Annex I

Report of the Sub-Committee on Small Cetaceans

Members: Martin (Chair), Albert, Allison, Baker, Belikov, Berggren, Bjørge, Bravington, Brown, Brownell, Childerhouse, Chythlook, Cipriano, Clarke, da Silva, Dawson, Deimer, DeMaster, Donoghue, Donovan, Ensor, Fabbri, Frost, Fujise, Gearin, Goodson, Gordon, Grønvik, Hakamada, Hammond, Hatanaka, Haug, Hedley, Ichii, Isaac, Kaschner, Kasuya, Kawachi, Kawahara, Kim, Kingsley, Kock, Komatsu, Kraus, Larsen, Last, Lauriano, Lawrence, Leaper, Lens, McPherson, Miyashita, Moore, Morishita, Moronuki, Nishiwaki, Northridge, O'Corry-Crowe, O'Hara, Øien, Okamoto, Okamura, Palka, Parsons, Peddemors, Pérez-Cortés, Perrin, Perry, Read, Reeves, Reijnders, Reilly, Robineau, Rogan, Rojas-Bracho, Rooney, Rose, Rowles, Saccheus, Senn, Simmonds, Smith, Stachowitsch, Suydam, Tanaka, E., Tanakura, Tarpley, Taylor, Thiele, Urbán-Ramirez, Van Waerebeek, Yamamura, Zhu.

1. ELECTION OF CHAIRMAN

Martin was elected Chairman.

2. ADOPTION OF AGENDA

The adopted Agenda is given as Appendix 1.

3. APPOINTMENT OF RAPPORTEURS

Bjørge, Northridge, O'Corry-Crowe, Palka, Read, Reeves and Rogan acted as rapporteurs.

4. REVIEW OF AVAILABLE DOCUMENTS

Documents relevant to the work of the sub-committee were SC/51/SM1-SM54, SC/51/O4, SC/51/E6, O'Corry-Crowe *et al.*, 1997, O'Corry-Crowe and Lowry, 1997, Dawson *et al.*, 1998, Connelly *et al.*, 1997 and national progress reports.

5. BYCATCH MITIGATION - ACOUSTIC DEVICES

The need for bycatch mitigation measures has long been acknowledged in view of the large numbers of cetaceans killed incidentally in passive fishing gear, particularly gillnets, around the world (Perrin *et al.*, 1994). The most prominent and widely applied approach to reducing cetacean bycatch in gillnets is the attachment of small sound-generating devices, called pingers, to the fishing gear. The effectiveness of pingers and the difficulties associated with their use were considered at two previous international meetings (Reeves *et al.*, 1996; Cox *et al.*, 1998). Martin stressed at the outset that the reports of those meetings should be treated as benchmarks and that the sub-committee's discussions should centre on new findings and on concerns not previously noted.

5.1 Recent experiments

The characteristics of recent successful pinger experiments are shown in Table 1.

5.1.1 Denmark

SC/51/SM41 described an experiment conducted in the North Sea during the period 30 August-10 October 1997. The total annual bycatch of harbour porpoises in the Danish North Sea bottom-set gillnet fisheries is estimated to be about 7,000 (Vinther, 1995). The fishery targeting cod has an especially high bycatch rate and for this reason was selected for the study. Fourteen vessels participated, each carrying an observer from the Danish Institute for Fisheries Research. The experiment was double-blind, with neither the fishing crews nor the on-board observers knowing which nets bore active pingers and which bore controls. Participating vessels spent a total of 168 days at sea and made 590 stations, or hauls, each involving from 4-240 nets. The total effort was 6,523 nets with active pingers, 5,680 with control pingers and 3,395 with no pingers. One harbour porpoise was caught

Table 1

Characteristics of well-designed pinger experiments.

Year	Location	Type of net	Bycatch species	Power analysis	Approx. cost	Pinger type	Sig. reduction	Reference
1994	Gulf of Maine	Bottom-set gillnet (cod etc.)	Harbour porpoise	Yes	$500,000	Dukane	Yes	Kraus *et al.*, 1997
1997	Gulf of Maine	Bottom-set gillnet (cod etc.)	Harbour porpoise	Yes	$200,000	Dukane	Yes	Kraus and Brault, 1997
1995	Washington State	Bottom-set gillnet (salmon)	Harbour porpoise	Yes	$20,000	Lien	Yes	SC/51/SM13
1996	Washington State	Bottom-set gillnet (salmon)	Harbour porpoise	Yes	$20,000	Lien	Yes	SC/51/SM13
1997	North Sea	Bottom-set gillnet (cod)	Harbour porpoise	Yes	$500,000	Pice	Yes	SC/51/SM41
1995-6	Bay of Fundy	Bottom-set gillnet (cod etc.)	Harbour porpoise	No	??	Dukane	Yes	Trippel *et al.*, 1997
1997	California	Drift gillnet (shark etc.)	Several including common dolphin	Yes	??	Dukane	Yes	SC/51/SM2
1997	Sweden	Bottom set gillnet (cod etc.)	Harbour porpoise	Yes	$80,000	Dukane	*	SC/51/SM20

*No bycatch in either pingered or control nets.

in a net with active pingers, 13 in nets with controls and 10 in nets without pingers, giving bycatch frequencies of 0.00015, 0.00229 and 0.00295, respectively. The difference in bycatch rate between nets with active pingers and nets with control pingers was highly significant, but there was no significant difference between the bycatch rates of harbour porpoises in nets with control pingers and nets without pingers. Pingers were attached at the net joints at 140m intervals or, where closely spaced strings were set parallel to each other, were arranged to ensure that all parts of the nets were within 70m of a pinger. The pinger used in this experiment was a prototype Pice alarm developed by Loughborough University, UK.

Larsen concluded from this study that pingers were highly effective in reducing the bycatch of harbour porpoises in the Danish North Sea bottom-set gillnet fishery for cod. He emphasised, however, that the mechanism of action was uncertain, as was the long-term effectiveness of the pingers in view of the possibility that harbour porpoises would habituate to the pinger sounds.

During the discussion of SC/51/SM41 Larsen noted that active pingers were checked to verify that they were functioning whenever they were brought ashore between trips. They were not checked between stations (hauls). He noted that the overall failure rate was about 5-8% over the course of the entire experiment.

Berggren suggested that it would be preferable to use the string rather than the net as the effort unit. Larsen agreed, noting that this had been done subsequently and that the results had been essentially unaffected.

Kraus called into question the statement in SC/51/SM41 that the extensive deployment of pingers would have excluded harbour porpoises from areas used for feeding, migration and other purposes. No surveys of harbour porpoise distribution had been conducted in association with the experiment, so there was no way of quantifying this effect. Most of the bycaught harbour porpoises had sandeels and sand in their stomachs (some also had whiting), indicating that they were probably feeding near the bottom on the same species as the large cod that were the targets of the fishery.

5.1.2 Celtic shelf

SC/51/SM43 described the results of an experiment in a set gillnet fishery, primarily for hake, on the Celtic Shelf between Ireland, Cornwall and Brittany. The bycatch of harbour porpoises in this Irish and English fishery is estimated to be about 2,200 per year. The experiment, begun in May 1998 and intended to last for one year, was designed to follow the same procedures used by Kraus *et al.* (1997) in the Gulf of Maine. It was established prior to the study that at least 60,000 net km.h of observed effort would be needed to detect a 70% reduction in the harbour porpoise bycatch. The Pice pinger manufactured in the UK was selected over the Dukane pinger from the United States, based on three considerations: (1) the lower cost of control Pice pingers; (2) signals emitted by the Pice pinger are inaudible to humans, thus facilitating the double-blind protocol; and (3) the expectation that the pingers would continue to function for a full year without replacing batteries. However, a series of difficulties ensued. Poor hake catches caused most of the Irish fleet to postpone their gillnetting season. Pinger delivery fell behind schedule, and there were problems with pinger attachment to the nets and with 'performance' of the control pingers. When the experiment finally began, unexpected catches of harbour porpoises in nets equipped with supposedly active pingers prompted the researchers to test the pingers. It was found that almost all of them had either a faulty switch or a dead battery. The trial was suspended in January 1999, having produced ambiguous results due to the unreliability of this batch of Pice pingers. Nets with supposedly active pingers had higher harbour porpoise bycatch rates than nets with dummy pingers, and it was suggested that partial deployment of active pingers could be worse than no deployment at all.

The authors of SC/51/SM43 made a number of observations on possible future wide-scale deployment of pingers and on practical aspects of future pinger design. These were: (1) attachment should be tested in advance with a variety of vessels, mesh sizes, net types and hauling techniques; (2) a reliable method needs to be available for testing pinger operation and remaining battery power level; (3) replaceable batteries with long lives are highly desirable for pingers used in this type of fishery; (4) several features in the design of the Pice pinger need to be improved (e.g. buoyancy, modification of square ends); and (5) consideration must be given to how inspection and enforcement will be achieved in any programme involving mandatory pinger use.

The sub-committee discussed the difficulty experienced in determining the period and operational status of the Pice pingers. Sound transmissions are ultrasonic, so an ultrasonic detector is required. However, the detector needs to be tuned for specific frequencies and not all frequencies used by the Pice pinger are picked up by a single setting of the device.

The Celtic Shelf study demonstrated several key issues related to pinger use in general: (1) researchers and fishermen need to be able to tell if the pingers are working; (2) incomplete deployment or undetected pinger failure could cause an increase in cetacean bycatch; and (3) it is essential that fisheries continue to be monitored after pinger use has become mandatory or widespread in a fishery.

5.1.3 South Africa

SC/51/SM28 described a study of the behaviour of Indo-Pacific humpbacked dolphins in the vicinity of permanently set shark nets off Richards Bay, KwaZulu-Natal. An average of five Indo-Pacific humpbacked dolphins per year die from entanglement in these nets, which are set for bather protection. The bycatch in shark nets is a concern because of the small size of the KwaZulu-Natal humpbacked dolphin population (approximately 200 individuals).

Pice pingers were deployed on a random weekly basis and in random positions on two of the nets. The pingers were checked regularly with an ultrasound detector to verify that they were functioning. Dolphin behaviour was monitored from a small boat before, during and after activation of the pingers. Photo-identification was used to determine 'residency' of individuals. Residency (individual resightings rate) was used as a proxy for familiarity with the nets.

During the seven-month study, no dolphins were caught in pingered nets but three were taken in non-pingered nets. All three bycaught dolphins were judged to be non-residents. Dolphin behaviour within 200m and beyond 200m of the nets was significantly different. Feeding was the only behaviour observed within 100m of the nets and social behaviour diminished significantly within 200m. There was no significant difference in activity indices when the pingers were on versus when they were off. The authors interpreted their results as indicating that dolphins were in a state of wariness around the nets but were not displaced or deterred from feeding. Peddemors noted that most dolphins taken in shark nets had food in their stomachs. An experiment with pingers in these shark nets is in progress.

Dawson noted that the power to detect differences in net-approaching behaviour in this study was relatively low. Read observed that the response of delphinids to pingers might be qualitatively different from that of harbour porpoises as the latter tend to be neophobic.

5.1.4 Australia

SC/51/SM36 summarised the acoustic properties of several different types of acoustic 'alarms' deployed in shallow coastal waters off Queensland. The bycatch in this area includes a variety of marine mammals ranging from small delphinids (e.g. Indo-Pacific humpbacked and Irrawaddy dolphins) to baleen whales (e.g. humpback whales) and dugongs. Although deployment of acoustic devices has occurred in shark control nets off Queensland, this has been *ad hoc* and no controlled studies have been reported. A controlled study is planned to examine the effects of pingers on the bycatch of delphinids in a shark driftnet fishery in northern Australia.

5.1.5 Gulf of Maine and Bay of Fundy

The sub-committee reviewed SC/51/SM3, which described an assessment of the efficacy of pingers in a sink gillnet fishery in the Bay of Fundy, Canada during 1994 and 1995. This document concluded that pingers were an effective means of reducing the bycatch of harbour porpoises in this fishery. The sub-committee noted that, due to problems of design, analysis and interpretation, it was impossible to draw conclusions from this paper.

Two field trials have been conducted in the Gulf of Maine to address the potential for pingers to reduce the bycatch of harbour porpoises in sink gillnets (SC/51/SM18). Kraus described the results of the second trial conducted during April and May 1997 (Kraus and Brault, 1997), which followed the initial experiment conducted in the same area during the autumn of 1994 (Kraus *et al.*, 1995). The second trial was designed to address the potential for seasonal variation in the efficacy of pingers. The trial was conducted during a season when Atlantic herring (*Clupea harengus*), an important prey species of harbour porpoises in the Gulf of Maine, are less abundant to ensure that effects of the pingers were not mediated through effects on prey. Two types of Dukane pingers were used in this trial, which was conducted using a double-blind protocol and strings of controlled length (12 nets). Each string was equipped with 13 active or 13 inactive pingers; some additional nets had neither control nor active alarms. The pingers were placed 100m apart, attached at the end of each string and at the bridles, where individual nets are tied together. Eleven harbour porpoises were caught in silent strings (inactive or no pingers); none were taken in nets with active alarms. This result was statistically significant. The bycatch rate in silent strings was 0.036 harbour porpoises/haul. No difference in the catch rate of target species or pinnipeds was noted between control and active strings.

5.1.6 Sweden

An experiment was conducted in Swedish waters of the southern Skagerrak Sea during March and April 1997 to address the bycatch of harbour porpoises in bottom-set gillnets (SC/51/SM20). A power analysis was conducted and the results of this analysis were used to design the experiment after discussion with the five participating fishermen. Six functional or inactive Dukane *NetMark 1000* pingers were attached to each 500m string of gillnet used in this experiment. No harbour porpoises were caught in 184 hauls of control strings or 189 hauls of active strings. Based on data collected from observer programmes in the previous two years and the level of effort in the experiment, seven harbour porpoises were expected to be captured in the control strings. Berggren noted four possible reasons for the lack of bycatch in control strings: (1) inter-annual variation in the distribution of harbour porpoises; (2) exclusion of harbour porpoises from the entire experimental area by pingers in active strings; (3) inactive pingers acted as passive reflectors and reduced bycatch in control strings; and (4) bycatches occurred in control strings but dropped out prior to or during haulback. The results of previous trials and observations from this fishery in prior years suggest that the latter two explanations are unlikely. No acoustic or sightings surveys were conducted during the course of the experiment, so it was not possible to determine whether or not the distribution of harbour porpoises was different than in previous years. However, two harbour porpoises were taken by other fishermen in the general area where the trial was conducted indicating that at least some animals were present during the course of the experiment.

5.1.7 New Zealand

Donoghue described a programme designed to examine the response of Hector's dolphins (*Cephalorhynchus hectori*) to acoustic alarms in Akaroa Harbour, New Zealand. In 1996, an experiment was conducted to determine whether Hector's dolphins avoided Dukane pingers (Stone *et al.*, 1997). Observers used a theodolite to monitor the movements of Hector's dolphins in relation to active and inactive pingers. The experiment used a blind protocol in which the observers did not know whether the pinger was active or not. There was a significant difference in the median approach distance with respect to active and inactive pingers; dolphins responded to active pingers by avoiding the sound source. Dawson noted that dolphins surfaced more frequently within 100m of active pingers than within 100m of control pingers. Donoghue described the current situation in New Zealand, in which some commercial fishermen have begun to use pingers voluntarily, although no systematic monitoring programme has yet been established.

5.1.8 California

A large-scale pinger experiment was conducted in the California drift gillnet fishery for swordfish and sharks during 1996 and 1997 (SC/51/SM2). Several species of cetaceans are taken in this fishery, although the majority of the bycatch consists of common dolphins, *Delphinus delphis* (SC/51/SM6). This experiment was recommended by the Take Reduction Team established to reduce the bycatch of marine mammals in this fishery. A power analysis was conducted *a priori* to determine the number of sets required to detect a 50% reduction in bycatch. Logistical considerations precluded the use of a double-blind approach, so observers determined whether or not each set would be experimental (with pingers) or control (without pingers) immediately prior to setting the net, using a random assignation scheme generated prior to each trip. Dukane *NetMark 1000* pingers were attached at 91m intervals along the headline and leadline in a staggered fashion to ensure ensonification of the entire net. The analysis included only sets and trips in which the experimental protocol was followed. A total of 74 marine mammals, including 43 cetaceans, were entangled in 609 sets. The bycatch of common dolphins, the species taken most frequently, was significantly less in experimental than in control nets. In general, the bycatch rate of marine mammals in nets with pingers was approximately 1/3 of the rate in nets without pingers. This is the first demonstration that pingers reduce the bycatch of delphinids in gillnet fisheries. The bycatch rates of other cetaceans were too low to determine whether pingers are effective with these species. Taylor noted that there have been two recent incidents of entanglements of sperm whales in drift nets equipped with pingers, which is a rate similar to that seen in non-pingered nets.

5.1.9 Washington

Experiments were conducted to determine whether pingers were effective in reducing the bycatch of harbour porpoises in a salmon bottom-set gillnet fishery in Washington State during 1995-1997 (SC/51/SM13). These experiments employed an early pinger model, developed by Jon Lien and described by Fullilove (1994). The experimental protocol varied from 1995 to 1996, but nets with active alarms had a significantly lower bycatch rate than control nets in both years. There was no significant difference in the catch of salmon or sturgeon, or in the number of fish damaged by pinnipeds in control or alarmed nets. In 1997, pingers were placed on all nets and fewer porpoises were taken than expected, based on bycatch rates in control nets from previous years. The bycatch rate in 1997 was higher, however, than that observed in alarmed nets in 1995 and 1996. Eleven of 12 bycatches of harbour porpoises observed in 1997 occurred during the last two weeks of the fishery, suggesting the possibility that porpoises habituated to the presence of alarms over the course of the summer (see Item 5.3.2). In addition to monitoring bycatch rate, this study also employed observations of the distribution of harbour porpoises around nets, which were placed close to shore. These observations indicated that porpoises were displaced a minimum distance of 125m away from alarmed nets (Laake *et al.*, 1998). The sub-committee agreed that this combination of observational and experimental approaches was a particularly useful means of exploring the efficacy of pingers in reducing bycatch.

5.2 Experiences with implementation

5.2.1 Gulf of Maine

Pingers have been an integral part of the Take Reduction Plan established in the Gulf of Maine to reduce the bycatch of harbour porpoises in the mixed groundfish sink gillnet fishery. Fishermen helped to develop this plan and have supported the development and use of pingers in this fishery. As outlined in SC/51/SM18, pingers are now required in several areas and seasons in the Gulf of Maine where the bycatch of harbour porpoises is known to be high. The general strategy of implementation has been to combine the use of time-area closures, in which all gillnet fishing is prohibited, with surrounding times and areas where pingers are required. The time-area closures are also used by fisheries managers to reduce fishing mortality of several species of groundfish and much of the Gulf of Maine is currently subject to some seasonal closures. The total bycatch of harbour porpoises has decreased, although it is not possible to say to what extent this can be attributed to the use of pingers, or to closed fishing zones and other restrictions. This approach to bycatch reduction is accompanied by an extensive monitoring programme, described in SC/51/SM26. The most important component of this programme is the use of observers to monitor the bycatch rate of harbour porpoises throughout the Gulf of Maine. This observer programme is designed to provide estimates of bycatch rate and total mortality on a quarterly basis. The observer programme monitors approximately 5% of hauls made in this fishery each year. In addition to the observer programme, the National Marine Fisheries Service is undertaking studies of the distribution of marine mammals and their prey in relation to pinger use, sound levels around gillnets equipped with pingers, pinniped depredation of fish catches in nets with pingers and the effects of pingers on catches of target fish species. A training and certification programme ensures that fishermen are familiar with pingers and their proper use in this fishery. The National Marine Fisheries Service and US Coast Guard are currently developing means to enforce regulations requiring the use of pingers in this fishery.

Before the Take Reduction Plan was implemented, several smaller-scale experimental fisheries were conducted during 1995-1998, where all bottom-set gillnets used in specific areas were required to use pingers. These experiments were not scientifically designed, however, and no control nets were used. SC/51/SM18 reported that during March and April 1996-97 the bycatch rate of strings with pingers was approximately 50% lower than the bycatch rate of strings without pingers which were set in the same general vicinity. In the same area, during September to December 1994-97, the bycatch rate of pingered strings was an average of 84% less than strings without pingers. The authors of SC/51/SM18 interpreted this to indicate that pingers are effective in reducing bycatch. However, the magnitude of reduction documented in the normal fishery was slightly less than that in controlled scientific experiments.

5.2.2 California driftnet fishery

As a result of the successful experimental test of pingers in the California driftnet fishery for sharks and swordfish, pinger use has been mandatory in this fishery since November 1997 (SC/51/SM2). Regulations specify the number and type of pingers that are required. Taylor noted that compliance with regulations has not been complete, even when observers were present on board. Some fishermen believe that attaching pingers increases the hazard of deploying driftnets in rough weather. There is variability in compliance among fishermen. This is a highly dispersed fishery operating several hundred kilometres offshore, and as a consequence it would be very difficult to inspect or monitor at sea. Penalties for non-compliance are currently being addressed and the Take Reduction Team (TRT) will meet again to address the issue. Although there is currently no formal enforcement, fishermen are aware that the TRT may impose punitive actions, including a closure of the fishery, if take reduction targets are not met.

5.2.3 Other fisheries

McPherson reported that the Government of New South Wales (Australia) would be purchasing pingers to use in shark control nets in the state. Pingers are already in use, at least on a trial basis, in both Natal (South Africa) and Queensland (Australia) shark control nets. Members of the sub-committee reported that many fisheries are now using pingers throughout the world, mainly to mitigate bycatch but also to reduce cetacean predation on longline fish catches. These fisheries include a tuna longline fishery in the Indian Ocean, set nets in New Zealand and shad nets in Virginia.

The sub-committee expressed its concern that there were a significant number of places around the world where pingers were being deployed without any apparent attempt to either test their efficacy beforehand. or to monitor their effects afterwards. Given the poor information on the subject, the sub-committee **recommended** that a survey of pinger use around the world should be conducted.

5.3 General issues concerning acoustic alarms

5.3.1 Why are pingers effective?

The sub-committee reviewed the results of recent work to address the question of *how* pingers reduce the bycatch of harbour porpoises and common dolphins in gillnet fisheries. Kraus *et al.* (1997) noted several alternative hypotheses that could explain the reduction in bycatch associated with pinger use: (1) pingers produce a sound that is aversive; (2) pingers produce a sound that alerts small cetaceans to the presence of a net; and (3) pingers produce a sound that the prey of small cetaceans find aversive. The sub-committee addressed these hypotheses in turn.

Read described an experiment (SC/51/SM48) in which harbour porpoise movements were tracked with a theodolite around a single moored Dukane pinger in the Bay of Fundy. The point of closest approach was measured both before and after the pinger had been activated. The point of closest approach to the pinger was significantly greater (about 150m) when the pinger was active compared to when it was not, suggesting that the animals had been displaced by the pinger. This displacement decreased by 50% over five days, suggesting that habituation may have been taking place. During the second half of the experiment a harbour porpoise detector (POD: see SC/51/SM44) was also deployed to monitor click rates. Harbour porpoise click rate decreased significantly when the pinger was active. The sub-committee agreed that this experiment lent support to the notion that pingers are aversive to harbour porpoises; that is they do not simply alert the animal to the presence of a net or other obstacle, but that harbour porpoises actively avoid them.

Observational studies of harbour porpoises in Washington State (SC/51/SM13) also suggest that the aversion hypothesis is more likely than the alerting hypothesis. Harbour porpoises in these studies were displaced from nets a minimum distance of about 125m and generally avoided the areas immediately around active pingers (Laake *et al.*, 1998).

Some discussion followed regarding the nature of aversive sounds, and on the behavioural mechanisms which lead to reduced bycatch in nets with pingers. It is possible that animals may respond to broad categories of noise, rather than to specific noises, much as humans respond to the noise of approaching motor vehicles regardless of the exact type. In such cases the precise nature of the aversive sound is not so important, although habituation could also occur to broad categories of sound.

The sub-committee then considered the possibility that harbour porpoises might simply be alerted to the presence of the net by pingers. Three studies have now shown that harbour porpoises move away from active pingers; one study has also demonstrated that porpoises respond to pingers by reducing their echolocating click rates. The results of these studies do not support the alerting hypothesis. However, SC/51/SM28 suggested that pingers were not aversive to Indo-Pacific humpbacked dolphins and that, instead, they might alert the dolphins to the presence of the nets. Humpback whales also seemed to be alerted to the presence of nets by acoustic warning devices deployed in Newfoundland (Lien *et al.*, 1992). Habituation to an aversive noise might also lead to a longer-term alerting function. On balance, the sub-committee considered that the existing evidence did not support the alerting hypothesis for harbour porpoises, at least in the short term, but that other species may differ in this regard.

In Washington State, several approaches were used to test the hypothesis that pingers reduce the bycatch of harbour porpoises by displacing their prey away from gillnets (SC/51/SM14). Direct observations were made of the reaction of Pacific herring (*Clupea pallasi*), an important prey species of harbour porpoises, to active and control alarms. In addition, small-mesh gillnets were set equipped with and without active pingers to examine the catch rate of herring. Finally, sonar surveys were conducted for the presence of herring and other small fish in the vicinity of salmon nets equipped with and without active alarms (SC/51/SM13). In none of these tests was there any indication that Pacific herring were displaced away from pingers, with the exception of an initial startle response in the observational study. The sub-committee concluded that the reduction of the bycatch of harbour porpoises attributed to pingers in Washington State salmon nets was not due to an indirect effect mediated through their prey.

The sub-committee considered several other alternative hypotheses, including ‘jamming’ (where echoes from the animal’s sonar are effectively masked by the pinger noise), passive imaging (where the pinger might ‘illuminate’ the net sonically) and learning (where animals learn to associate pingers with a net). Jamming would seem unlikely given the time interval between ‘pings.’ There is currently no evidence to support any of these hypotheses, although SC/51/SM28 suggested that Indo-Pacific humpbacked dolphins behaved differently near nets. It was concluded that for harbour porpoises, and in the short term at least, the most plausible hypothesis was that pingers work by aversion. Insufficient evidence was available to allow any conclusion for species other than harbour porpoises.

Goodson introduced SC/51/SM49, in which ongoing experimental work with two harbour porpoises in a captive facility in Denmark was described. In one part of these studies the animals were observed foraging at night in a floodlit area on live fish, while their echolocating clicks were also recorded. The female harbour porpoise was observed to forage among the stones at the bottom of the study area head down and echolocating almost continuously. She was apparently oblivious to a gillnet headrope which was introduced to her foraging area and repeatedly passed underneath it. In contrast, the male porpoise avoided the headrope. Previous captive studies have shown that pingers produce a startle effect in captive animals, and a second part of current studies is to elucidate the nature of this more clearly. The two captive harbour porpoises are being exposed to noises that are slowly ramped up above ambient levels to determine when behavioural changes and alterations in heart rate are first noted. One objective of these studies is to determine the optimum aversive signal for inclusion in pinger design. The sub-committee noted that the behaviour of captive animals will be modified by their captivity, and may not therefore be generalised to situations in the wild. Nevertheless, studies of captive animals may allow hypotheses to be developed and then tested in field situations. It was suggested that any candidate aversive sounds should be tested as soon as possible in the field, where much larger sample sizes could be obtained. In addition, the sub-committee **recommended** that audiograms and behavioural studies of captive small cetaceans be made to assist in the design of acoustic alarms and field trials.

SC/51/SM19 used the large database from USA observer programmes in sink gillnet fisheries to explore associations between the harbour porpoise bycatch and various fishing practices and gear characteristics. The relationships were described using General Additive Models applied to data on hauls observed from 1994-1998. The modelled characteristics most strongly associated with bycatch were, in descending order of significance:

(1) spatial and temporal distribution of harbour porpoises;
(2) amount of net in the water (soak duration and string length);
(3) the presence or absence of tie-downs; and
(4) the use of pingers (in the Gulf of Maine only) or restrictions on mesh and twine size ('Mid-Atlantic' states only).

Assuming that fishing continues with a similar level of effort, gear modifications and restrictions, such as those used in the 'Mid-Atlantic' fishery, pinger use seems to have contributed to reducing the bycatch of harbour porpoises. However, the possibility cannot be ruled out that annual variability in the relative abundance of porpoises or the use of shorter strings was responsible for the lower bycatch in 1996 and 1997 when pingers were widely used. Bravington suggested that there could be some spatial confounding in the database, because pingers are used primarily in areas where the bycatch of harbour porpoises is high. Palka acknowledged that this could be the case, but that as the fishery expanded into new areas, bycatch rates in those areas quickly increased to levels similar to those in other areas.

The harbour porpoise and the short-beaked common dolphin are the only cetacean species for which properly designed studies with sufficient statistical power have been conducted to evaluate pinger effectiveness. In all cases, significant reductions in bycatch have been achieved through the use of pingers. Nevertheless, some bycatch has occurred in nets with active pingers during experiments, sea trials and fishery implementation. Thus, pingers are not 100% effective in eliminating the bycatch of these two species. It is important to consider why pingers do not always work as expected, apart from the obvious problem of major instrument or battery failure (e.g. SC/51/SM43). Taylor called attention to the value of collecting data from observer programmes that would contribute to understanding why pingers are or are not effective. Very large amounts of data are potentially available from fisheries in comparison with what is available from experiments. For example, it would be useful to know where animals are caught in the net, the environmental conditions when bycatch occurs, failure rates of pingers, etc. The sub-committee **recommends** that observer programmes should collect data on where cetaceans are caught in nets (both in general and in relation to pingers), associated environmental information, pinger failure rates etc.

The sub-committee discussed whether spacing and placement of the pingers was a critical factor in the success or failure of pingers to reduce bycatch. Pingers used in the first Gulf of Maine experiment produced sounds of 132 dB re 1 micropascal at 1m, with a fundamental frequency of 10kHz (Kraus *et al.*, 1997). Based on a human model, it was estimated that porpoises would be able to detect the signal at a distance of 100m if the received level was at least 15dB above ambient. Inter-pinger spacing was determined to ensure the prescribed level of ensonification. An entirely different set of specifications was used in the Washington State experiments, based on modelling of transmission loss and ambient noise characteristics in the local fishing area (SC/51/SM13). As a general rule, using many 'quiet' pingers is preferable, from an ecological perspective, to using a few 'loud' ones.

'Black holes', or areas of net that are not ensonified due to pinger failure, are a potentially serious problem. Incomplete deployment of pingers may lead not only to the loss of the beneficial effect of deterring entanglement, but also make nets more dangerous to cetaceans by creating quiet areas ('black holes') that dolphins or porpoises mistake for openings.

5.3.2 Habituation

Habituation by small cetaceans could reduce the effectiveness of pingers over time. The experiment conducted in the Bay of Fundy in 1998 (SC/51/SM48) showed that harbour porpoises habituate to pingers in a fixed position. Initially, the animals were displaced to a distance of about 150m from the pinger, but this response began to wane almost immediately. However, this does not necessarily translate into a loss of pinger effectiveness in reducing bycatch. Goodson noted that in some contexts (not necessarily that of the Bay of Fundy experiment) the gradual loss of battery power and consequent decline in sound output of the pinger could confound evidence of habituation. Although the Bay of Fundy experiment suggests a degree of habituation, this does not imply that the aversive affect was nullified, simply that it was reduced. The implications of this habituation for potential bycatch rates are unclear.

The increased bycatch rate of harbour porpoises in the Washington State salmon set gillnet fishery during 1997 also suggests that harbour porpoises habituated to the presence of alarms over the course of the summer (SC/51/SM13). The sub-committee agreed that monitoring programmes were essential to detect the potential for habituation once pingers are implemented in gillnet fisheries.

5.3.3 Displacement and other effects on target animals

The sub-committee noted that displacement and habituation are opposing processes. Scale is obviously critical to any evaluation of displacement. Larsen's calculations suggest that the likely area from which porpoises would be displaced if pingers were used on all Danish bottom-set gillnets was relatively small. Read pointed out, however, that the use of pingers in the wreck fishery in the North Sea could potentially displace porpoises from areas that are important to them for foraging. SC/51/SM20 suggested that pingered nets deployed along the Skagerrak coast of Sweden could create an acoustic 'barrier' to porpoises, essentially excluding them from a long segment of coastline which potentially constitutes critical habitat. In discussion, Berggren emphasised the importance of evaluating such broad-scale potential effects of pingers. Gordon noted that it would be very useful to focus on small areas where good data are available to evaluate exclusion or displacement in the light of detailed fishery data. The Gulf of Maine would be a good area to examine this question by reference to the data on bycatch rates in areas near where pingers have been used. Kraus interpreted the capture of porpoises in control nets set among pingered nets in the Gulf of Maine experiments as indicating that the scale of displacement is relatively small. It might be illuminating to analyse data from the Gulf of Maine experiments to determine the geographical distribution of pingered nets in relation to bycatch in non-pingered nets, with the idea of evaluating the issue of displacement.

5.3.4 Effects on non-target animals

After considerable discussion, it was agreed that non-target animals included all species other than those intended to be prevented from being bycaught. Two papers attempted to address the effects of pingers on non-target species. In SC/51/SM30, the authors tested the responses of *teleosts*, *elasmobranchs* and a sea turtle to pingers in an aquarium tank. None of the fish responded to the Dukane pinger, but clupeids and possibly scombrids showed a significant attraction to the Pice pinger. Read called attention to the anecdotal evidence presented at this meeting that sperm whales and humpback whales reacted to pingers in undesirable ways. The responses of pinnipeds to pingers have become an issue because of the 'dinner bell' effect (Mate and Harvey, 1987). The US National Marine Fisheries Service is collecting data on pinniped damage to fish catches in the Gulf of Maine (SC/51/SM26) so that it should eventually be possible to evaluate the effect of pingers on this fishery-interaction problem. Taylor pointed out that there was considerable information on the bycatch of non-target species in SC/51/SM2 and SC/51/O4 for bycatch rates in pingered and non-pingered nets. These data might be useful for identifying species for which directed studies are needed to determine the effects of pingers.

The sub-committee expressed concern that pinger use introduces artificial noise into the marine environment. For many reasons, including the possibility that this noise could have negative effects on cetaceans and other species, it is **recommended** that pinger development is directed towards using the lowest power output possible to achieve the desired result of reducing bycatch.

5.3.5 Applicability of results for one species from one area to another

No documents directly related to this topic were available to the sub-committee. The question of whether more field experiments are necessary before pingers are introduced into a fishery was discussed. Northridge commented that sea trials with pingers (see Item 5.4.2) were important prior to full implementation in a fishery. The sub-committee agreed that, at least for harbour porpoises, sufficient experiments had been carried out to demonstrate a high probability that bycatch would decrease with the use of pingers. Berggren considered that these results may not necessarily be replicated in areas and environments that are substantially different (e.g. harbour porpoises in the Baltic Sea). The sub-committee agreed that a comprehensive monitoring programme (with sufficient statistical power to detect changes) was crucial with any use of pingers.

5.3.6 Applicability of results from one species to another

Reijnders described work currently underway at Harderwijk Park in the Netherlands examining the reactions of a harbour porpoise and a striped dolphin (*Stenella coeruleoalba*) to sounds emitted from an underwater loudspeaker. The sounds deterred the harbour porpoises, whereas the striped dolphin was attracted to the loudspeaker. It was concluded that sounds that deter harbour porpoises from fishing nets will not necessarily deter other cetacean species. Other work conducted at Harderwijk suggests that, at least in the case of harbour porpoises, some individuals may be more acoustically sensitive than others. In discussion, some members of the sub-committee urged caution about the extrapolation of results on captive animals to those in the wild.

The sub-committee noted the results presented in SC/51/SM2 on the decrease in bycatch of a large number of species (and in particular short-beaked common dolphins) in a drift gillnet fishery for swordfish and sharks. This experiment used pingers which had been shown to reduce harbour porpoise bycatch. As these pingers had been successful in reducing the bycatch of common dolphins, they may also be useful in reducing incidental entanglement of other delphinid species.

5.3.7 New technologies

SC/51/SM1 described a technique called 'multi-path' or 'reverberation-ranging', to selectively activate acoustic deterrents when an animal approaches a fishing net. Using whistles recorded on a single hydrophone, acoustic multi-path ranging allows the underwater locations of animals to be detected by reference to the different arrival times of the multi-path signals created by reflections from the surface and the seabed. Kaschner described the system as simple, reliable and accurate. It uses a single hydrophone to determine when the animal has approached to within a certain threshold distance of the fishing gear. Although developed for pelagic trawls, it could be used in other fisheries. The primary constraints are that it works only at certain depths and is limited to use with whistling species. The system was estimated to have a detection range of 1km. Gordon noted that at the time small cetaceans are detected they are either within or dangerously close to fishing gear so that while passive acoustic detection might be useful, complicated methods of estimating range are redundant. A number of sub-committee members noted that even species which whistle (with the possible exception of the white whale) do not vocalise continuously. They may remain silent for considerable periods, depending on behavioural state (including boat presence), group size, time of day, etc. This raised concern about the probability of detecting animals. It was also noted that habituation may occur despite the selective 'turning on' of acoustic deterrents. Perrin suggested that deterrents could be developed to emit louder sounds as the animal approaches the net, possibly producing a more aversive effect. While elements of the approach described in SC/51/SM1 were welcomed, and a reactive device could have benefits compared with existing pingers, the sub-committee considered that any application would need to be examined carefully.

SC/51/SM44 described the development and application of an automatic porpoise detector (POD). The POD is a self-contained unit that records the presence of porpoise clicks. It is battery operated, with either rechargeable NiCads giving up to four days of logging or alkaline cells giving 14+ days. It has been tested in a number of geographic areas and in different operations, including attachment to bottom-set gillnets in the Celtic Sea (as described in SC/51/SM43), where it detected porpoises near nets several times a day. Northridge noted that the unit was bulky and therefore not easily deployed, but that work was ongoing to reduce the size. The sub-committee welcomed the development of the POD and saw numerous potential uses. It was noted, however, that the data output is currently difficult to interpret. For example, it is not possible to determine the number of porpoises actually present.

Gordon provided an update to the sub-committee on the development of equipment that allows passive acoustic monitoring (Chappell *et al.*, 1996). A second-generation model is now available to monitor the distribution and relative abundance of phocoenids and other small odontocetes that produce similar high-frequency, narrow-band echolocation clicks. The equipment has been tested successfully in several situations, most notably in the SCANS survey of small cetaceans in the North Sea and adjacent waters. Gordon considered that this approach holds considerable promise for monitoring the movements and acoustic behaviour of harbour porpoises and other species around gillnets. Since it can be used in periods of poor weather and at night, it provides an economical means of examining questions such as the potential for displacement of porpoises from areas where pingers are used (see Item 5.3.3). The sub-committee welcomed these developments, though noting again that results from such devices are critically dependent on whether target animals are acoustically active or not.

Goodson presented an interactive deterrent based on microcontroller technology and signal synthesis, incorporating a listening capability to sense the presence of echolocating animals (SC/51/SM53). Other features involve the ability to programme changes in signal frequency and intensity. This system is still being developed but will be ready for testing in 18 months. Kraus noted that the output was loud, at 145dB, and that the signal was a single sweep, and should perhaps be random. Gordon considered the development ambitious and unnecessarily complicated.

The sub-committee discussed a number of practical features that should be incorporated into current and future pinger design. Pingers should:

(a) be quieter;
(b) have a longer battery life;
(c) possibly be incorporated into the headrope or have improved mechanisms for attachment;
(d) have an acoustic or visual mechanism for testing functionality;
(e) have a guaranteed life span for enforcement and replacement;
(f) stand up to operational rigours;
(g) be cheaper.

The sub-committee **recommends** that future research and development emphasises these aspects.

5.3.8 Other

The sub-committee agreed that pingers may not be an appropriate solution to the problem of bycatch in all circumstances; for example, where the cost of pingers is high relative to the economic return to fishermen (Perrin *et al.*, 1994; SC/51/SM31). In such fisheries, there is little potential for enforcing the use of pingers should they be required. Instead, community based management approaches employing alternative mitigation techniques, such as the use of marine protected areas, are more likely to be effective. Unfortunately, in most areas, biological assessments of small cetacean populations have not yet been conducted, precluding the development of any conservation strategy. Okamoto reminded the sub-committee that the bycatch of small cetaceans is not an undesirable feature of fisheries in areas of the world where these animals are used for human consumption.

If pingers are to play a role in reducing bycatch in less affluent parts of the world, they will need to be reliable, inexpensive and simple to operate and deploy.

5.4 Conclusions and recommendations

When acoustic alarms are being considered to reduce the bycatch of a small cetacean species in a fishery, the sub-committee agreed to the following approach:

(1) controlled scientific experiments be conducted to determine whether the devices significantly reduce bycatch;
(2) if so, field trials be conducted to address practical operational issues and acoustic properties with respect to ambient noise and spacing of pingers; and
(3) when the devices are used routinely, a scientific monitoring programme be implemented, preferably using independent observers at sea.

5.4.1 Scientific experiments to examine efficacy of pingers

A number of scientifically designed studies have been conducted to evaluate the efficacy of pingers to reduce harbour porpoise bycatch in bottom-set gillnets. All of these with sufficiently high statistical power to detect differences have shown substantial reductions in harbour porpoise bycatch. These studies were conducted over several seasons and in three areas (Gulf of Maine, Bay of Fundy, Washington State and Denmark). The sub-committee concluded that the results of these experiments can be generalised to other situations where harbour porpoises are taken in bottom-set gillnet fisheries. To date, no experiments have been carried out on the use of pingers to reduce harbour porpoise bycatch in driftnet fisheries. However, the results of behavioural studies and from experiments with bottom-set gillnet fisheries suggest that the use of pingers may be effective in reducing the bycatch of harbour porpoises in driftnets. The sub-committee **recommends** that suitable, scientifically monitored, field trials be undertaken with pingers in driftnet fisheries. However, this may not be an appropriate strategy for populations thought to be at low levels (e.g. harbour porpoises in the Baltic Sea) because of unacceptable bycatch mortality during the trials.

Currently, results are available for only one scientific experiment that used pingers on driftnets to reduce the bycatch of small cetaceans other than harbour porpoises. The results of SC/51/SM2 are promising, especially in relation to common dolphins. The sub-committee **recommends** further controlled experiments be conducted to test pingers in fisheries that experience bycatch of delphinids and other small cetaceans.

5.4.2 Implementation

After it has been demonstrated that an acoustic device is associated with reduced bycatch of a small cetacean species in a particular type of fishery, and implementation is being considered, the sub-committee **recommends** that before implementation, field trials should be conducted. These trials should address practical operational issues and acoustic properties with respect to ambient noise and spacing of pingers.

The sub-committee **recommends** that when pingers are used routinely in any fishery to reduce bycatch, a scientific monitoring programme should be in place. Such a monitoring programme should have sufficient statistical power to detect changes in bycatch rates. Whenever possible, the programme should use independent observers to monitor bycatch at sea. In addition, the monitoring programme should evaluate pinger function and note the location of bycatch in relation to functional and any malfunctioning pingers.

5.4.2.1 USE WITH VAQUITA

The sub-committee endorsed the recommendation made by the International Committee for the Recovery of the Vaquita (CIRVA) that pingers should not be used to reduce the bycatch of vaquitas in gillnet fisheries in the Upper Gulf of California. CIRVA noted that pingers were not an effective solution to the bycatch of vaquitas because:

(1) pingers will not reduce the bycatch to zero;
(2) it would be extremely difficult to convince fishermen to use pingers and to ensure that the devices were kept in working order;
(3) the need for experimental verification would result in the mortality of some vaquitas;
(4) the cost of an experiment would be prohibitive due to the low bycatch rate; and
(5) that other more effective alternatives exist to conserve this highly endangered species.

Two workshops (Reeves *et al.*, 1996; Cox *et al.*, 1998) have reached similar conclusions.

5.4.3 Further research

The sub-committee noted with great concern that, for most of the world's fisheries, there is still no information available on cetacean bycatch, and that this precludes any attempt at mitigation in circumstances where it might otherwise be appropriate and possible. As in previous years, the sub-committee **recommends** that information on cetacean bycatch be collected from all marine fisheries, preferably using independent observers at sea.

The sub-committee **recommends** research on potential problems with widespread pinger use, including displacement of small cetaceans from important habitat, habituation, depredation of caught fish and effects on other species.

The sub-committee noted that pingers are only one of several potential tools to mitigate bycatch, and **recommends** that research should be conducted to identify any other measures that could be effective.

6. STATUS OF MONODONTID WHALES

6.1 White whale

The sub-committee had previously reviewed the status of white whales in 1992 (IWC, 1993b, pp.130-2). Since that time a great deal of research has taken place that is relevant to this topic.

6.1.1 Stock identity and discreteness

At the 1991 meeting a total of 16 'stocks' was provisionally identified (IWC, 1992, p.186). A large amount of new information has become available since then on the subject of white whale stock differentiation, particularly with regard to molecular DNA. O'Corry-Crowe introduced SC/51/SM37, which identified a total of 22 putative stocks based upon information on distribution and migration patterns, morphology, contaminant profiles, population trends and genetics. The paper reviewed the recent literature on stock concepts and noted that the appropriate unit of species management depends on the conservation goal. It suggested that for a species such as the white whale, which is or has been directly exploited over a large proportion of its range, it may be more relevant to measure the level of dispersal between sub-populations than to determine their evolutionary distinctiveness because the immediate goal of management would be to prevent a stock from becoming depleted due to excessive take. Recent genetic studies of white whales have primarily involved analyses of mitochondrial or nuclear DNA. The mtDNA analyses suggest that there is limited movement between major summering grounds, and therefore colonisation of depleted areas by whales from other summer concentrations would be slow. It was also noted, however, that recent satellite tracking data show white whales to be less ice-limited than previously thought; they travel long distances into the permanent polar ice during the summer. Thus, ideas about the physical barriers to movement and hypotheses concerning the convergence of several summering stocks on a single wintering ground may need to be reconsidered.

During the ensuing discussion, Belikov noted that in Russia traditional ecological knowledge (TEK) in northern hunting communities has come to be viewed as an additional tool that can be used to help understand stock relations. The same is true in Alaska, Canada and Greenland.

6.1.1.1 DEFINITION OF 'STOCK' OR MANAGEMENT UNIT

There was considerable discussion about what constitutes a stock or management unit in the case of white whales. National and bilateral management bodies, as well as the sub-committee, have traditionally defined stocks of white whales on the basis of summer estuarine aggregations. It has been recognised that whales from different summer aggregations may mix spatially and perhaps interbreed during the winter or spring.

The sub-committee agreed on the principle that management units should be established with the goal of maintaining white whales throughout the full extent of their historical range (see SC/51/RMP23). To achieve this goal, it is necessary to adopt the smallest reasonable population units. The default position would be to start from the assumption that estuarine groups are separate stocks unless they are shown to be otherwise. This precautionary approach is intended to ensure that removals based on large area population estimates are not inadvertently taken from smaller discrete stocks within the area. Evidence of white whale fidelity to estuaries, bays or other small areas, and persistent local depletion after severe hunting, suggests that such takes could lead to the extinction of small populations. In several areas, there is TEK and scientific evidence that animals move sequentially between two or more aggregation sites within a season (e.g. Bristol Bay – Frost *et al.*, 1985; Frost and Lowry, 1990; Somerset Island – Smith and Martin, 1994). As such information becomes available, the small 'stocks' defined *a priori* as separate can be combined into larger units. Shifting the burden of proof in this way represents a fundamental change in the policy of the sub-committee towards white whale stock identity.

Stock boundaries sometimes overlap spatially and in such cases the geographical delineation of white whale stocks must have a temporal component. At some locations along the Alaskan coast, white whales from more than one stock are hunted at different times of the year. Migrating whales from different stocks may approach and move past a given site in 'waves', while a summer 'resident' stock moves into that same area for an extended period. For example, the eastern Chukchi Sea stock is temporally delineated as the group of whales that arrives in Kotzebue Sound or Kasegaluk Lagoon as the ice begins to break up and remains there for at least several weeks. Earlier in the year, whales from the Beaufort Sea stock move through this area in the spring lead system. Thus, the annual catch at villages such as Point Hope, Kivalina and Barrow can consist of whales from both of these stocks.

Frost noted that stocks of white whales, particularly in Alaska, have been named by reference to where they come close to shore and where they are hunted. In most areas, the hunting takes place in spring, summer or autumn. The hunting places and seasons have strongly influenced genetic (and other) sampling; most samples are obtained from hunted whales through the cooperation of local hunters. Smith pointed out that genetic samples should be obtained as soon as possible after whales arrive in an area, just as the water becomes ice-free, to maximise the opportunity for identifying discrete stocks.

Smith and Frost proposed that recognition of a stock should require more than one line of evidence. Preferably and in most cases, the geographical evidence of seasonal occupation of particular estuaries or embayments will be reinforced by TEK, genetic, morphologic, behavioural, telemetric or contaminant evidence.

6.1.1.2 CONTAMINANT COMPARISON AS A TOOL FOR STOCK IDENTIFICATION

Several papers available to the sub-committee used comparisons of contaminant levels or patterns to help distinguish white whale stocks. Some members of the sub-committee raised the question of how robust contaminant data are for distinguishing white whale stocks. Reijnders pointed out that problems are usually encountered because differences in contaminant levels can be correlated to either biological variables (e.g. age, sex, reproductive status) or exposure. However, it was also pointed out that most distinctions have been drawn on the basis of contaminant profiles rather than levels, and that the former are perhaps less influenced by age, sex or reproductive history. Even if whales remain in the same general area, they may switch from one type of prey to another and thus change their level of exposure and, in turn, their contaminant signature. Within-group individual variation in feeding behaviour may require large sample sizes to reliably discern stock differences. It is important to know something about diet in order to interpret whether an inferred difference in exposure is due to stock difference or is an artefact of a change in feeding behaviour or the distribution of prey.

O'Hara summarised the findings in SC/51/E6 where organochlorine comparisons were made among three of the five Alaskan white whale stocks. The authors took account of differences in age and sex in their analysis. Significant differences were found among the stock areas and these differences were consistent with the genetic, survey, TEK and other kinds of evidence. Principal Components Analysis indicated that PCBs were the most influential group of contaminants in demonstrating stock differences in Alaska.

Contaminants data alone are unreliable for identifying stocks. The primary concern for management is likely to be in a coastal area where hunting occurs, and most or all tissue samples will have been taken from that area. If two stocks occur there seasonally and they use a common feeding ground, contaminants comparisons may show a spurious lack of difference. Similarly, if contaminant signatures are labile (e.g. due to interannual or seasonal changes in prey availability and composition, differential metabolism of organochlorine compounds), spurious differences may be found between samples taken from the same stock at different times. Thus, although contaminants data can be useful to supplement or reinforce other evidence, they should not be used as the sole basis for stock identification in the absence of other corroborative evidence.

Dawson pointed out that contaminant profiles can change faster than genetic signatures and are therefore potentially more 'sensitive' indicators of stock difference. Smith added that it is important to consider how transient an organochlorine signature, for example, may be.

Kingsley noted in regard to sampling for both contaminants and genetics analyses that there can be problems of lack of independence. Sets of biological samples from white whale stocks often result from hunting incidents in which the animals taken may be from a related group. Statistical analyses of genetics or contaminants data often assume independent sampling from the hypothesised stocks and may therefore detect differences when none exist or, alternatively, no difference when there is one.

6.1.1.3 STOCKS

The sub-committee discussed the evidence of stock identity for each part of the white whale's circumpolar range, beginning in Cook Inlet, Alaska, and proceeding coastwise to the north and east. Proposed stock divisions are shown in Fig. 1. The evidence for those divisions is summarised in Table 2. The following text summarises the discussions pertaining to areas that were particularly difficult to resolve. It should be read as a complement to Table 2.

NEARCTIC

Stock identity in Alaskan waters is relatively well established because of the large amount of appropriate information available. It was noted in regard to the Beaufort Sea stock that animals in the Mackenzie Delta region should be sampled on a finer scale to determine whether there is genetic structuring within the region, e.g. between Kugmalik Bay and Shallow Bay. Belikov noted that many of the white whales that migrate through the Bering Strait along the Chukotka coast in the spring and autumn are thought to be from the Beaufort Sea and eastern Chukchi Sea stocks. Recent satellite-tagging data have confirmed this for the Beaufort Sea animals in the autumn (SC/51/SM55).

Stock identity in eastern Canadian and West Greenland waters is problematic. It was long believed that the whales summering in Prince Regent Inlet, Barrow Strait and Peel Sound migrate east to Greenland and south along the Greenland coast in the autumn. However, satellite telemetry data suggests that a high proportion of the whales summering in Canada do not migrate to West Greenland, but rather move into the North Water, a large polynya in northern Baffin Bay, where they may remain for the winter (SC/51/SM55; Smith and Martin, 1994). Genetics and contaminants evidence supports the idea that there is structuring within the large Davis Strait-Baffin Bay-Lancaster Sound region, but many samples have not yet been completely analysed.

Following the principle that possible stock units should be split until evidence is available to justify combining them, the group agreed to provisionally recognise two stocks on the basis of their winter rather than summer distributions. The sub-committee noted that West Greenland was an area where a serious management problem exists (overhunting from a depleted and declining stock), and it was partly for this reason that it was felt to be prudent to recognise the whales in this area as a putative stock. It **recommends** that genetic samples from Greenland and Canada be analysed promptly to examine stock identity and test the two-stock hypothesis. Smith estimated that there are in the order of 100 genetic samples from Somerset Island in Canada, and a much larger sample has been collected from West Greenland.

Fig. 1. Approximate worldwide distribution of the white whale, *Delphinapterus leucas.* Numbers refer to the 29 putative stocks recognised. See Tables 2 and 3.

Another area where there has been considerable difficulty in defining stocks is southeast Baffin Island. The summer concentration at the head of Cumberland Sound is a well-defined stock unit. In contrast the summer population in Frobisher Bay, although apparently distinct from that in Cumberland Sound (SC/51/SM56; SC/51/SM62), is not known to home on any estuary within the bay, nor has this population been surveyed regularly. Several members expressed doubts about whether the putative Frobisher Bay stock should be recognised as a separate unit. In the past, white whales hunted along the north shore of Hudson Strait (e.g. at Kimmirut) were considered to belong to a 'Southeast Baffin stock.' However, Smith and Kingsley pointed out that these were more likely migrants from Hudson Bay stocks hunted in Hudson Strait during the spring and autumn.

The Ungava Bay stock is critically endangered, numbering a few tens of individuals at most. The sub-committee noted the importance of obtaining genetic samples from this area and **recommends** that an effort be made to locate and sample bones from Ungava Bay white whales to facilitate comparisons with white whales from adjacent stock areas.

Traditionally, two stocks have been recognised in Hudson Bay: eastern and western. However, the sub-committee noted that there was insufficient data to justify grouping the whales in southern Hudson Bay and Foxe Basin with the western stock, or animals from James Bay with the eastern stock. White whales occupy estuaries of southern Hudson Bay (e.g. Severn and Winisk rivers) and at least one estuary in southern Foxe Basin in summer. In the absence of evidence to the contrary it was agreed that they should be recognised as separate stocks. Smith noted that whales from the high Arctic (Prince Regent Inlet) might also enter Foxe Basin from the north in some years. White whales are widely distributed in James Bay in summer and little is known about their affinities with groups elsewhere in Hudson Bay. Again, in the absence of data to justify grouping, the animals in James Bay were listed as a separate putative stock.

Kingsley cited both tagging data (SC/51/SM24) and genetic data (SC/51/SM62) to support the hypothesis that whales found offshore of eastern Hudson Bay (Belcher Islands) in the summer do not belong to the eastern Hudson Bay coastal stock. Smith pointed out that the Belcher Islands area does not provide typical summering habitat for white whales. The sub-committee was unable to agree on a way of resolving this question and concluded that the problem should simply be identified as one that needs to be examined more closely.

Palearctic

Much less is known about stock separation in the Palearctic, where virtually no genetic studies have been conducted and satellite tracking has only begun in Svalbard. Most of the evidence of stock separation in the Palearctic is based on distribution and movements as observed from shore sites, aerial surveys, ice reconnaissance and fisheries for white whales.

Table 2

White whale stocks recognised by the Committee, using the precautionary principle that aggregations should be considered independent until proven otherwise. Types of evidence supporting these stock delineations are indicated. NTD = not determined.

	Stock	Summer concentration area	Hypothesised wintering area	Genetics mtDNA	Genetics nDNA	Contaminants	Movements
1	Cook Inlet	Upper Cook Inlet	Lower Cook Inlet-Gulf of Alaska	Yes	Yes	Yes	Congregates in river mouths in summer.
2	Bristol Bay	Bristol Bay	Bering Sea	Yes	Yes	-	Local movements in northeast Bristol Bay in summer.
3	E. Bering Sea	E. Bering Sea	Bering Sea	Yes	Yes	-	
4	E. Chukchi Sea	E. Chukchi Sea	Bering Sea	Yes	Yes	Yes	Migrate along Chukchi coast in spring, congregate in lagoons in summer, move offshore and north into Beaufort Sea late summer-early autumn.
5	Beaufort Sea	Mackenzie Delta-Amundsen Gulf	Bering Sea	Yes	Yes	Yes	Migrate through east Chukchi Sea in spring, congregate in Mackenzie Delta and Amundsen Gulf in summer, move offshore and north in late summer, migrate west to west Chukchi Sea in autumn.
6	North Water	Canadian High Arctic	North Water (N. Baffin Bay)	NTD	NTD	Yes	Arrive from east into High Arctic in summer, return east and then northeast to North Water in autumn.
7	W. Greenland	Canadian High Arctic?	W. Greenland	NTD	NTD	Yes	Overwinter in open water and pack-ice off West Greenland.
8	Cumberland Sound	Cumberland Sound	Hudson Strait	NTD	Yes (not strong)	Yes (but temporal diffs)	Remain in Cumberland Sound in summer and autumn.
9	Frobisher Bay	Frobisher Bay?	Hudson Strait	NTD	Yes (not strong)	Yes (but temporal diffs)	Not known to form concentrations in Frobisher Bay in summer.
10	Ungava Bay	Ungava Bay	Hudson Strait		-	-	-
11	Foxe Basin	Foxe Basin	Hudson Strait- Foxe Basin	NTD (may be mixed stocks)	NTD	-	-
12	W. Hudson Bay	W. Hudson Bay	Hudson Strait	Yes	NTD	Yes	Remain near the coast in summer and early autumn.
13	S. Hudson Bay	S. Hudson Bay	Hudson Strait	-	-	-	-
14	James Bay	James Bay	Hudson Strait	-	-	-	-
15	E. Hudson Bay	E. Hudson Bay	Hudson Strait	Yes	Yes	Yes	Remain in E. Hudson Bay through summer before moving north along coast of north Quebec to Hudson Strait in autumn.
16	St Lawrence	Estuary of St Lawrence	Estuary and Gulf of St Lawrence	Yes	Yes	Yes	Restricted range throughout summer.
17	Svalbard	Svalbard	Barents Sea	-	-	-	Local movements near coast in summer. May occasionally travel to East Greenland.
18	Franz Josef land	Franz Josef Land	-	-	-	-	-
19	Ob Gulf	Ob Gulf	Barents and Kara Seas	-	-	-	-
20	Yenesy Gulf	Yenesey Gulf	Barents and Kara Seas	-	-	-	-
21	Onezhsky Bay	Onezhsky Bay	White-Barents Seas*	-	-	-	Local movements in Onezhsky Bay in summer.
22	Mezhenskyi Bay	Mezhenskyi Bay	White-Barents Seas*	-	-	-	Local movements in Mezhenskyi Bay in summer.
23	Dvinsky Bay	Dvinsky Bay	White-Barents Seas*	-	-	-	Local movements in Dvinsky Bay in summer.
24	SW Laptev Sea	SW Laptev Sea	Barents Sea	-	-	-	-
25	W. Chukchi- E. Siberian Seas	W. Chukchi - E. Siberian Seas	Bering Sea	-	-	-	Not seen nearshore in summer or autumn. Presumed to migrate offshore and summer in pack-ice.
26	Anadyr Gulf	Anadyr Gluf	Anadyr Gulf	-	-	-	Some migrate north through Bering Strait in spring and south in autumn.
27	Shelikov Bay	Shelikov Bay	Okhotsk Sea	-	-	-	-
28	Sakhalin-Amur	Sakhalin-Amur	Okhotsk Sea	-	-	-	-
29	Shantar	Shantar	Okhotsk	-	-	-	-

*After the meeting, Belikov informed that according to Belkovitch (1995) there are 5 (not 3) isolated stocks (of 80-160 animals each) in the southern part of the White Sea; 2 in Dvinsky Bay, 2 in Onezhsky Bay and 1 in the Solovetsky Islands. This information was obviously not able to be considered by the sub-committee.

The sub-committee was uncertain about separation of the putative Svalbard and Franz Joseph Land stocks. Martin described satellite tracking data (SC/51/SM61) which suggests that Svalbard animals remain close to the coast until forced offshore by ice; and Bjørge noted that there was open water and some historical evidence of white whale hunting in the winter off the west coast of Spitsbergen. In the absence of evidence to the contrary, it was proposed that the whales near Franz Joseph Land be considered a separate stock pending better documentation. Martin observed during tagging and tracking operations at Svalbard that white whales tended to congregate along glacier fronts. Noting that there are no estuaries in Svalbard where white whales aggregate, Martin hypothesised that the meltwater from glaciers may serve, in some sense, as the ecological equivalent of freshwater river discharge in this area. Belikov confirmed that there were many glaciers in Franz Joseph Land but he had no detailed information on white whale distribution and habitat use within the archipelago.

Belikov referred to expert opinion in Russia that there are three distinct stock units in the White Sea, each of them essentially resident in a different large bay system[1]. These animals evidently remain in the White Sea all year round, moving offshore only when they are driven out of the bays by ice in the winter. The evidence for this stock separation scheme comes solely from multi-year aerial surveys, and O'Corry-Crowe emphasised that other lines of evidence were needed for corroboration.

According to Belikov, the distribution of white whales in the Russian Arctic has traditionally been viewed in terms of two geographical populations separated by the ice massif between the Laptev and East Siberian Seas. Based on what is known about seasonal distribution and movements, Belikov proposed three separate putative stocks in the Kara and Laptev Seas centred during the summer in Ob Gulf, Yenisey Gulf and the southwestern Laptev Sea. There may be further structuring in the Laptev Sea.

The sub-committee discussed at length the problem of assigning white whales in the eastern East Siberian Sea and the western Chukchi Sea during the summer and autumn to a coastal summering area. Satellite tracking data from northern Alaska and northwestern Canada has demonstrated that whales move great distances to the north and west in the late summer and autumn (e.g. SC/51/SM39). For this reason, some members favoured the hypothesis that the whales seen offshore of Chukotka near the pack-ice in summer are from one or more of the Alaskan or Canadian stocks. Some members also considered it likely that some white whales from the Bering Sea move west rather than east after entering the Chukchi Sea in the spring, and that these whales travel to offshore waters of the western Chukchi or eastern East Siberian Sea for the summer. However, no major estuary or lagoon system along the north coast of Chukotka is known to support a concentration of white whales, therefore the sub-committee was very tentative in proposing a separate stock for this area.

SC/51/SM27 considered stocks in the Okhotsk Sea and referred to the whaling as 'well developed' in Tauy Inlet in the 1930s and that white whales had not been seen there in recent years 'despite repeated surveys'. The sub-committee noted the possibility that there had been a Tauy Inlet stock at one time and that it was essentially extirpated by whaling. Perrin pointed out that the geographical distance between Shelikov Bay and Tauy Inlet was greater than that between Shantar Bay and the Sakhalin Island/Amur River area. Frost cautioned that white whales are known to make rapid long-distance movements and that their appearance in some areas can be erratic. The question of a fourth stock in the Okhotsk Sea was thus unresolved.

6.1.2 New information on life history

DeMaster summarised SC/51/SM4 in which Hohn and Lockyer reported counts of Growth Layer Groups (GLGs) in tooth sections from two wild-caught white whales held in captivity for eight years, indicating a deposition rate of one GLG per year. This finding led the authors to question the currently accepted rate of two GLGs per year in the white whale. The paper also argued that the data in the literature used to support the two GLG/year hypothesis may, in fact, support a deposition rate of one GLG per year. Such a change in age estimation could result in an overall reduction in estimates of the maximum rate of increase despite an upwards revision of adult survival. Suydam and DeMaster summarised the evidence from teeth that had been evaluated to date from captive white whales and questioned some of Hohn and Lockyer's interpretations. One difficulty with Hohn and Lockyer's counts was that they fell between expected counts for deposition rates of one and two GLGs per year. Suydam made his own counts of the GLGs shown in the photographs of tooth sections in SC/51/SM4 and got slightly higher values that appeared to be more consistent with the traditionally accepted rate of two GLGs/year. Kasuya agreed with the reservations expressed by Suydam and DeMaster. Suydam concluded that the results presented in SC/51/SM4 were intriguing, particularly those relating to the tetracycline-marked tooth, and that further work was warranted. Perrin suggested that a model of tooth development (i.e. how GLGs are formed) was required and Read stated that there were enough white whales born in captivity to develop such a model. Apart from an incomplete understanding of the rate of deposition, Suydam also stressed that a certain amount of subjectivity and inter-observer variation was inevitable. This was reflected in the differing counts of GLGs by a number of members of the sub-committee from cursory examination of the photographs. O'Hara and da Silva proposed that several examiners should read the same teeth to estimate the variance associated with this factor. There was general agreement that GLG counts in general, and certainly where they are being used to calibrate the number laid down per year, should not be attempted from examination of photographs but only from direct examination of sectioned teeth.

6.1.3 Review of current knowledge on a stock-by-stock basis

Each of the 29 stocks proposed in Table 2 was reviewed for available information on geographical range and migrations, abundance, directed takes, indirect takes, known and potential threats, and status. This information is summarised in Table 3. The quality and quantity of available information varied greatly among the stocks and thus confounded inter-stock comparisons. Differing methods of data collection contributed to the uncertainty surrounding some of the stock designations.

6.1.3.1 GEOGRAPHICAL RANGE AND MIGRATIONS

TEK, shore-based, ice-based and aerial surveys and, more recently, satellite telemetry have been used to document the

[1] Editor's note: After the meeting, Belikov informed that according to Belkovitch (1995) there are 5 (not 3) isolated stocks (of 80-160 animals each) in the southern part of the White Sea: two in Dvinsky Bay, two in Onezhsky Bay and one in the Solovetsky Islands. This information was obviously not able to be considered by the sub-committee.

geographical range and movement patterns of stocks. Range and migrations are also covered to some extent in Item 6.1.1 and Tables 2 and 3.

6.1.3.2 ABUNDANCE

See Table 3.

6.1.3.3 DIRECTED TAKES

White whales are not currently commercially harvested anywhere throughout their range. Direct takes are from aboriginal hunting. Estimates of direct takes in Alaska include those whales that were struck and lost.

6.1.3.4 INDIRECT CATCHES

Indirect takes are primarily from incidental catches in fishery operations, and for Alaska these are combined with direct takes in Table 3.

6.1.3.5 KNOWN AND POTENTIAL THREATS

Current known or potential threats include a wide variety of human activities: oil and gas development, over harvesting, fisheries, vessel traffic (recreational, commercial and military), hydroelectric development in Hudson Bay and industrial and urban pollution. The most immediate concerns relate to continuing harvests from small and depleted populations. Reeves pointed out that a number of the smaller stocks may experience the effects of demographic and environmental stochasticity on small populations. Frost expressed the view that although some of the aforementioned activities may indeed threaten particular stocks, others are better regarded as conservation concerns than immediate threats. She drew the sub-committee's attention to SC/51/SM38, which outlined issues of potential conservation concern for western Alaskan white whale stocks.

6.1.3.6 STATUS

It was agreed that status designations should be based on both: (1) current relative to historical abundance; and (2) current trends. Thus, whenever possible, there should be a two-part designation of status (Table 3).

6.1.3.7 RECOMMENDATIONS

The sub-committee expressed concerns about the conservation status of a number of stocks because of their: (1) depleted status relative to historical abundance (Cook Inlet, West Greenland, Ungava Bay, Cumberland Sound, East Hudson Bay, St Lawrence River); (2) likely depleted status relative to historical abundance (Svalbard, Ob Gulf, Yenise Gulf, Onezhsky Bay, Dvinski Bay, Mezhensky Bay, Shelikov Bay, Shantar Bay, Sakhalin/Amur); (3) current small population size or reduced range (Cook Inlet, Ungava Bay, Cumberland Sound, West Greenland, Ob Gulf, Yenise Gulf); or (4) recent decline (Cook Inlet, West Greenland, Ungava Bay). In the majority of stocks it was recommended that surveys be continued to determine current abundance and assess trends. Considering the wealth of information on movement patterns and habitat use gathered from satellite telemetry studies, it was recommended that such studies be continued and expanded. Recent genetic and contaminant analyses have resolved much about stock discreteness in some areas. However, more research is required to resolve microgeographic structure and seasonal movement patterns within some of these areas. In other regions no research of any kind has been conducted to determine stock boundaries. Belikov stated that there is very little evidence, other than summer distribution, that supports the stock delineations of many of the Russian stocks proposed in Table 2. The sub-committee **recommends** that studies, including genetics, be undertaken to resolve the stock structure of white whales in Russian waters. Considering the potential impacts of industrial pollution on white whales in some areas of the Russian Arctic, O'Hara recommended that samples be collected for contaminant analysis and health assessment. It was suggested by some members that such a sampling programme could assist in stock-ID as well as health assessment studies as has been the case in Alaska, Canada and Greenland.

DeMaster stated that since the last review of white whales by the sub-committee in 1992, Canada, Greenland and the USA (particularly the Alaska Beluga Whale Committee) have conducted numerous studies on white whales. The sub-committee acknowledged these efforts and recommended that such work continue, particularly related to abundance, population trends, migration, stock identity, complete and accurate catch statistics, and collection of samples for age estimation and studies of reproduction parameters. The sub-committee also recognised the importance of biological samples collected by hunters in helping resolve issues related to stock identification.

Specific Recommendations of the sub-committee:

(1) The sub-committee **recommends** that stocks that are either depleted, small in size, or currently declining in numbers or range be considered as of highest conservation concern. Efforts to improve their current status should be undertaken and supported. Particular emphasis should be placed on those stocks where all three characteristics apply, e.g. Cook Inlet, Ungava Bay, West Greenland and East Hudson Bay. It is important to document catch localities and stock affinities of whales taken by settlements in Ungava Bay and Hudson Strait in order to evaluate the implications for the Ungava Bay and East Hudson Bay stocks.
(2) The sub-committee **recommends** that genetic and contaminant studies continue in order to further resolve questions about local structuring and movement patterns, and that sampling programmes be initiated in other areas, Russia in particular, to resolve questions of stock structure.
(3) The sub-committee **recommends** that sampling programmes to assess the health status of white whales continue throughout Alaska, Canada and Greenland, and that such programmes be initiated in Russia. Of particular concern are areas of high anthropogenic influence, including the southeast Barents Sea, which is the probable wintering ground for many of the Russian stocks (e.g. the Ob Gulf, Yenise Gulf) and the Sakhalin/Amur region in the Okhotsk Sea.
(4) The sub-committee noted that tagging and telemetry studies of white whales have provided important new information relevant to stock identity, migrations, habitat use and abundance. It **recommends** that such studies are continued to increase sample size and expanded to other regions.
(5) The sub-committee **recommends** that surveys of white whale distribution and abundance continue, particularly in areas where there is little recent information on either.
(6) The sub-committee **recommends** further research on age estimation, including the examination of teeth from known-age captive-born white whales, and encourages greater cooperation among relevant institutions and scientists to resolve this important issue.

Table 3
Summary information regarding the status of white whale stocks recognised by the sub-committee. IA = Initial abundance.

Stock	Range	Abundance[1]	Takes[2]	Known and potential threats	Trends/status	References
1. Cook Inlet	Summer: northern Cook Inlet Winter: unknown (Cook Inlet-Gulf of Alaska)	1998: 347 (CV = 0.29)	1994-96: 72/year 1997: 65-75 average take 94-98 was *ca* 20% of pop. size	Small stock size; continued harvest; oil/gas development; eco-tourism; shipping; commercial fishing; sewage from Anchorage	15% decline/year between 94-98 Depleted	SC/51/SM8; SC/51/SM9; SC/51/SM11; SC/51/SM12; SC/51/SM15
2. Bristol Bay	Summer: Inner Bristol Bay Winter: unknown* (outer Bristol Bay-Bering Sea) *Some winter observations in Bristol Bay	1993-94: 1,100 (likely conservative)	1994-1998: 13/year 1.2% of estimated pop. size	Interaction with salmon stocks	Stable or increasing	Frost, pers. comm.; SC/51/SM34; SC/51/SM38; Hill and DeMaster, 1998
3. East Bering Sea	Summer: Norton Sound and Yukon Delta Winter: unknown (Bering Sea)	1992-95: 17,675 (9,056-34,515 95%CI)	1994-98: 130/year 0.7% of estimated pop. size	Interaction with salmon stocks, coastal activity; vessel traffic and noise	Unknown	Frost, pers. comm.; SC/51/SM33; SC/51/SM34; SC/51/SM38; Hill and DeMaster, 1998
4. East Chukchi Sea	Summer: Coastal concentrations in Kotzebue Sound, off Kasegaluk lagoon Winter: Unknown (Bering Sea)	1990: 3,700 Surveyed in 1996-98, but no pop. estimate	1994-98: 70/year 1.9% of estimated pop. size	Coastal mining; coastal activity; vessel traffic and noise	Stable (since late 1970s)	Frost, pers. comm.; SC/51/SM33; SC/51/SM38; SC/51/SM39; Hill and DeMaster, 1998
5. Beaufort Sea	Summer: North Slope of Alaska and Mackenzie Delta Winter: Bering Sea	1992: 39,257 (CV = 0.23) (survey did not cover all areas)	1990-94: 113/year in Canada 1994-98: 61/year in Alaska	Petroleum development	Stable	Frost, pers. comm.; Hill and DeMaster, 1998; Richard, 1999
6. North Water winter (North Baffin Bay)	Summer: Somerset Island Winter: Jones Sound North Water Polynya (Baffin Bay)	1996: 28,000[3]	30-60/year in Canada + possible additional in West Greenland	None documented	Stable	Richard, 1999
7. West Greenland winter	Summer: Somerset Island Winter: West Greenland	1996: 2,000[4]	Recent takes: *ca* 600/year Present takes are not available to IWC SC	Continued harvest	Reduced *ca* 60% between 1981-1994	Heide-Jørgensen and Reeves, 1996; Innes, pers.comm.
8. Cumberland Sound	Summer: Cumberland Sound (Clearwater Fjord) Winter: not confirmed (Hudson Strait, North Labrador)	1986: 485 counted IA in 1922: 5,000	35/year (under quota)	Continued harvest	Trend: unknown Depleted	Mitchell and Reeves, 1981; Richard, pers.comm.
9. Frobisher Bay	Summer: (Frobisher Bay) Winter: not confirmed (Hudson Strait, North Labrador)	No information (no concentration area documented)	5-5-/year	Continued harvest	Unknown	Richard *et al.,* 1990; Reeves, pers. comm.; Richard, pers.comm.
10. Ungava Bay	Summer: S. Ungava Bay (Muclic and Whale Rivers) Winter: Hudson Strait	IA in 1880: 1,000. Present <50	Probably <15	Small stock size, continued harvest	Close to extirpation	SC/51/SM24; Finley *et al.*,1982
11. West Hudson Bay	Summer: Churchill, Nelson and Seal Rivers Winter: Hudson Strait	1987: 25,100 (18,300-32,800)	300-400/year	None documented Hydro-electrical developments	Stable (?)	Smith, pers. comm.; Kingsley, pers. comm.; Richard *et al*., 1990; Richard, pers.comm.
12. Foxe Basin	Summer: Foxe Basin Winter: Hudson Strait	1983: 1,000[5]	Northern Foxe Basin approx. 25/year	None documented	No information	Smith, pers. comm.; Kingsley, pers. comm.; Richard, 1999; Richard, pers.comm.
13. South Hudson Bay	Summer: Northern Ontario coastline Winter: Hudson Strait	1987: 1,299 (counted)	No known harvest	None documented	No information	Smith, pers. comm.; Kingsley, pers. comm.; Richard *et al*., 1990.
14. James Bay	Summer: James Bay Winter: Hudson Strait	1993: 3,300	Little or no harvest in James Bay; Possible takes in other areas	Hydro-electrical developments	No information	SC/51/SM24; Smith, pers. comm.; Kingsley, pers. comm.

cont.

Table 3 continued.

Stock	Range	Abundance[1]	Takes[2]	Known and potential threats	Trends/status	References
15. East Hudson Bay	Summer: Nastapoca and Little Whale Rivers Winter: Hudson Strait	1993: 1,014 (includes Belchers) IA in 1850: 6,600	55/year	Estuaries frequently used for recreational activities, continued harvest, hydro-electrical developments	Depleted, not recovering	SC/51/SM24; Smith, pers. comm.; Kingsley, pers. comm.; Reeves and Mitchell, 1987
16. St Lawrence River	Summer: Central Maritime Estuary of St Lawrence River Winter: Lower estuary and gulf	1997: 1,238 (corrected) IA in 1885: 5,000	None	Marine traffic/harassment; pollution (organochlorines and heavy metals)	Depleted Increasing at 2.9 (SE 1.2)%/year Concern for health status	SC/51/SM22; SC/51/SM23; Reeves and Mitchell, 1984
17. Svalbard	Summer: Svalbard archipelago Winter: Svalbard – Barents Sea	No estimate Assumed population size few hundreds to low thousands	No directed takes Negligible incidental takes	None documented	No information Likely depleted compared to historical level	Martin, pers. comm.
18. Franz Josef Land	Summer: Franz Josef Land Winter: Barents Sea	Few hundreds	No directed takes	None documented		SC/51/SM21; Belikov, pers. comm.
19. Ob Gulf (Kara Sea)	Summer: Ob Gulf Winter: Barents and Kara Seas	Few hundreds	No directed takes	Chemical and radioactive contaminants from riverine waters and marine dumping	Depleted compared to 1930s	SC/51/SM21; Belikov, pers. comm.
20. Yenisey Gulf (Kara Sea)	Summer: Yenisey Gulf Winter: Barents and Kara Seas	Few hundreds	No directed takes	Chemical and radioactive contaminants from riverine waters and marine dumping	Depleted compared to 1930s	SC/51/SM21; Belikov, pers. comm.
21. Onezhsky Bay (White Sea)	Summer: Onezhsky Bay Winter: White Sea[6]	Few hundreds	No directed takes	None documented	Likely depleted compared to historical levels	Belikov, pers. comm.
22. Dvinsky Bay (White Sea)	Summer: Dvinsky Bay Winter: White Sea[6]	Few hundreds	No directed takes	None documented	Likely depleted compared to historical levels	Belikov, pers. comm.
23. Mezensky Bay (White Sea)	Summer: Mezhensky Bay Winter: White Sea[6]	Few hundreds	No directed takes	None documented	Depleted	Belikov, pers. comm.
24. Southwest Laptev Sea	Summer: Southwest Laptev Sea Winter: Kara and Barents Sea	No information	No directed takes. Few incidental takes	None documented	Unknown	SC/51/SM21; Belikov, pers. comm.
25. West Chukchi Sea/Eastern East Siberian Sea	Summer: Ice edge in Chukchi/ E. East Siberian Sea. Winter: Bering Sea	No estimate, assumed few thousands	No directed takes	None documented	Unknown	SC/51/SM21; SC/50/SM4; Belikov, pers. comm.
26. Anadyr Gulf	Summer: Anadyr Lagoon and River Winter: (Cape Navarin area) Anadyr Gulf	No estimate assumed few thousands	None	Increasing marine traffic	Unknown	SM/50/SM4; Belikov, pers. comm.
27. Shelikov Bay	Summer: Shelikov Bay Winter: Okhotsk Sea	1987: 18-20,000 in the larger Okhotsk Sea. This estimate covers stocks 27, 28 and 29.		None documented	Depleted Stable?	SC/51/SM27
28. Shantar Bay	Summer: Shantar Bay Winter: Okhotsk Sea		Few occasional takes. Few live captures per year for display in dolphinarium	None documented Future petroleum development planned	Depleted Stable?	SC/51/SM27
29. Sakhalin/Amur River	Summer: Amur Lagoon and River Winter: Okhotsk Sea		Few occasional takes. Few live captures per year for display in dolphinarium	Increasing petroleum developments	Depleted Stable?	SC/51/SM27

* Indicates stocks that have annual takes but where data were not available to the sub-committee. [1] Alaska estimates are corrected for availability. (Cook Inlet is corrected for availability and sightability). [2] Takes for Alaska include hunting loss and incidental takes. [3] Abundance estimate for the entire Canadian High Arctic – probably includes both North Water and West Greenland winter stocks. [4] Estimated based on catch analysis. An estimate of 1,077 is pro-rated from Canadian High Arctic based on tagging (Innes, pers.comm.). [5] In 1988, extrapolated from a count of 685. [6] After the meeting, Belikov informed that according to Belkovitch (1995) there are 5 (not 3) isolated stocks (of 80-160 animals each) in the southern part of the White Sea; 2 in Dvinsky Bay, 2 in Onezhsky Bay and 1 in the Solovetsky Islands. This information was obviously not able to be considered by the sub-committee.

6.2 Narwhal

In comparison with white whales, little new information has become available for the narwhal since this sub-committee last reviewed the species (IWC, 1993b).

6.2.1 Stock identity and discreteness

Two stocks have traditionally been recognised in the Nearctic, one centred in northern Hudson Bay and southern Foxe Basin in summer, the other in the fjord waters of northwest Greenland and the Canadian High Arctic archipelago. Summer aggregations occur annually in distinct areas (e.g. Melville Bugt, Inglefield Bredning, Eclipse Sound, Admiralty Inlet, Prince Regent Inlet, Peel Sound, Repulse Bay etc.). There is within-season movement between some of these areas but also a suggestion that groups may be 'resident' for the entire open-water season in, for example, Melville Bugt and Inglefield Bredning (Born *et al.*, 1994; Dietz and Heide-Jørgensen, 1995). Mitochondrial DNA evidence indicates that the narwhals off West and East Greenland are clearly separate, as expected, and that narwhals found off West Greenland in the autumn come from more than one stock (Palsbøll *et al.*, 1997). Genetic (Palsbøll *et al.*, 1997), satellite tagging (Martin *et al.*, 1994; Dietz and Heide-Jørgensen, 1995) and traditional knowledge (Remnant and Thomas, 1992; Thomsen, 1993) studies all point to the fact that stock structure in eastern Canada and West Greenland is complex.

As noted above, the narwhals in East Greenland belong to a separate stock from those in West Greenland (Palsbøll *et al.*, 1997). Nothing is known about stock structure in the Eurasian Arctic.

In the absence of a model similar to that for white whales (summer fresh water outlet aggregations), and for the reasons mentioned under Item 6.2 concerning the lack of new information available at this meeting, the sub-committee was reluctant to propose any new 'stocks' of narwhals. However, it recommends further research on the question of stock identity, noting that samples for genetic and contaminant analyses are readily available from hunting in Canada and Greenland and from capture operations related to satellite tracking. It was suggested that a reasonable working hypothesis would be that disjunct summering areas in deep fjord complexes represent different stock units.

6.2.2 Review of current knowledge on a stock-by-stock basis

6.2.2.1 GEOGRAPHICAL RANGE AND MIGRATIONS

The narwhal's distribution is discontinuous circumpolar. Although scattered observations, usually involving only individuals or small groups, occur in the circumpolar Arctic, the species is far more abundant and widely distributed in the eastern Nearctic (Canada and Greenland) than elsewhere in its range (Fig. 2).

Range and movements in Canada have been well described in the literature (e.g. SC/51/SM55; Heide-Jørgensen *et al.*, 1993; Born *et al.*, 1994; Heide-Jørgensen, 1994; Koski and Davis, 1994; Martin *et al.*, 1994; Richard *et al.*, 1994). Smith referred to recent aerial survey observations of feeding groups of narwhals in the central Canadian Arctic as far west as M'Clintock Channel, indicating that the summer range in Canada is probably more extensive than previously believed.

The only area of the Palearctic (defined here as waters east of Greenland and west of the Bering Strait) where regular summer concentrations of narwhals are known to exist is East Greenland, particularly Scoresby Sound (Dietz *et al.*, 1994; Larsen *et al.*, 1994). Martin summarised observations and satellite tagging studies carried out at Nordaustlandet, Svalbard, in summer 1998 (SC/51/SM61). Three juvenile narwhals were tagged from a pod of more than 100 animals, and were subsequently tracked to the north and east for up to 46 days. Dives were to depths of up to 600m. Narwhals appear in Svalbard waters periodically but are not known to occur annually in any one area on a regular basis (Gjertz, 1991). Bjørge noted that they have been observed historically along the ice-edge from the Greenland Sea to Novaya Zemlya (cf. Dietz *et al.*, 1994). According to Belikov, the only area of the Russian Arctic where narwhals are frequently observed is the Franz Joseph Land area, especially the inter-island channels.

6.2.2.2 ABUNDANCE

No new information was available to the meeting. The best previous estimate (uncorrected) for the Baffin Bay-Davis Strait region is 34,700 (95% CI 21,600-54,600) from aerial surveys in May to early July 1979 (Koski and Davis, 1994; Reeves *et al.*, 1994). In addition, there is an estimate of 18,000 (90% CI 14,700-21,300) for the Canadian high Arctic in August 1984 (Richard *et al.*, 1994) and a series of August estimates for Inglefield Bredning in the mid 1980s ranging from about 1,000-2,000 (Born *et al.*, 1994). Richard (1991) estimated 1,355 (90% CI 1,000-1,900) narwhals for the summering area in northern Hudson Bay/southern Foxe Basin, and Larsen *et al.* (1994) estimated about 300 (95% CI 165-533) in Scoresby Sound. In its previous review of this species, the sub-committee had suggested that survey estimates of narwhals should be multiplied by 1.8 to account for visibility bias (IWC, 1993a, p.133).

6.2.2.3 DIRECTED TAKES

Directed takes are known to be continuing in Canada and Greenland, presumably at a similar scale to what they have been for at least the past decade. However, no current data were available to the meeting. Belikov noted that the narwhal is on the list of protected species in Russia so there is no organised or regular hunt for it there. The same applies to the Norwegian Arctic.

6.2.2.4 INDIRECT CATCHES

There are no known incidental takes of this species.

6.2.2.5 KNOWN OR POTENTIAL THREATS

Radionuclide contamination in the Russian high Arctic could potentially represent a threat to the narwhals there.

6.2.2.6 STATUS

With almost no new information available for consideration, the sub-committee was unable to make a meaningful assessment of any of the stocks.

6.2.2.7 RECOMMENDATIONS

The sub-committee drew attention to, and reiterated, its previous recommendations (IWC, 1993a, p.134) concerning the importance of genetic and telemetry studies to identify stocks, and improved catch reporting (including estimation of hunting loss) in Canada and Greenland.

Fig. 2. Summer distribution of the narwhal (cross hatching).

7. REVIEW OF PROGRESS OF THE IWC/ASCOBANS JOINT HARBOUR PORPOISE WORKING GROUP

At last year's meeting the sub-committee requested that Read convene a joint IWC/ASCOBANS working group to provide scientific advice concerning target levels of harbour porpoise bycatch reduction required to meet the management objectives of ASCOBANS. The working group met intersessionally in St Andrews, Scotland, and reviewed information on the distribution, abundance and bycatch of harbour porpoises in the ASCOBANS area. During its deliberations the group outlined a simulation modelling approach that would allow ASCOBANS to develop algorithms to meet their conservation objectives. The UK Ministry of Agriculture, Fisheries and Food has contracted the Sea Mammal Research Unit to conduct this simulation exercise. The report of the working group is published as Annex O.

The chairman thanked and commended Read and the other working group members for their hard work on the sub-committee's behalf. The sub-committee endorsed the general approach taken by the group and looked forward to reviewing the modelling results at next year's meeting.

Okamoto recorded that not all IWC members share the conservation objectives of ASCOBANS in relation to the harbour porpoise. In some areas harbour porpoises are subject to direct takes under completely different conservation philosophies.

Reijnders advised that ASCOBANS may request future advice from the sub-committee regarding the appropriateness of 80% of carrying capacity as a target population level for harbour porpoise stocks. He explained that the original basis for 80% had been that it was more risk-averse than the 72% level used in the RMP for baleen whales to achieve maximum production from the population, and was a natural fluctuation level for many terrestrial mammal species.

8. REVIEW OF PROGRESS OF THE VAQUITA RECOVERY PROGRAMME

Rojas-Bracho summarised SC/51/SM54 on risk factors affecting the vaquita. After analysing the four main possibilities (habitat alteration from reduced flow in the Colorado River, organochlorine pollution, inbreeding depression, and bycatch), the authors concluded that bycatch was the most immediate and direct threat to the survival of the species. Using population growth rates ranging from $r = -0.05$ to $r = -0.15$, it was clear that conservation action is urgently needed.

Rojas-Bracho also informed the sub-committee of the results of the second meeting of the International Committee for the Recovery of the Vaquita (CIRVA). The mandate of this group was to develop a recovery plan based on the best available scientific information, and which considers the socio-economic impacts of any necessary regulations. At the second meeting, the group reviewed the results of work carried out in response to the recommendations of the first meeting in 1997. The most important activity was a sightings survey carried out in summer 1997 using three research vessels and covering the entire potential area of vaquita distribution. This was a joint effort between the Mexican and US governments. The survey resulted in an estimate of 567 (CV = 0.51, 95% CI 177-1,073).

In response to an earlier recommendation, Jaramillo and Rojas-Bracho presented a brief analysis of the capture localities documented in Hohn *et al.* (1996) in order to evaluate hypotheses concerning age and sex segregation. The sample, however, was not large enough to provide conclusive evidence of segregation.

CIRVA also discussed whether the unusual age structure in the sampled bycatch (lack of 3-6 year old animals) reflected the true population age structure or instead was the result of non-random sampling. Taylor and colleagues had presented a paper to CIRVA in which they concluded that the unexpected age distribution of the sample was not random with respect to the actual age distribution of the population. Also during the CIRVA meeting, Jaramillo and Rojas-Bracho reported the results of an acoustic survey to test equipment developed by Chappell *et al.* (1996) for use with vaquitas. This was a combined effort of the International Fund for Animal Welfare, Oxford University and Mexico's Fisheries Institute (INP). The equipment worked very well and results indicated that vaquita density near San Felipe in the spring was higher than previously thought. Other subjects such as fisheries development, fisheries management and the socio-economic features of the upper Gulf were also discussed. Potential mitigation measures, including acoustic deterrents, seasonal/area closures, gear restrictions and marine protected areas, were analysed.

In summary, CIRVA concluded that only about 600 vaquitas remain and the species is critically endangered. To prevent extinction, bycatch of vaquitas must be reduced to zero as rapidly as possible. Complete protection will need to continue for at least 20-30 years. It was recognised that protective measures would have significant economic and social impacts on residents of the upper Gulf and that it was not possible to implement full protection immediately. CIRVA therefore recommended that gillnet fishing in the area inhabited by vaquitas be removed in three stages, starting with large-mesh gillnets. CIRVA noted that protective measures taken on behalf of the vaquita would also improve the health of the upper Gulf ecosystem and thus increase economic opportunities for residents in the long term. CIRVA called upon the international community and non-governmental organisations to join the government of Mexico in this conservation initiative. It is hoped that they will provide technical and financial assistance to implement conservation measures described in the recovery plan and to support the continued conservation activities of the Biosphere Reserve.

The sub-committee welcomed the report by Rojas-Bracho and commended the government of Mexico for the process they have followed to develop a recovery strategy for the vaquita. The vaquita is endemic to the Gulf of California, Mexico, but CIRVA includes scientists from several countries. The sub-committee endorsed the Recovery Plan and **strongly urges** the Commission to encourage the government of Mexico to implement it urgently. The sub-committee looks forward to receiving an update of the implementation at its next meeting.

9. REVIEW OF OTHER PRESENTED INFORMATION ON SMALL CETACEANS

Northridge presented the interim results of an ongoing bycatch monitoring scheme in UK gillnet fisheries (SC/51/SM42). Independent observers have been monitoring gillnet vessel catches in the North Sea and to the West of Scotland. A total of 3,953 hauls had been observed in gill and tangle net fisheries with seven different target species between 1995 and 1998, representing nine fishery metiers. Forty-one harbour porpoises and no other cetaceans had been recorded entangled. Using the officially recorded landings statistics for the whole fleet, the authors had allocated all recorded days at sea (the officially recorded effort unit) to one of the nine metiers on the basis of the recorded fish species landed. The authors had then generated estimates of total bycatch in each of the observed metiers by extrapolating from observed bycatches per haul. Total harbour porpoise bycatch estimates for the North Sea ranged from 768 (95% CI 619-1,392) to 582 (95% CI 483-1,027) for 1995-1997, and 165 (95% CI 82-365) to 209 (95% CI 95-475) for the same years for the Scottish west coast.

A significant offshore freezer-netter fleet was noted, which in recent years had apparently shifted some of its fishing effort into the waters around Shetland. No observations had been made on board this fleet, which had previously worked mainly in offshore Atlantic waters.

The sub-committee welcomed the interim results of this study. Kingsley and Read both asked about the possibility of using tonnage landings as a basis for extrapolation to total catch. Bravington and Northridge pointed out that this was a less reliable indicator of fishing effort, and therefore a less useful basis for extrapolation, because catches and landings fluctuate considerably from year to year in relation to fishing effort, and because landings may be mis-reported. Recorded days at sea were thought to be a less biased index of fishing activity. The sub-committee **recommended** that the pelagic sector and the freezer-netter fleet should receive increased attention and that estimates of bycatch in the turbot fishery should also be refined.

Bjørge presented SC/51/SM7 in which the population structure of harbour porpoises in the Barents Sea and northern North Sea had been investigated using mitochondrial DNA analysis. Three putative sub-populations had been proposed, in the Barents Sea and Norwegian waters north of 67°N, Norwegian waters south of 66°N and northern UK waters. One haplotype was common in all areas, and there was no difference in molecular variance among males in the areas. Haplotype frequencies among females showed significant differences when UK animals were compared to Barents Sea animals, and also when UK animals, excluding those from Shetland, were compared to southern Norwegian animals. These results confirm those of previous studies suggesting greater philopatry among female harbour porpoises than among males. Bjørge informed the sub-committee that further samples were currently being collected from Norwegian fishery bycatches and that genetic studies on population structure would continue.

Perrin noted that the generally clinal nature of porpoise population structure was similar to that observed in harbour seals in Alaska, and that current modelling work on harbour seal population genetics by Karen Fear might be useful in future considerations of harbour porpoise population structure. The sub-committee agreed that these results would all be useful in furthering the porpoise population modelling work that was the focus of the joint IWC-ASCOBANS working group (Annex O).

The sub-committee noted the contents of SC/51/SM16, in which the German islands of Sylt and Amrum were discussed in relation to a proposed protected area for porpoises. In the absence of the authors the sub-committee did not discuss this proposal.

Barlow introduced SC/51/O4 and SC/51/SM6, in which two Californian gillnet fisheries had been addressed. In the offshore shark and swordfish driftnet fishery about 20% of fishing effort was observed in 1998, during which year the use of pingers had been mandatory. Total bycatch mortalities were substantially reduced (to about 50 cetaceans) compared with previous years (around 200-300 cetaceans). Short-beaked common dolphins were still the most numerous species recorded in this fishery. In the inshore halibut/angel shark set net fishery harbour porpoises were the main species taken. No additional observations have been made for this fishery since 1994. New bycatch estimates were made based on estimates of previous catch rates and fishery effort data for 1997 and 1998, and additional geographical stratification had been introduced. Harbour porpoise bycatches were estimated at around 40-50 in 1997 and 1998, higher than in previous years as fishing effort had shifted into higher porpoise density areas.

The sub-committee noted estimates of small cetacean bycatch in the US pelagic longline fishery in 1992-1997 (SC/51/SM25). Annual catches of pilot whales, Risso's dolphins and bottlenose dolphins ranged from around 45 to around 580 between 1992 and 1997; many animals were released alive but injured.

The sub-committee welcomed the contribution made by SC/51/SM45 which presented data on the incidental catch of dolphins in a midwater anchovy trawl fishery in Argentina. Sixty common dolphins were reported by fishermen over a nine-year period. Over a single month of more intensive study by one vessel, common dolphin catches averaged 2.3 per day, with one catch of 20 animals in a single tow.

Van Waerebeek reported on a survey of small cetaceans in Ghana (SC/51/SM35). Six cetacean species had been recorded in the region, and surveys of four ports suggested that cetacean bycatches were widespread and frequent, with a local market for cetacean meat, at least some of which is smoked and sold on the bone. Ghanaian fisheries are extensive, with 306 landing sites and over 97,000 fishermen working just 550km of coastline. It was clear that some intentional catches of small cetaceans were occurring in driftnet fisheries in at least two sites, and it seemed that these intentional catches may have developed from pre-existing bycatches in a targeted shark or tuna fishery. None of the catches were documented and there are currently no controls or quota restrictions on the taking of small cetaceans in the region generally. Van Waerebeek also noted that although the Atlantic hump-backed dolphin was widely thought to inhabit the waters of the Gulf of Guinea, no sightings of this species had been made, and it was suggested that this might imply some local change of status over the past few decades.

The sub-committee welcomed this contribution to information on west African cetaceans and cetacean bycatch as little information was previously available. The sub-committee expressed its concern over the apparent development of yet another directed fishery for small cetaceans from a pre-existing bycatch without any accompanying controls on the level of take or assessment of the stock. This phenomenon which had previously been reported in both Peru and the Philippines clearly presents a risk of over-exploitation in the absence of any controls on the level of exploitation, and the sub-committee **recommended** that such takes be monitored and their impacts on the stocks assessed.

Continuing high levels of bycatch in Peru were also reported by Van Waerebeek (SC/51/SM17). The authors of this paper reported the remains of a minimum of 452 cetacean specimens of seven species in 25 of 30 fishing ports visited. Although cetacean hunting, harassing and killing, and trading in cetacean products, are all illegal in Peru, it is clear that hunting is continuing. There is also evidence that cetaceans are being harpooned for bait, and cetacean meat was reportedly being used both in longline and driftnet fisheries for sharks. The proportion of dusky dolphins identified in the remains of accidentally or deliberately taken cetacean carcasses had fallen yet again to 45% of the total, further suggesting the decline of this species in the area as had been suggested previously by Van Waerebeek (1994).

SC/51/SM17 also addressed cetacean bycatch in Chile where, in a more limited port survey, nine cetacean specimens of five species were identified. It was assumed that a similar pattern of bycatch utilisation was occurring here as in Peru.

The sub-committee once again commended the authors for their continued work in addressing the issue of cetacean bycatch and directed takes in this region. The sub-committee expressed its concern for the status of the stocks now being subjected to high and unregulated levels of bycatch and intentional take. As it is not possible to assess the potential impact of these catches without population size estimates, the sub-committee **recommended** that population surveys should be conducted in the region to enable such an assessment to be made.

Perry reported recent information on the directed take of Dall's porpoise in Japan (SC/51/SM46). Historically, catch levels had been below 10,000 per year until the early 1980s, when they increased to a peak of more than 40,000 in 1988. Subsequently, catches fell to around 11,000 in 1992, and thereafter rose towards the quota of 17,700 that was established in 1991 on the basis of an abundance estimate. This quota remains in place to the present time. The most recent abundance estimates come from surveys in 1989/90, which estimated a central Okhotsk Sea *truei*-stock of 217,000 and a stock of *dalli*-type porpoises in the Southern Okhotsk Sea numbering 226,000, but no corrections had been made for positive bias as a result of vessel attraction by this species. Kawahara noted, however, that in areas with mothers and calves present there may also be a negative bias as such animals move away from vessels.

SC/51/SM46 also provided some data on the age and sex composition of the catch. The proportion of mature and lactating females appears to have increased in recent years. This high proportion has been interpreted as a change in hunting strategy in the Sea of Japan whereby some vessels catch porpoises through the extended chase of mother-calf pairs because of a decreased occurrence of porpoises coming to the bow.

The sub-committee noted that changes in the fishery had occurred in recent years. It did not discuss the biological data that were presented in SC/51/SM46, but **recommended** that existing biological samples from this fishery should be worked up in accordance with the recommendations made in the 1991 Scientific Committee report, and that changes in CPUE should be examined in relation to changes in fishing power.

The sub-committee recognised that there is a lack of current data on the bycatch of this species. There are fisheries that are potentially of concern for these stocks, including the Japanese driftnet fishery that operates inside the Exclusive Economic Zone (EEZ) of Russia in the Okhotsk Sea. The sub-committee learned that Russian observers are present on Japanese driftnetters working in Russian waters and **recommended** that data on porpoise bycatch should be provided from this observer programme.

Some discussion ensued on the reported landings of Dall's porpoises by Japan. The catch in 1998 had been reported in the Japanese progress report as 11,385 whereas in the Japanese progress report for 1997 it had been 18,540. Okamoto explained that this discrepancy was solely because the reporting period had been changed from 1996 onwards, and that it was now for an August-July fishing season rather than a calendar year. Okamoto also noted that the catch of Dall's porpoise between 1 August 1997 and 31 July 1998 was 15,401.

The sub-committee reiterated its previously expressed concern for these stocks. Kawahara informed the sub-committee that the estimate of 440,000 animals had not been revised since 1991, and that population surveys had been planned last year, but that bad weather had interrupted them. Further survey work is planned for 1999. Bravington noted that the question of bias should be addressed in any future surveys.

Finally, the question of population structure was raised. Kawahara noted that two colour forms were recognised, and that survey work would be addressed to these two forms. Perrin informed the sub-committee that genetic analysis at his laboratory by Sergio Escorza had yielded results consistent with the stocks of this species recognised by the sub-committee in the past. The sub-committee welcomed this information and **recommended** that further genetic analyses should be undertaken.

The Scientific Committee has offered advice on Dall's porpoise to the Government of Japan in the past, and such advice led to very positive responses from the Government of Japan. The sub-committee expressed its hope that this process can be continued in a spirit of collaboration.

The sub-committee agreed that the issue of Dall's porpoises should be reviewed in the near future (see Item 12).

10. TAKES OF SMALL CETACEANS IN 1998

The sub-committee noted that the table of recent small cetacean catches (Appendix 2) is incomplete. In particular, it does not contain information about known or presumed high levels of bycatch in many parts of the world. The sub-committee therefore reiterated its **recommendation** of earlier years that member nations should submit full and complete information about all direct and indirect takes in their progress reports. Without such information the sub-committee is unable to carry out its work in assessing the conservation status of small cetacean populations and identifying areas of particular concern in this regard.

11. REVIEW OF PROGRESS ON PREVIOUS YEAR'S RECOMMENDATIONS

Agenda Item 8 covers the only area (vaquita conservation status) in which the sub-committee was informed of progress.

12. WORK PLAN

The sub-committee reviewed its proposed schedule of priority topics (IWC, 1999, p.218) in light of the unacceptably high workload it had undertaken at these 1999 meetings. It agreed that the list of topics previously identified should remain unchanged, but that the second 'bycatch mitigation measures' topic should be addressed in a separate meeting (Table 4), preferably immediately before the Scientific Committee's meeting in the year 2000. It was also agreed that the 'status of freshwater cetaceans' topic scheduled for 2000 should be expanded to embrace coastal marine populations of tucuxi, Irrawaddy dolphin and finless porpoise. The species to be considered are boto, baiji, Indus and Ganges susus, tucuxi, Irrawaddy dolphin and finless porpoise. No new priority topics were added to the list for consideration in the years 2001 and later.

13. PUBLICATION OF DOCUMENTS

Martin informed the sub-committee that authors of submitted documents should contact the Scientific Editor if they wished their papers to be considered for publication in the *Journal of Cetacean Research and Management*.

14. ANY OTHER BUSINESS

Donovan introduced a preliminary proposal by the ASCOBANS Advisory Committee for a meeting and workshop to address bycatch mitigation measures with special reference to the ASCOBANS area. These would be held under the auspices of the ASCOBANS agreement. The sub-committee welcomed this proposal, noting its own recent and forthcoming work in this subject area.

15. ADOPTION OF REPORT

The report was adopted as amended on 11 May 1999.

Table 4

Schedule of priority topics.

Year	Topic	Justification
2000	Status of freshwater cetaceans	Poor conservation status and continuing threats
	Bycatch mitigation measures	Large amount of new research results
2001+	Status of Dall's porpoises	Continuing catches; lack of recent assessment
	Systematics and population structure of *Tursiops*	Large amount of new research results
	Status of ziphiids in the Southern Ocean	Lack of previous assessment
	Status of small cetaceans in the Caribbean Sea	Lack of previous assessment; continuing catches and bycatches

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Appendix 1

AGENDA

1. Election of Chairman
2. Adoption of Agenda
3. Appointment of rapporteurs
4. Review of available documents
5. Bycatch mitigation – acoustic devices
    - 5.1 Recent field trials
        - 5.1.1 Denmark
        - 5.1.2 Celtic Shelf
        - 5.1.3 South Africa
        - 5.1.4 Australia
        - 5.1.5 Gulf of Maine and Bay of Fundy
        - 5.1.6 Sweden
        - 5.1.7 New Zealand
        - 5.1.8 California
        - 5.1.9 Washington
    - 5.2 Experiences with implementation
        - 5.2.1 Gulf of Maine
        - 5.2.2 California driftnet fishery
        - 5.2.3 Other fisheries
    - 5.3 General issues concerning acoustic alarms
        - 5.3.1 Why are pingers effective?
        - 5.3.2 Habituation
        - 5.3.3 Displacement and other effects on target animals
        - 5.3.4 Effects on non-target animals
        - 5.3.5 Applicability of results for one species from one area to another
        - 5.3.6 Applicability of results from one species to another
        - 5.3.7 New technologies
        - 5.3.8 Other
    - 5.4 Conclusions and recommendations
        - 5.4.1 Scientific experiments to examine efficacy of pingers
        - 5.4.2 Implementation
            - 5.4.2.1 Use with vaquita
        - 5.4.3 Further research
6. Status of monodontid whales
    - 6.1 White whale
        - 6.1.1 Stock identity and discreteness
            - 6.1.1.1 Definition of 'stock' or management unit
            - 6.1.1.2 Contaminant comparison as a tool for stock identification
            - 6.1.1.3 Stocks
        - 6.1.2 New information on life history
        - 6.1.3 Review of current knowledge on a stock-by-stock basis
            - 6.1.3.1 Geographical range and migrations
            - 6.1.3.2 Abundance
            - 6.1.3.3 Directed takes
            - 6.1.3.4 Indirect catches
            - 6.1.3.5 Known and potential threats
            - 6.1.3.6 Status
            - 6.1.3.7 Recommendations
    - 6.2 Narwhal
        - 6.2.1 Stock identity and discreteness
        - 6.2.2 Review of current knowledge on a stock-by-stock basis
            - 6.2.2.1 Geographical range and migrations
            - 6.2.2.2 Abundance
            - 6.2.2.3 Directed takes
            - 6.2.2.4 Indirect catches
            - 6.2.2.5 Known or potential threats
            - 6.2.2.6 Status
            - 6.2.2.7 Recommendations
7. Review of progress of the IWC/ASCOBANS joint harbour porpoise Working Group
8. Review of progress of the vaquita recovery programme
9. Review of other presented information on small cetaceans
10. Takes of small cetaceans in 1998
11. Review of progress on previous year's recommendations
12. Work plan
13. Publication of documents
14. Any other business
15. Adoption of report

Appendix 2

SMALL CETACEAN CATCHES 1996-1998

Appendix 2 [Table on following pages]

Table 1

All information was taken from National Progress reports unless otherwise stated. Catches are presented by nation, rather than ocean area, except in the case of the data submitted by the IATTC for the eastern tropical Pacific (ETP). In this case, the submitted estimated catches are not broken down by country and a summed total incidental catch for the participating countries is given. The reported catch columns include catches reported by observer programmes, from interviews with fishermen and incidental reports (e.g. stranded whales determined to have died in nets). Please note that catches should be tabled according to the calendar year in which they were taken. All direct and incidental removals (including live captures) should be recorded but not stranded animals.

	1995					1996					1997					1998				
	Direct		Indirect		Live	Direct		Indirect		Live	Direct		Indirect		Live	Direct		Indirect		Live
Nation/species	Rep.	Est. total	Rep.	Est. total	Rep.	Rep.	Est. total	Rep.	Est. total	Rep.	Rep.	Est. total	Rep.	Est. total	Rep.	Rep.	Est. total	Rep.	Est. total	Rep.
Argentina																				
Franciscana	-	-	-	+[a]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dusky dolphin	-	-	-	50-100[c]	-	-	-	-	-	-	-	-	-	-	-	-	-	15[e]	-	-
Commerson's dolphin	-	-	91[b]	111[d]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peale's dolphin	-	-	1[b]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Australia																				
Bottlenose dolphin	-	-	7	-	-	-	-	3	-	-	-	-	14	-	-	-	-	3	-	-
Common dolphin (?sp.)	-	-	1	-	-	1	-	6	-	-	-	-	7	-	-	-	-	7	-	-
Irrawaddy dolphin	-	-	4	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Indo-pacific humpback	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	2	-	-
Spinner dolphin	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-
Unidentified dolphin	-	-	18-26	-	-	-	-	12	-	-	-	-	1	-	-	-	-	27	-	-
Unidentified cetacean	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-
Brazil																				
False killer whale	-	-	-	-	1[a]	-	-	1[n]	-	-	-	-	-	-	-	-	-	-	-	-
Spinner dolphin	-	-	1[j]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bottlenose dolphin	-	-	-	-	-	-	-	1[n]	-	-	-	-	1[k]	-	-	-	-	-	-	-
Common dolphin	-	-	1[b]	-	-	-	-	1[n]	-	-	-	-	1[n]	-	-	-	-	-	-	-
Franciscana	-	-	133[c]	-	-	-		33	413-624	-	-	-	58	-	-	-	-	100[o]	37[p]	3[s]
Tucuxi	2[d]	-	43[e]	-	-	2	-	27	-	-	1	-	80[l]	20-25[m]	-	-	-	7[r]	11[q]	-
Spotted dolphin	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Atlantic spotted dolphin	-	-	1[f]	-	-	-	-	1[n]	-	-	-	-	2[k]	-	-	-	-	-	-	-
Pantropical spotted dolphin	-	-	1[h]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Risso's dolphin	-	-	1[b]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rough-toothed dolphin	-	-	2[g]	-	-	-	-	2	-	-	-	-	2	-	-	-	-	-	-	-
Boto	4[d]	-	22[d]	-	-	11	-	3	-	-	-	-	-	-	-	-	-	1	-	-
Unidentified dolphins	-	-	5[i]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unidentified species	-	-	7[n]	-	-	-	-	18[n]	-	-	-	-	11[n]	-	-	-	-	-	9	-
Canada																				
Narwhal	-[a]	-	-	-	-	-[a]	-	-	-	-	-[a]	-	-	-	-	-[a]	-	-	-	-
White whale	-[a]	-	-	-	-	-[a]	-	-	-	-	-[a]	-	-	-	-	-[a]	-	-	-	-
Dall's porpoise	-	-	1[b]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Long-finned pilot whale	-	-	9[c]	-	-	-	-	6[c]	-	-	-	-	15[d]	-	-	-	-	-	-	-
Atlantic white-sided dolphin	-	-	-	-	-	-	-	1[c]	-	-	-	-	-	-	-	-	-	-	-	-
Unidentified dolphin	-	-	-	-	-	-	-	2[c]	-	-	-	-	-	-	-	-	-	-	-	-
Denmark																				
Harbour porpoise	-	-	-	7,000[a]	-	-	-	-	+	-	-	-	-	+	2	-	-	-	+	-
Unidentified species	-	-	-	+[ab]	-	-	-	-	+	-	-	-	-	+	-	-	-	-	+	-

cont.

Table 1. Continued.

Nation/species	1995 Direct Rep.	1995 Direct Est. total	1995 Indirect Rep.	1995 Indirect Est. total	1995 Live Rep.	1996 Direct Rep.	1996 Direct Est. total	1996 Indirect Rep.	1996 Indirect Est. total	1996 Live Rep.	1997 Direct Rep.	1997 Direct Est. total	1997 Indirect Rep.	1997 Indirect Est. total	1997 Live Rep.	1998 Direct Rep.	1998 Direct Est. total	1998 Indirect Rep.	1998 Indirect Est. total	1998 Live Rep.
ETP																				
Bottlenose dolphin	-	-	48[a]	48[a]	-	-	-	11[b]	11[b]	-	-	-	10[c]	10[c]	-	-	-	-	29	29
Pantropical spotted dolphin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northeastern	-	-	952[a]	952[a]	-	-	-	818[b]	818[b]	-	-	-	721[c]	721[c]	-	-	-	-	298	298
Western-southern	-	-	859[a]	859[a]	-	-	-	545[b]	545[b]	-	-	-	1,044[c]	1,044[c]	-	-	-	-	341	341
Coastal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spinner dolphin (? stock)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eastern	-	-	654[a]	654[a]	-	-	-	450[b]	450[b]	-	-	-	391[c]	391[c]	-	-	-	-	422	422
Whitebelly	-	-	445[a]	445[a]	-	-	-	447[b]	447[b]	-	-	-	498[c]	498[c]	-	-	-	-	249	249
Central	-	-	17[a]	17[a]	-	-	-	11[b]	11[b]	-	-	-	-	-	-	-	-	-	12	12
Striped dolphin	-	-	34[a]	34[a]	-	-	-	5[b]	5[b]	-	-	-	80[c]	80[c]	-	-	-	-	24	24
Common dolphin (?sp.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northern	-	-	9[a]	9[a]	-	-	-	77[b]	77[b]	-	-	-	9[c]	9[c]	-	-	-	-	261	261
Central	-	-	192[a]	192[a]	-	-	-	51[b]	51[b]	-	-	-	114[c]	114[c]	-	-	-	-	172	172
Southern	-	-	-	-	-	-	-	30[b]	30[b]	-	-	-	58[c]	58[c]	-	-	-	-	33	33
Rough-toothed dolphin	-	-	2[a]	2[a]	-	-	-	-	-	-	-	-	20[c]	20[c]	-	-	-	-	-	-
Risso's dolphin	-	-	1[a]	1[a]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Short-finned pilot whale	-	-	-	-	-	-	-	-	-	-	-	-	5[c]	5[c]	-	-	-	-	-	-
Pygmy sperm whale	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Unspecified dolphins	-	-	61[a]	61[a]	-	-	-	102[b]	102[b]	-	-	-	55[c]	55[c]	-	-	-	-	35	35
Faroes																				
Long-finned pilot whale	228[a]	-	-	-	-	1,524[b]	-	-	-	-	1,162[c]	-	-	-	-	-[d]	-	-	-	-
Atlantic white-sided dolphin	151[a]	-	-	-	-	152[b]	-	-	-	-	350[c]	-	-	-	-	-[d]	-	-	-	-
Bottlenose dolphin	-	-	-	-	-	21[b]	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harbour porpoise	-	-	-	-	-	3[b]	-	-	-	-	-	-	-	-	-	-	-	-	-	-
France																				
Long-finned pilot whale	-	-	2[a]	-	-	-	-	2[a]	-	-	-	-	3[a]	-	-	-	-	1[a]	-	-
Bottlenose dolphin	-	-	4[a]	-	-	-	-	1[a]	-	-	-	-	5[a]	-	-	-	-	7[a]	-	-
Striped dolphin	-	-	1[a]	-	-	-	-	7[a]	-	-	-	-	12[a]	-	-	-	-	17[a]	-	-
Common dolphin (?sp.)	-	-	9[a]	-	-	-	-	16[a]	-	-	-	-	205[a]	-	-	-	-	19[a]	-	-
Atlantic white-sided dolphin	-	-	-	-	-	-	-	-	-	-	-	-	1[a]	-	-	-	-	-	-	-
Risso's dolphin	-	-	-	-	-	-	-	-	-	-	-	-	2[a]	-	-	-	-	2[a]	-	-
Common porpoise	-	-	-	-	-	-	-	-	-	-	-	-	9[a]	-	-	-	-	1[a]	-	-
Unidentified dolphin	-	-	2	-	-	-	-	5[a]	-	-	-	-	87[a]	-	-	-	-	2[a]	-	-
Unid./other cetacean	-	-	-	-	-	-	-	1[a]	-	-	-	-	-	-	-	-	-	-	-	-
Germany																				
Harbour porpoise	-	-	8	-	-	-	-	6	-	-	-	-	4	-	-	-	-	5	-	-
Long-finned pilot whale	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-
White-beaked dolphin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Greenland																				
Narwhal	461[a]	-	-	-	-	-[b]	-	-	-	-	-[b]	-	-	-	-	-[b]	-	-	-	-
White whale	606[a]	-	-	-	-	-[b]	-	-	-	-	-[b]	-	-	-	-	-[b]	-	-	-	-
Harbour porpoise	1,135[a]	-	-	-	-	-[b]	-	-	-	-	-[b]	-	-	-	-	-[b]	-	-	-	-

cont.

Table 1. Continued.

	1995					1996					1997					1998				
	Direct		Indirect		Live	Direct		Indirect		Live	Direct		Indirect		Live	Direct		Indirect		Live
Nation/species	Rep.	Est. total	Rep.	Est. total	Rep.	Rep.	Est. total	Rep.	Est. total	Rep.	Rep.	Est. total	Rep.	Est. total	Rep.	Rep.	Est. total	Rep.	Est. total	Rep.
Ireland																				
Common dolphin	-	-	-	-	-	-	-	170	345	-	-	-	1[a]	-	-	-	-	14[c]	-	-
Harbour porpoise	-	-	1	-	-	-	-	2[a]	-	-	-	-	3[b]	-	-	-	-	2[a]	-	-
White-sided dolphin	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1[a]	-	-
Striped dolphin	-	-	-	-	-	-	-	65	134	-	-	-	-	-	-	-	-	14	-	-
Bottlenose dolphin	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
Pilot whale	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-
Risso's dolphin	-	-	-	-	-	-	-	1	-	-	-	-	1[a]	-	-	-	-	-	-	-
Unidentified dolphin	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-
Italy																				
Striped dolphin	+	-	+	-	-	+	-	-	+	-	+	-	+	-	-	-[a]	-	-[a]	-	-
Bottlenose dolphin	+	-	+	-	-	+	-	-	+	-	+	-	+	-	-	-[a]	-	-[a]	-	-
Common dolphin	+	-	+	-	-	+	-	-	+	-	+	-	+	-	-	-[a]	-	-[a]	-	-
Japan																				
Baird's beaked whale	54	-	-	-	-	54	-	-	-	-	54	-	-	-	-	54	-	-	-	-
Killer whale	-	-	-	-	-	-	-	-	-	-	1	-	-	-	5	-	-	-	-	-
False killer whale	43	-	-	-	6	35	-	-	-	5	28	-	-	-	15	45	-	-	-	3
Short-finned pilot whale[a]	238	-	1	-	1	482	-	-	-	2	347	-	-	-	-	229	-	-	-	-
Pacific white-sided dolphin	-	-	-	-	2	-	-	2	-	19	-	-	-	-	-	-	-	1	-	-
Bottlenose dolphin	890	-	-	-	85	280	-	-	-	34	299	-	-	-	53	245	-	-	-	21
Pantropical spotted dolphin	105	-	-	-	-	67	-	-	-	-	23	-	-	-	-	460	-	-	-	-
Striped dolphin	537	-	80	-	2	303	-	-	-	-	602	-	-	-	-	449	-	2	-	-
Short-beaked common d.	-	-	2	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
Risso's dolphin	405	-	7	-	-	369	-	5	-	3	228	-	14	-	-	442	-	-	-	3
Dall's porpoise	12,396	-	-	-	-	16,100	-	2	-	-	18,540	-	1	-	-	11,385	-	2	-	-
Finless porpoise	-	-	7	-	-	-	-	3	-	-	-	-	1	-	-	-	-	6	-	1
Unidentified dolphin	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unidentified species	-	-	-	-	-	-	-	4	-	-	-	-	3	-	-	-	-	-	-	-
Korea																				
Baird's beaked whale	-	-	-	-	-	-	-	-	-	-	-	-	1[af]	-	-	-	-	-	-	-
Killer whale	-	-	-	-	-	-	-	1[ao]	-	-	-	-	-	-	-	-	-	-	-	-
Short-finned pilot whale	-	-	-	-	-	-	-	-	-	-	-	-	2[ag]	-	-	-	-	-	-	-
Pacific white-sided dolphin	-	-	-	-	-	-	-	32[ab]	-	-	-	-	2[ah]	-	-	-	-	7[kl]	-	-
Common dolphin	-	-	-	-	-	-	-	13[ac]	-	-	-	-	71[ai]	-	-	-	-	18[km]	-	-
Risso's dolphin	-	-	-	-	-	-	-	45[ad]	-	-	-	-	2[j]	-	-	-	-	7[en]	-	-
Harbour porpoise	-	-	-	-	-	-	-	1[ae]	-	-	-	-	-	-	-	-	-	-	-	-
Finless porpoise	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2[ek]	-	-
Mexico[a]																				
Vaquita	-	-	0[c]	-	-	-	-	-	-	-	-	-	1[e]	-	-	-	-	-	-	-
Bottlenose dolphin	-	-	-	-	12[b]	-	-	-	-	12[d]	-	-	-	-	10[d]	-	-	-	-	4[b]
Netherlands																				
Long-finned pilot whale	-	-	-	-	-	-	-	16	-	-	-	-	1	-	-	-	-	-	-	-
Atlantic white-sided dolphin	-	-	10	-	-	-	-	27	-	-	-	-	43	-	-	-	-	29	-	-
Common dolphin (?sp.)	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
Harbour porpoise	-	-	1	-	-	-	-	-	-	-	-	-	4	-	-	-	-	4	-	-
Unidentified dolphins	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-

cont.

Table 1 Continued.

Nation/species	1995 Direct Rep.	1995 Direct Est. total	1995 Indirect Rep.	1995 Indirect Est. total	1995 Live Rep.	1996 Direct Rep.	1996 Direct Est. total	1996 Indirect Rep.	1996 Indirect Est. total	1996 Live Rep.	1997 Direct Rep.	1997 Direct Est. total	1997 Indirect Rep.	1997 Indirect Est. total	1997 Live Rep.	1998 Direct Rep.	1998 Direct Est. total	1998 Indirect Rep.	1998 Indirect Est. total	1998 Live Rep.
New Zealand																				
Long-finned pilot whale	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1[b]	-	-
Bottlenose dolphin	-	-	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Common dolphin (?sp.)	-	-	-	-	-	-	-	2[a]	-	-	-	-	4	-	-	-	-	-	-	-
Hector's dolphin	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	14	-	-
Dusky dolphin	-	-	-	-	-	-	-	1[a]	-	-	-	-	1	-	-	-	-	1	-	-
Unidentified dolphin	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Peru																				
Dusky dolphin	-	-	62[m]	-	-	-	-	-	-	-	-	-	-	-	-	7[g]	-	-	-	-
Long-beaked common d.	-	-	22[n]	-	-	-	-	-	-	-	-	-	-	-	-	23[h]	-	-	-	-
Common dolphin	-	-	4[o]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Common dolphin (?sp.)	-	-	8[p]	-	-	-	-	1[a]	-	-	-	-	-	-	-	1[I]	-	-	-	-
Bottlenose dolphin	-	-	16[q]	-	-	-	-	1[b]	-	-	-	-	-	-	-	1[j]	-	-	-	-
Burmeister's porpoise	-	-	100[r]	-	-	-	-	12[cd]	-	-	-	-	8[f]	-	-	16[k]	-	1[v]	-	-
Cuvier's beaked whale	-	-	1[s]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lesser beaked whale	1[u]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unspecified species	-	-	38[t]	-	-	-	-	1[e]	-	-	-	-	-	-	-	7[l]	-	-	-	-
South Africa																				
Bottlenose dolphin	-	-	59[c]	-	-	-	-	62[a]	-	-	-	-	50[fg]	-	-	-	-	28	-	-
Common dolphin (?sp.)	-	-	26[d]	-	-	-	-	32[a]	-	-	-	-	90[fg]	-	-	-	-	7	-	-
Indo-Pacific humpbacked d.	-	-	9[a]	-	-	-	-	4[e]	-	-	-	-	7[fg]	-	-	-	-	8	-	-
Heaviside's dolphin	-	-	1[b]	-	-	-	-	-	-	-	-	-	2[fh]	-	-	-	-	-	-	-
Risso's dolphin	-	-	-	-	-	-	-	1[a]	-	-	-	-	-	-	-	-	-	-	-	-
Spinner dolphin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Unidentified dolphins	-	-	-	-	-	-	-	1[a]	-	-	-	-	-	-	-	-	-	1	-	-
Spain																				
Common dolphin (?sp.)	-	-	1	-	-	-	-	3	-	-	-	-	3	-	-	-	-	-	-	-
Cuvier's beaked whale	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
False killer whale	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harbour porpoise	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bottlenose dolphin	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Clymene dolphin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Unidentified dolphin	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	5	-	-
Sweden																				
Harbour porpoise	-	-	11[a]	53[a]	-	-	-	17[b]	113[c]	-	-	-	8[d]	-	-	-	-	14	-	-
UK																				
White-beaked dolphin	-	-	2[b]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Striped dolphin	-	-	29[a]	104[e]	-	-	-	-	-	-	-	-	-	-	-	-	-	1[h]	-	-
Common dolphin (?sp.)	-	-	19[d]	61[e]	-	-	-	-	-	-	-	-	6[b]	-	-	-	-	5[h]	-	-
Risso's dolphin	-	-	1[c]	-	-	-	-	2[c]	-	-	-	-	-	-	-	-	-	-	-	-
Harbour porpoise	-	-	19[b]	933[j]	-	-	-	11[f]	752[j]	-	-	-	41[g]	791[j]	-	-	-	33[i]	-	-
White-sided dolphin	-	-	-	-	-	-	-	-	-	-	-	-	2[c]	-	-	-	-	-	-	-
Bottlenose dolphin	-	-	-	-	-	-	-	-	-	-	-	-	1[c]	-	-	-	-	-	-	-

cont.

Table 1 Continued.

Nation/species	1995					1996					1997					1998				
	Direct		Indirect		Live	Direct		Indirect		Live	Direct		Indirect		Live	Direct		Indirect		Live
	Rep.	Est. total	Rep.	Est. total	Rep.	Rep.	Est. total	Rep.	Est. total	Rep.	Rep.	Est. total	Rep.	Est. total	Rep.	Rep.	Est. total	Rep.	Est. total	Rep.
USA																				
White whale	-	229[k]	-	-	-	-	411-460[l]	-	-	-	-	341-351[m]	-	-	-	-	366[w]	-	-	-
Killer whale	-	-	1	6	-	-	-	-	-	-	-	-	1	2	-	-	-	1	1	-
Dwarf sperm whale	-	-	1[b]	1[b]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Long-finned pilot whale	-	-	21[c]	31[c]	-	-	-	8[cu]	11[cu]	-	-	-	1[p]	93[p]	-	-	-	-	-	-
Short-finned pilot whale	-	-	-	-	-	-	-	-	-	-	-	-	1[n]	6[n]	-	-	-	-	-	-
Pacific white-sided dolphin	-	-	1	6	-	-	-	3[j]	25[j]	-	-	-	3[n]	11[n]	-	-	-	1	1	-
Atlantic white-sided dolphin	-	-	2[h]	80[h]	-	-	-	2	114	-	-	-	5[q]	314[q]	-	-	-	-	-	-
Bottlenose dolphin	-	-	14[f]	22[f]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Striped dolphin	-	-	2[e]	2[e]	-	-	-	7[v]	10[v]	-	-	-	-	-	-	-	-	-	-	-
Short-beaked common d.	-	-	36	231	-	-	-	27[j]	319[j]	-	-	-	18[n]	90[n]	-	-	-	-	-	-
Long-beaked common d.	-	-	6	39	-	-	-	1[j]	12[j]	-	-	-	4[n]	24[n]	-	-	-	-	-	-
Common dolphin (sp.)	-	-	87[d]	312.4[d]	-	-	-	80[r]	1,195[r]	-	-	-	7[s]	281[s]	-	-	-	9	9	-
Spotted dolphin	-	-	-	-	-	-	-	2[b]	2[b]	-	-	-								
Northern right whale dolphin	-	-	15	58	-	-	-	5[j]	27[j]	-	-	-	5[n]	25[n]	-	-	-	-	-	-
Risso's dolphin	-	-	14[g]	47[g]	-	-	-	1[x]	25[x]	-	-	-	3[n]	8[n]	-	-	-	-	-	-
Harbour porpoise	-	-	69[a]	1,537[a]	-	-	-	100[t]	1,540[t]	-	-	-	129[o]	1,622[o]	-	-	-	1	2	-
Dall's porpoise	-	-	41	131	-	-	-	2[j]	24[j]	-	-	-	4[n]	17[n]	-	-	-	7	9	-
Beaked whales	-	-	9[b]	9.1[b]	-	-	-	8[b]	13[b]	-	-	-	-	-	-	-	-	-	-	-
Unidentified species	-	-	9[i]	9[i]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Argentina: (a) SC/46/SM25 estimate, Southern Buenos Aires province. Not monitored in 1995 but the estimated effort and catch are probably similar to 1993. (b) Shore-based robalo nets in Tierra del Fuego (Goodall, unpublished). (c) 0 estimated catch in midwater trawling fishery off Patagonia (SC/48/SM22) + 50-100 from other trawls off Patagonia (Crespo, unpublished). (d) 111 from shore-based robalo nets in Tierra del Fuego (Goodall, unpublished) + 0 from midwater trawls off Patagonia (Crespo, unpublished). (e) 5 caught by FV *Humpback* and 10 caught by FV *Harengus* (2 Apr. 1998 - 13 Apr. 1998) (SC/51/SM45).

Brazil: Note: all the information for the 1995, 1996, 1997 and 1998 catches was taken from the revised Brazilian Progress Reports except for the 44 strandings of franciscana in Southern Brazil (M.C. Pinedo, pers. comm. 1995), 1 common dolphin (E. Secchi, pers. comm. 1995) and the 12 franciscana and 4 tucuxi caught on Northern RJ State (A.P. Beneditto and R. Ramos, pers. comm. 1998).

(a) Caught in a monofilament longline set for tuna and swordfish fisheries in southeastern and southern Brazil (Secchi and Dalla Rosa, unpublished data). (b) Caught in Rio Grande do Sul State coast (E. Secchi, pers. comm.). (c) 10 from Rio Grande port by about 20% of the total coastal gillnet fleet + 4 caught in gillnets set for gadids & sciaenids from northern Rio Grande (May 1995 - April 1996) + 40 caught in gillnets in northern Rio Grande (May 1995 - April 1996) + 1 caught in fishing nets in Pontal do Sul, Paraná + 22 caught in Rio de Janeiro + 12 caught in Cabo de Santa Marta, Santa Catarina State (4 observed + 8 reported by fishermen) + 44 strandings from a long-term monitoring programme in southern Brazil, assumed to be caught in gillnets (M.C. Pinedo). (d) Caught in the Mamirauá system. (e) 8 caught in fishing nets in Pontal do Sul, Paraná + 9 caught in Rio de Janeiro + 2 strandings, 1 with net marks and another with knife cuts + 8 taken in fishing nets + 16 in the Mamirauá system. (f) Stranded with net marks on the body. (g) Taken in fishing nets. (h) Caught in Cabo de Santa Marta, Santa Catarina State. (i) 4 from Rio de Janeiro + 1. (j) Taken off the coast of Rio Grande do Sul (SC/49/SM7). (k) Captured by boats operating from Ubatuba (SC/49/SM7). (l) Northeast 7,Southern/SC 6, Southern/PR 16, Southeast/BA 3, Amazon 36, Rio de Janeiro (UENF) 12. (m) Southern/SC. (n) Caught in Rio de Janeiro (UENF). (o) 17 from Southern (north RS) + 61 from Southern (south RS) + 6 from SW Atlantic + 4 from Praia Grande, SP State + 12 from North of RJ State. (A.P. Beneditto and R. Ramos, pers. comm.). (p) 4 from Praia Grande, SP State + 6 from SW Atlantic + 12 from Northern RJ State (A.P. Beneditto and R. Ramos, pers. comm.) + 15 from Northern Rio Grande do Sol. (q) 3 from SW Atlantic + 8 from Northern RJ State. (r) 3 from SW Atlantic + 4 from Northern RJ State (A.P. Beneditto and R. Ramos, pers. comm.). (s) from Praia Grande, SP State.

Canada: (a) No information. (b) SC/48/O2. (c) SC/49/O5. (d) Incidentally bycaught in bottom trawls off Nova Scotia (Hooker, S.K., Baird, R.W. and Showell, M.A., unpublished).

Denmark: (a) ASCOBANS Annual National Report 1998. Estimate of bycatch in the set-net fishery mainly in late summer and fall. Turbot fishery has declined within the last years. (b) A few other species, exact number and species unknown.

ETP: (a) SC/48/SM4. (b) SC/49/SM4. (c) Annual Report of the Inter-American Tropical Tuna Commission 1997.

Faroes: (a) NAMMCO Annual Report 1996: Faroe Islands Progress Report 1995. (b) NAMMCO Annual Report 1997: Faroe Islands Progress Report 1996. (c) NAMMCO Annual Report 1998: Faroe Islands Progress Report 1997. (d) No information.

France: (a) Includes those found stranded with marks indicating that they had been most probably caught in fishing gear. Data are provided by the CRMM-La Rochelle, France (A. Collet, pers. comm.).

Greenland: (a) NAMMCO Annual Report 1997: Greenland Progress Report 1995. (b) No information.

Ireland: (a) Bycatch determined from post-mortems. (b) bycatch of 2 determined from post-mortem + 1 incidentally caught. (c) Bycatch of 1 determined from post-mortem + 13 incidentally caught in surface gillnet.

Italy: (a) Centro Studi Cetacei della Societa Italiana di Scienze Naturali 1998 report in preparation.

Japan: (a) Northern & Southern forms.

Korea: (a) Kyeong-Buk area. (b) Figures composed as follows: 19 coastal drift gillnet, 9 set-net, 3 coastal trap, 1 coastal gillnet. (c) Figures composed as follows: 10 set-net, 3 coastal drift gillnet. (d) Figures composed as follows: 44 set-net, 1 offshore angling. (e) Set-net. (f) Coastal drift gillnet. (g) Drift gillnet. (h) Figures composed as follows: 1 coastal trap, 1 coastal gillnet. (i) Figures composed as follows: 48 set-net, 9 coastal trap, 8 coastal drift gillnet, 3 offshore drift gillnet, 1 coastal gillnet, 1 drift gillnet, 1 coastal longline. (j) Figures composed as follows: Kyeong-Nam area 1 set-net, Kang-Won area 1 gillnet. (k) East sea. (l) Figure composed as follows: 4 set-net, 2 gillnet, 1 drift gillnet. (m) Figure composed as follows: 9 set-net, 7 gillnet, 1 drift gillnet, 1 trap net. (n) South sea. (o) Coastal trap.

Mexico: (a) see the ETP table for catches taken in the Eastern Tropical Pacific. They are not included here. (b) permits issued by SEMARNAP. The animals are being kept in captivity at recreational facilities. (c) Two out of three main fishing towns in the Upper Gulf of California (Puerto Peñasco, Sonora and San Felipe, Baja California) were monitored during December, observing 122 gillnet settings. Fishing activities in the Upper Gulf of California were not monitored during other months. Besides, there were no other reports from other field researchers working in the area. (d) Animals live captured at locations in the Gulf of California under permits issued by SEMARNAP. They are being kept in captivity at recreational facilities. (e) Captured in the Gulf of California.

New Zealand: (a) M. Donoghue, pers. comm. (b) R.G. Johnston, pers. comm.

Peru: Note: figures are taken from SC/51/SM17 and are a mixture of direct and incidental catches. All catches have been tabled as incidental because it is not clear which were direct and which were incidental.

Salaverry (monitoring period 3-12 Dec. 1996). (b) Chimbote. (c) Salaverry - 3 fresh heads + Pucusana - 1 fresh blubber remains, found on Naplo beach. (d) San Jose - 2 caught - in unspecified gillnet (monitoring period 7-14 Oct. 1996) + Salaverry - 2 caught (monitoring period 3-12 Dec. 1996) + 2 reportedly taken in seiners + 1 apparently caught in seiners + 1 caught + Cerro Azul - 1 caught - inshore gillnet fishery (monitoring period 15-23 Jan. 1996). (e) Cerro Azul – fisherman told observer, animals not seen; unidentified may be Dusky dolphin (monitoring period 15-23 Jan. 1996). (f) Salaverrry - collected during sealion census 15-28 Feb. 1997 (5 were fresh heads). (g) Salaverry - 4 heads, and skulls/calvaria + Chimbote - 1 head + San Andres - 2 butchered. (h) Salaverry - 19 heads, and skulls/calvaria + Chimbote - 2 heads + Pucusana - 1 head, backbone & viscera on beach; young animal + 1 head found on beach; young animal. (i) Chimbote - relatively fresh head found on beach close to fishmarket. (j) Pucusana - Entire but cut specimen found on Naplo beach. (k) Salaverry- 9 heads, and skulls/calvaria + Chimbote - 4 relatively fresh heads found on beach close to fishmarket + 3 heads. (l) Chimbote – 2 + Pucusana – 1 freshly cut stomach of an unidentified small cetacean washed ashore on Naplo beach + 1 blubber of an unidentified cetacean + 1 blubber of an unidentified cetacean seen on Naplo beach + San Andres - 2. (m) Chancay 41 + Pucusana 3 + Cerro Azul 16 + Laguna Grande 1+ Salaverry 1. (n) Chancay 6 + Matacaballo2 + Parachique 1 + Bayovar 7 + San Jose 3 + Pimental 1 + Santa Rosa 1 + Salaverry 1. (o) Zorritos 1 + Talara 2 + Bayovar 1. (p) Mancora 1 + Constante 1 + Bayovar 1 + San Jose 1 + Salaverry 4. (q) Chancay 4 + Pucusana 2 + Cerro Azul 5 + San Andres 1 + Talara 2 + Bayovar 2. (r) Chancay 21 + Pucusana 1 + San Andres 3 + Constante 10 + Bayovar 19 + San Jose 8 + Pacasmayo 1 + Salaverry 27 + Chimbote 10. (s) Mancora. (t) Chancay 16 + Cerro Azul 10 + Zorritos 1 + Constante 2 + Bayovar 3 + Salaverry 8. (u) Playa Choros, IV R – beach pick-up; evidence in bone of two gunshots through head. (v) Port Punta de Choros IV R – carcass (II) with net marks butchered openly on wharf; meat reportedly used for human consumption.

South Africa: (a) Annual catch of small cetaceans in shark nets (SC/49/SM34). (b) fishery-related mortalities (excluding live-fishery) (SC/49/SM34). (c) Figure composed as follows: 57 in shark nets + 2 fishery-related mortalities (SC/49/SM34). (d) Figure composed as follows: 25 in shark nets + 1 fishery-related mortality (SC/49/SM34). (e) Figures composed as follows: 3 in shark nets + 1 fishery-related mortality (SC/49/SM34). (f) P. Best, pers. comm. (g) Caught in shark nets. (h) Died in research trawl.

Sweden: (a) Bycatch in the Swedish codfish gillnet fishery in ICES area 4456 (SC/48/SM25). Reported catch taken during a total of 95 observer days at sea. (b) The bycatch observer schemes reported 6 harbour porpoises in the Skagerrak Sea and 8 in the Kattegat Sea. An additional 3 animals were collected in the Skagerrak Sea from the driftnet fishery during the satellite telemetry study. (c) Estimate for bycatch in the Swedish Skaggerak Sea cod fish gillnet fishery based on observer scheme data. (d) 2 bycaught in Skagerrak Sea mackerel driftnets + 5 bycaught in Skagerrak Sea bottom set gillnets + 1 bycaught in Baltic Sea bottom set gillnet.

UK: (a) Bycatch from Biscay driftnets. (b) Bycatch determined from strandings post-mortems (England and Wales). (c) Bycatch determined from strandings post-mortems (Scotland). (d) Figure composed of: 17 observed bycatch from Biscay driftnets + 2 determined from strandings post-mortems (England and Wales). (e) Estimate of bycatch from Biscay driftnets. From observation of 28% of effort for Biscay driftnets only (observed bycatch 17). (f) Figure composed of: 3 from bottom-set gillnets + 8 determined from strandings post-mortems (7 from England and Wales + 1 from Scotland). (g) Figure composed of: 25 from bottom set gillnets + 16 determined from strandings post-mortems (12 from England and Wales + 4 from Scotland). (h) bycatch diagnosed at necropsy (England and Wales). (i) Figure composed of: 20 from gillnets, 12 unknown but diagnosed at necropsy, 1 reported to SWF in Shetland (2 from Scotland, 30 from England and Wales + 1 from Shetland). (j) SC/51/SM42.

USA: Note: figures for the years 1995-1996 were compiled by Janeen Quintal (except for the white whale figures). The reported catch columns include catches reported by observer programmes, from interviews with fishermen and incidental reports (e.g. stranded animals determined to have died in nets). There are no live captures to report. All information is taken from published USA National Marine Fisheries Service Annual Marine Mammal Stock Assessment Reports unless otherwise indicated. Stranded animals are not included. The 1997 information was taken from National Progress reports unless otherwise stated.

In the following notes the estimated catch is given, followed by observed catch in brackets.

(a) Figure composed as follows: 1,400(43) in New England sink gillnet + 14(0) in California halibut set gillnet + 20(20) in N. Washington marine set gillnet + 103 (6) in Mid-Atlantic coast sink gillnet. (b) New England pelagic drift gillnet. (c) may include some short-finned pilot whales; Atlantic swordfish gillnet and pair trawl fisheries. (d) figure composed as follows: 163 (82) in New England pelagic drift gillnet + 142(3) in N. Atlantic bottom trawl + 7.4 (2) in Mid-Atlantic coastal gillnet. (e) New England pelagic drift gillnet. (f) Figure composed as follows: 5(5) in New England pelagic drift gillnet + 17 (9) in New England pelagic pair trawl. (g) Figure composed as follows: 6(6) in New England pelagic drift gillnet + 2 (2) in New England pelagic pair trawl + 39 (6) in California shark/swordfish drift gillnet. (h) New England groundfish sink gillnet. (i) New England pelagic drift gillnet. (j) California swordfish/shark drift gillnet fishery (SC/49/SM2). (k) K.J. Frost 1999. Harvest report: statewide summary for western Alaska beluga stocks, 1994/98. Report 99-1, Alaska Beluga Whale Committee; Cook Inlet figures - Hill & DeMaster 1998. Alaska Marine Mammal Stock Assessments, 1998. NOAA Technical Memorandum NMFS-AFSC-97. Includes 38 struck and lost. (l) K.J. Frost 1999. Harvest report: statewide summary for western Alaska beluga stocks, 1994/98. Report 99-1, Alaska Beluga Whale Committee; Cook Inlet figures - Hill and DeMaster, 1998. Alaska Marine Mammal Stock Assessments, 1998. NOAA Technical Memorandum NMFS-AFSC-97. Includes 96-145 struck and lost. (m) K.J. Frost, 1999. Harvest report: statewide summary for western Alaska beluga stocks, 1994/98. Report 99-1, Alaska Beluga Whale Committee; Cook Inlet figures (DeMaster, pers. comm.). Includes 100-105 struck and lost (35-40 estimated for Cook Inlet). (n) California drift gillnet. SC/50/SM2. (o) Figure composed as follows: 50(50) California halibut/angel shark set-net. (This fishery has not been observed since Jul. 1994; consequently estimates of harbour porpoise were based on observations during the period Jul. 1990-Jul. 1994. Using mean-per-unit estimation, an estimated 50 harbour porpoise were killed in this fishery during 3,215 effort days in 1997) + 1,000 (47) NE multispecies sink gillnet + 572 (32) mid-Atlantic coastal sink gillnet. (p) N. Atlantic otter trawl. (q) figure composed as follows: 153 (4) from NE multispecies sink gillnet + 161 (1) Atlantic squid, mackerel, butterfish trawl. (r) Figure composed as follows: 106 (74) NE pelagic drift gillnet + 43 (2) mid-Atlantic coastal sink gillnet + 63 (1) NE multispecies sink gillnet + 940 (3) Atlantic squid, mackerel, butterfish trawl. (s) figure composed as follows: 11(3) California drift gillnet. (SC/50/SM2), + 16(2) mid-Atlantic coastal gillnet + 161(1) Atlantic squid, mackerel, butterfish trawl + 93(1) N. Atlantic bottom trawl. (t) figure composed as follows: 1,200 (52) NE multispecies sink gillnet + 311 (19) mid-Atlantic coastal sink gillnet and 29(29) N. Washington set gillnet fishery. (u) Western North Atlantic figure composed as follows: 11 (7) pelagic drift gillnet + (1) squid, mackerel, butterfish. (SC51\ProgRepUSA). (v) Western North Atlantic pelagic drift gillnet. (SC/51/ProgRep USA) (w) K.J. Frost 1999. Harvest report: statewide summary for western Alaska beluga stocks, 1994/98. Report 99-1, Alaska Beluga Whale Committee; Cook Inlet figures (DeMaster, pers. comm.). Includes 39 struck and lost (except Cook Inlet, where no data were available). (x) Bycatch in the US Atlantic longline fishery - Gulf of Mexico (SC/51/SM25).