (pers. comm. to Heyning from James G. Mead, Smithsonian Institution, during the meeting) and that these could be compared with samples from the Faroese to

examine genetic relatedness between whales from the two sides of the Atlantic.

### 5.1.2 Abundance

There are insufficient data to estimate the number of long-finned pilot whales in the entire North Atlantic. There is no systematic survey information available seaward from the US continental shelf across the central North Atlantic south of 60°N or from the continental shelf of North America between roughly 43°N and 60°N. However, there are data in different regions that can be used to provide some information on abundance. These are described below for three regions: the eastern North Atlantic, the western North Atlantic and the central North Atlantic.

#### *Eastern North Atlantic*

Prior to 1987, only limited surveys had been conducted, off Norway, off Iceland, and off Spain (SC/41/SM10). These were designed to study several species of whales, and their main usefulness for pilot whales has been in delimiting overall distribution. The 1987 North Atlantic Survey (NASS-87) provided substantially more information on abundance, over a much larger area (SC/41/SM10). Additional information has also been made available from sightings made aboard Icelandic whaling vessels from 1979 to 1988 (SC/41/O 22).

The Icelandic sightings suggest that pilot whales occur on the western side of Iceland consistently each summer and that the animals appear to be concentrated off southwestern Iceland in the early summer and northwest of the island later in the summer. The data appear reliable for this level of interpretation but are not useful for estimating absolute abundance. The data suggest that whales are not generally found very near the coast, but SC/41/SM26 notes that they occur near the shore occasionally, possibly in conjunction with irregular migration of squid into shallow waters.

Estimates of abundance are presented in SC/41/SM10 for the combined 1987 North Atlantic Sighting Survey study area using data from both Icelandic and Faroese survey vessels. The Norwegian part of the survey did not sight any pilot whales; this is useful negative information about spatial distribution. (It should be noted, however, that pilot whales are known from the coastal waters of Norway to roughly 70°N (SC/41/O 5 and Jongsard, 1977)). Spain reported 11 sightings, of 123 whales (SC/39/SM14). Pilot whales were seen off West Greenland during the same period (see *Western North Atlantic* below).

For the area covered by the Faroese vessel the estimate of abundance is 72,000 whales (CV 0.4). The main objective for this vessel was to survey pilot whales, and it closed on all but one school. For the Icelandic vessels the abundance estimate is given in two parts, one of 18,950 (CV 0.5) for sightings which the vessel closed on, and the second of 12,945 (CV 0.25) for sightings which the vessel did not close on. All estimates were based on the assumption that  $g(0)=1$ . Further, the estimates only relate to the surveyed areas; this corresponds to only part of the range of the species in the Northeast Atlantic. Because the primary objective for the Icelandic vessels was to survey fin and minke whales, the decision to close or not to close on pilot whale sightings was made as the survey proceeded; the authors of the paper felt that the decision process was such that larger schools were more likely to be closed on.

These two estimates were obtained by treating the sightings made under the two protocols as if they were of two different species.

A number of factors were identified in SC/41/SM10 that need to be considered as potential analytical problems. These include (1) low observer eye-level height aboard the Faroese vessel, (2) the diffuse nature of some of the pilot whale schools, where the initial sighting frequently was of a component of a school, (3) different levels of experience of the observers with respect to estimating school size for this species, and (4) uncertainty in how to account for diving animals. It was also noted that the smaller average sighting distances for the Faroese vessel were on the order of the apparent diameter of the spread-out schools, making estimating distance of the school from the trackline when sighted problematical for some schools. However, this problem had been addressed in part by truncating the data to eliminate the largest schools, which tend to be spread out, in the analysis. It was noted that this may tend to bias the estimate downward.

The sub-committee agreed that these factors, especially that of the form of schools (which might introduce a positive bias) and the difficulties in estimating total school size because of diving behaviour (which would introduce a negative bias), were of concern. Additional concerns were raised about the treatment of the Icelandic data separately for passing and closing mode. Several alternative analytic approaches should be explored, for example by using hazard-rate estimation procedures or by ignoring the closing versus passing mode issue and stratifying by school size. The authors felt that this would not change the results significantly, as distance from the trackline shows no relationship with school size in the data. Given the above concerns it is clear that the passing mode estimate is biased downward, and it is not obvious how to combine the two estimates for the Icelandic vessels.

The sub-committee noted that there was greater uncertainty in the estimate than indicated by the calculated CVs because of the effects of the above-described factors; however, it is not possible to determine if the several estimates are likely biased upward or downward. The sub-committee believes that it would be useful to include all relevant details of the surveys and analyses in the paper rather than referring to information reported elsewhere, i.e. in SC/41/O 30 and SC/40/O 30 Revised. It would also be useful to include a map showing the actual tracklines and the division of effort into passing and closing modes. Data on size estimates of schools at the Faroes *before* they are driven would also be useful in evaluating the survey school size estimates.

Additionally, the sub-committee **recommended** that the survey area should be extended in the future to better determine the area occupied during the survey period, that information from radio telemetry on dive times (such as collected by Mate, 1988) might be used to improve estimates of school size, and that detailed behavioural studies of school conformation be done to better understand the applicability of line-transect theory to pilot whales.

#### *Western North Atlantic*

Mercer (1975) estimated the abundance of pilot whales in the Newfoundland area to have been 60,000 animals in 1947, based on cumulative catches after WWII. Pilot whale abundance in the Newfoundland area was thought to have

been greatly reduced by the early 1960s by a directed fishery. A single aerial survey conducted in 1980 off Newfoundland and Labrador (Hay, 1982) yielded an estimated abundance of 6,700 to 19,600 pilot whales. A series of aerial surveys have been conducted off Greenland in 1984, 1985, 1987 and 1988 (SC/41/O 17); these noted the presence of pilot whales in similar areas in two of the four years. Both surveys have provided information on distribution along the coastal regions on both sides of Labrador Strait, but the stock relationships between animals on the Canadian and Greenland sides are unknown.

A series of systematic sighting surveys were conducted off the northeastern USA from 1978 using airplanes and from 1980 to the present using fishery research vessels (SC/41/SM18; Smith, Payne, Heinemann, Waring and Longe, 1988). The aerial sighting surveys have been used for estimating abundance, with estimates in the range of 10,000 to 12,000 pilot whales. Insufficient information was available to allow review of these estimates by the sub-committee. For example, estimates of variance were not given. The sighting surveys aboard the fishery research vessels were conducted during transits between sampling stations. The sampling design of the fishery surveys includes both stratified-random and fixed sampling stations. Densities of animals for the several geographic strata are shown to vary seasonally, with increases in the summer and fall in the northern part of the study areas and along the shelf edge.

The density estimates are derived using line transect methods, but the methods of the analyses are not given in sufficient detail. The estimates were expanded to estimates of total abundance within the study area; these range seasonally from roughly 4,000 to 10,000 pilot whales. Estimates of variability of the estimates are not given; this prevented the sub-committee from assessing their validity.

A difficult problem faced by the survey analysis is separating sightings for the two species of pilot whale inhabiting the region, *G. melas* and *G. macrorhynchus*. Contrary to the assumption made in SC/41/SM18, these are indications that the two species strand with roughly equal frequency in a band of overlap between about 35° and 40°N (pers. comm. to Heyning from J.G. Mead, Smithsonian Institution, during the meeting). The information presented in SC/41/SM18 was not sufficient for determining if the gaps in the winter distribution indicated presence and separation of the two species in the survey area; inclusion of effort data would help with this determination.

The difficulty of identifying the two species of pilot whales at sea and determining their relative distributions were noted and several alternative approaches suggested. These included examination of the skulls and teeth of animals killed incidentally in the mackerel fishery, biochemical or genetic analysis of tissues from animals in the catch or of biopsy samples collected during the surveys, and analysis of recordings of sound production.

These shipboard surveys provide needed information on the distribution of cetaceans in the North Atlantic, and the sub-committee notes with concern that the surveys are now occurring at very reduced frequency. It is suggested that in future surveys the area covered be extended to the east because of the likely occurrence of pilot whales there. Mate reported that the pilot whale that he tracked by satellite moved out of the survey area to the east in waters of over 4,500m.

#### *Central North Atlantic*

There are few sighting data for this region beyond those summarised by Brown (1961); none are suitable for estimating abundance. No systematic sighting surveys have been conducted here. The results from the NASS-87 do not reveal a decline in encounter rate along the legs reaching southwest from the Faroe Islands, and the US surveys suggest no decline in sightings eastward across the study area, suggesting that the distribution of pilot whales continues into at least certain parts of the central North Atlantic. Further, Smith reported that G. Waring of the Northwest Fisheries Center at Woods Hole, Massachusetts, has data on several sightings of pilot whales by US observers aboard Japanese longline vessels in the region of the Gulf Stream.

#### *5.1.3 Migration*

There is very little direct information on migrations. There is a suggestion of an increase of abundance in Icelandic waters in the early summer, with numbers peaking between July and September (SC/41/O 22). Pilot whales occur in Faroese waters in all months of the year, and the seasonality of catches, with most animals historically taken in the summer, may now be less evident (SC/41/SM8). Similarly, in British waters pilot whales occur year-round (Evans, 1980; Martin, Reynolds and Richardson, 1987) and there is no recent evidence to support an earlier hypothesis of seasonal offshore-onshore movements. The sightings data in SC/41/SHM18 (and Smith *et al.*, 1988) provide useful information on seasonal distributional patterns seaward to the edge of the continental shelf, suggesting longshore and inshore-offshore movements. No clear distinction has yet been shown between animals in any two areas of the North Atlantic which could exclude the possibility of latitudinal or longitudinal movements or migration, but neither has any migration been proven. The availability of prey is likely to be a major factor in determining the seasonal movements of pilot whale schools, but recent evidence from the Faroes indicates that pods may still occupy traditional feeding grounds when the normal prey are not available (SC/41/SM13).

The sub-committee agreed that the long-finned pilot whale is a species likely to be particularly suitable for studies of migration and movements using radio and recommended that the proposed project using satellite-linked transmitters at the Faroes to study movements, described at this meeting two years ago, be undertaken.

#### *5.1.4 Life history*

##### *Age determination*

SC/41/SM4 examined in detail the characteristics and rate of deposition of dentinal and cemental layers in pilot whale teeth. The principal conclusion, based on the examination of tetracycline-marked teeth from captive *G. macrorhynchus* of known history, is that one growth-layer group (GLG) is deposited annually in cementum and in dentine until 15–25 years of age. This confirms that the current criteria used to determine age in *Globicephala* spp. are correct. Other features in the teeth, principally anomalous layers and deposits, varied in frequency between pods from different geographical regions and between sexes and age groups. Some anomalies may result from stress and, if so, could be used to indicate major physiological occurrences such as puberty or periods of starvation. The sub-committee received this paper with

interest and **recommended** that the incidence of marker lines and other anomalies in teeth be looked at in more detail to determine possible links with oceanographic conditions, food availability and life-history events.

#### *Growth and reproduction*

The sex ratio of fetuses in the Faroese catch was examined in SC/41/SM12, using sex chromatin, phenotype and gonadal histology. The sex ratio of the sample did not differ significantly from unity. SC/41/SM14 gives a preliminary report on growth and sex distribution of Faroese pilot whale fetuses. The sex ratio in this sample was 47% males:53% females in fetuses less than 92cm long and 40%:60% in larger fetuses. It was agreed that further analysis is required before the authors' suggestion of a greater length-at-birth in Faroese whales than in those off France and Newfoundland can be accepted.

SC/41/SM11 presents data on the male sexual cycle and age at attainment of sexual maturity in Faroese pilot whales. From an examination of testis weight, histological characters such as spermatogenesis and tubule diameter, and testosterone levels it was concluded that male sexual activity peaks between March and August, but that successful mating could occur throughout the year. In discussion, it was suggested the testosterone levels may be correlated with dominance rather than maturity; the highest levels were found in males less than 30 years old. The sub-committee discussed whether the methods used in this analysis can be equated with those employed by Sergeant (1962) on Newfoundland samples and concluded that comparison between the results for the two areas is difficult.

SC/41/SM15 provides useful new information on age-related parameters. The authors indicated that they will undertake a more complete analysis of these parameters, taking into account comments made by the sub-committee.

Information on two mass strandings of pilot whales on the Icelandic coast is presented in SC/41/SM26. One of the strandings was thought to comprise almost an entire pod, whereas the other was known to represent only part of a larger group of animals. In general, biological parameters are within the range found elsewhere in the Northeast Atlantic. In discussion, it was suggested that the age of sexual maturation given in the paper, based on small sample sizes, should be treated with caution.

#### *Social organisation and breeding system*

The results of genetic fingerprinting work on Faroese pods are given in SC/41/SM30. Although the data are as yet preliminary, some very important conclusions can apparently be drawn about the social structure of *G. melas*. Reproductively active adult males move between schools, and do so within a few months of fertilising females in such a school. Faroese pilot whale pods may be considered as matrilineal, which male offspring will eventually leave but in which female offspring will probably remain. The mechanism by which males might transfer from one pod to another was discussed by the sub-committee. With little evidence so far of males being encountered individually or in small groups around the Faroes, transfer may be accomplished when two or more pods merge at times of year when aggregations of the species are particularly large. The genetic analyses discussed above under *Stock identity*, using starch-gel electrophoresis of isozymes, gave results in accord with the picture emerging from the DNA fingerprinting work.

Some selected external morphological characteristics, including colour pattern, were examined in the Faroese catch (SC/41/SM9) in an attempt to characterise individual pods, but no differences could be detected between the pods. Variation in length of dorsal fin previously noted turned out to be ascribable to seasonal variation in fatness.

#### *Seasonal change in body condition*

SC/41/SM5 reports on the body fat condition of Faroese pilot whales. A marked annual cycle was found in all age and sex classes whereby blubber thickness and thus energy reserves increased during the winter and decreased during the summer, peaking around the probable time of mating activity in spring. A link between the cycle of energy reserve levels and reproductive demands was postulated, but, if this is the case, it is not clear whether reproduction is timed to take advantage of peak food availability or simply more food is eaten when energetic demands due to reproduction are high. The fact that all categories of animals synchronise their deposition of blubber, regardless of reproductive status, indicates that food availability is the more likely driving factor.

#### *Mass die-offs*

Information is given in SC/41/O 5 and ProgRep Norway on an unusual apparent die-off of sperm, killer and pilot whales in the North Atlantic. It is speculated in SC/41/O 5 that the bodies may have drifted in the Trans-Atlantic Current from a region off North America where odontocetes and baleen whales have been involved in other recent die-offs, but the estimates of rates of decomposition and current speed upon which this speculation is based need further examination. Further, some of the stranded sperm whales were freshly dead. Other reports of unusual mortality of odontocetes in European waters may be linked to the event reported by Norway. Martin reported that many freshly dead pilot whales were reported to be floating off the northernmost Shetland island by several fishermen in February/March 1989, and Desportes reported (pers. comm. from R. Duguay, Oceanographic Museum of La Rochelle) that about 600 dolphins, mostly *Delphinus delphis* but including striped dolphins and pilot whales, were washed up in western France in late February-March 1989 after a heavy storm. The sub-committee **recommended** that efforts be made to determine the causes of mortality in any new die-offs. These efforts should include examination of the carcasses by veterinarians experienced in marine mammal pathology.

#### *5.1.5 Population dynamics*

No paper was presented on this topic, and the sub-committee **recommended** that attention be given to it using the Faroese data. For example, it was suggested that enough frequency-at-age data may now exist to allow construction of life tables for males and females.

#### *5.1.6 Ecology*

##### *Feeding habits*

Paper SC/41/SM13 considers the evidence on pilot whale feeding derived from examination of stomachs in the Faroese catch. In contrast to a smaller study in 1984, the 1986-88 samples contained no flesh whatsoever, and this coincided with the collapse of the local squid fishery. Squid beaks continued to be found, indicating that squids remained the primary prey group, but pilot whales apparently did not feed in nearshore waters in recent years.

Squid species represented by indigestible remains were mostly pelagic, luminous and shoaling. Variable digestion rates render quantitative assessment of the composition of prey species taken very difficult. In discussion, it was noted that some fish species, such as cod and blue whiting, are very common and abundant in Faroese waters at particular times of the year, yet rarely appear in pilot whale stomachs. Thus, while the type of prey taken may reflect local availability to some extent, some degree of choice is apparently exercised by the whales, especially between squid and fish.

#### Contaminants

SC/41/SM22 provides information on the levels of DDT and PCBs in Faroese pilot whale tissue. In general, levels were within the range encountered in this and other species elsewhere in the North Atlantic, but significant differences in pollutant loads were found between the two pods examined in this study. Comparison between pilot whales from the Faroes and other areas is complicated because the results available in the literature extend from the mid-1970s to the late 1980s, and environmental pollution is known to have changed during this period. Moreover, some samples were based on stranded animals while others were from driven pods. A second paper on synthetic pollutants in Faroese pilot whales, SC/41/SM24, gives results consistent with those in SC/41/SM22, but was based on fewer data and lacked biological information on the sampled whales. In discussion, concern was expressed about the impossibly high relative lipid content reported for many samples, and there was some indication that tissues may have been contaminated by incorrect storage, perhaps in plastic bags.

A study of heavy metals in pilot whale tissues is reported in SC/41/SM21. Cadmium levels were fairly high, and mercury accumulative with age. At this point in the continuing study, variances for mercury are high, so that little can yet be said about differences between pods or among the various age and sex categories of whales, but for cadmium significant difference were found between pods. These results will be investigated further.

#### Parasites

Parasite burdens of Faroese and other Northeast Atlantic pilot whales are examined in SC/41/SM28. Twenty-one different species were encountered, including three new to science. Cyamids were more common on large males than on other age and sex classes. This may be a result of behavioural differences or because adult males are likely to be more scarred and thus present a potentially greater area for cyamid colonisation. Nematode infestation first became obvious in the second year of life, presumably as a direct result of the increasing proportion of solid food in the diet. Thereafter, quantities of nematodes found in the stomach increased through life, before showing a slight decrease in the oldest individuals. The authors speculated that this may be due to the death of the most heavily parasited older animals. Four parasite species were considered to have significant pathological effects on the host, perhaps causing death in extreme cases. As noted above under *Stock Identity*, it was suggested in discussion that permanent parasites, such as the cestode *Diphyllobothrium*, are likely to be good indicators of animal movements or of segregation between geographical areas on the time scale of at least one whale lifespan.

#### 5.1.7 Exploitation

The now defunct Canadian pilot whale fishery, the Faroese drive fishery and the several fisheries causing incidental mortality (including the USA mackerel fishery – SC/41/SM19 and Waring, Parry, Nicolus, Gerrior and Payne, 1989) have removed a large number of pilot whales from the North Atlantic.

There was no new information available on analysis of the long time series of catch statistics (several hundred years) for the Faroes (SC/38/SM7, 20); 1,690 pilot whales were landed in 1988 (SC/41/ProgRep Faroes).

SC/41/SM19 presents an analysis of the spatial distribution of the kill of long-finned pilot whales in the western Atlantic mackerel fishery. Waring *et al.* (1989) provide a complete discussion of incidental mortality in this and related fisheries. SC/41/SM19 shows that the spatial distribution of trawl hauls where pilot whales were killed is much smaller than the total range of that fishery. The paper suggests that a sharp increase in the incidental take of pilot whales in 1988 was associated with a contraction of the range of the fishery into the range where pilot whale mortalities have principally occurred in the past.

The sub-committee noted the possibility of reducing the level of incidental mortality by controlling areas allowed for mackerel fishing and recommended that more detailed analyses be carried out of both mackerel and pilot whale seasonal distributions to identify suitable areas. The sub-committee also notes with concern that levels of incidental take of pilot whales and other cetaceans were possibly much greater when the mackerel fishery was much larger in the period 1964–74, possibly affecting the status of the cetacean stocks. The sub-committee recommended that the data on distribution and season of that fishery be examined to determine if large incidental catches may have occurred.

The sub-committee notes that recent information on the social structure of pilot whales and other odontocetes such as killer whales (Bigg, 1982) suggest that the effects of exploitation may vary with the nature of the fishery. For example, selective fisheries removing young animals from the matriarchal schools may result in increased reproductive rates, while drive fisheries removing whole schools may result in at least temporarily reduced population productiveness (Kasuya and Marsh, 1984). Information on how new schools become established is needed to address this concern and might be obtained from further genetic analysis of schools.

The existence of a past Icelandic drive fishery was confirmed; historical data have been identified. The sub-committee notes that the data on that fishery would be useful and recommended that they be obtained and reported.

#### 5.1.8 Status

The level of incidental mortality in the western Atlantic is not well enough known, and the current population estimates have not been available for sufficient examination and do not cover sufficient area, to allow reliable conclusions about status to be drawn. The level of take in the Faroese fishery has been maintained for at least four hundred years, with cyclic fluctuations having a periodicity of about 120 years, and is small relative to the abundance estimates given (SC/41/SM10), but the potential biases in these estimates, and particularly uncertainties concerning net reproductive rates, do not allow status to be assessed with confidence.

## 5.2 Other populations

### 5.2.1 Antarctic Ocean

The following papers include information relative to the Antarctic population(s) of pilot whales: SC/41/O 20, SHM7 and 14, and ProgReps Australia and New Zealand.

SC/41/O 20 provides an estimate of abundance of long-finned pilot whales in the Antarctic south of 60°S, based on sightings during IDCR cruises, of roughly 100,000 (CV 0.7). The estimate was generated using standard line-transect methods developed over the past few years for estimating minke whale abundance. There were relatively few sightings, and the estimate was very sensitive to the manner in which one sighting of about 250 animals close to the trackline was taken into account. The difficulties and uncertainties in this estimate led the sub-committee to question the utility of using these data for determining the distribution and abundance of small cetaceans. It was suggested that better estimates of abundance might be obtained using other analytical procedures, and using the co-distribution of other species.

The importance of using these data, even though they may not be ideal, was emphasised, as there are few other opportunities for studying many of the commercially unimportant species in this region. Further, an understanding of all aspects of the cetacean biomass in the Antarctic may be important in understanding that ecosystem. It was also noted that data from the Japanese sighting vessels operating south of 40°S since 1965 include sightings of many species in addition to the target species. Kasamatsu reported that an analysis of those data is being started.

### 5.2.2 Other regions

SC/41/SM23 provides a summary of the distribution and abundance of the short-finned pilot whale off the Pacific coast of Canada and concludes that the animals do not appear to be abundant in this area. It was noted that sighting effort is very low, however.

Da Silva reported on the occurrence of *G. melas* off the coast of Brazil. The species cannot be considered common, but strandings and sightings have occurred between 28°50' and 34°12'S. An apparent stranding of one *G. macrorhynchus* at about 25°S will, if confirmed, constitute the first record of this species in Brazil.

SC/41/ProgRep Japan records sightings and catches of short-finned pilot whales off Japan. Catches totalled 99 whales of the northern form and 493 of the southern form, taken principally by driving, hand-harpoon and small-type whaling. The sub-committee noted take of 28 southern-form whales by small-type whaling methods, an areal expansion of the fishery that probably served to offset the recent decrease in access to large whales. At present the annual take from the southern-form stock represents about 1% of the estimate of abundance in a recent stock assessment (Miyashita, 1986). This estimate, of 53,000 whales, covers an area much larger than that from which the current catch is taken. Because it is possible that inshore and offshore populations are involved in the putative single stock, the sub-committee **recommended** that the stock structure question be addressed before the catches are increased.

Three mass strandings of *G. melas* are reported in SC/41/ProgRep New Zealand and six strandings including one of 13 animals, in SC/41/ProgRep Australia.

Eight long-finned pilot whales, as well as sperm whales and other species, are reported to have been taken

incidentally in a new and rapidly growing swordfish gillnet fishery in the Tyrrhenian Sea (SC/41/SM3).

## 6. NEW INFORMATION ON OTHER STOCKS

### 6.1 Northern bottlenose whale

The sub-committee reviewed the available information and concluded that re-assessment of the stock would be premature. Gunnlaugsson noted that the estimates of abundance in Icelandic and Faroes waters in SC/40/O 30 Revised are likely biased downward because of lack of adjustment for the long dive times of the species. It was noted that the results of the survey of Norwegian waters reported in SC/41/O 4 are not relevant to bottlenose assessment, because the survey took place in July, when most bottlenose whales have migrated to the south. SC/41/O 22 gives sightings data from Icelandic whalers for the period 1979-88. The frequency of recorded sightings has increased over the period, but the quality of the data needs further investigation. Also, the number of sightings, typically ten to twenty per vessel-season, is insufficient to allow detection of other than very large trends. The paper shows that there is a clear change in the distribution of the animals on the ground west and southwest off Iceland during the season. In the late season the sightings were concentrated at the northwestern boundary of the grounds.

The sub-committee notes that three bottlenose whales were taken in the drive fishery in the Faroes. The sub-committee notes with concern that these catches were taken from a Protected Stock. Bloch reported that she is gathering historical data on the bottlenose whale drive fishery in the Faroese and will report on them at next year's meeting of the sub-committee. The sub-committee agrees that these data will be important in any future assessment and welcomes them.

### 6.2 Dolphins associated with tuna in the eastern Pacific

Information available to the sub-committee this year included SC/41/SM2, 6 and 29 and reports from scientists from the US National Marine Fisheries Service (NMFS) and the IATTC.

The Scientific Committee last year noted its concern about the continuing high mortality of dolphins when compared to the most recent estimates of absolute abundance and recommended that every effort be made to reduce it and estimate its impact on the stocks, that behavioural and gear research be carried out to lower kill rates, that kills be reported on a stock-by-stock basis, and that the level of biological sampling be increased.

#### 6.2.1 Kill estimates

The incidental kill in 1988 is estimated at 78,927 or 84,881, depending on the the method of calculation (SC/41/SM6). This is lower than the estimated kills in 1986 (by 40%) and 1987 (by 20-25%) but still higher than the estimated kills of the late 1970s and early 1980s (Fig. 1). The sub-committee notes that the estimates have been calculated on a stock-by-stock basis and wishes to thank the IATTC for responding to its recommendation so promptly and fully. Revised estimates for earlier years and details of the methodology used for the 1988 estimate and for the revised estimates are given in Appendix 2. Hall noted that about 3/4 of the reduction in kill over that in 1987 was due to a reduction in fishing effort; he believes that at least part of the remainder of the reduction was due to better performance in dolphin rescue, although changes in

dolphin species and stock composition and changes in areal distribution of the fishery may also be responsible. Comparison with the year 1986, which had a level of effort about equal to that in 1988, shows a decrease in kill rates of close to 40%. The sub-committee notes the importance of accurately assessing changes in dolphin-rescue performance and recommended that methodology to do this be developed.

The sub-committee notes that the kill of eastern spinner dolphins, perhaps the most depleted stock involved in the fishery (Smith, 1983), has continued at a high level (about 20,000 in both 1987 and 1988) despite the overall reduction in dolphin kill. However, Hall noted that the more recent information available from research-vessel surveys and tuna-vessel observer data does not show any significant change in population abundance over the period covered (1986-88 and 1975-87, respectively). Smith drew attention to the fact that precision was as yet poor from research-vessel data and that there were some unresolved biases in analyses of the tuna-vessel data (Buckland and Anganuzzi, 1988; Edwards and Kleiber, in press) that may relate to interannual changes in spatial distribution in response to environmental conditions, such as seen in 1983 and 1988 (see Item 6.2.4). The sub-committee continues to be concerned about the possible impacts of the kills on the status of the stocks of offshore spotted and common dolphins and recommended that the efforts to reduce the kill be continued by all the agencies and nations involved.

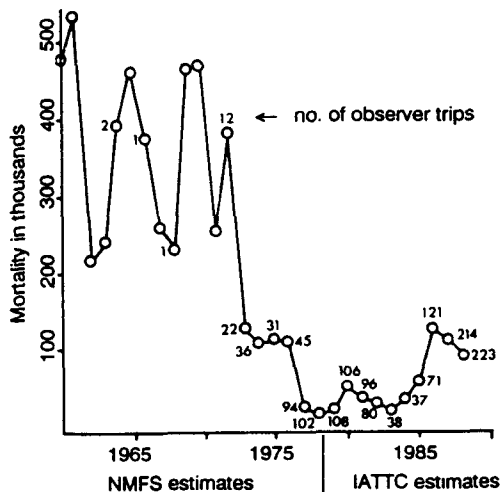


Fig. 1. Estimated incidental mortality of dolphins in the tuna purse-seine fishery in the eastern tropical Pacific, 1960-1988. From IATTC (1989) and SC/41/SM6.

#### 6.2.2 Biological sampling

The Committee last year recommended that biological sampling of the observed kill be increased, to improve estimates of possible trends in growth and reproductive parameters. The proportion of the kill sampled in 1988 was 18%, lower than the 20% of 1987 and the second lowest during the 10-year period 1979-1988 (Table 1). Hohn reported that instructions to the observers changed in mid-1987. In an effort to obtain samples from large-kill sets, which are more representative of population age and

sex structures than samples from small-kill sets, the observers now process only carcasses from sets in which 7 or more dolphins (per species) have been killed. In addition, a program offering pay bonuses to observers for collecting samples from more than 30 dolphins when the kill is greater than 30 was started in mid-1988. The results of these initiatives in terms of quality and quantity of the overall sample have not yet been analysed, but an analysis will be presented to this sub-committee next year.

Table 1

Biological sampling of dolphins killed incidentally in the tuna purse-seine fishery in the eastern Tropical Pacific, 1979-88. From SC/41/SM2 and earlier reports listed therein.

Year	No. of dolphins biologically sampled	Total observed kill	Propn. of observed kill sampled (%)
1979	2,161	4,900	44.1
1980	1,389	3,125	44.4
1981	1,160	3,297	35.2
1982	1,832	9,262	19.8
1983	750	2,999	25.0
1984	1,166	4,427	26.3
1985	2,293	8,996	25.5
1986	1,277	10,241	12.5
1987	2,874	14,206	20.2
1988	1,881	10,479	18.0

#### 6.2.3 US sightings surveys using research vessels

SC/41/SM31 presented relative abundance indices from the 1988 NMFS survey of ETP dolphin stocks. Under the standard stratified-analysis option, the estimated abundance of the northern offshore stocks of spotted dolphins was 1.92 million, compared with 1.28 million in 1987 and 0.93 million in 1986. The total estimate for common dolphins was 3.11 million in 1988; previous estimates were 0.69 million in 1987 and 1.39 million in 1986. Although the standard errors are large, these estimates indicate very large increases that cannot be explained biologically. By pooling data across geographic strata, fluctuations were appreciably smaller for the northern offshore stock of spotted dolphins, but larger for common dolphins. One of the causes of fluctuations in stock estimates was the detection of several large common dolphin schools in 1988, which increased the estimate of average school size across species from 80-90 animals to 173 animals.

It was noted that estimated size of the eastern stock of spinner dolphin had increased since 1987 and also was higher than earlier estimates. Hall noted that, as discussed above in Item 6.2.1, recent trends in abundance from tuna vessel data also did not indicate a decline; in fact the 1988 estimate was higher than any previous estimates during 1985-87.

Estimates of abundance of SC/41/SM31 for all stocks are affected by the large common dolphin schools recorded in 1988. Concern was expressed that the estimates of one stock are influenced by the data collected on others of different species, including non-target species. This influence might be reduced by, for example, estimating effective search width for all target schools, but estimating other components in the procedure for each species or stock separately. The practice of truncating observations at 2 n.miles from the trackline was queried, as a high

proportion of observations is lost. It was noted by the authors that there were problems in fitting the data at greater distances.

Data for Baja neritic and northern common dolphins were pooled in the analyses of SC/41/SM31. There was too little coverage in the Baja area to estimate stocks separately, and they were not distinguished in the field. It was recommended that observers should be trained to differentiate the stocks in future cruises, since this will provide information on the offshore distribution of the Baja neritic stock and on stock boundaries.

It was pointed out that more than half the sightings of (and sets on) southern offshore spotted dolphins by tuna vessels were south of the area searched by research vessels in 1988. This mismatch between the area surveyed for abundance estimation and the area in which the mortality occurred could result in problems in stock assessment. The change in dolphin distribution in 1988 suggests that adjustable stock boundaries might be considered, and that environmental factors are relevant to the analysis.

#### 6.2.4 Relationship between dolphin abundance and oceanographic variables

Reilly reported on the progress of research on the distribution of spotted and common dolphins relative to their environment during 1986/88. There was a moderate El Niño event in 1987, and a strong anti-El Niño in 1988. These years therefore provide a useful contrast. In 1988, the thermocline was particularly shallow in an area extending west along the equator, and research vessel sightings of common dolphins were more numerous there than in the previous two years. Also, in 1988 temperatures in the vicinity of the equator were low, and relatively few spotted dolphins were seen in these areas of lower temperatures. Sightings of spotted dolphins seemed to reflect their preference for a thermocline of intermediate depth. Hall suggested that stratification of sightings could be carried out *a posteriori*, using environmental factors. Reilly noted that they were investigating the possibility of mapping dolphin habitat for each year. The 'habitat' would be identified by relating various environmental variables to dolphin distribution using multivariate techniques.

#### 6.2.5 Efforts to reduce the kill

Hall reported progress in technological research and extension work to reduce kill rates. A new type of small boat propelled by a water-jet engine is being tested on several vessels for use in dolphin rescue in the net; it can cross the corkline and approach the webbing closely without becoming entangled. The results of the trials will be given to the sub-committee next year. He also reported that an international workshop on the dolphin/tuna problem was held in Costa Rica; it was attended by representatives of Colombia, Costa Rica, Ecuador, El Salvador, Spain, France, Guatemala, Japan, Mexico, Nicaragua, Panama, United States, Vanuatu and Venezuela and concentrated on ways to improve performance in dolphin rescue. A second workshop on rescue gear and techniques was organised by Vanuatu for the captains of its fleet of several vessels in Cartagena, Colombia. The Costa Rica meeting also had a session on national legislation, which had been passed recently in attempts to regulate and reduce the dolphin kill.

The sub-committee notes with pleasure the continued effort by the IATTC and the several nations involved toward reduction of the kill.

It is **recommended** that research be continued to be carried out with the objective of improving gear and methods to reduce kill rates.

### 6.3 Porpoises

The sub-committee agreed to defer consideration of information on phocoenids contained in several documents (SC/41/SM1 and 29; O 5, 12, 22, 25 and 36; ProgReps Denmark, Faroes, FRG, Iceland, Netherlands, Sweden, UK, USA; and SC/40/O 30 Revised) to next year's meeting (see Item 7.3), considering only the information in SC/41/SM25 (because of its relevance to census of all small cetaceans) and ProgRep Japan concerning the great increase in catch of Dall's porpoise.

#### 6.3.1 Line transect survey of harbour porpoise

SC/41/SM25 presents partial results from a survey of harbour porpoise in the Bay of Fundy that was designed to test the applicability of line transect methods to this species. The cruise was designed with comments offered by the sub-committee at last year's meeting on a paper describing a preliminary study (Polacheck and Smith, 1989). The analyses presented suggest a strong vessel avoidance response of animals, although the possibility was noted that this could be due solely to random movement of the animals as seen from a moving platform. The need to conduct a simulation study of the effects of animal movement was noted. The existence of avoidance of research vessels by harbour porpoise in the California Current region was noted, although there the animals appeared to initially move away from the vessel and then in the opposite direction. It was suggested that the data might be analysed to determine if the animals are moving away from the vessel at its current position or away from the vessel's trackline. It was also suggested that the direction of currents might be noted, to determine if the porpoise move with the currents when moving away from the vessel. Further, it was suggested that the experimental survey design of repeating transects in opposite directions might be used to check the movement patterns further. There is also the possibility that harbour porpoise respond to an approaching vessel by increasing their speed of swimming, causing them to rise higher at the surface and become more visible. The effect of this on the detection of avoidance and accuracy of school size estimation was discussed.

#### 6.3.2 The Japanese take of Dall's porpoises

The sub-committee is extremely concerned about the recent very great increase in the catch of Dall's porpoises in Japanese waters, from 13,406 in 1986 (*Rep. int. Whal. Commn* 39:128) to 41,455 last year (SC/41/ProgRep Japan). There is evidence that the porpoise meat is being substituted for whale meat in commerce because of the decrease in access to large whales (Kasuya and Miyazaki, 1989; SC/41/ProgRep Japan). The Committee in previous years has expressed its concern that the (smaller) takes in those years may not have been sustainable (*Rep. int. Whal. Commn* 31:67; 34:57; 35:53).

The increase in catch is mainly in the hand-harpoon fishery and comes from two stocks. With present statistics, the catches cannot be allocated between the two stocks. The two stocks are the Sea of Japan/Okhotsk stock of *dalli*-type porpoises that winters in the Sea of Japan and summers mostly in the Okhotsk Sea and also off the Pacific coast of Hokkaido and the *truei*-type stock that inhabits



Japanese and Soviet Pacific waters (Fig. 2). Estimates of abundance are 47,000+ for the former and 58,000 for the latter, for a total of roughly 105,000+ (Table 2).

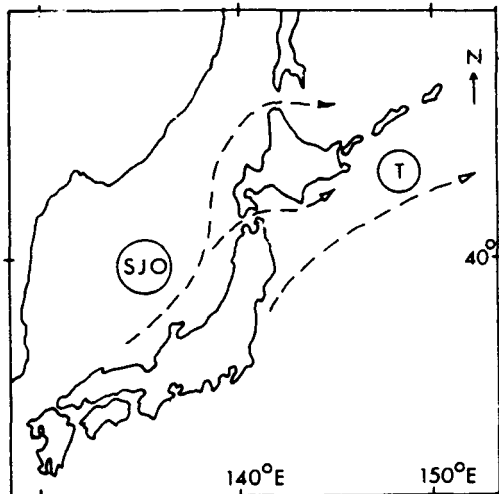


Fig. 2. Seasonal movements of Dall's porpoise and location of the Dall's porpoise fishery in Japanese waters. SJO = Sea of Japan/Okhotsk Sea stock. T = truei-type stock. From Kasuya and Miyashita (1989).

Table 2

Estimates of abundance for stocks of Dall's porpoise exploited in the Japanese hand-harpoon fishery. From Miyashita and Kasuya (1988).

Stock and component	Abundance
<b>Sea of Japan/Okhotsk Sea stock</b>	
East Sea of Japan (May-June)	32,000 (CV 0.23)
West Sea of Japan (May-June)	(+)
Pacific (July-August)	15,000 (CV 0.50)
Okhotsk (May-June)	A few
Total	47,000+
<b>Truei-type stock</b>	
Japanese waters (May)	26,000 (CV 0.25)
USSR waters	32,000
Total	58,000
Grand Total	105,000+

Kasuya reported that there may be some over-reporting of catch because of the initiation of a licensing system for 1989 and beyond, in which licenses are only being issued to fishermen who report that they took some Dall's porpoises in 1988. However, incidental take from the truei-type stock in squid gillnet fisheries by Taiwanese and Korean vessels in the western North Pacific is not reported and is of unknown size. Some porpoises are struck and lost in the hand-harpoon fishery, but the struck-and-lost rate varies with type of vessel and has not been estimated.

The sub-committee concluded that the take is clearly not sustainable. Depending on the stock composition of the catch, the situation may be even worse for one or other of

the two stocks than immediately apparent. The sub-committee believes that it is urgent that the catch be at least reduced to the levels of previous years (which themselves may have been too high) and that assessments of status of the stocks be carried out, to determine safe levels of catch for the two stocks independently. The sub-committee also recommended that catch statistics be collected and reported on a stock-by-stock basis. A further recommendation is that the Republic of Korea be requested to report by-catches of Dall's porpoises (and other cetaceans) in its squid gillnet fishery to the IWC.

### 6.3.3 Baird's beaked whale

Kasuya reported that the 50% increase in the Japanese national quota of Baird's beaked whales (from 40 to 60 - SC/41/ProgRep Japan) is a one-year emergency increase for the small-type whaling fleet, to partially replace the former catch of minke whales pending settlement of the question of whether or not there will be a take of minke whales in Japanese small-type whaling in the future.

### 6.2.4 Other species

New information was received on a number of other species, but time limitations prevented substantive review. The species included *Kogia breviceps* (SC/41/ProgRep Australia, Brazil, New Zealand), *Kogia* sp. (SC/41/ProgRep Japan), unidentified ziphiids (SC/41/SHMi14; ProgRep Japan, Australia), *Ziphius cavirostris* (SC/41/SM3; ProgRep Australia, New Zealand), *Berardius arnuxii* (SC/41/ProgRep Australia), *Hyperoodon planifrons* (SC/41/ProgRep Australia), *Mesoplodon* spp. (SC/41/SM29), *M. bidens* (SC/41/O 36), *M. layardi* (SC/41/ProgRep Australia), *M. grayi* (SC/41/ProgRep Australia), *Pontoporia blainvillei* (SC/41/ProgRep Brazil), *Inia geoffrensis* (SC/41/ProgRep Brazil), *Delphinapterus leucas* (SC/41/SM27, 32; O 4, 12, 36; ProgRep Denmark, UK, USSR), *Monodon monoceros* (SC/41/O 36; ProgRep Denmark), *Orcaella brevirostris* (SC/41/ProgRep Australia), *Cephalorhynchus hectori* (SC/41/ProgRep New Zealand), *Steno bredanensis* (SC/41/ProgRep Brazil), *Sotalia fluviatilis* (SC/41/ProgRep Brazil), *Sousa chinensis* (SC/41/ProgRep Australia), *Grampus griseus* (SC/41/SM3, 29; ProgRep Australia, Japan), *Tursiops truncatus* (SC/41/SM3, 29, 33; O 29; ProgRep Australia, Japan, New Zealand, UK, US), *Delphinus delphis* (SC/41/SM29; O 12; ProgRep Australia, Brazil, New Zealand, Spain, US), *Stenella coeruleoalba* (SC/41/SM3; ProgRep Australia, Faroes, Japan, New Zealand, Spain), *S. longirostris* (SC/41/ProgRep Australia), *S. attenuata* (SC/41/ProgRep Australia, Japan), *S. frontalis* (SC/41/ProgRep Brazil), *Lissodelphis peronii* (SC/41/SHMi14; ProgRep New Zealand), *L. borealis* (SC/41/ProgRep Japan), *Lagenorhynchus obscurus* (SC/41/SM29; ProgRep New Zealand), *L. acutus* (SC/41/O 7, 12, 36; ProgRep Denmark, Faroes), *L. albirostris* (SC/41/SM29; O 25, 27, 36; ProgRep Iceland), *L. cruciger* (SC/41/SHMi14), *Lagenorhynchus* spp. (SC/41/ProgRep Netherlands), *Peponocephala electra* (SC/41/ProgRep Australia), *Pseudorca crassidens* (SC/41/SM16; SHMi14; ProgRep Australia, Japan, New Zealand), *Feresa attenuata* (SC/41/ProgRep Australia) and *Orcinus orca* (SC/41/SM20; O 4, 5, 17, 20, 22, 25, 27, 33, 36; SHMi7, 14; ProgRep Australia, Denmark, Faroes, Iceland, Japan, New Zealand, Norway, Spain, UK, US, USSR; SC/40/O 30 Revised).

## 7. OTHER BUSINESS

### 7.1 Takes of small cetaceans in 1988

Reported takes are summarised in Appendix 3. The sub-committee notes that these statistics are incomplete; takes in several IWC member nations are known to occur but have not been reported or have been reported incompletely. It is recommended that these nations again be requested to submit complete catch statistics to the IWC. For example, SC/41/SM18 and 19 deal with a by-catch of pilot whales and other cetaceans by foreign-flag vessels in the US EEZ. Some of these vessels are from IWC member nations, but the by-catches do not appear in any national progress report.

The sub-committee notes that data from strandings are useful in determining distribution and movements, both necessary to stock assessment, and therefore recommended that member nations not having stranding reporting programmes take steps to establish them.

### 7.2 Publication of documents

The following documents are recommended for possible publication in a special volume on pilot whales: SC/41/SM4, 5, 7, 8 (in part, combined with 7), 9, 10, 11, 13, 14 (in part, combined with other papers), 15, 17, 18, 19, 21, 22, 23, 26, 28, 30. Other papers developed from documents submitted to the sub-committee will be considered for publication in the volume, as will papers on pilot whales which have not been previously submitted to the sub-committee. The deadline for submission of the papers in revised form to the Scientific Editor is January 1 1990. A list of papers recommended for possible publication in *Rep. int. Whal. Commn* 40 was submitted to the Editorial Board.

### 7.3 Priority topics for 1990 meeting

The sub-committee proposes to review populations of phocoenids at the next meeting.

### 7.4 Convention on Migratory Species

Johnson and Ford explained the plans in CMS for conducting a global review of the status of small cetaceans. The review will have the objective of identifying species and populations whose conservation status would benefit from regional agreements among parties and non-parties to the Convention. A small-cetaceans working group is now being established and will provide expert guidance to the Convention's Scientific Council on the review. The review itself may be initially undertaken by a consultant or other expert for further discussion and, if necessary, refinement by the working group and endorsement by the

Scientific Council. It was stressed that advice is welcome from the sub-committee or any of its members.

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