Report of the Scientific Committee

The Committee met in the Aberdeen Exhibition and Conference Centre, Aberdeen, from 5–17 June 1996 under the Chairmanship of Dr S. Reilly. A list of participants is given in Annex A.

1. CHAIRMAN'S WELCOME AND OPENING REMARKS

Reilly welcomed the participants to the meeting. The meeting observed a period of silence in memory of Dr Alfred Berzin. It also sent thoughts and best wishes to Dr Steve Leatherwood,* a long-standing contributor and colleague, who is ill.

2. ADOPTION OF AGENDA

The adopted Agenda is given as Annex B. A statement on the Agenda is given as Annex S.

3. ARRANGEMENTS FOR THE MEETING

3.1 Appointment of Rapporteurs

Donovan was appointed Rapporteur, with various members of the Committee assisting as appropriate. Chairmen of sub-committees appointed rapporteurs for their meetings.

3.2 Meeting procedures and time schedule

The Committee agreed to a work schedule similar to that in previous years. This took into account comments, suggestions and procedures agreed to at earlier meetings (IWC, 1982; 1988b).

3.3 Establishment of sub-committees

Five sub-committees were established (management procedures; Southern Hemisphere baleen whales; stocks subject to aboriginal subsistence whaling; North Pacific Bryde's whales; and small cetaceans), and their reports are given as Annexes D–H, respectively. Two workshops were held prior to the meeting, one on aboriginal whaling management procedures (Annex I) and one on North Pacific minke whale trials (Annex J). A number of other working groups were established and their reports are given as Annexes or incorporated under the relevant Agenda Items.

3.4 Computing arrangements

Allison outlined the computing facilities available to the meeting. This included several personal computers, some of which were available for use by members. A difference from previous years was the lack of a link to the University of Cambridge computing system as this is no longer used.

* Editor's note: sadly Dr Leatherwood died on 25 January 1997. He will be greatly missed.

4. REVIEW OF AVAILABLE DATA, DOCUMENTS AND REPORTS

4.1 Documents submitted

The list of documents submitted is given as Annex C.

4.2 National progress reports on research

The revised guidelines for national progress reports are given in IWC, 1989b. Since then, the Committee has agreed that progress reports should also include information on the number of biopsy samples, by species and area, collected during the year (IWC, 1995a, p.53). This year the Committee agreed that information on whales killed as a result of collisions with ships or entanglement in fishing gear should be included, along with the source of data and methodology used to determine cause of death (see Annex D, Item 11). It noted that such data are already required (in considerable detail) for stocks considered under the RMP (Revised Management Procedure) (IWC, 1994b, p.44). The progress reports received this year are listed in Annex C. The Committee reaffirmed its view of their importance and again **recommends** that the Commission urges member nations to provide them following the approved guidelines.

4.3 Data collection, storage and manipulation

4.3.1 Catches and other statistical material

Table 1 lists the data which have been received by the Secretariat in the past year.

4.3.2 Progress of data coding projects

Allison reported that all available individual Southern Hemisphere catch records since 1940 had now been encoded and validated, and also that all available records for the period 1931-39 had been encoded. Work was now concentrating on validation of the 1930s data and encoding data from the 1920s. In addition, data from the 1994/95 IWC/IDCR sightings cruise had been validated and validation of the 1995/96 data had begun.

4.3.3 Progress on program verification projects

Allison reported that the standard Bayesian synthesis programs had been validated (but not the program implementing the 'backwards' method - see IWC, 1995b).

The Secretariat had completed the major task of transferring its holding from the University of Cambridge computer system (Phoenix) as this system closed in August 1995.

Progress made on the sightings database contract, including the calculation of abundance estimates from 1993/94 and 1994/95 IWC/IDCR minke sightings surveys, is reported and discussed in Items 7.3 and 9.2.3.

Table 1
List of Data and Programs received by the IWC Secretariat in 1995/96.

Received	From	IWC ref.	Contents
Catch data:			
22-4-96	Norway: N. Øien	D121	Individual catch records from the Norwegian 1995 commercial catch and corrected data on the 1994 Special Permit + commercial minke catch.
5-6-95	Japan	C	Individual catch records from the Japanese 1995 North Pacific and 1995/96 Antarctic Special Permit catch.
Sightings data:			
2-10-95	Norway: G. Hagen	D114	Dive-time data for northeastern Atlantic minke whales as used in SC/47/NA6.
19-12-96	Norway: N. Øien	D118-9	Data from the NILS-95 sightings survey distance and angle experiment.
22-4-96	Norway: N. Øien	D121	Copies of the final versions of sightings data from the 1988, 89 and 90 North Atlantic surveys.
		D122	Sightings data from the NILS-95 survey. (This supersedes older versions which were received earlier).
5-6-96	Japan: T. Miyashita	D127	Data from dedicated sightings surveys for minke whales 1993, 94 and 95. Ref. SC/48/NP7.
	Japan: S. Ohsumi	D128 rev	JARPN data 1994 and 95. (Access restricted). Ref. SC/48/NP7.
18-3-96	P. Ensor	D120	1995-96 IDCR cruise data (sightings, effort, weather and ice-edge + charts and photographic film).
16-4-96	L. Pastene	Dc126	List of individuals photographed for natural markings during 1994-95 JARPA surveys.
Programs:			
30-5-95	Norway: T. Follestad	D108rev	Programs for abundance estimation of northeastern Atlantic minke whales as used in SC/47/NA6.
15-6-95	J. Cooke	D112	Duplicate classification program used in SC/47/NA14.
28-9-95	G. Givens	D113	Updates of Bayesian synthesis programs: BAYSYN version 2.2 + BAKBAY version 2.2.
13-11-95	J. Zeh	D116	Data, programs + reports to compute Bayes empirical Bayes estimate of 1993 bowhead population size. Ref. SC/47/AS10.

4.4 Whale marking

The following national progress reports included information on natural markings: Australia; Brazil; Ireland; Germany; Japan; Mexico; New Zealand; Norway; UK; and USA. Australia and Brazil also included information on artificial marks.

5. COOPERATION WITH OTHER ORGANISATIONS

The Committee received the reports from IWC Observers attending meetings of other organisations, and information from the representatives of those organisations follows.

5.1 CMS

The 5th Meeting of the Parties of the Convention on the Conservation of Migratory Species of Wild Animals (CMS) will be held in Geneva, 10–16 April 1997. Perrin agreed to act as IWC observer.

5.1.1 ASCOBANS

Heimlich-Boran, Secretary to ASCOBANS, summarised the activities of the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS). The ASCOBANS Advisory Committee held its second meeting in Cambridge from 29 November to 1 December 1995 and made further progress in defining priority topics. An intersessional Working Group on the effects of pollutants has been established. Bycatch in fishing nets is considered to be the greatest threat facing small cetaceans in the ASCOBANS area, followed by disturbance due to human activities. A major review of present bycatch observer schemes was commissioned from the UK, with a view to establishing a standard approach for assessing bycatch (Northridge, 1996). ASCOBANS has endorsed an EC-funded project examining bycatches of porpoises in bottom-set gillnet fisheries and dolphins in driftnets (BY-CARE). The usefulness of net-markers and other deterrents in reducing cetacean bycatch has also been reviewed.

The research issues correspond to some of the topics examined by the IWC sub-committee on small cetaceans. This IWC work provides a valuable source of information relevant to the aims of ASCOBANS. It is expected that information exchange will improve as ASCOBANS becomes more firmly established.

The IWC has been invited to participate at the next Meeting of Parties for ASCOBANS, which is provisionally scheduled to be held in Bonn in late 1997.

5.1.2 ACCOBAM

The observer's report on the Negotiating Meeting for the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area is given as IWC/48/10. The meeting was held in Monaco from 26-30 September 1995. A number of disagreements remain, including the precise definition of the geographical perimeter, but some progress was made.

The Agreement will cover all cetaceans, and include habitat protection. Attention was drawn to the potential overlap with IWC's mandate, and the benefits of explicit institutional links between the two Secretariats.

The Committee thanked Briand for an informative report.

5.1.3 Project in southeast Asia

Perrin reported that the field portion of the CMS-sponsored project on distribution and abundance of cetaceans and cetacean/fish interactions in the southwestern Sulu Sea and northeastern Malaysia described in SC/48/O 31 was successfully completed. It included a 15-day demonstration survey of abundance and fishery interactions, as well as a workshop in Sabah on research techniques.

Two researchers from Malaysia and two from the Philippines will visit the Southwest Fisheries Science Center (SWFSC) in California next month for a month to collaborate on analysis of the survey data and receive training in techniques of marine mammal assessment and management.

5.2 ICES

The report of the IWC observer at the 83rd statutory meeting of the International Council for the Exploration of the Sea (ICES) is given as IWC/48/10B. The 1995 ICES Annual

Science Conference was held in Aalborg, Denmark, 21–29 September 1995. The Marine Mammals Committee (MMC) discussed priorities for research activities and the future organisation of marine mammal studies and working groups within ICES.

The MMC also discussed problems related to bycatches of marine mammals in fishing operations, and the potential for new approaches and solutions to some of these problems in a closer operation between the MMC and the expertise on fish capture and gear selectivity within ICES. After consultations with the Fish Capture Committee, it was decided to arrange a theme session on marine mammal bycatches. This will be cosponsored by the two committees and will cover gear technology, marine mammal behaviour and kill rates.

The ICES Study Group on long-finned pilot whales had been working by correspondence and the MMC noted that a final meeting was necessary before the report could be finalised.

Of particular relevance to the IWC were papers presented to the MMC on the main results of a survey for Small Cetaceans in the North Sea (SCANS), diet and food availability of northeast Atlantic minke whales, bycatch of harbour porpoise in German fisheries and cetacean trophic interactions off the northeast USA inferred from spatial and temporal codistribution patterns.

The Committee thanked Bjørge for attending the meeting on its behalf.

The Secretary referred to the wish of ICES to establish a formal link with IWC. The theme session on marine mammal bycatches will be held at the ICES Annual Science Conference, Reykjavik, 27 September–1 October 1996. Bjørge agreed to act as Observer.

5.3 IATTC

The report of the IWC observer to meetings of the Inter-American Tropical Tuna Commission (IATTC) is given as IWC/48/10D. Of most relevance to the IWC were discussions relating to the International Dolphin Conservation Program. These matters are considered further in Annex H.

The Committee thanked Tillman for attending the meetings on its behalf. He agreed to act as observer at the forthcoming meetings.

5.4 CCAMLR

The report of the IWC observer at the 14th meeting of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) is given as IWC/48/10E. Discussion at the Scientific Committee was based particularly on the reports of two major intersessional Working Groups on Ecosystem Monitoring and Management (WG-EMM) and on Fish Stock Assessment (WG-FSA).

WG-EMM had been formed from two earlier groups, on krill and ecosystem monitoring. The latter had been investigating the integration of predator, prey (krill), environmental and fisheries indices into a unified assessment and ultimately into management advice, but with some difficulty. This year, WG-EMM had agreed it could most usefully provide advice on an ecosystem assessment by combining information from dependent species (e.g. sea birds, seals) and harvested species (e.g. krill) and the environment. Such an ecosystem assessment would have two parts - analysis of the status of key ecosystem components, and prediction of the likely consequences of alternative management actions on those components' future status. The first steps were being taken towards developing a strategic model and much time had been spent reviewing current knowledge of the status of dependent and harvested species, the environment, and the links between them.

Other items discussed or reviewed at the Scientific Committee were: management under conditions of uncertainty; increases in the efficiency of the scientific observer scheme; a proposed international krill symposium; and the publication *CCAMLR Science*, now in its second year.

Matters of mutual interest raised at the meeting included: the participation of a CCAMLR krill specialist at the 1995 blue whale cruise planning meeting, to provide expertise in the context of possible evaluation of the potential competition for krill between blue whales, other baleen whales and other high level predators; participation by CCAMLR scientists in the IWC Hawaii symposium/workshop on the effects of climate change on cetaceans; on-going exchange of data between the two organisations; addition of whale sightings components to CCAMLR sponsored/coordinated field activities; exchange of information on interactions between cetaceans and fisheries; and a request for reports on the status of Antarctic whales.

Action on the request for information on the status of Antarctic stocks had been initiated by the Secretary, who had circulated a draft response to Scientific Committee members for comment. The Committee agreed that the information proposed, on Southern Hemisphere blue, humpback and minke whales, should be forwarded as indicated.

In regard to whale sightings components on CCAMLR-associated fieldwork, the CCAMLR Scientific Committee had decided that IWC should be invited to provide a document for evaluation at WG-EMM outlining the minimum effort required to undertake statistically reliable whale observations on Antarctic platforms of opportunity, as well as technical advice on the influence of active acoustics on whale behaviour and the influence that might have on the results from, or design of, combined sightings and acoustic surveys. The Secretariat had complied informally with the request by providing information to Kock for use by German scientists on the forthcoming Antarctic cruise of *R.V. Polarstern*. The Committee endorsed that response and noted that such information together with similar material prepared for the Australian Antarctic krill hydroacoustic survey (see SC/48/SH22) would form a most appropriate basis of a more formal response.

Interactions between cetaceans and fisheries, for example sperm and killer whales taking toothfish (*Dissostichus* sp), are a matter for concern to CCAMLR; any advice available on possible remedial measures would be welcomed. The CCAMLR Committee noted that killer whales are a particular problem and research into deterrent methods is likely to continue.

The Committee noted with interest the information on the proposed symposium on euphausid biology and ecology, to be held in or after mid-1997. Among a number of suggested session themes of likely interest to the Committee are: demography and life history; role in marine food chains; and distribution and abundance.

Kock (CCAMLR observer) welcomed the steps taken by the Scientific Committee in embarking on cetacean research in relation to environmental issues (Item 6). He noted that while sighting and acoustic studies had been incorporated into an Australian survey dedicated to CCAMLR work on krill and oceanographic conditions in the Indian Ocean

sector in the 1995/96 season (SC/48/SH22), a similar study on krill and oceanographic conditions in part of the CCAMLR Integrated Study Region of the Antarctic Peninsula in the 1996/97 season by Germany will include whale sighting and acoustic investigations.

CCAMLR-associated scientists participated actively in the IWC Workshop on Climate Change and Cetaceans on Hawaii in March 1996 (SC/48/Rep.2). Kock looked forward to close collaboration on matters of mutual interest, such as the incorporation of cetacean research into CCAMLR surveys and fisheries interactions with cetaceans in the Southern Ocean.

In this context, the work of the CCAMLR Working Group on Ecosystem Monitoring and Management would be of particular interest to the IWC.

The Committee welcomed these examples of continued cooperation between IWC and CCAMLR. It thanked Bannister for attending on its behalf and agreed that at the forthcoming CCAMLR Scientific Committee meeting, in Hobart in October, it should be represented by Ichii. It further noted that direct interactions with the CCAMLR Working Group on Ecosystem Monitoring and Management would be most fruitful and agreed that the Secretary should formally seek IWC Scientific Committee representation on that Working Group, and assuming a favourable response, the Chairman and Secretary would arrange for appropriate representation there.

5.5 IOC

The IWC has been invited to send an observer and make a presentation to the First Southern Ocean Forum to be held by the Intergovernmental Oceanographic Commission (IOC) in Bremerhaven, 9-13 September 1996. The Scientific Committee recognised the value of demonstrating its interest in collaborating in such activities and nominated the Secretary to attend.

5.6 NAMMCO

The observer's report on the 6th meeting of the North Atlantic Marine Mammal Commission is given as IWC/48/10H. The NAMMCO Scientific Committee stressed the need for further research concerning the role of marine mammals in the ecosystem. The Secretary reported on the contacts between the IWC and NAMMCO Secretariats.

The Committee thanked Fischer for attending the meeting.

5.7 FAO

The observer's report on the International Conference on Sustainable Contribution of Fisheries to Food Security, held by the United Nations Food and Agriculture Organisation (FAO) in Kyoto, 4–9 December 1995 is given as IWC/48/10G.

The resulting Kyoto Declaration included in its immediate actions a call to increase efforts to estimate bycatch levels, including marine mammals, in fishing operations.

The Committee thanked Gambell for attending the meeting.

5.8 UNEP

The observer's report of the Planning and Coordinating Committee (PCC) of the Marine Mammal Action Plan held in Rome, 5-7 June 1995 is given as IWC/48/10A.

A main item was discussion of a revision of the Marine Mammal Action Plan being prepared by the United Nations Environment Programme (UNEP) under contract. Further development occurred at a later meeting of the PCC held in May 1996, and UNEP proposes that direct involvement and consultation with the IWC Scientific Committee be considered once the revised text is completed by Autumn 1996.

UNEP is also supporting marine mammal programmes in the Black Sea, Southwest Atlantic and Southeast Pacific and for river dolphins in Asia and South America. In addition, UNEP has commissioned a comprehensive review of marine mammals of West Africa, and it was noted that this will be particularly useful in the proposed review of small cetaceans of West Africa planned for the 1997 Scientific Committee meeting.

The Committee thanked Gambell for attending the meeting.

5.9 Southern Ocean GLOBEC

Reference was made to a forthcoming meeting of the Southern Ocean GLOBEC (Global Ocean Ecosystem Dynamics), to which the IWC will be invited. The Committee welcomed the opportunity to extend cooperation with GLOBEC (see Item 6.1).

5.10 IUCN

A new edition of the IUCN (International Union for the Conservation of Nature and Natural Resources) Red List of globally threatened species will be published this autumn in time for the World Conservation Congress and IUCN's 20th General Assembly in Montreal in October. It is the first edition to be based on the new quantitative criteria adopted by the IUCN Council last year. The List contains a new category *Critically Endangered* to highlight the most threatened species. Two cetacean species, the vaquita (*Phocoena sinus*) and the baiji (*Lipotes vexillifer*) are in this category. IUCN's Cetacean Specialist Group has been especially active in facilitating conservation projects for the baiji, but more work is required. Some cetacean species that were previously listed as threatened have been reclassified as Low Risk in the new List. These include, for example, the bowhead whale (*Balaena mysticetus*) because of the encouraging recovery of the Beaufort/Bering Sea population. It should be emphasised that the Red List relates to the global conservation status only, and that some individual populations of species listed as Low Risk remain at dangerously low numbers.

IUCN has invited IWC to attend its World Conservation Congress, to be held in Montreal, 13-23 October 1996. Komatsu agreed to act as IWC observer.

6. ENVIRONMENTAL CONCERNS

6.1 Report of Workshop on Climate Change and Cetaceans

6.1.1 Chairman's summary

The purpose of this summary is merely to identify some of the key points in what is a thorough and extensive report. It is not intended to replace that report.

The meeting was held in Kahuku, Hawaii from 25-30 March 1996 and was preceded by a two-day symposium. It was convened by S. Reilly and chaired by A. Martin. A feature of the meeting was that it brought together Scientific Committee members and scientists from appropriate disciplines not normally represented in the Committee.

In 1993, the Commission had stated that the Scientific Committee should

> 'give priority to research on the effects of environmental changes on cetaceans in order to provide the best scientific advice for the Commission to determine appropriate response strategies to these new challenges' (IWC, 1994a).

The Committee agreed that its initial work on this issue would include the holding of two workshops: one on chemical pollution and cetaceans that was held last year (IWC, 1996a, p.55); and the one on climate change that is discussed here (SC/48/Rep2).

The main tasks of the Workshop were taken to be to determine (a) which predicted climatic changes could impact cetacean populations, and with what likelihood will they do so, (b) what would be the likely consequences of such change given current knowledge, and (c) what research would improve understanding of the consequences of climate change on cetaceans?

Before addressing these questions, the Workshop considered the results of the recently completed report of the IPCC's (Intergovernmental Panel on Climate Change, 1995a; b) second assessment of climate change. The following summarises some of the IPCC's conclusions of most relevance to the IWC.

TEMPERATURE

Global average temperature is expected to increase by 1–3.5°C by 2100. Changes in oceanic conditions will lag behind changes on the continents perhaps by about 10 years and rise as much or nearly so as the land. Global Circulation Models (GCMs) predict that greenhouse gas induced warming will be greatest at high northern latitudes. Night time and winters should warm more than the average.

Redistribution of sea surface temperature (SST) could cause geographical shifts in biota as well as changes in biodiversity and in polar regions the extinction of some species and proliferation of others. A rise in mean SST in high latitudes should increase the duration of the growing period and the productivity of these regions if light and nutrient conditions remain constant.

Warming and possible wind changes would affect the distribution and characteristics of polynyas (ice free areas) and ice edges that are vital to polar ecosystems. However, little change is forecast in Antarctic ice for 100 years.

Global warming will probably be accompanied by changes in water temperature, precipitation, winds, water and nutrient flows, water level, biogeochemistry, sedimentation, salinity, water mixing, upwelling, ice coverage and UVB radiation. Changes in amounts, structures and timing will affect ecosystem components.

SEA LEVEL RISE

Sea level is forecast to rise 15–95cm by 2100. Changes will occur from thermal expansion and melting of ice, with regional variations. Tide gauge and other information show a 10–25cm rise in sea level over the past 100 years. No acceleration in the rate of rise has been detected this century.

POLLUTANTS

Changes in the magnitude and temporal pattern of pollutant loading in the coastal ocean will occur as a result of changes in sea level, precipitation and runoff.

STABILITY

Even if greenhouse gas emissions stabilise, climate stability will not be reached for centuries, largely because of the thermal mass of the ocean.

SEA ICE

Considerable reductions in sea ice are expected. The Northwest Passage and Northern Sea Route of Russia will probably be opened up for routine shipping for 40-100 days annually.

ZONAL DIFFERENCES

ANTARTIC

Given a rate of increase in greenhouse gas concentrations of 1% CO_2 per year, GCMs predict less warming in the Antarctic over the next century than in northern polar regions. Although GCMs predict delayed warming of sea surface temperature in the Antarctic for the next 6–8 decades, after 140 years there is expected to be a marked reduction in the production of Antarctic Bottom Water and a disruption of the thermohaline circulation of the Southern Ocean.

The response of the Antarctic ice sheets, both continental and sea-level, to long-term warming is uncertain. Accumulation rates vary from the margin of the ice sheet to the interior and are very dependent on regional temperature. Sea level around the Antarctic Continent is expected to fall due to increases in accumulation (Warrick *et al.*, 1995). Seasonal production on the marginal ice edge zone (MIZ) plays an important role in the Antarctic ecosystem. Climate models at present do not have the regional resolution and predictive capabilities to project changes in ice edge dynamics.

From the perspective of highly mobile oceanic predators, such as baleen whales, changes in the distribution of krill concentrations as a result of climate change may not in themselves be a major problem. Even declines in the overall abundance of krill may not necessarily represent a problem, depending on how such declines manifest themselves in terms of the amount of krill 'available' to cetaceans. Availability will be a function of: patch area and volume density of krill within the patch; density and abundance of suitably sized patches; and the degree of habitat specialisation exhibited by cetaceans. However, there have been no Southern Ocean studies of the foraging ecology of baleen whales, or of the characteristics of patches which they exploit. It is clear that a considerable amount of research is needed with respect to the relationship between krill and baleen whales.

ARCTIC

GCMs predict that greenhouse gas induced warming will be greatest at high latitudes in the Northern Hemisphere. Associated with this warming is a reduction of the sea ice cover.

At the present rate of increase of greenhouse gases (1% CO_2 per year), average sea surface temperature is predicted to increase by 2–3°C over the northern North Pacific and North Atlantic. GCMs predict a warming of this magnitude to occur over a period of 60–80 years (Manabe *et al.*, 1991).

Given the uncertainties in the model predictions for both climate and productivity in these areas, particularly with respect to potentially dramatic changes in water circulation, it is very difficult to predict likely outcomes for cetacean populations, beyond making a number of general observations. It seems likely that changes in the distribution

of prey species will be less significant for wide ranging oceanic species than those occurring at the ice edge. Similarly, catholic feeders will be better able to cope with changes in the relative abundance of potential prey than those dependent on one prey species. Large natural variations in the distribution and abundance of cephalopod species suggests that cetaceans feeding on cephalopods may be capable of adjusting to such change arising out of climate change.

TROPICAL/WARM TEMPERATURE REGIONS

GCMs predict: less warming in low latitude waters than in high latitudes (e.g. one model predicts a 1–2°C rise in sea surface temperature after 60-80 years, Manabe *et al.*, 1991); sea level rise of the order of 0.5-1.0m by 2100 (Warrick *et al.*, 1995); and a decrease in trade wind intensity (Ittekkot *et al.*, 1995).

Sea level increases will affect coastal features (e.g. lagoons and shelf areas) and the availability of these areas to some cetacean species. Among the baleen whales, humpback and gray whales breed in such areas but may not be disadvantaged by sea level changes. For example, on a geological time scale, it was noted that there have been dramatic changes in coastal features throughout the region currently occupied by gray whales.

The direct effects of sea temperature changes will be most important in species at the limit of thermal tolerance.

COLD TEMPERATURE REGIONS

GCMs predict sea surface temperature rises of up to 2°C in the North Pacific, 0–3°C in the North Atlantic and 1–2°C in the Southern Hemisphere after 60–80 years (Manabe *et al.*, 1991).

Cold temperate regions are the feeding areas for many baleen whales and strong links between invertebrates, fish, cephalopods and cetaceans are to expected.

OTHER EFFECTS

The interplay between global climatic change, chemical pollution and pathogens was considered. There was not enough information available to report on a regional basis and therefore only broad areas of potential concern have been identified. Whilst most impacts can be expected to shift existing pollution to new areas, some climate-related perturbations will result in a general intensification of pollution problems. Associated impacts on cetaceans would be expected to be most significant in populations living near highly populated coastal areas and/or where wetlands are lost.

Separate appraisal of the impacts of environmental changes may not be sufficient to evaluate cetacean responses. It was also noted that the IWC may need to respond rapidly as new information in this developing field becomes available. Noting the potential significance of mass mortalities and emergent diseases to population dynamics and their potential role as integrators of global changes, the Committee should consider holding a workshop on this theme.

The IPCC report suggested that overfishing and diverse human stresses on the environment will probably continue to outweigh climate change impacts for several decades. Most marine organisms have rather high genetic and behavioural plasticity, making them able to adapt to constantly changing conditions and enhancing stability. Although the mix of marine species is always changing with climate, the changes forecast by IPCC would happen relatively rapidly and be long lasting. Since not all parts of an ecosystem shift at the same rate or amount, some food chain disruptions and instabilities in populations are likely.

KEY SPECIES

The Workshop identified a number of cetacean species/stocks that could be of particular concern in the context of conservation and management if predicted climate change occurred (based on three factors: low abundance; life history characters; and/or restricted range). These included: all northern right whale populations; eastern Arctic and Okhotsk Sea bowheads; western gray whales; most blue whale populations; white whales; narwhals; river dolphins; Black Sea dolphins; and the vaquita. It was also noted that all whale species/populations subject to exploitation are of special management interest to the IWC.

The Workshop also developed a list of species particularly suitable as subjects of research on the effects of climate change. It comprised minke, humpback, right, blue, bowhead, gray, killer and white whales, together with the bottlenose dolphin and harbour porpoise.

The Workshop recognised that given the uncertainties in modelling climate change at a suitable scale and thus modelling effects on biological processes, at present it is not possible to model in a predictive manner the effects of climate change on cetacean populations. Despite this, the Workshop believed that the available evidence is sufficient to warrant some general concern for cetaceans.

The Workshop developed a list of factors to be borne in mind when assessing potential research programmes.

The Workshop stressed the major difficulties in reaching the long-term goal of being able to usefully predict the effects of change on cetacean populations, given the complexities of the physical and biological processes involved. It is clear that if any progress is to be made in describing and understanding pathways such as those illustrated in Fig. 1, this must be carried out within the context of a multidisciplinary, multinational focused programme of research that concentrates on those species/areas where there is most chance of success. The Workshop **strongly recommends** that the Scientific Committee (and the Commission) consider ways to facilitate the development and execution of such research.

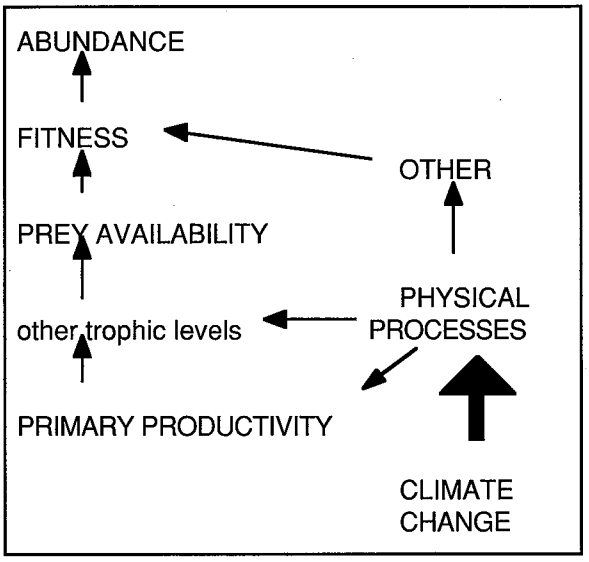

Fig. 1.

ACCOMMODATION OF IWC INTERESTS IN THE FRAMEWORK OF EXISTING PROGRAMMES

Throughout the Workshop it was apparent that any attempts to address issues relating to the effects of climate change are beyond the capacity of the IWC alone. This is well illustrated by the example in Fig. 1, in which most of the links are outside the competence of cetologists.

It is thus essential to continue to strengthen and forge links with other relevant international organisations. It is important for the IWC to emphasise that cooperation will be two-way. For example, the IWC has considerable expertise that may be of value to cooperative programmes, both in available data on past and present abundance and distribution of cetaceans as top-level predators in the ecosystems under investigation and in providing expertise and advice for further work. In this regard, the focus of current Southern Hemisphere research cruises might be reviewed in the light of cooperative studies.

It is particularly important that, where possible, the IWC becomes involved in the planning stages of cooperative programmes. It is not sufficient merely to ask that cetacean sightings be recorded. The IWC should consider developing and distributing advice on standard data collection and methodology and, where appropriate, encourage the placement of trained observers on existing surveys, taking into account the spatial and temporal aspects of the sampling.

The Workshop noted the particular relevance of the work of CCAMLR and Southern Ocean GLOBEC to its work. It **recommended** that joint CCAMLR-IWC and GLOBEC-IWC working groups be established to consider collaborative work in the Southern Ocean.

Similarly it notes the value of the SCAR/APIS (Scientific Committee on Antarctic Research/Antarctic Pack Ice Seals) programme which is investigating the role of other marine mammals in the Antarctic. A number of other SCAR programmes are of relevance to the IWC and the Workshop **recommended** that the Secretary contacts SCAR with a view to establishing formal IWC/SCAR links.

The input from the IPCC was essential to the conduct of the Workshop. The Workshop **recommended** that IPCC be contacted about the possibility of IWC input to the next series of reports.

The Workshop noted that a number of other organisations were undertaking work of potential value to the IWC. It **recommended** continued contact with such organisations and requests that they be sent copies of this report.

Many member nations of the IWC are carrying out related work under national research programmes. The Workshop **recommended** that member governments make known the interest of the IWC in such work and **recommended** that they consider contacting the IWC with a view to adding cetacean components where appropriate. The need to consult the IWC for advice on standard data collection and analytical methodology is stressed.

IMPLICATIONS FOR THE WORK OF THE SCIENTIFIC COMMITTEE

The Workshop urged that the impetus generated by its report and recommendations should not be lost and that the Scientific Committee should consider ways to ensure that this does not happen. It made a number of suggestions:

(1) that the Committee invites scientists with the relevant expertise to its regular meetings and member nations include such experts on their national delegations;
(2) the holding of a future Workshop to review progress;
(3) that a mechanism should be developed to synthesise results of the various topics included in the overall examination of effects of environmental change on cetaceans and in particular the results of the two Workshops held thus far;
(4) that consideration should be given to collection of samples and associated data from any directed takes of cetaceans under IWC regulations.

MANAGEMENT RECOMMENDATIONS

Current attempts to predict the effects of climate change on cetaceans are severely limited by the inherent uncertainties in the GCMs and other models, the mismatch of scales, the lack of knowledge of biological responses of both cetaceans and their prey and the lack of suitable models (including a guiding conceptual model of how cetaceans interact with their environment) and data for several of the many stages of the predictive process.

However, in accordance with the precautionary principles that guided the development of the RMP (which the Scientific Committee agrees has been shown to be robust to effects of environmental change – IWC, 1995a, pp58–9), the Workshop believes that the uncertainty about the effects of climatic change implicit throughout its deliberations makes it possible to suggest broad management actions that the Commission might urge its member governments to take.

(1) Whatever the detailed consequences might be at the ecosystem level, it is clear that increased UVB radiation will act in a negative manner. The Workshop therefore **recommends** that the IWC urges its member nations to abide by the provisions of the UN Protocol on Substances that Deplete the Ozone Layer (and amendments).
(2) Notwithstanding the uncertainty about the predicted effects of climate change and the rates at which these changes might occur, concerns about the ability of at least some cetacean populations to adapt to future conditions are justified. The IPCC models predict that such changes will be heightened by increasing greenhouse gas emissions. The Workshop therefore **recommends** that the IWC urges its member governments to join international efforts to reduce greenhouse gas emissions.

6.1.2 Committee Discussion

The Workshop had recognised that in order to predict the effects of climate change on cetaceans, the physical and biological processes affecting the temporal and spatial patterns of cetacean distribution and abundance must first be established. The Committee agreed to the following objectives in that context.

(1) Define how changes in the physical environment (e.g. sea surface temperature, salinity, mixed layer depth, upwelling, extent of ice cover) and the biological environment (e.g. prey availability) influence cetacean species, (a) distributions, abundance and stock structure; (b) extent and timing of migrations; (c) fitness (condition factors).
(2) Define the spatial and temporal scales of variability in the ocean most important to cetacean species.
(3) Determine which oceanographic processes in the marine ecosystem best explain interannual or longer-term changes in the geographic and temporal variability in cetacean distribution and abundance.

(4) Reduce the variance in estimating trends of cetacean distribution and abundance by quantifying the amount of variability in sighting surveys related to environmental variability.

The Committee recognised that there are numerous lines of research which could be pursued to try to meet these objectives. The following two broad approaches were proposed:

(1) an ecosystems approach which examines physical-biological processes related to the availability of cetacean prey (e.g. the approach taken by CCAMLR; Southern-Ocean GLOBEC) – only by identifying the scales and processes important to cetacean prey can we predict redistributions of feeding whales in altered environments;
(2) investigation of the power of time series of various data types on cetacean populations to detect the effects of environmental change on their population dynamics – this requires concurrent time series of both environmental data and cetacean population parameters or indices of fitness.

The first approach could be accomplished through IWC collaboration with international, extant marine ecosystem programmes such as Southern Ocean GLOBEC and CCAMLR. This Committee noted that CCAMLR had developed an ecosystem monitoring programme (CEMP) which includes sampling within integrated study regions (ISRs). These programmes are capable of incorporating cetacean sighting observation into surveys and studies of krill. In addition, these programmes integrate concurrent measurements of water column processes, ice edge dynamics and regional circulation patterns. Within these, hypotheses can be tested on the effects of environmental variability on cetaceans and their selection of habitat. This approach meets the criteria of: (a) likelihood of success; (b) results within several years; and (c) ease of implementation.

The second approach, investigating the power of time series, relies first on: a more retrospective analysis of existing time series on cetacean distributions; timing of migrations; indices of fitness; and physical data sets of similar temporal and spatial resolution. Dual physical and biological data sets, on decadal scales, which meet criteria of spatial and temporal coherence, should be identified.

The Committee supported the initiative represented by the Workshop on Climate Change and agreed to establish a Standing Working Group (to be convened by Reilly) to work intersessionally to oversee and facilitate the examination of effects of environmental change on cetaceans. The Standing Working Group might meet, normally at an Annual Meeting, should the Convenor and the Chairman of the Committee deem that sufficient progress had been made to warrant this.

The Committee welcomed the thorough report of the Workshop and **fully endorsed the recommendations** therein.

6.2 Arctic issues

This item had been placed on the Committee's agenda in response to a request by the Commission. The Commission had also asked for comment on a draft Resolution (IWC/47/51 Rev.1) submitted at last year's Commission meeting.

As discussed under Item 6.1 above, the Workshop on climate change had included the Arctic region in its discussions. This information is not repeated here.

The Committee had two papers submitted to it on this item.

SC/48/AS15 had initially been considered at the Workshop on the development of an aboriginal subsistence whaling management procedure (Annex I). It presented a summary of the conclusions and recommendations of the IPCC that are relevant to the stocks of whales currently harvested by aboriginal subsistence whalers, all but one of which are in Arctic or sub-Arctic regions. In particular, it summarised the information on the extent of sea ice, a factor that may be particularly important to the prey of cetaceans. Additionally, the prediction that the Northwest Passage and Northern Sea Route may become open for shipping for between 41–100 days per year has implications for cetaceans in terms of increased boat traffic, noise pollution and other disturbances. The authors concluded that any new management procedure for aboriginal subsistence whaling should be tested for robustness to climate change effects.

SC/48/O 21 also looked at observations and predictions of Arctic climatic change. It proposed that in view of both model predictions and recently observed trends in the Arctic climate, monitoring of the physical environment (e.g. sea ice extent) and the seasonal distribution of potential indicator species (e.g. the bowhead whale, the narwhal and the white whale) should be accorded some priority. It also examined potential effects on cetaceans, particularly in terms of possible changes in distribution (and potentially gene flow) and unknown effects on cetacean prey.

In discussion, the importance of investigating the role of ice-related processes to cetacean ecology was stressed, as was the need for cooperation with other organisations working on environment-related matters in the Arctic.

6.3 Mexican salt works proposal and possible effects on gray whales

At last year's Commission meeting (IWC, 1996a) the Commission agreed to a request by Mexico for assistance in the selection of a scientist or scientists expert in the fields of gray whale migration and reproduction to assist it in reaching a scientifically-based decision regarding the proposed expansion of commercial salt operations in the El Vizcaino Biosphere Reserve of Baja California. After consultation, three scientists were nominated to the Scientific Advisory Committee (SAC), Reilly, Swartz and Mate.

Reilly reported on the progress made thus far. The SAC participated in a number of meetings from 26 February - 1 March aimed at giving it an overview of the project. It has developed scientific terms of reference for an environmental impact assessment and these will constitute the primary environmental aspects that must be addressed and will form the basis of their review of such an assessment. SAC will pass on its recommendations concerning the ecological feasibility of the project to the Mexican Ministry for the Environment, Natural Resources and Fisheries, who will make the final decision as to whether the project will proceed. Reilly noted that the three cetologists were acting in their individual capacities and not representing the Committee.

7. COMPREHENSIVE ASSESSMENT OF WHALE STOCKS – RMP GENERAL ISSUES

7.1 Guidelines for surveys

At last year's meeting, several matters were considered which the Committee agreed should be incorporated into the Guidelines for Conducting Surveys and Analysing Data Within the Revised Management Scheme (IWC, 1996b,

p.57–8). In addition, a Resolution (Resolution 1995–7) on Surveys Intended to Provide Abundance Estimates for the Implementation of the Revised Management Scheme (IWC, 1996a, p.45–6) adopted by the Commission last year had, among other things, requested the Committee 'to prepare, as appropriate, further revision to the Guidelines'. The Committee agreed that Section 2 of the 'Guidelines', *Requirements under the RMS*, should be restructured to allow text to be incorporated on improved arrangements for the design and conduct of surveys and the validation and analysis of resulting data.

The Committee considered revisions of the 'Guidelines' as itemised in Annex D, Item 3. These were: additional provisions under Section 2; guidelines for field procedures and data to be collected in independent observer surveys; simulation testing of abundance estimators; and hazard probability methods.

In reviewing its 'Guidelines', the Committee stressed that

> 'their main purpose is to aid the process of obtaining estimates of abundance for use in the *Catch Limit Algorithm* (*CLA*) by:
>
> (i) stating the requirements of the RMS in this respect (Section 2); and
>
> (ii) providing guidance on methods of conducting surveys and analysing data, in particular as adopted by the Scientific Committee in recent years (Sections 3–6).'

It reaffirmed its view that only Section 2 should be regarded as compulsory. In order to emphasise this it was agreed to amend the title to: *Requirements and Guidelines for Conducting Surveys and Analysing Data Within the Revised Management Scheme.*

The Committee **recommends** that the revised requirements and guidelines given in Annex K be adopted by the Commission.

The Committee noted that IWC Resolution 1995–7 was to be discussed by a Working Group of the Commission.

The Committee considers that the intent of the word 'oversight' in Resolution 1995–7 is unclear in terms of its implications for the Committee's work. Three examples of recent Committee involvement in sighting surveys illustrate a range of possible meanings of 'oversight'. The most extreme form is represented by past IWC/IDCR surveys, where the Committee has been responsible for cruise design and data analysis. A less restrictive form was the involvement of the Committee's Abundance Estimation Working Group (AEWG) with Norway's NILS-95 survey. This included major input to survey planning, execution and data analysis, but did not involve assumption of responsibility for the research; nor were the AEWG's inputs and advice considered binding. The least restrictive form was the Scientific Committee's review in 1994 of sighting surveys proposed by Japan for North Pacific Bryde's and minke whales. In that case, the Committee reviewed survey design documents, but did not formally have further involvement in either the execution of the surveys or analyses of the data.

The level of involvement that is desired under the term 'oversight' would have several implications. If levels of 'oversight' similar to either the IWC/IDCR surveys or the Norwegian NILS-95 survey are required, substantial work intersessionally and during Annual Meetings will be required, possibly with considerable financial implications.

The Committee **records its strong belief** that, from the perspective of scientific oversight, any representative or representatives of the Committee should be chosen on the basis of scientific competence and relevant experience, not nationality.

7.1.1 International collaboration

Hatanaka summarised the contents of a letter to the Chairman of the Scientific Committee from the Commissioner of Japan that had been circulated to other Commissioners prior to the meeting. He noted that Resolution 1995–7 was adopted at the 47th Commission meeting without any prior consultation with the Scientific Committee. A particular difficulty concerns the concept of the mandatory placement of 'overseeing' personnel onboard and the specification with respect to nationality. Japan could not accept the Resolution at the last Commission meeting and was ashamed by the concept that the credibility of scientists and their research was being questioned, which does not occur in any other international forum (IWC, 1996a, p.27).

7.2 Estimation of 'process error'

SC/48/SH25 presented calculations conducted to assess the appropriateness of the degree of so-called 'process error' apparent in the Southern Hemisphere minke whale implementation trials (IWC, 1994b, p.76/90). Details are given in Annex D, Item 4.

The Committee has previously used the term 'process error' to refer to additional variation in a time series of estimates, over and above that estimated from individual surveys. This additional variance depends strongly on the spatial resolution at which abundance estimates were calculated; so-called 'process error' incorporated more than one type of additional variation. This must be borne in mind when interpreting estimates of 'process error' which include additional variation due to a failure of the individual survey variance estimators to capture all components of uncertainty in the abundance estimator, and variation in the number of animals available to be surveyed at any one time.

SC/48/AS3 presented estimates of additional variation in Pacific gray whale abundance estimates over and above that estimated from individual surveys, using Bayesian methods from a series of 19 annual estimates. More details of this paper and discussion of it are given in Annex D, Item 4.

The Committee concluded that to obtain the best estimate of additional variance (previously referred to as 'process error') from the full series of IWC/IDCR surveys, abundance estimates needed to be calculated at longitudinal resolutions which do not always coincide with half-Areas. It noted that the IWC database and estimation software system (DESS, see Item 7.3) can readily generate estimates at any resolution. The Committee **recommends** that, prior to the 1997 meeting, abundance estimates be generated from both passing and IO survey mode at three longitudinal resolutions (10°, 60° and either 20° or 30°) and that additional variance be estimated at each resolution. The blocks should be located so as to maximise the number of replicate surveys within blocks. Borchers, Cooke and Punt agreed to carry out this work intersessionally.

7.3 Survey database and software

7.3.1 Development of the IWC database and estimation software system (IWC-DESS)

SC/48/O 36 reported on the development of the IWC-DESS carried out under contract to the IWC. The IWC-DESS standardises IWC line transect survey data storage and provides powerful data manipulation and estimation facilities for abundance estimation by linking the database to the program DISTANCE (Laake *et al.*, 1993), and the *MapInfo* GIS system, for estimation by *Small Areas* and for visual data display. The addition of the GIS component of

the IWC-DESS went beyond the original specifications for the system and substantially enhances the power of the system. Development and documentation of the IWC-DESS has been completed, but there remain some problems relating to the validation of data held in the system. These data problems are outside the scope of the contract, which has now terminated, but need to be addressed before the system can be considered fully operational. The outstanding data issues are as follows:

(1) provision and incorporation of NASS boundary data;
(2) provision of adequate documentation of Icelandic NASS-89 data and/or new data in a uniform format; cooperation with a scientist familiar with these data was considered necessary for successful completion of this task;
(3) resolution of discrepancies between IWC/IDCR boundary data provided and those used in previous analyses, and between the boundary data provided and the vessel cruise tracks.

IWC-DESS has been transferred to the Secretariat at this meeting. Access to the system by accredited members of the Committee will be possible as soon as Items (1) and (3) above are resolved. This is expected to be within three months.

The Committee thanked the developers of IWC-DESS for their presentation and for the work accomplished during the last two years. Discussion focused on those matters which require additional work in order to complete the current version of the system, and the addition of other datasets which could be added to the database.

The Committee requests that information about each dataset should appear on screen whenever the dataset is accessed, including: a short description of the data collection protocol; an indication of the analysis method(s) for which the data were collected; and pointers to key references. The information should be provided by those responsible for collecting the data and its original analysis, so that it can be incorporated into the database by the Secretariat.

Matters requiring work for completion of the current system were summarised as: incorporation of the boundary data for NASS-87 and NASS-89 survey blocks; resolving discrepancies in the boundary data for early IWC/IDCR surveys; some minor matters relating to pooling options when calculating abundance estimates; and verification of the Icelandic NASS-89 data. It was agreed that resolution of the first three of these should be done through discussion between the developers and the Secretariat. This had minor financial implications (see Item 22).

The Committee agreed it was important that the Icelandic NASS-89 data be fully verified and noted that this will require assistance from someone familiar with the details of the data. In addition, the status of the availability of these data needs to be clarified. The Committee **recommends** that the Secretariat and the developers liaise with the relevant Icelandic scientist(s) to accomplish these tasks noting that the priority accorded to this depended on data availability. This has financial implications (see Item 22). These data are particularly valuable for estimating the abundance of two species in the North Atlantic subject to aboriginal subsistence whaling (fin and minke whales). Walløe noted that ongoing discussion between Norwegian and Icelandic scientists may facilitate accomplishing these tasks.

Concerning the addition of other datasets to the database, the Committee noted that the developers of the database system were currently entering data from the NILS-95, recent IWC/IDCR, Japanese North Pacific, and JARPA (Japanese Whale Research Programme under Special Permit in the Antarctic) surveys as recommended last year (IWC, 1996b, p.59; IWC, 1996f). This work was on schedule. The Committee noted the importance of entering into the database as much data that could be used to estimate abundance as possible. However, it noted that incorporating data on gray and bowhead whale stocks subject to aboriginal subsistence whaling, for which very different methodologies were used to estimate abundance, would be a major task. Incorporating historical data, such as 'Discovery' data, would also be a major task. The Committee recommends that, at this time, data entered into the database system should be limited to those collected before and after IWC/IDCR cruises in the Southern Hemisphere (these data have been coded but not verified), and those from the Japanese and IDCR dedicated surveys conducted in the Southern Hemisphere between 1978/79 and 1982/83 (these data have not been coded). Accomplishing this task will have significant financial implications (see Item 22).

The Committee agreed that entering these new data into the database was a higher priority than incorporating new abundance estimation software.

7.3.2 Review of methods for estimating abundance

Following the recommendation at last year's meeting (IWC, 1996b p.59), the developers of the IWC-DESS had been contracted to evaluate and present options for the development of analytical methods for estimating abundance at this meeting. SC/48/O 4 provided a review of this. The review addressed three areas: mean school size, estimation of abundance by *Small Area*, and methodology for two-platform data.

MEAN SCHOOL SIZE

Available methods for mean school size estimation from line transect surveys were evaluated in SC/48/O 4, with a view to implementing them in the IWC-DESS. Details are given in Annex D, Item 9.

The Committee agreed that the most appropriate method at this time for estimating mean school size when estimating the abundance of Southern Hemisphere minke whales, assuming $g(0) = 1$, was the regression method as described in SC/48/O 4 and currently implemented in the database and estimation software system. There was little to separate this method from the kernel estimation method described in SC/48/O 4 except that the latter method would require additional software to be incorporated into the IWC-DESS.

The Committee noted that there are other methods which may be used to estimate mean school size, including the hazard probability methods outlined in SC/48/NA1 and SC/48/NA7, which could benefit from further development. It further noted that the Horvitz-Thompson method, recommended as the best general method by the authors of SC/48/O 4, can accommodate factors which could minimise bias and variance and was a promising method, although some concerns about the reliability of school size estimates in passing mode were raised.

ESTIMATION OF ABUNDANCE BY *SMALL AREA*

Two methods for abundance estimation by *Small Area* were evaluated in SC/48/O 4, in the context of implementing them in the IWC-DESS. These were the 'clipping method' (SC/48/O 36) currently implemented in the IWC-DESS, and a spatial modelling approach. The latter approach was described in SC/48/O 12 which also reported on a preliminary application of the method to IWC/IDCR survey

data, using a GLM to model spatial trend in abundance. While the results of the application were promising, the Committee noted that the method required further development.

TWO PLATFORM DATA

Available methods for abundance estimation from double platform line transect survey data were evaluated in SC/48/O 4, with a view to implementing them in the IWC-DESS. Details are given in Annex D, Item 9.3. The IWC-DESS currently does not provide for analysis of two platform data. Inclusion of software for such analysis would require substantial additional software to be linked to the system.

NEW DEVELOPMENTS

The Committee received a number of papers describing ongoing developments in various aspects of abundance estimation (SC/48/NA7, SC/A96/AE31, SC/48/O 15 and O 17). Details are given in Annex D, Item 9.4.

CONSIDERATION OF FUTURE COMMITTEE WORK ON ABUNDANCE ESTIMATION

SC/48/O 34 took up the discussion last year (IWC, 1996b p.58), continued during the intersessional meetings of the AEWG, of the importance of defining factors that should be considered when evaluating the appropriateness of methods of estimating abundance, and of defining a process for testing and evaluating such methods. There was some discussion of the merits of testing estimation methods against real versus simulated data and of how much the review in SC/48/O 4 had accomplished in defining factors which needed to be considered.

The Committee considered the report of an *ad-hoc* Working Group on evaluating the performance of abundance estimators (Annex L) which had been set up by the sub-committee on Management Procedures and General Matters. The Working Group addressed the question of identifying estimation methods that would be candidates for adding to the IWC-DESS.

In discussion of Annex L, the importance of the testing of estimators using simulated data was stressed. This should be sufficiently extensive to address bias and precision in abundance estimates and their variance over an appropriate range of factors. It was also stressed that simulated data be conditioned on appropriate data. The merit of testing abundance estimators using real data was also stressed.

The Committee agreed that this topic needed further discussion and established an intersessional correspondence group (Palka (convenor), Borchers, Butterworth, Miyashita, Polacheck, Schweder and Smith) to report to the Committee at next year's meeting.

7.4 Presentation of trial results including combination trials

Smith reported that the Working Group established to consider combination trials had continued its work intersessionally as identified last year (IWC, 1996b p.59) but that it had not yet been possible to finalise analyses. However, a final set of simulations required to complete the statistical analysis had now been specified and this work would be completed in time for inclusion in the Special Issue on Management Procedures (see Item 23). The Working Group was not anticipating results which would require review by the Committee but, if this was necessary, these would be circulated to Committee members for comment.

7.5 Guidelines for data collection and analysis – operational data

Ohsumi reminded the Committee of the potential value of time budget data from whaling operations in estimating indices of relative abundance. He proposed that the operational data specified in Tables 1 and 2 of the Schedule could be amended so that they contained only items relevant to the estimation of sighting rates and to remove other redundant items. The proposed changes involved: ensuring searching distance could be calculated from the data by collecting information on positions during searching; recording separately each sighting of the target species; and recording the details of whales caught at the time of capture.

The Committee thanked Ohsumi for responding to the request last year to submit proposals on this subject and agreed that it was timely to propose changes to Tables 1 and 2 in Appendix A of the Schedule that could be considered by the Commission. The Committee agreed that the appropriate mechanism for this was to amend the Guidelines for Data Collection and Analysis under the Revised Management Scheme (RMS) Other than those Required as Direct Input for the *Catch Limit Algorithm* (*CLA*) (IWC, 1995c).

Ohsumi had also proposed that the collection of weather data should not be required because whaling operations only took place in good conditions. The Committee agreed, however, that such conditions included a range of conditions which may affect sighting rates and that these data should continue to be collected albeit not in as much detail as currently specified.

The Committee considered draft revisions to Tables 1 and 2 of Appendix A of the Schedule prepared at the request of the sub-committee on management by Ohsumi, Øien and Donovan. It **recommends** that the Daily Record Sheet given in Annex M be included in the Guidelines for Data Collection and Analysis under the Revised Management Scheme (RMS) Other than those Required as Direct Input for the *Catch Limit Algorithm* (*CLA*) (IWC, 1995c) and that the Commission adopts the revised Daily Record Sheet when it considers revision of the Schedule in this respect.

8. CA/RMP – PREPARATIONS FOR IMPLEMENTATION

8.1 North Pacific minke whales

8.1.1 Report of intersessional group on trials

The Working Group on North Pacific minke trials met over six days immediately prior to the meeting of the Scientific Committee, and concluded discussions on more technical aspects of these trials during the latter meeting. Its aims were to review new information relevant to Implementation Simulation Trials for North Pacific minke whales, and to revise the existing specifications for these trials developed by an earlier meeting of a similar Group (IWC, 1994c) as might be considered appropriate. Its report is given in Annex J.

The Group structured its discussions around the existing trial specifications as detailed in Appendix 3 (IWC, 1994c). It first reviewed the data available for 'conditioning' trials (i.e. choosing population parameters for the trials compatible with such data). These comprised sighting survey estimates of abundance; historical catches and their geographic distribution; conception data, isozyme, DNA and length frequency data; and CPUE information.

The greatest part of the Group's time was taken up by a detailed discussion of stock/sub-stock structure. Seventeen contributions dealing partly or wholly with these issues were

presented. These addressed general questions about drawing inferences from genetic data, as well as presentations and/or analyses of genetic data, length and sex compositions of catches, whaling ground locations, and information on conception dates, morphology, parasites and pollutants. Both historical information, and that obtained from the whale research programme under Special Permit conducted in sub-area 9 (see Fig. 1 of Annex J) in 1994 and 1995 were considered.

The Group agreed that the available data and information were generally inconsistent with there being substocks to the east of Japan characterised by different levels of latitudinal migration. Earlier, the presence of discrete whaling grounds had been argued to indicate site specific aggregations. However, SC/48/NP6 argued that this was rather the result of the discrete distribution of land stations, and the continuous distributions shown by sighting surveys do not support the existence of local aggregations. Instead, this coastal region seems to be a migratory corridor. Furthermore, the lack of mature females in sub-area 7 implies that a separate group of interbreeding animals is not present there. In contrast, much less information is available on the minke whales to the west of Japan, with consequential uncertainty about the linkage between those found to the east and west of Korea.

In the light of these discussions, the original *Implementation Simulation Trials* for North Pacific minke whales were revised as reflected in Appendix 5 of Annex J. The most important changes are:

(1) the time step used in modelling whale migration has been shortened from two months to one, to better match model predictions and the further data now available for conditioning;
(2) substock structure has been dropped;
(3) the catch mixing matrices (reflecting spatio-temporal changes in stock distribution) are now age- and sex-structured.

The 144 trials agreed by the Group are listed in section G of Appendix 5 of Annex J.

The basis used to select the trials was by and large that used in the past, i.e. concentrating on cases with MSYR (mature) = 1% and factors likely to render the trials more difficult with regard to meeting risk-related criteria. The Group agreed that the relative plausibility of different trials needed to be taken into account in future discussions, but that this could not be done in the absence of consideration of the risk associated with the results for each.

Punt undertook recoding of the trials, but was unable to complete this task before the end of the Scientific Committee meeting.

In noting the discussion of substocks in Annex J, the Committee agreed that it was important to consider the general question of management units, and specifically questions associated with the conservation of the range of a species that may have a habitual component to its migration. This is discussed further under Item 20.2.

The Committee **recommended** that the Secretariat carry out computations of the trials listed in Appendix 5 of Annex J intersessionally. This Appendix includes a suggested order to conduct the large number of trials suggested. The reason for this is that results for the initial trials in this set may be sufficient to show that sensitivity to certain factors is minimal, and hence that there is no need to carry out some of the further trials suggested for that factor. The Committee appointed an intersessional Steering Group (comprising Allison, Butterworth, Hatanaka, Punt, Tanaka (E) and Taylor) to review results of these initial trials by correspondence, and to advise the Secretariat whether or not certain of the remaining trials need to be carried out in the light of these initial results. Since it was not possible to complete the coding of the trials during the meeting, this Group was also authorised to effect minor amendments to Appendix 5 of Annex J if some specifications therein were shown in the coding process to be mutually inconsistent.

The Committee noted that the RMP specifications (IWC, 1994d) as presently drafted, do not envisage temporal constraints within a season on a catch limit for a *Small Area*, although the specifications for the trials in Appendix 5 of Annex J (see section D thereof) include such restrictions. The Committee agreed that should the results of the trials proposed indicate satisfactory performance, it would give attention to consideration of an appropriate amendment to the RMP specifications at a future meeting.

8.1.2 Future surveys

The Committee did not have sufficient time available to fully review the survey designs specified in SC/48/NP18 relative to the requirements specified under Item 7.1 and Annex K, particularly as the discussions under that item were not completed until the penultimate day. However, the Committee did provide general advice and comments about the design presented.

SC/48/NP18 presented the plans for sighting surveys in the North Pacific for the summer and winter seasons of 1996/1997. Eight surveys with six vessels will be carried out between 15 May 1996–28 March 1997 in four different areas. All surveys will be conducted with experienced observers using the IDCR closing mode approach. For each survey a primary species or group of species has been identified but sightings of all species observed will be recorded. Distance and angle data will be collected with reticule binoculars and angle boards respectively. Training in distance and angle measurement will be conducted prior to the trip and testing will be conducted during the trip. All except one vessel (survey 8) have a top barrel for sightings. For the survey of Baird's beaked whale (survey 4) and the winter small cetaceans survey (survey 9), only one person will observe from the barrel but in the remaining surveys there will be two observers in the barrel. For survey 8 in winter, sightings will be made from the upper bridge. Only results from surveys 2, 3, 4 and 5 will be considered with respect to the RMP implementation.

Discussion was limited by time and the information available. It was noted that abundance estimates will be derived from the survey data assuming that $g(0) = 1$. However, encouragement was given for attempts to be made to collect independent observer data and to assess the feasibility of applying methods of estimating $g(0)$ based on such data. The use of a single observer in a survey because of limited vessel capacity was discussed. It was recognised that $g(0)$ will most likely be less than unity and that estimates from these surveys would most likely underestimate abundance.

The Committee noted the potential importance of the sightings surveys outlined in SC/48/NP18 for its work, and notes the importance to their success of the granting of research or entry permits into the EEZs (Exclusive Economic Zones) of relevant countries.

8.2 Southern Hemisphere minke whales

The Committee noted the discussion within the Commission last year regarding the implementation of the RMP (IWC, 1996a, p.25). A number of countries believed that adoption

of the Sanctuary precluded the adoption of the RMP in the area, at least for the time being. They considered that the Committee should not consider Southern Hemisphere minke whales in this context unless advised to do so by the Commission.

Japan had opposed this majority view because of its objection to the Sanctuary and the advanced state of the Committee's work on minke whales.

Item 9.2 considers other aspects of Southern Hemisphere minke whales.

8.3 North Atlantic minke whales

8.3.1 Abundance estimates from work of AEWG

CHAIRMAN'S SUMMARY OF SC/48/REP1

After the failure of the Scientific Committee to agree on an acceptable estimate of abundance for the northeast Atlantic minke whales last year (IWC, 1996b, p.61–2), an intersessional abundance estimation working group (AEWG) was established with a developed workplan (IWC, 1996g)

> 'to 'maximise' the probability that the Scientific Committee would be able to agree on an estimate at its next annual meeting'.

The multinational AEWG was comprised of biologists and statisticians with extensive experience in the conduct and analysis of line transect surveys: Polacheck (Chair); Butterworth; Cooke; Hammond; Laake; Øien; Palka; Schweder and Smith. The work plan included two intersessional meetings and an extensive set of identified tasks and working papers which needed to be completed. The identified work included analyses and verification of:

(1) the survey and experimental data that had been collected in 1988–1990;
(2) the survey conducted during the summer of 1995; and
(3) the specifics of the hazard probability method as it had been developed for the analyses of these data.

As agreed in the Workplan, the AEWG had extensive intersessional communication using electronic mail for the automatic distribution of correspondence to all members (e.g. over 250 messages were exchanged); completed to their satisfaction all specific tasks identified in its terms of reference; produced 41 working papers; met twice; and produced an agreed report as a record of its work over the year (SC/48/Rep1). This report documents the AEWG's consensus on acceptable estimates of abundance of northeast Atlantic minke whales.

As recommended by the Committee, the AEWG agreed to use the hazard probability approach as the basic analytical method for obtaining abundance estimates from the survey data. This approach estimates the density of whales by integrating estimates of the surfacing rate with estimates of the conditional probability of detecting a whale that surfaces at a particular position relative to the survey platform, given that the whale has not previously been observed. The hazard probability is modelled and estimated as a function of sighting angle, radial distance and covariates which can include environmental, observer, platform and whale heterogeneity effects. The basic data available for estimating the parameters of the hazard probability model are the initial sighting positions of whales and the success/failure of Bernoulli trials data collected from independent observer teams tracking surfacings of whales. The estimation procedure is based on a maximum likelihood approach.

The AEWG reviewed the sighting survey plans of the Institute of Marine Research (Bergen) and provided advice on details of the data collection procedure prior to the 1995 survey. Four members of AEWG participated in the 1995 Norwegian Independent Line Transect Survey (NILS-95) and summary reports from seven survey participants describing their experience were presented to it. These reports dealt with potential problems in the data collection and implementation of the survey protocol that could have had implications for the analyses. The AEWG reviewed these reports and the data collected, including a large number and variety of summary statistics. Based on this review, the problems identified were either: (1) corrected in the data prior to the finalisation of the analyses; (2) taken account directly in the analyses; or (3) judged to be of minimal consequence in the estimation. The AEWG agreed that the data were acceptable for use in estimating minke whale abundance.

The hazard rate estimation procedure as applied to the northeastern Atlantic minke whale survey data is complex and comprises a large number of components. Responses to concerns raised at last year's Committee meeting resulted in substantial new developments in methodology. This resulted in an increased workload for both the AEWG and the NCC (Norwegian Computing Centre). Nevertheless, the AEWG was able to complete extensive examination of the various components (including new developments) and agreed on an acceptable approach for each of these relative to the estimation of abundance from the available data. At its January meeting, the AEWG concluded that there was nothing in principle to prevent the adoption of abundance estimates based on the agreed procedures, given that the result yielded satisfactory performance as demonstrated by suitable diagnostics. The second meeting of the AEWG was delayed by six weeks until the end of April to allow completion of the implementation of the new developments and finalisation of the analyses of the data.

The specific methodology and analytic issues for which the AEWG developed agreed approaches with respect to the analysis of the 1988-90 and 1995 data included:

(1) the specific definition of the components of the likelihood function;
(2) the specification of the inverse logit model as the functional form of the hazard probability model;
(3) the use of only linear terms in the link function in the bias correction procedure;
(4) the estimator for the parameters for the Neyman-Scott process model used to model the spatial distribution of whales;
(5) the need for an interactive procedure for the estimation of the effective strip half width and the parameters of the Neyman-Scott process used in the bias correction procedure;
(6) the decision on whether a single iteration of the Neyman-Scott parameters was sufficient for estimating abundances;
(7) the set of covariates and levels of stratification to be used in the estimation of the hazard probability function;
(8) the decision on whether the use of the estimated 'whale' presentation angle or 'fisk' categories at the time of initial sighting should or should not be included at this time as a covariate;
(9) the definition of the truncation region;
(10) the procedure to use for combining the data from the independent observer teams;
(11) the procedures for accounting for measurement errors;

(12) the specific functional form and parameter values used for modelling measurement errors;
(13) rules for duplicate identification;
(14) the surfacing rate model; and
(15) the method for estimating the variances of abundance estimates.

The extensive documentation of the data, the analytical methods and the software implementation were reviewed by the AEWG which concluded that they were sufficient. With respect to verification of the NCC software implementation used to calculate the abundance estimates, the AEWG recognised that several approaches had been undertaken. These included:

(1) an extensive and independent review of software by computer scientists from the University of Aarhus, Denmark; and
(2) use of simulated data to compare estimates with data where the correct answer is known.

The AEWG agreed that the software had been sufficiently validated for use in estimating minke whale abundance.

The AEWG undertook extensive review, testing and comparison of the automated procedures that had been developed for the classification of surfacings from independent observer teams in terms of whether they were duplicates. Analyses were also developed for estimating the probability of missing a surfacing when tracking a whale and the probability of losing a track altogether. Comparison of the automated procedures when applied to the 1995 survey data and to simulated data indicated that the different rules are in general agreement with each other and yield reasonable agreement to the true proportions in the simulated data. The AEWG noted that the form and application of the duplicate rule is an area where it is difficult to examine sufficient diagnostics and the sensitivity of the estimation procedure to the specific rule used. Because of this, it agreed that it would be necessary to examine the effect of this uncertainty by using at least two different duplicate rules to evaluate the robustness of the bias correction procedure. Such a comparison was provided for the final estimates considered by the AEWG at its April meeting and the resulting estimates were found to be in close agreement.

An important component of the identified intersessional work was the testing of the procedure with simulated data. The AEWG agreed on a small set of simulation tests to be conducted for verification given limitations imposed by the computing time requirements of the software developed by the NCC. In addition, more extensive simulation testing of the general performance of the methods was conducted with the less computationally-intensive implementation developed by Cooke. Based on the results of these simulation tests, the AEWG agreed that they constituted confirmation of satisfactory estimation performance in the context of the analyses of the 1988/89 and 1995 survey data.

The implementation of the abundance estimation procedure assumed no whale movement. The AEWG agreed that, although accounting for whale movement would be desirable, insufficient information was available at this time to allow specification of other than arbitrary models. It agreed that there was no evidence for attractive movement towards the vessel under survey conditions and that there was some suggestion of avoidance behaviour for whales with radial sighting distances less than 1,000m based on the estimated swim directions observed at the time of initial sighting. However, because of large estimation errors in angular swimming direction measurements and because the ability of observers to classify swim direction may be a function of sighting angles, the results need to be interpreted with caution. The AEWG agreed that while additional research in this area was needed, an estimate that did not account for whale movement would be acceptable.

The AEWG reviewed estimates of $g(0)$ for minke whales from other surveys in other areas with respect to their relevance to the estimation of abundance from the 1988/90 and 1995 data. The AEWG concluded that current quantitative comparisons from other surveys did not provide a basis for an estimate or for setting an upper bound for $g(0)$ for the northeastern Atlantic minke whale surveys.

At the AEWG's April meeting, working papers were presented and reviewed which detailed the application of the hazard probability method to the two sets of survey data for the northeastern Atlantic minke whales based on the methods and procedures agreed on by the AEWG. These documents presented abundance estimates, results of intermediate calculations and extensive sets of diagnostic and descriptive statistics. The diagnostic and descriptive statistics presented were based on the set developed by the AEWG and which it had agreed were sufficient for evaluating the adequacy of the fit. The AEWG concluded that the diagnostics demonstrated an adequate fit to the data. However, it did note some lack of fit of the estimated hazard probability model for the Bernoulli success data with respect to the marginal distribution of radial sighting distances. In particular, there was an underestimation of the proportion of observed successful trials within 400m of the vessel. The AEWG recognised a number of factors that could be contributing to this lack of fit and concluded that the overall effect of this lack of fit on the estimates of abundance in terms of possible bias were (i) of unknown direction and (ii) of second order. Immediately following the April meeting, further diagnostic statistics were discussed via e-mail that confirmed this conclusion.

The AEWG also agreed on the specific and implementation details of the method for calculating the variance for these abundance estimates. Time did not permit finalisation of these calculations during the April meeting. Preliminary calculations indicated CVs on the order of 20% for the 1988-90 data and 11% for the 1995 data.

Based on its careful examination of the hazard probability method and approach, the AEWG agreed that the application of the procedure as described in its report, and in the supporting working papers submitted to it, is acceptable for estimating the abundance of northeastern Atlantic minke whales from the 1988-90 and 1995 data. The application of the method resulted in estimates of 67,531 and 118,299 whales for 1989 and 1995 respectively. Specific estimates by survey strata are given in SC/48/Rep1 (table 5). The AEWG recommended the acceptability of the estimates given in Table 2 (from SC/48/NA1).

The AEWG agreed that the data collection and analysis methods on which these estimates are based are a substantial advance on previously-used methods for North Atlantic minke whales. Nonetheless, as is always the case, the method could be further improved for use in the northeastern Atlantic and elsewhere. During the course of its work and discussions, the following areas were identified as warranting further investigation:

(1) improved methods of obtaining representative dive time data;
(2) methods of measuring whale movement and a possible responsive behaviour, and of incorporating such information in the estimates;

(3) methods of estimating presentation angle more accurately, and of incorporating this and other heterogeneity;
(4) methods of estimating the bias and variability in positional estimates that are taken during the survey, with special focus on how uncertainty in these estimates would affect the abundance estimate uncertainty;
(5) methods for incorporating encounter rate information directly into the likelihood for estimating the parameters of the hazard probability function;
(6) models of and methods for estimating spatial distribution patterns, especially the suitability of the Neyman-Scott process at different spatial scales.

Noting that the methods developed in SC/48/NA1 for North Atlantic minke whales are a substantial advance on methods based on perpendicular distances, the AEWG recommended that a programme of experimental comparison of methods of analysis of double-team sighting survey data be conducted to compare the performance of this approach with that of perpendicular distance-based estimation methods.

At the end of his presentation of SC/48/Rep1, Polacheck thanked all the members of the AEWG for their long hours of hard work and effort. From his perspective, he noted that the report of the AEWG represented a truly collaborative and cooperative effort. All members of the AEWG were active participants throughout the process, making substantial contributions to the actual analyses and contributing to at least one of the 41 working papers presented to the meeting. These contributions were combined and synthesised into the final report and estimates of abundance. Finally he expressed his gratitude and thanks on behalf of the AEWG and the Scientific Committee to the staff of the NCC for the logistical support, cooperation and good humour they had displayed throughout the process.

DISCUSSION

Polacheck noted that the calculation of the variance estimates for the abundance estimates had been completed prior to the Committee meeting and the results were presented in SC/48/NA1. The resulting CVs were 19% and 10% for the 1984 and 1995 estimates, respectively.

The Committee's discussion of this item was dominated by consideration of a working paper submitted by Cooke, a member of the AEWG. That working paper is reproduced as Annex N1. Its contents can be separated into two general concerns:

(1) the way in which the AEWG had conducted its business; and
(2) scientific questions about the conclusion the AEWG had reached.

The report of the Committee's deliberations below follows that structure. More general issues of how the Committee can improve its working practices are considered under Item 20.2.

WORKING OF THE GROUP

In response to a question from the Committee chairman as to why he had changed his opinion since the report had been finalised, Cooke noted that although the AEWG Report had been adopted by consensus, he had expressed reservations on many issues at the AEWG's meeting, some of which he thought were mentioned in the report at the time. He had not, however, dissented from the agreed report. He noted the psychological fact that if one was in a minority of one, one tended to go along with one's colleagues. He noted that with the benefit of hindsight he should not have agreed to all of the decisions made at and between the AEWG meetings. He took full responsibility for this, stating that his concern was that the Committee was once again being pressured into premature acceptance of an estimate of abundance for northeast Atlantic minke whales.

The other members of the AEWG expressed complete surprise at this response and to Annex N1 in general. They noted that the AEWG had had extensive intersessional communication including the distribution of electronic mail to all of its members in addition to the two meetings that had been held. The AEWG Chairman had been extremely careful to structure the work to ensure, in accordance with its remit, 'that all decisions are based on consensus'. All members of the AEWG (except Cooke) and in particular its Rapporteur, noted that they had not detected any lack of consensus around any of the many decisions taken by the AEWG. They noted that all members of the AEWG had entered into serious discussion throughout the process that involved addressing reservations from many members about technical aspects of the estimation procedure. All of these reservations were resolved in coming to a consensus on each of the many decisions taken. In the end no concerns were expressed to the Rapporteur or to other members of the AEWG that any member held reservations which were not expressed in the report.

Despite the impression created by Annex N1, the other members of the AEWG noted that Cooke had participated fully in the work of the AEWG, entering into all discussions and debates, participating in the NILS-95 cruise and contributing many important ideas that had been incorporated into the estimation method adopted. They noted that there had been ample opportunity for members of the AEWG to indicate disagreement throughout the year-long process. Indeed one member of the AEWG, relatively new to the Committee, had expressed some concern about one aspect of the analysis after the final report had been agreed at the April meeting. All members of the AEWG, including Cooke, had communicated during this period and additional calculations had been completed and agreement reached.

After this agreement, the Rapporteur had e-mailed the AEWG with the hope that they 'would continue to communicate freely prior to the meeting so that we may all have time to consider any new issues that may arise in the meantime'.

Members of the AEWG believed that the impression Annex N1 created about the way the AEWG worked was in complete contrast to the spirit in which the AEWG had been established and had carried out its work. Cooke's concerns were not indicated to any other member of the AEWG at any time during the meetings either before or after the finalisation of the report. They were particularly disappointed and surprised that Annex N1, which criticised some consensus agreements reached in January, was not circulated to the Committee until a few hours before discussion of the report, nine days after the start of the Committee meeting and one month after it had been agreed by consensus. In addition, Annex N1 does severe injustice to the other members of the AEWG and is misleading to readers who did not participate in the process.

Whilst strongly supporting the right of scientists to express and alter their views, the AEWG believed the manner in which it was done in this case to be unacceptable and an impediment to the work of the Scientific Committee.

This has serious implications for the future work of the Committee, which must be carried out in an atmosphere of trust and legitimate scientific debate, if it is to meet its responsibilities.

Some members of the AEWG found Cooke's explanation unconvincing given his previous contributions to the work of the Committee. Indeed in Annex N1 he refers to his own previous minority statement on the subject of northeastern Atlantic minke whales. They believed it was particularly unfortunate that this should have involved the IUCN representative, an organisation that has close links and special status within the Scientific Committee.

Cooke responded that, while he understood what he perceived were negative reactions of some members towards those who try to check or reproduce accepted estimates, he considered such checking to be part of the normal process of peer review which is within the Committee's remit. He regretted that not more members of the Committee were willing to take on the thankless task of cross-checking abundance estimates. De la Mare commented that he believed that the timetable established for the Working Group had been too severe.

During review of the meeting report, the other members of the AEWG expressed their appreciation for Cooke's work in helping to validate abundance estimates and affirmed that they also considered such checking to be part of the peer review process. They regretted he felt that such negative reactions existed towards his contribution, but reassured him that they did not hold such feelings.

SCIENTIFIC ASPECTS

In discussion of SC/48/Rep1, a number of issues were raised in a scientific context. The most important can be summarised as follows:

(1) the adequacy of the simulation testing element in (a) verifying the software and (b) determining whether the hazard probability method is acceptable for estimating abundance and its variance;
(2) the reasons for differences in estimates from the 1989 and 1995 surveys;
(3) the differences between the NCC and Cooke estimates for 1989;
(4) an apparent inconsistency between estimates for part of the North Sea for three different surveys and years.

What follows is structured to present a brief summary of the issues raised and the responses given.

(1) SIMULATION TESTING

With respect to simulation testing in Annex N1, Cooke had commented that his estimation procedure had been run on the full suite of simulation trials developed in SC/A96/AE18 and AE20 whereas the NCC method had only been run on four simulated data sets. A number of other members of the Committee requested clarification of this issue.

In response it was noted that simulation testing is only one tool, albeit important, in addressing two quite different questions (1(a) and (b) above). With respect to the verification of the software, the process followed by NCC and reviewed by the AEWG was to develop and check the software during all stages of its development and after its completion and included:

(i) detailed documentation and specification of the statistical, computing and mathematical procedures;
(ii) the internal procedures used within the NCC for writing and checking the codes;
(iii) the numerical internal testing conducted by the NCC for each of the components or modules in the estimation procedure;
(iv) the use, where possible, of pre-existing and well established sub-routines and procedures for performing specific computation tasks;
(v) the development within the NCC of an alternative set of software for producing approximate numerical solutions that yielded similar numerical results;
(vi) the independent review and evaluation of the software performed by the University of Aarhus (Denmark);
(vii) the agreement in the results from the simulation tests for the NCC and Cooke implementation;
(viii) the extensive comparative work that previous working groups of the Committee on abundance estimation had done on the NCC and Cooke implementations (e.g. IWC, 1996e). This had resulted in an agreement in the numerical results to within two decimals when the methodological differences in the implementation were removed.

More specifically, the four simulations conducted were carefully selected to cover the range of important components of the estimator. It was recognised that 100% certainty in the verification process is not possible. While additional simulations would have strengthened the process of verification in conjunction with the results of the other extensive checks, the level of scrutiny and testing of the software far exceeded that performed on most software used by the Committee. The AEWG had agreed that the software had been adequately verified for use in estimating minke whale abundance.

(1B) ACCEPTABILITY OF THE HAZARD PROBABILITY METHOD

With respect to the question of whether the hazard probability method is acceptable, the AEWG conducted extensive simulation testing, the results of which are presented in Polacheck and Cooke (SC/A96/AE29). These tests were carried out using Cooke's software which was agreed by the AEWG to be a sufficiently similar mathematical estimator to the NCC software for the purpose of addressing this question. These results confirmed the previous conclusion of the Committee (IWC, 1996b, p.61) that the hazard probability method is an acceptable approach to estimating abundance. Specifically, the simulation testing showed that the hazard probability method has, at most, small statistical bias and is robust to a range of factors. The simulation testing was more limited with respect to investigating the variance of the point estimate but did indicate that it was low, as expected for sample sizes typical of those actually achieved for the NILS-95 surveys. More importantly, independent empirical bootstrap methods confirmed this.

Despite the explanation given above, De la Mare, Lankester and Slooten did not consider that four single simulation trials provided an adequate basis for validating the statistical properties of the NCC estimation procedure.

(2) THE DIFFERENCE BETWEEN THE 1989 AND 1995 ESTIMATES

Annex N1 had commented that the increase in the point estimates from 67,531 in 1989 to 118,299 in 1995 will be 'puzzling to outside observers'. There was considerable discussion over this in the Committee.

In response a number of plausible reasons for this were put forward that are not mutually exclusive:

(1) the extrapolation from the 1990 experiment to the 1989 survey data may introduce a negative bias;
(2) the 1989 estimate may have been negatively biased because the covariates it was agreed should be included in the 1995 estimate could not be incorporated in 1989 to the same extent;
(3) the number of minke whales in the survey area may have increased in 1995 from immigration;
(4) a natural rate of increase in the population during the six year period – for the lower 95% confidence interval for the 1995 abundance estimate this represents an annual increase of around 2%;
(5) the 1989 and 1995 estimates may not be different statistically if the CV is under-estimated from unaccounted sources such as potential greater variability in dive sequences than is exhibited in the data from the eight minke whales used in the analysis.
(6) the 1995 estimate of minke whale abundance is a more reliable estimate because it was derived from a designed survey with independent teams of observers and did not depend on extrapolation from independent observer data collected in a different year as was the case for the 1989 estimate. The Committee last year (IWC, 1996b, p.62) had agreed that analysis of the 1989 data was problematic.

(3) THE DIFFERENCE BETWEEN THE 1989 COOKE AND NCC ESTIMATES

Annex N1 had noted that the unstratified abundance estimate for the 1988–90 data given in SC/48/NA14Rev of 42,500 was different from the unstratified abundance estimate presented in SC/48/NA1 (56,700). SC/48/Rep1 had identified a number of differences in the implementations (p.280) and the AEWG had concluded that the estimates were not comparable. However, some members of the Committee believed that the source of the differences should have been investigated more fully and that they cast doubt on the validity of the 1995 estimate. Cooke stated in Annex N1 that it was 'not worth going to the trouble of calculating an estimate for 1995' but in discussion noted that part of this decision was that he did not have the resources available to him to produce the software for calculating the estimates as quickly as the NCC.

Butterworth (Annex N2) examined one of the several factors identified in SC/48/Rep1 (different measurement error models) and noted that this difference alone would increase the estimate from SC/47/NA14Rev by some 12%. Because of substantial differences such as these, the AEWG had noted that the two estimates are not directly comparable and as such do not provide any information with respect to the verification process. The AEWG recalled that the main focus of its work was to validate methods for analysing data from 1995, where double-team data were collected as part of the survey (IWC, 1996g). The AEWG reaffirmed its view that because of differences in methodology, apparent differences between the NCC and Cooke estimates for 1989 cannot be used as a justification for questioning the validity of the 1995 estimate.

The AEWG had hoped and expected to see alternative estimates of abundance presented based on two conceptually comparable, but technically different, implementations of the hazard probability approach as part of its verification process. However, it was not within its resources to produce alternative estimates and it was dependent upon the efforts of its individual members. The AEWG appreciated the efforts of Cooke in this regard, and it was unfortunate that no such alternative calculations were able to be produced. The AEWG had agreed that 'given the additional verification that had been accomplished, the results presented in AE17 [SC/48/NA1] had been verified to its satisfaction'.

(4) APPARENT INCONSISTENCIES IN ESTIMATES FOR THE NORTH SEA

Annex N1 referred to differences in point estimates of abundance for some parts of the North Sea between surveys carried out in 1989 (5,580 – SC/48/NA1), in 1994 (3,000–4,000 – SC/48/NA17) and 1995 (20,294 – SC/48/NA1), noting that such differences might be implausible to lay-people and that the high 1995 estimate from this area would have been substantially reduced if a vessel-specific estimate from the distance experiments had been applied. This was discussed at some length by the Committee.

In discussion a number of points were made indicating that such comparisons were inappropriate.

(1) The North Sea area was only one sub-area in the large area covered by the NILS-95 survey. It is not surprising that the distribution of whales within a large survey area might change seasonally, with resultant changes in abundance in sub-areas. This is well known from other surveys (e.g. Palka, 1995) and is related to environmental factors such as food availability. This is supported by the fact that changes in estimated abundance between 1989 and 1995 are apparent in other survey blocks in the opposite direction. For example the abundance estimate for the Kola region was more than 10 times higher in 1989 than in 1995 (SC/48/NA1).
(2) Important differences in the objectives, methodology and survey blocks are particularly relevant to the comparison between the SCANS-94 and NILS-95 surveys (SC/48/NA17), rendering interpretation of differences difficult, if not impossible, even if Item 1 above is not considered.
(3) An average (instead of a vessel-specific bias) correction factor for radial sighting distance was used in the abundance estimate because analyses of the distance experiments indicate that, when the variance between days for individual observers was taken into account, there was no significant added variance due to observers, vessels or platform (SC/A96/AE34).
(4) If abundance in the North Sea was overestimated in 1995 as a result of the use of an average distance bias correction factor, underestimation of abundance in other survey blocks would be expected and the net effect will be approximately unbiased.

After addressing these factors the Committee considered how to interpret the abundance estimate endorsed by the AEWG and presented in SC/48/NA1. It was noted that the objective of the work in recent years had been to obtain an estimate of abundance adequate for use in the *CLA* of the RMP, not to obtain a 'perfect' estimate. The latter is not an achievable scientific goal. Indeed, as noted above, SC/48/Rep1 had identified a number of areas for future work.

Some members believed that there were some parallels with the 1992 situation when the Committee had accepted an abundance estimate for this area without a full set of simulation tests and without independent recalculation of the results. They noted that the fact that the estimate subsequently turned out to be erroneous had led the

Committee to decide that it was determined to avoid its previous mistake of prematurely accepting an abundance estimate (IWC, 1996b, p.62). They further noted that despite the earlier discussion (Issue 3 above), they remained concerned about the considerable differences between the estimate of 42,500 in SC/47/NA14Rev for 1988-90 for the case of no covariates, and the estimate for this case of 56,721 in SC/48/NA1. Although they could accept the conclusion that the estimates would be adequate for implementation of the RMP, they did not consider the estimates scientifically validated until the tasks identified below had been satisfactorily completed.

Most members disagreed that the current situation paralleled that in 1992, noting that the process undertaken by the AEWG had substantially advanced the Committee's work since 1992, thanks in no small degree to contributions by Cooke. This work had greatly reduced the possibility of the Committee accepting an erroneous estimate and had ensured that the estimates had been adequately validated taking into account the procedures identified in the Report of the Verification Working Group (IWC, 1996h).

The Committee **agreed** that the estimates of abundance presented in SC/48/NA1 are adequate for use in the RMP.

The Committee also agreed that some analyses should be carried out during the coming year and completed by next year's meeting. These are:

(1) additional simulation tests to more fully explore the statistical properties of the NCC estimator and for the purpose of further confirmation that the software was adequately verified (Wallløe indicated that this work would be undertaken in Norway during the coming year with respect to the method described in SC/48/NA1, based on advice from the Steering Group, see below);
(2) to reconcile any differences between comparable estimates obtained from the NCC (as described in SC/48/NA1) and Cooke (SC/47/NA14Rev) implementations by identifying the main causes of any such differences (Cooke undertook to complete a comparable analysis of the NASS-89 and NILS-95 data for his implementation);
(3) to further assess the implications, in terms of possible bias in the NCC estimates, of the lack of model fit to the Bernoulli data, with respect to the marginal distribution of radial distances (Wallløe indicated that this work will be undertaken in Norway).

The Committee agreed that specification of the details of these analyses should be determined by a Steering Group to be appointed by the Chairman. It was agreed that the intention of these analyses is not to preclude further development of the methods, but such work falls outside the terms of reference of the Group.

At the close of the discussion the Committee expressed its thanks and admiration to Polacheck, the AEWG Chairman. Under his wise guidance the AEWG had undertaken a considerable volume of work on the Committee's behalf.

8.3.2 Future surveys

The Committee did not have sufficient time available to fully review the designs specified in SC/48/NA4 relative to the requirements specified under Item 7.1 and Annex K, particularly as the discussions under Item 7.1 were not completed until the penultimate day. However, the Committee did provide general advice and comments about the design presented, as below:

SC/48/NA4 presented an overview of a proposed six year sighting survey programme for northeastern Atlantic minke whales. The following issues relative to survey design and conduct were discussed in the context of previous northeast Atlantic minke whale surveys:

(1) data quality variation between the 11 vessels during the 1995 large scale survey;
(2) the fact that a series of smaller scale surveys would enable better control of training and selection of qualified personnel and would spread survey costs over years;
(3) the importance of observer training and testing;
(4) expansion of the survey region to include the entire CM block;
(5) international participation;
(6) annual reports to and reviews by the Committee on the series of surveys; and
(7) further collection of dive data in 1996.

Two different designs were considered in SC/48/NA4 using a series of small scale surveys across six years which would in total provide slightly more sampling effort than the 1995 survey:

(1) to cover the entire survey region with two vessel months each year; and

Table 2

Comparison of abundance estimates for 1989 and 1995; 95% confidence intervals, evaluated as per *Rep. int. Whal. Commn* 42:235, are given in square parenthesis.

Blocks 1988/89	Blocks 1995	Abundance 1989		Abundance 1995	
BA	BAE	5,354	[2,444; 11,774]	16,101	[9,068; 28,588]
	BAW			4,062	[2,439; 6,764]
GA	GA	2,522	[1,107; 5,746]	10,615	[6,987; 16,127]
KO	KO	14,554	[8,617; 24,583]	962	[342; 2,706]
BJ	BJ	2,549	[1,689; 3,846]	7,164	[4,556; 11,266]
VS	VSS	2,988	[1,907; 4,683]	1,959	[1,249; 3,073]
	VSN			1,672	[1,145; 2,442]
	VSI			345	[160; 742]
SV	SV	4,052	[2,234; 7,350]	4,719	[3,439; 6,476]
	SVI			2,691	[1,555; 4,657]
NO	NON	9,519	[6,008; 15,081]	3,357	[2,033; 5,542]
	NOS			22,678	[16,750; 30,704]
FI	FI	2,626	[1,342; 5,137]	5,974	[3,382; 10,552]
LO	LOC	3,192	[1,855; 5,492]	2,462	[1,583; 3,829]
SN	NSC	11,935	[6,259; 22,757]	7,070	[4,478; 11,163]
NS	NS	5,429	[2,814; 10,475]	20,294	[12,338; 33,381]
NV	NVN	1,803	[544; 5,977]	4,835	[2,162; 10,812]
JM	JMC	847	[434; 1,655]	1,339	[481; 3,728]
Total		67,380	[46,572; 97,485]	118,299	[96,681; 144,750]

(2) to cover a different sub-area more intensely with two vessel months each year for five years and an additional year reserved to cover the area that had had the poorest coverage due to unfavourable sighting conditions. SC/48/NA4 had recommended the latter.

During discussion, the cost and problems of managing a large scale survey were recognised as very practical constraints. However, concerns were raised about problems that might be encountered in interpreting survey results that were obtained from different areas in different years in light of the distributional shifts observed between 1989 and 1995. The Committee **recommends** further consideration be given to the survey design in light of the following ideas:

(1) use a similar design as in 1995 with a higher priority and greater resources spent on training and coordination, if adequate funding is made available;
(2) find a suitable compromise between the suggested two designs such as doubling the size of the areas with less effort per year but sample for two years in some rotation;
(3) evaluate designs by examining observed spatial variability in the survey data and catch statistics;
(4) evaluate whether the current block stratification is appropriate; and
(5) use a different randomly chosen set (instead of a fixed set) of tracklines for each survey of the same area.

In addition, the following suggestions (in no particular order) were made relative to the survey protocol and data collection:

(1) to the extent feasible, use the same vessels and observers each year;
(2) consider rotation schemes for observers which maintain team integrity (i.e. pairs of observers remain constant);
(3) avoid vessels with masts in front of the observation platforms;
(4) develop standard methods for collection of whale angle and methods for measuring its bias and variance;
(5) collection of dive data should be widened relative to geographic areas and time of day;
(6) plans for collection of dive data should be considered as an integral part of the overall survey plan and the relative resources and effort expended between surveys and collection of dive data should be considered;
(7) annual changes in ice extent in the northern blocks should be considered relative to the survey design and area calculations;
(8) double platform effort should be used exclusively and all observers should track a whale after initial sighting as specified in the protocol; and
(9) conduct of distance experiments should be re-evaluated on the basis of the 1995 experiment.

The Committee encourages individual members to submit comments and suggestions relative to the design and conduct of this particular survey to the Institute of Marine Research in Bergen; in particular scientists who participated in the 1995 survey and in the review of the analysis.

9. COMPREHENSIVE ASSESSMENT – SOUTHERN HEMISPHERE BALEEN WHALES

9.1 Research programme for large baleen whales

9.1.1 Progress with acoustic studies

Last year the Committee had encouraged further research and development leading towards incorporation of acoustic techniques into Southern Ocean blue whale surveys. It had welcomed the information that a feasibility study combining visual and acoustic survey techniques was to be undertaken off California. A report of the work was available this year in SC/48/NP19.

Preliminary results show that visual and acoustic methods can be merged successfully. Blue whales were heard at least six times more frequently than they were seen, and fin whales three times more, although these comparisons do not take into account the fact that the areas over which whales are acoustically detected and sighted are different. Acoustic surveys can be conducted in conditions where sightings were not possible, e.g. 24 hours per day and in poor weather. The range of detection was conservatively estimated to be 3–4 times greater from acoustics than sightings. Further analyses are under way to locate and track vocalising blue and fin whales reliably, to provide information on movement patterns relative to the vessel and for independent comparison with sighting results. The authors believe that combining the two methods offers significant improvement over visual methods alone, particularly for counting large, vocally-active baleen whales in areas where sighting densities are low.

Concerns were raised in discussion over problems in the comparability between acoustic and visual sightings. Factors to consider included the greater range of detection of calls compared with sightings, the difficulty of determining from the calls how many animals were present, and the proportion of non-vocalising animals. In response, Clark explained that these concerns were largely being met in the analyses. Blue and fin whales did not appear to avoid vocalising, although there are seasonal variations. The Committee noted that, for example, very few sounds were recorded on the Japan/IWC blue whale cruise (see SC/48/SH9 and 9.1.2 below), even in areas where blue whales were sighted in the vicinity. There is also a problem where vessel speed exceeds the speed at which existing acoustic devices operate effectively, but thinner cables for use at higher speeds are being developed.

The Committee **recommends** that such development work should continue, together with work to develop a theoretical and practical framework for combined visual/acoustic assessment surveys.

9.1.2 Report of the Japan/IWC blue whale cruise

As proposed last year, a blue whale cruise was conducted south of Australia from 4 December 1995–3 January 1996 (SC/48/SH9). It was a joint venture between Japan and IWC, with cooperation from Australia and the US, using the two 1995/96 minke whale assessment vessels. The main aim was to obtain scientific information relevant to developing shipboard identification methods for separating 'true' and pygmy blue whales. Research techniques included skin biopsy, photo-identification, photogrammetry and acoustics.

Relatively large numbers of blue whales were sighted in inshore waters off Rottnest Island, Western Australia (*ca* 32°00'S, 115°00'E) and off Portland, Victoria (*ca* 38°30'S, 141°30'E). The cruise was successful in meeting the primary objective of locating concentrations of blue whales, but the number of biopsy samples obtained was low and photogrammetry proved difficult. Most blue whales were tentatively identified as pygmy blue whales (but see Annex E, Appendix 2).

Acoustic results were reported in SC/48/SH26. Vocalising blue whales were scarce in areas where blue whale sightings were common; the calls recorded were generally short and of high frequency. In 97 hours of monitoring, there were approximately 3.7 hours of tape containing sounds

attributable to pygmy blue whales. The Committee agreed that while no biopsy samples could most likely be attributed to calling animals – indeed no vocalisations could be attributed to animals seen – and the sounds had some similarity to those of fin whales, they were most likely to have come from the only large baleen whale seen in the area, i.e. pygmy blue whales. It noted that regional differences have been reported for blue whale sounds, but that there is a need for more acoustic recordings of blue whales from high latitudes.

Genetic analyses involving biopsy material from the cruise – collected only from animals provisionally identified as pygmy blue whales by experienced crewmen – and other samples, from southern Australia, California, eastern tropical Pacific, Gulf of California and samples from strandings in the Northern and Southern Hemispheres, were reported in SC/48/SH5. The analyses had been conducted in response to last year's recommendation that genetic 'types' be established for 'true' and pygmy blue whales (IWC, 1996b, p.63). All the samples were genetically similar, with surprising similarity between Northern and Southern Hemisphere sequences. The Committee noted the need to collect further blue whale samples, and to include those, particularly from 'true' blue whales, sampled on recent minke whale assessment cruises. It was advised that the latter samples were being forwarded from Japan to the La Jolla laboratory via the Secretariat, but that there had been difficulties in obtaining the necessary UK CITES permit. The Committee **recommends** that passage of the samples through the UK be given high priority to permit analysis as soon as possible, and requests that IWC member nations try to facilitate this.

The Committee was informed that the results of mitochondrial DNA studies of blue whale material from Chile and Antarctic Area V (from JARPA) would be available shortly, and it was agreed that the Japanese and US groups working on blue whale samples would compare the results of their analyses.

A genetic analysis of blue whale samples from Iceland, Australia, New Zealand and California (SC/48/O38) had found similarly low variability between samples. The Committee agreed that further samples from a wide range of regions were needed; approximately 12-20 samples would be required from each local population.

The Committee noted that some progress had been made in response to last year's recommendations concerning the establishment of genetic 'types' for 'true' and pygmy blue whales, but that the results so far indicate that blue whale taxonomy may well be more complex than previously thought. In this uncertain situation, and in light of the proposal for a second blue whale cruise (SC/48/SH11), the Committee reviewed and concurred with the conclusions of a small working group established under Donovan to address the issue (Annex E, Appendix 2). The Committee **recommends** that:

(1) Further work be carried out to develop a visual identification key for blue and pygmy blue whales. This should include examination of blowhole shape as a possible diagnostic character.
(2) Further consideration should be given to developing appropriate photogrammetric methods for measuring blue whales at sea.
(3) Acoustic work on the recognition of signals from blue and pygmy blue whales be continued.
(4) An inventory of material, both osteological and soft parts lodged in museums and other institutions should be compiled as a basis for further taxonomic and genetic work on blue and pygmy blue whales. Bannister undertook to develop an initial list of contact persons.
(5) Institutions should cooperate in the sharing and analysis of genetic material from blue and pygmy blue whales.
(6) When analysing genetic material from blue and pygmy blue whales, nuclear DNA sequences should also be examined to investigate *inter alia* the degree of possible hybridisation.
(7) Consideration be given to establishing an acoustic database of blue whale vocalisations.

The Committee noted that the following materials are appropriate for genetic analyses: skin, muscle, and other soft tissue; baleen – preferably including the gumline; and bone in that order of priority.

By analogy with the Northern Hemisphere, a period of high vocal activity of blue whales might be expected between December and mid-March to the south of 60°S. The Committee therefore **recommends** that consideration be given to assigning some priority to blue whale research during any Antarctic minke whale cruise. Suggested work is given in Annex E, Appendix 2.

9.1.3 Future work

A proposal for a second blue whale research cruise was contained in SC/48/SH11; it was referred to the working group under Donovan. The Committee welcomed the very generous offer of Japan to provide two vessels and logistical support for the cruise.

As outlined in Annex E, Appendix 2, the Committee **recommends** that a cruise to survey blue and pygmy blue whale concentrations be undertaken, off Peru or Madagascar, as part of the IWC-SOWER programme discussed under Item 9.2.2. It agreed that a Steering Group comprising Bannister, Best, Donovan and Kato be established. A decision on which region should be surveyed will depend on the decision on a 1996/97 Southern Ocean survey, given that the same vessels will be involved. Given also that full cooperation of the relevant coastal State is essential, it **recommends** that relevant governments and the Secretary provide assistance in obtaining any necessary permission to enter the EEZs of coastal states and facilitate the conduct of the cruise. The Committee agreed that the detailed recommendations in Annex E, Appendix 2 should be referred to the proposed planning meeting. It **recommends** that such a meeting should take place consecutively with any planning meeting for the 1996/97 Southern Ocean survey (see Item 9.2.2). Funding for attendance by two Steering Group members will be required (2 × £1500) and the financial implications for the cruise are discussed under Item 22.

9.2 Minke whale survey

9.2.1 Cruise report

The report of the 1995/96 minke whale assessment cruise in Area VI was given in SC/48/SH2. Survey design and data forms had been modified slightly since the previous cruise. Some difficulties had arisen because of poor weather and an inability to locate the ice edge accurately. Further improvements to survey design are still possible. Some concern was expressed over the increasing trend in the ratio of minke to 'like minke' sightings in this and previous surveys. It was pointed out that survey methodology had remained fairly constant: one contributing factor might be the relative experience of observers; another might be the effect of weather on the ability to identify species.

An analysis of abundance estimates from the minke whale assessment cruises from 1978/79 to 1990/91 indicated a non-significant rate of decline of 1.5% per annum (SC/48/SH25).

Concerns were raised over the relatively small number of minke whales seen on a 1996 Australian hydroacoustic and oceanographic krill assessment cruise in Area IV (SC/48/SH22), where, however, relatively high numbers of humpback whales had been recorded. The Committee identified a number of possible reasons for this and agreed that the Australian survey data were insufficient to estimate minke whale abundance, but could be used to estimate humpback abundance. The Committee looks forward to receiving such an analysis next year, including consideration of the associated environmental data collected.

9.2.2 Cruise plans in 1996/97 and 1997/98

Last year the Committee had an extensive discussion on the need to establish a third IDCR, recognising that this had become synonymous with its major ongoing project, the Southern Hemisphere minke whale assessment cruise programme (IWC, 1996b, p.83). This had broadened into a discussion concerning the overall objectives and priorities of the Committee.

In the light of this the Committee agreed that it was important to review the basis of the minke whale assessment cruises and consider the need for their continuation given the identified objectives and priorities (see Item 20.1). Annex O formed the basis for this discussion.

The Committee considered the information that the cruises had provided thus far and the information that they would be likely to provide in the future.

The Committee stressed the importance of time series of data in monitoring the abundance and considering the status of cetaceans in the Southern Ocean Sanctuary. It noted that the cruises thus far, whilst largely directed at minke whales, also provide valuable information, and often the only information, on other whale species in the Sanctuary, especially blue and humpback whales. It agreed that it was important to continue the cruises with the primary focus on abundance estimation, at least until the third circumpolar series had been completed. This series of cruises, unlike the previous two, extends as far north as 60°S and was 61% complete. The value of the data thus far collected will be considerably reduced if this series is not completed.

The Committee agreed that whilst at present it is important to follow essentially the same methodology as before to preserve comparability, certain changes were desirable in the light of discussions on the Committee's objectives and priorities. For example, Annex E (Appendix 2) had recommended that some survey time be allocated to identified studies on blue whales, related to photo-identification, biopsy sampling and acoustics. The Committee **recommends** that this be done.

The Committee agreed that the Antarctic and blue whale cruises should be considered as part of a broad programme of research in the Southern Ocean. Given the discussions under Item 20 it **recommends** that this be designated the IWC Southern Ocean Whale and Ecosystem Research Programme (the IWC-SOWER programme). As discussed below the emphasis on environmental research and cetaceans will increase as work on such matters is developed by the Standing Working Group established under Item 6. The Committee noted that this programme will contribute significantly towards its objectives and priorities as discussed under Item 20.

The Committee agreed that final details of the cruises for 1996 and 1996/97 should be referred to a joint planning meeting for the blue whale and Antarctic cruises referred to under Item 9.1.3 and Annex O. It also noted with approval that recent cruises have dedicated some effort to collecting associated biological and oceanographic data and **recommends** that this be continued and expanded where appropriate. In conclusion, the Committee strongly **recommends** that the Antarctic cruises proposed under the IWC-SOWER programme take place (in conjunction with the blue whale cruise discussed under Item 9.1.3), and that, following discussion in Annex E (Appendix 3), the 1996/97 cruise takes place in Area II E. The Committee welcomed the very generous offer of Japan to provide two vessels and logistical support for the cruises.

In the longer term the Committee reaffirmed the importance of coordinated planning of research with other organisations discussed under Items 5 and 6. It recognised that its expertise in estimating cetacean abundance may well be of most value as its contribution to broad cooperative programmes of this nature. It **recommends** that the facilitation of this be considered by the Standing Working Group established under Item 6. In this context it noted that should a suitable research programme be developed, a single year delay in the completion of the third circumpolar series would not compromise the value of the time series.

The Committee noted the potential for a number of broader analyses of the existing IWC/IDCR data. This has been greatly facilitated by the development of the IWC-DESS and consideration should be given to analysing these data in conjunction with existing oceanographic and biological databases for the Antarctic.

9.2.3 Development of the basis for a 1997 review of Antarctic assessment cruise abundance estimates

Analyses of the results of the 1993/94 and 1994/95 cruises were provided in SC/48/SH6 and 7 respectively. A detailed discussion of their results appears in Annex E (Item 5.1.3). Arising out of those discussions, the Committee agreed that a number of issues require further review. They include:

(1) the increase in 'like' minke whale sightings in recent surveys;
(2) the correct school-size estimator to use;
(3) the need for recalculation of the factor that converts closing-mode density estimates to passing-in-IO mode density estimates;
(4) the methodology for making valid inter-survey comparisons for investigating trends in abundance; and
(5) the possibility of 'biased counting' while in IO-passing mode.

The prevalence of double-counting had been explored in SC/48/SH24, through modelling whale behaviour and distance/angle measurement error by observers and using sightings from the barrel in earlier surveys. This approach neglected the possibility of genuinely different schools occurring in close proximity being scored as the same school, so to that extent the results could be considered as representing maxima. A more probable approach to the problem of double-counting in Antarctic minke whale assessment cruises was developed at the meeting (Annex E, Appendix 4).

In response to a query over the extent to which observers on Antarctic surveys track sightings as in the North Atlantic, so as to distinguish between 'new' and 'old' sightings, it was

reported that primary observers (in the barrel) did not distinguish in this way; groups were typically larger than in the North Atlantic and seen at greater distances, so that many more cues would have to be recorded. The question of re-examination of resighting data using existing methods for the North Atlantic and possible new methodology was referred to a small working group under Borchers. Its report is detailed in Annex E (Item 5.1.3). Based on its findings, the Committee **recommends**:

(1) the development of objective duplicate identification methods for the analysis of IO data, using currently available data from IWC Antarctic surveys (including resighting data from the upper bridge, and IO tracking data from the 1987/88 survey);
(2) further analysis of the probability of biased counting on the Antarctic surveys, as outlined by the working group; and
(3) further investigation of appropriate values for swimming speeds for minke whales, for use in (2) above.

A small group under Butterworth drew up a comprehensive list of specific items for the review of abundance to be undertaken at the 1997 meeting (Annex E, Appendix 6). It includes a number of other items for attention arising from the Southern Hemisphere sighting data.

9.3 Humpback whales

9.3.1 Progress on short-term assessment work

9.3.1.1 CATCH AND MARKING DATA CODING

Allison reported that coding and validation of the 1940s catch data were complete, coding of the 1930s data were complete and validation was in progress, and catch data for the 1920s were being coded. A large pelagic dataset for 1931–72, previously coded by a Norwegian bureau, was being validated. No progress had been made with marking data; the 'Discovery' scheme data from the mid 1950s had previously been coded and validated.

The South Georgia catch data could be coded if requested. Only data from 1913/14 onwards were available, although the largest catches were between 1908/09 and 1912/13. The Committee agreed that revised Soviet and *Olympic Challenger* catches should be incorporated into the IWC databases.

9.3.1.2 BIOPSY SAMPLING

Progress since last year is recorded in Annex E (Item 6.1.2). The Committee welcomed the additional sampling effort but again **recommends** as last year, that intensified sampling is required in Areas II and III.

The Committee was informed of problems similar to those encountered with blue whale samples (see 9.1.2) in transferring samples obtained on minke whale assessment cruises to analytical laboratories. It **recommends** that the Secretary make a further approach for CITES clearance, stressing the international importance of the work, and requests member nations of the IWC to assist in the process. It also stressed the need for more sampling from breeding grounds/migratory corridors, to assist in elucidating stock-mixing on the feeding grounds.

9.3.1.3 PHOTO-IDENTIFICATION

Given little progress in implementing last year's recommendations (IWC, 1996b, p.64), a working group under Pastene had been asked to draw up guidelines for development of the Southern Hemisphere Centralised Humpback Whale Photograph Directory, and to review the likely costs of the Antarctic Catalogue.

Based on its recommendations, the Committee **recommends** establishment of:

(i) a *Centralised Directory*, to be administered by the Secretariat. Options and a proposed format are given in Annex E (Item 6.1.3.1);
(ii) a *Centralised Antarctic Catalogue*. Its creation and curation should be put out to contract by the IWC. However, at this stage there is insufficient information to formulate the terms of a contract, and the Committee **recommends** that a person should be appointed and funded to:
  (a) assess and collate the current collection at the IWC Secretariat;
  (b) assist in contacting all individuals and groups holding Antarctic photographs;
  (c) assess the extent of yearly contributions to the catalogue;
  (d) offer advice on storage, retrieval and transfer.

Once completed, information on the above should be presented to the Scientific Committee so that a request for proposals from institutions/groups to maintain the catalogue can be issued.

The Committee **recommends** that Carlson should undertake these tasks, for which a nominal budget (£200) has been prepared.

A number of other issues considered under this item are considered below.

(1) *Review of an Australian catalogue*. Carlson had undertaken the review and reported that poor photographic reproduction or poor photograph quality prevented useful intra-catalogue fluke matching. She believed it would be more effective to develop a system for standardising assessment of photographic quality and distinctness of markings, against which original photographs from this and other catalogues could be scored.
(2) *Assessment of photographic quality on the YONAH (Years of the North Atlantic Whale) project*. Prior to the use of the 5,000 or more images in the catalogue, they are to be assessed for photographic quality and distinctiveness of natural markings. Criteria are being developed for consistent application; the resulting classifications could then be used sequentially in analyses to test for their effect.
(3) *Progress in developing a computerised sorting/matching system*. The Committee was informed of a promising Australian pilot project, based on defining a grey-scale index for each fluke for comparison, but the costs of development were likely to be prohibitive at present. A related study concentrating on sperm whale flukes was discussed by the Committee. Although not yet directly applicable to humpback whales it is included as Item 9.3.1.4 below.
(4) *The need to include photographs of aspects of the body other than flukes (flanks, dorsal fin, 'knuckles')*. The Committee recognised the importance of this particularly in areas, such as the Antarctic, where fluking behaviour was infrequent.
(5) *The need for communication between holders of photographs from high latitudes with those holding catalogues of photographs from low latitudes*. The Committee reiterated the importance of this.

9.3.1.4 MATHEMATICALLY BASED TECHNIQUES FOR RECOGNITION ANALYSES

A working group discussed SC/48/O 24 which presents some results from the application of wavelet transform to photo-identification of individuals, using a limited set of sperm whale fluke edges as an example. This technique facilitates interpretation and comparisons of cues in large databases. The application of digital signal processing techniques (such as wavelet transform) for automated photo-identification is expected to be significantly faster than present methods. Some applications already exist, for example seal recognition (Hiby and Lovell, 1990). The technique should also be applicable to other identification keys, such as dorsal fins, black and white patterns or sound sequences.

The use of automated signal processing techniques for individual recognition appears promising because in recent years the requirements for hard- and software have become few and the costs low. CD-ROMs and the Internet greatly facilitate data exchange. However, it is recognised that for cetaceans different recognition algorithms will be better suited for the different objects (e.g. sperm whale fluke edges, humpback pigmentation patterns, dorsal fins). Further examination is needed of the family of automated signal processing techniques to (i) identify specifications required for the various recognition patterns, and (ii) resolve various potential problems in the signal processing. This requires a fuller exchange of information between the disciplines of whale photo-identification and signal processing research. In addition, the orientation of the object (the fluke) may influence the effectiveness of the classification process. The development of 3D-models was suggested to investigate this. It was also suggested that the algorithms of these models be compared using standardised data sets with agreed specifications.

The Committee welcomes further development of work along these lines and **recommends** that scientists with expertise in automated signal processing for recognition patterns be encouraged to participate at next year's annual meeting.

9.3.2. Progress in long-term assessment work

9.3.2.1 HISTORICAL CATCH AND OTHER DATA

Last year the Committee was informed of the examination and coding of 'Discovery' Investigations data held in the UK. The Committee was informed that more data had now been entered into the database, that the contract had now finished and further funding to complete the project is being sought.

9.3.2.2 ABUNDANCE ESTIMATES

(A) SHORE BASED SURVEYS

No new estimates were available. Another survey is currently underway on the Australian east coast; results should be available next year. A further aerial survey off the Australian west coast is due in 1997; results should also be available at next year's meeting.

(B) OTHER SURVEYS

SC/48/SH27 detailed preliminary results of a line transect survey from a platform of opportunity (research trawler) on the northwest shelf of Australia in August 1995. Whale density estimates were obtained using a hazard rate model fitted to the perpendicular distance distribution.

A preliminary estimate of numbers off the Abrolhos Bank, Brazil (SC/48/SH8) had used a Bayesian mark-recapture approach. The Committee recognised the importance of data from this breeding ground and encouraged continuation of the study, in particular to obtain increased sample sizes and information on between-year resightings.

The preliminary results of the Australian survey in Areas IV and V (reported in SC/48/SH22 and already discussed under Item 9.2.1) were noted. There are sufficient sightings for an abundance estimate, which should be available at the next meeting.

The Committee was informed of plans to provide an estimate of abundance of Tongan humpback whales using at least five years of photo-identification data; the impression is that abundance there is low.

Too few whales for abundance estimation had been seen on a 50-day cruise in the southern Indian Ocean where 12 groups of 33 humpbacks had been seen. The Committee **recommends** that identification photographs obtained be incorporated into the Antarctic Catalogue in due course.

The Committee noted that a third set of IWC/IDCR circumpolar surveys had begun since the last estimates of humpback whale abundance (Butterworth *et al.*, 1994). The Committee **strongly recommends** that the previous (unpublished) estimates should be rechecked and updated using whatever information is available from the third set of cruises, both to provide abundance estimates and to permit further examination of population trends.

9.3.2.3 REVIEW OF WORK REQUIRED TO COMPLETE THE ASSESSMENT

The Committee noted that the main obstacle to the use of previous approaches for assessment (HITTER, and possibly FITTER) was the absence of an agreed catch series. In the interim, it might however be useful to set priorities amongst the different 'stocks'.

Most members considered that Areas IV and V were natural choices as priority stocks for assessment, given the greater amount of information on migratory links (from historical data) and the recent information on current trends from coastal surveys. Recent JARPA information from those areas could also be useful. A concern was expressed, however, that concentration on those stocks (for which there was much historical evidence on status) might simply perpetuate ignorance of other southern stocks, some of which must have been equal to or greater in number than those in Areas IV and V. Nevertheless the Committee concluded that some information from assessments of those two areas, e.g. likely MSY rates, might be critically important in attempting to assess the other stocks.

The Committee agreed that assessments should be based on breeding rather than feeding stocks. Recognising the need to allocate catches on the feeding grounds to breeding grounds, in a number of cases without direct evidence of linkages, either qualitative or quantitative, assessments would have to proceed on the basis of alternative plausible scenarios of allocations to breeding grounds.

The views of a small working group set up under Bannister to develop initial allocation scenarios for further discussion are given in Annex E (Item 6.2.3). The Committee agreed with their conclusions, and noted that for progress to be made, certain work would have to be undertaken. The key factor in the catch series to be used was the revised Soviet catch data. Zemsky, Tormosov and Mikhaliev stated they would endeavour to obtain as much detailed information on the humpback whale catch locations as possible before the next Annual Meeting. In welcoming this initiative the Committee expressed its gratitude for the effort already made by the Russian scientists to retrieve and preserve the true whaling data.

Information on biological parameters would also be required. Because observed increase rates off Australia have been so high (10% or greater), the Committee recognised that independent information on reproductive and survival rates would be useful.

OTHER

A study of mtDNA haplotypes in humpback whales from Areas IV and V (SC/48/SH10) showed no significant differences in haplotype distribution between Areas IV and V, possibly because of the small sample size and its geographical distribution. It was agreed that further examination of samples especially from Area IVW is needed, and that a direct comparison with animals from the east and west coasts of Australia was desirable. The Committee welcomed the information that Baker and Pastene were collaborating on a comparison of samples from feeding and breeding grounds.

Information on records from Peru between 1990 and 1996 (SC/48/SH1) indicated the presence of at least some animals in tropical waters in the southern summer, further inshore than previously indicated. The Committee encouraged the authors to undertake proposals for resumption of systematic research in the region. It noted the major El Niño event in 1990/91 which might have accounted for the presence of humpbacks in tropical waters in summer.

SC/48/O 39 drew attention to the possibility of some similarity between the situation on the south coast of Oman and northern Chile/Peru, where humpbacks were present throughout much of the year, and where predictable food supplies may provide suitable conditions year-round. The presence of humpbacks in low latitudes in summer off Namibia and in the Coral Sea was also noted.

SC/48/SH29 provided information on Soviet recoveries of foreign marks, twenty of which were from humpbacks. Most conformed with previously documented migratory links, particularly between Australasian waters and Areas IV and V, but two animals showed considerable longitudinal movements, although there was some doubt about the exact dates and locations of recovery. The Committee expressed its appreciation to Tormosov and his colleagues for their efforts in salvaging this very important information.

A review of data from several sources, including shipboard and shorebased surveys and acoustic sampling (SC/48/SH14) revealed three possibly distinct migratory paths in the southwest Indian Ocean, one along the South African coast to Mozambique, one along the Madagascar ridge to Madagascar and another up the centre of the Mozambique Channel, possibly to the Comores Islands or Aldabra. The information had been used in establishing possible breeding ground/feeding ground linkages (see Annex E, Item 6.2.3).

9.4 Catch history revisions

Zemsky introduced the publication (Zemsky *et al.*, 1995b). In it were documented the revised Soviet catches that he and his colleagues had been collecting for the past few years from original sources. A few minor corrections were needed but this remains the best available list of catches. Work is still continuing to correct errors and fill gaps in information.

At this meeting, data were provided for the *Sovietskaya Ukraina*, 1959/60-1971/72 (Annex E, Appendix 5), representing a total take of 73,778 whales compared with the reported catch of 41,723. Information had been obtained from reports of expedition commanders, catcher boat captains and scientific groups. Almost complete data had now been obtained for 1963/64–1968/69, but less complete data were available for other seasons. It was hoped to continue the work and complete the data base.

The Committee noted that there had been particular difficulties in reconstructing *Sovietskaya Ukraina*'s catch because of the large number of expeditions to the Antarctic (she and *Slava* had undertaken 50, more than those of the other two combined), and the volume of documents, including individual whale 'passports', whaling review reports, scientists' and whaling captains' reports; they were stored in state and local archives and time and manpower available to examine them were limited. The authenticity of the records was supported by the personal experiences of Zemsky, Berzin, Tormosov and Mikhaliev, each of whom had participated in Antarctic expeditions and headed laboratories for some 15–30 years.

On behalf of the Contracting Party of the Russian Federation, Stankaninets asked that a statement concerning the use of official statistics be included in the sub-committee's report (Annex E, Item 7).

The Committee expressed its sincere appreciation to Zemsky, Tormosov and Mikhaliev for their efforts in collating these very important data, and hoped they would be able to continue their work in the coming year.

As promised last year, Kock provided a review of Southern Hemisphere catches by the *Olympic Challenger*, 1950/51–1955/56 (SC/48/O 28), based on unpublished notes by crew members, pursers' logs and two German scientists' reports. There were considerable discrepancies between blue, fin and humpback whale catches previously reported and now available. The Committee expressed its appreciation for this work which is now effectively complete.

9.5 Other stocks of Southern Hemisphere baleen whales

Given the limitations of time, the Committee accepted a compilation of information of the main features of relevant documents given in Annex E, Item 8.

10. COMPREHENSIVE ASSESSMENT – NORTH PACIFIC BRYDE'S WHALES

This year, the Committee completed the Comprehensive Assessment process for North Pacific Bryde's whales which began last year.

10.1 Catch data

Catches continue in the Philippines. SC/48/NP4 reported that one whale is known to have been taken off Mindanao in March of this year, and active whaling continues by several crews from Pamilacan Island, Bohol and Camiguin, Mindanao. Information was provided to the authors that catches by the Pamilacan group continue at about five per year. While catch per effort of search is extremely low, the same vessels hunt whale sharks and manta rays, which are much more abundant, and thus find it worthwhile to continue whaling despite low returns from whaling alone.

Brownell noted that USSR pelagic catch data tabulated last year (IWC, 1996c, p.148) for the period before initiation of the international observer program in 1972 may not be complete or accurate. It has recently come to light that Soviet catches of other species in the Antarctic and North Pacific and in other areas were seriously under-reported during the 1950s to the early 1970s (Yablokov, 1994; Zemsky *et al.*,

1995a). Ohsumi pointed out there was no need for Soviet fleets to engage in under-reporting of Bryde's whales, because a large catch quota was set at the time. Therefore he believed that the impact on the stock is minimal.

10.2 Species and stock identification, distribution and migration

SC/48/NP15 reported a continuation of the research reported last year on comparative analysis of samples from the eastern Indian Ocean and western North Pacific (WNP), with the addition of samples from the western South Pacific and eastern South Pacific and an increase in sample sizes for some subdivisions of the western North Pacific. Only Bryde's whales of the typical form were included; pygmy Bryde's whales from Java and the Solomon Islands were excluded. Four restriction enzymes were used in a RFLP analysis of the control region of the mtDNA molecule. Nine unique haplotypes were encountered. No significant differences were found between males and females, and they were pooled for further analysis. No significant differences were found between the three subdivisions of the WNP (Taiji, Ogasawara and central western North Pacific), and they were pooled. In a nested AMOVA comparison of the four major regions, 62% of the variance was accounted for by a division between the Indian and Pacific Oceans, about 1% by divisions within the Pacific and 37% by diversity within the oceanic divisions. All of these variances showed significant p values. It was noted that the negative results (no significant differences) obtained for the comparison of subdivisions within the WNP could be due to the inadequate power of the analysis. Pastene reported that he plans to carry out direct sequencing of a segment of the mtDNA control region that should increase power by four to five times, by taking into consideration the results found in SC/48/SH10. The Committee welcomed this and looks forward to a report on the results at a future meeting. Baker noted that sequencing and mapping of restriction sites would also allow other laboratories to conduct similar analyses.

SC/48/O 27 reported an expansion of last year's report (Dizon *et al.*, 1995) on genetic analysis of Bryde's and sei whales from localities around the world, including the pygmy form of Bryde's whale. A sample from Hong Kong has been added and is associated with a pygmy sample from the Philippines and two market pygmy samples from Korea. As in the previous analysis, the pygmy clade lies outside a sei/typical Bryde's clade, suggesting that the pygmy form constitutes a species separate from the typical form. It was noted that addition of more samples from the Gulf of California, Mexico has yielded clades suggesting that two types of typical Bryde's whales may exist there. Urban reported that the differences may be associated with interannual climatic variation, with different stocks moving into the Gulf in different years. Several members emphasised the need for samples of inshore and offshore forms of the typical Bryde's whale (as reported for South Africa and other localities). Ohsumi noted that Northern and Southern Hemisphere stocks may migrate into the Gulf of California in different seasons and pointed out a need for genetic samples from different latitudes in the eastern North and South Pacific in different seasons, in particular from Peruvian waters. It was also noted that genetic samples are needed to determine the affinities of the inshore population of small Bryde's whales off Kochi, Japan. Kato reported that negotiations with local whale watchers to allow biopsy of the whales have been unsuccessful, but that efforts to collect sloughed skin continue.

SC/48/O 38 reported the results of analysis of samples which included both typical and pygmy forms of Bryde's whales and were acquired in markets in Korea and Japan. The need was emphasised for more samples from known sources.

The Committee noted that tissue samples collected almost 20 years ago by Japanese scientists from the region of the Solomon Islands exist but have not been subjected to mtDNA analysis and urged that such analyses be carried out, as the results may be very useful in resolving the status of the pygmy form.

Andersen (1996) reports on Bryde's whales in Thailand. From 22 osteological specimens (seven physically mature), he concluded, as did Perrin *et al.* (1996), that these Bryde's whales are of a pygmy form perhaps belonging to a different taxon than those from outside Southeast Asia. He also noted that the name *B. edeni* may belong to these whales, if they prove to be conspecific with the holotype specimen from Burma. Perrin reported that the skulls of physically mature whales that Andersen measured were clustered at the upper end of the range of Philippine skulls (of unknown degree of maturity) and about the size of the type of *B. edeni*, which was nearly physically mature. This (and the size of the mature whale taken this year in the Philippines) is consistent with the hypothesis that the Thai and Philippine specimens and the holotype are of the same, pygmy form.

Brownell pointed out that the boundary of the e stock may extend farther south than indicated in the present stock-division scheme (IWC, 1996c, fig. 1). Chittleborough (1959) reported three small Bryde's whales (immature female 10.56m, mature? male 11.23m, and mature female 11.73m) taken at Shark Bay, Western Australia. These may have been pygmy Bryde's whales, which would extend the e boundary some 20° south of its present position at the southern edge of Indonesia. The Committee agreed the whales in question were Bryde's whales, but could not determine which form. An attempt will be made in the US to extract DNA from the baleen plates of the Chittleborough specimens.

10.3 Biological parameters

Current knowledge of biological parameters for the typical-form Bryde's whale in the western North Pacific is summarised in Annex G.

The Committee noted these estimates of life history parameters and decided to use them in the assessment below, noting that the assessment method used was not particularly sensitive to their values.

10.4 Abundance and trends

SC/48/NP16 reported an abundance estimate for the inshore Bryde's whales at Kochi, in southeast Japan based on line transect surveys in 1994/95 and 1995/96 (SC/48/NP16). The central estimate was 53 with CV of 0.58 and 95% confidence interval of 18–160. An aerial survey of the Kochi whales is planned for September 1996.

Last year, the Committee endorsed the abundance estimate of North Pacific Bryde's whale for use in *Implementation Simulation Trials*.

An improved estimate of abundance in the western North Pacific (stock division **b** under the stock scheme adopted last year (IWC, 1996c) was described by Shimada and Miyashita (SC/48/NP17). More area was added, between 0 and 22°30'N, with data obtained in a summer 1995 cruise. The estimate was 25,640 (CV = 0.20), an increase of about 2,000 whales over the estimate reported last year (IWC, 1996c,

p.153). It was noted that a body of sightings was made inside stock division **b** but 300 miles off the Philippines and that more information was needed for the whales in this area in order to make sure that they are not of the pygmy form (stock division **e**).

In discussion, it was noted that adjustment for errors in angle and distance estimates by smearing is a standard procedure for line transect estimates of abundance based upon the assumption that $g(0) = 1$ but that this had not been done for the new estimate. The Committee considered that this estimate required further evaluation. Miyashita stated that the standard procedures would be carried out and the results reported at the Committee's next meeting.

10.5 Ecosystem and habitat considerations

The western North Pacific stock of Bryde's whales is found in waters with surface temperatures between 16.4 and 26.9°C during the summer feeding season. These waters extend from about 20 to 40°N.

Information on species composition of cetaceans from about 20 to 40°N and 130°E and 160°W, prey species of Bryde's whales', Bryde's whales' biomass, and their estimated food consumption is summarised in Annex G.

No information on analysis of contaminants is available for the Bryde's whale in the North Pacific.

10.6 Assessment and management advice

It was agreed that sufficient information was available to attempt an assessment of the Bryde's whales in stock division **b**, using HITTER with fixed MSYR, and carrying out the calculations for a series of MSYRs to determine depletion in terms of the mature female component of the population.

Concern was expressed about the reliability of the catch statistics, in particular those from Taiwan, and those from the USSR for the period before implementation of an international observer scheme. Some members expressed the opinion that the catch data are accurate and of sufficient quality for the assessment. They noted that the catch data agreed last year (IWC, 1996c, p.148) reflected a long period of debate in the Scientific Committee. They saw no reasons for under-reporting because sei and Bryde's whales records were not apportioned separately during this period. However, others believed that unreported catches may have occurred. It was agreed that the assessment would include sensitivity analysis of the robustness of the abundance estimate to changes in catch data inputs.

It was noted that Japanese data on sex composition of the catch were not available for the period before 1955 because the catch numbers were arrived at by proration of total number of putative sei whales to sei and Bryde's whales. Ohsumi reported that Japan could provide any missing information on sex composition of the catch after that date.

It was agreed that commercial Philippine catches as noted up to 1985 would be included, as at least some were likely to be from the **b** stock division.

The assessment was carried out in a standard manner following the example provided by the comprehensive assessments of minke whales carried out by the Scientific Committee in recent years. The results of the assessment are given in Appendix 2 of Annex G. They incorporate trials for sensitivity to catch level (with 1.2 as the agreed likely upper limit for a factor argued necessary by some members to account for possible unreported Soviet and Taiwanese catches). The range of MSYR (mature) considered is 0–6%, and trials are included for (a) the best estimate of abundance and (b) the lower 5th percentile of the best estimate.

Although there is as yet no accepted level for MSYR, it was agreed that 1% is a reasonable lower bound. Given this, under the most conservative of the options considered (unreported-catch factor of 1.2, lower 5th percentile of abundance estimate, and MSYR of 1%) the mature female component of the population is at approximately 51% of its pre-exploitation level.

No other management advice was provided.

It was noted that there remains concern about the validity of the geographical boundaries for this stock, and the Committee **recommends** that sensitivity trials using various positions of the stock boundaries, especially to the south, be carried out during RMP *Implementation Simulation Trials*. It also **recommends** that any new available information on catches or their possible bounds be reviewed and the adequacy of the unreported-catch factor re-examined before the trials are carried out.

The Committee **recommends** development of RMP *Implementation Simulation Trials* for the western North Pacific stock (**b**); (IWC, 1996c. p.151) (see Section 10 above).

Komatsu requested the classification of this stock. The Chairman noted that since the RMP has been adopted by the Commission, the Committee is not required to classify stocks. However, Komatsu commented that Article 10 of the Schedule requires the Committee to provide advice on classification.

The Secretary commented that paragraph 10 of the Schedule is the current legal basis for the management of whale stocks and includes the requirements of the NMP. However, the Commission in 1992 recognised by a Resolution on the Revised Management Scheme (IWC, 1993a) that 'Schedule paragraphs 10(a) to 10(c) had proved to be deficient in several important respects'. This had led to the development and adoption by the Commission of the RMP, and in the present context it would seem sensible for the Scientific Committee to concentrate its efforts in the limited time available on this rather than the now discredited (but legal) NMP.

The Committee agreed to put forward this matter to the attention of the Commission.

11. COMPREHENSIVE ASSESSMENT – GENERAL MATTERS

11.1 New abundance estimates for other stocks

There were no abundance estimates presented to the Committee other than those discussed under other Items, except for SC/48/O 29 concerning sperm whales which the Committee had insufficient time to consider.

11.2 Interactions with fishing gear and shipping

This subject will be considered by a Commission Working Group this year. Hester presented SC/48/O 32 which raised two questions:

(1) What is the estimated annual level of mortality from vessel and fishing gear interactions on North Atlantic species or stocks of whales?
(2) What effect is such mortality having on these stocks in the context of the Comprehensive Assessment?

The Committee agreed that it was important for all known human-induced mortalities to be documented for large and small cetaceans and that the most appropriate means for

making these data available was through the national Progress Reports. Even if populations were not threatened by such mortality, these data could be valuable in Comprehensive Assessments and are essential for stocks considered under the RMP (IWC, 1994b, p.44).

The Committee therefore **recommends** that data on all cetaceans determined to have been killed as a result of interactions with fishing gear or shipping should be reported in annual national Progress Reports on cetacean research (and see Item 4.2). Such data on bycatches have already been recommended to be reported in the context of the RMP and the Scientific Committee's Workshop on the mortality of cetaceans in passive fishing nets and traps (Perrin *et al.*, 1994, p.52). The source of data and method for determining that death was a result of interaction with fishing gear or shipping should be clearly identified. If estimates of total mortality extrapolated from observed data are presented, this should be clearly identified. Data from previous years should be reported where available. The Secretariat is requested to prepare an annual summary of these data. The Committee noted that there are other anthropogenic interactions which can result in cetacean mortality.

12. COMPREHENSIVE ASSESSMENT – FUTURE WORK

The Committee had before it a proposal to undertake a comprehensive assessment of North Atlantic humpback whales. Justification for this included the increasing availability of information on abundance and population spatial and genetic structure (from the Years of the North Atlantic Whale (YONAH) study), catch histories, and information on life history and behaviour from photo-identification and other studies. The Workshop on the Development of an Aboriginal Subsistence Whaling Management Procedure had commented on the need for a comprehensive assessment (Annex I).

In fact, a number of stocks had been recognised as candidates for assessment by the Aboriginal Subsistence Whaling sub-committee (Annex I), and from that perspective, a higher priority would be assigned to the assessment of North Atlantic fin whales, for which recent catches had been larger than those from the humpback whale stock. It was pointed out however that while it might now be appropriate to consider actually undertaking an assessment for fin whales, what was being proposed for humpbacks were the preparatory stages leading to a full assessment. The Committee was reminded that a major concern when fin whales were last considered, in 1992, was the question of North Atlantic fin whale stock structure (Annex I, Appendix 3, Table 2).

A separate proposal was available for a worldwide comparative assessment of right whales. They had last been reviewed in 1981, and much information had accumulated since then, including revised information on Soviet catches. It would be valuable to compare the very different situations in the Northern and Southern Hemispheres, where stocks in the south were showing signs of healthy increase, by contrast with the North Atlantic right whale, which for a number of years has failed to show any signs of increase from low numbers.

It was proposed that a workshop should be held in early 1998, where information could be reviewed and a report provided to the 1998 annual meeting, at which the question of a subsequent full assessment could be examined. Arrangements for the workshop could be handled on a cooperative basis, with the Commission as a major co-sponsor. It would be necessary to appoint a Steering Committee to plan the meeting, and the Committee agreed that the Chairman should act accordingly.

The Committee also noted that its work involves topics outside the Comprehensive Assessment such as the effects of environmental changes on cetaceans. Account of this will be taken when considering the Committee's overall priorities.

It was also proposed that attention should be given to an assessment of pygmy blue whales, for which new information was becoming available through the results of the recent cruise, revisions of catch data and analyses of past sightings data. There was some support for the view that the assessment should include Southern Hemisphere 'true' blue whales.

Ohsumi noted that an assessment of sperm whales would be of value, particularly because the RMP was only applicable to baleen whales.

The Committee recognised that none of the species or stocks proposed were appropriate for assessment at the 1997 meeting. The question of priority among them in the Committee's future work is discussed under Item 20.2.

13. ABORIGINAL SUBSISTENCE WHALING

13.1 Aboriginal Subsistence Whaling Management Procedure (AWMP)

13.1.1 Report of the Workshop (Annex I)

DEFINITION OF BIOLOGICAL UNIT TO BE CONSERVED

The following question introduced the topic.

Is the intent of management

(1) to solely conserve unique genetic adaptations (i.e. a specific genome) within a species; or
(2) to both conserve unique genetic adaptations and maintain a species' functional role in the ecosystem throughout its entire range?

It was agreed that the term 'stock' has not been used consistently within the Committee (e.g. Donovan, 1991). For example, in some circumstances stocks have been considered equivalent to evolutionarily significant units, while in others, stocks have been considered to be equivalent to management units.

It was noted that different standards appeared to have been used within the Committee to establish the minimum unit to be conserved for different stocks. For example, stock/substock discussions for whales taken by aboriginal hunters were sometimes less risk-adverse than those associated with preparations for implementation of the RMP. It was agreed that it would be useful for an AWMP Working Group to address the issue of whether there were some features of aboriginal whaling that would either require or favour a different use of the stock concept than was used in the development of the RMP.

Although rarely explicit in Committee reports, most Committee stock boundaries, whilst attempting where possible to represent biological boundaries, were actually delineating management stocks (Donovan, 1991). Taylor noted that, where takes are distributed relatively evenly over the entire area for which an abundance estimate has been made, the problem of stock identification is negligible. However, where takes are distributed in only a portion of the area for which an abundance estimate is made, an accurate assessment of mixing or dispersal rates of animals between putative stocks within the survey area is necessary to avoid local extinction.

In discussion it was agreed that localised harvesting would not necessarily result in a loss of genetic diversity and range. While it is obvious that the Commission's objectives require that genetic diversity is not lost, the Commission's intentions regarding the loss of range (associated with whaling) are not clear. Unfortunately, the information needed to assess whether localised harvesting would have adverse population effects is often not available.

In conclusion, it was agreed to use the following definition of a management stock in the context of discussions regarding the AWMP: the management unit for which a limit on strikes is set, where area must be specified on a case by case basis. It was agreed that in reports and documents the term stock should either be defined or clarified in the text (e.g. biological stock or management stock). It was agreed that the general issue of appropriate biological units to conserve requires further discussion in the Committee next year, particularly in the context of conservation of range (and see Items 8.1 and 20.2).

TYPES OF CATCH CONTROL LAWS (CCL) THAT WOULD SATISFY THE RESOLUTION FROM THE COMMISSION

SC/48/Mg3 utilised *CLA*-variants to examine the question of the most appropriate method for evaluating CCLs. This was based on a variety of performance measures. In the development of a CCL it should be recognised that there is a trade-off between risk to the population and the proportion of time subsistence need might exceed allowable removal levels.

SC/48/Mg7 presented three CCLs, one based explicitly on Schedule Paragraph 13(a), one based on the potential biological removal (PBR) level developed by the US National Marine Fisheries Service and one based on a simplistic algorithm. Their performance was examined using statistics designed to evaluate the extent to which the Resolution objectives were satisfied.

The basic approach in SC/48/Mg6 was to identify a family of CCLs that would satisfy the principles listed in Paragraph 13(a) of the Schedule. Givens noted that these CCLs were not intended to be considered as candidate *Strike Limit Algorithms* (*SLA*), but rather only as examples of CCLs that would be consistent with the Commission's resolution regarding aboriginal whaling.

Several participants commented that CCLs that required information on MSYL and MSYR would be as difficult to implement as was the NMP. After some discussion, it was agreed that at a minimum, CCLs such as those described in SC/48/Mg6 could be evaluated with performance measures by incorporating stochasticity and uncertainty into the simulation trials.

The primary intent of SC/48/AS5 was to develop a management framework for aboriginal whaling that was based on a slightly modified Revised Management Procedure (RMP). The author suggested that both the principles listed in Paragraph 13(a) of the Schedule and the current need level of aboriginal subsistence hunters would be met in the cases that he examined.

The Committee noted that none of the authors considered that the CCLs they had reported on had been adequately tested or developed to be considered as candidates for the AWMP in their present form.

INFORMATION AVAILABLE FOR STOCKS HARVESTED BY ABORIGINAL SUBSISTENCE WHALING

This is summarised in Appendix 3 of Annex I.

INFORMATION CURRENTLY NEEDED FOR MANAGEMENT OF ABORIGINAL WHALING

The workshop summarised and discussed the available data and the Committee's most recent experience in applying the provisions of Paragraph 13(a). There are no stocks for which the information needed to implement this paragraph is completely available. Given the earlier discussions regarding the importance of correctly identifying stock structure for species where harvests are spatially localised, the lack of adequate information on stock structure for four of the six stocks is highly problematic. For most stocks, status (i.e. depletion level) cannot be reliably estimated. The Committee believed that five stocks were likely to be above any minimum level (below which catches should not be taken).

NEED

It was agreed that consideration of the values for 'need' under this Item referred to determining suitable values for use in simulation trials only and should not be confused with the absolute determination of need as carried out by the Commission.

Last year the Committee had noted that need could be modelled explicitly in simulation trials in several ways, including: (1) a range of need levels could be investigated in risk analyses; (2) need could be modelled in light of the expected changes in human populations; and (3) information regarding need could be supplied by the Commission.

After some discussion, it was agreed (1) to use a collection of case-specific need trajectories and (2) that the time series of need values to be used in the simulation trials was likely to be related in some manner to the levels of need currently recognised by the Commission. Whilst noting that the Committee did not have either the competence or mandate to evaluate need for individual fisheries, it was agreed that based on the Commission's presently identified need values for each fishery, the Committee should specify an 'envelope' of likely need for each fishery, for use in *Initial Exploration Trials* (see below), and examine several scenarios within the envelope. This should be drawn to the attention of the Commission for its approval and comment. The importance of obtaining advice from representatives of the harvesting peoples throughout the development process was also recognised and is discussed later in this report.

SC/48/AS13 presented information that for the Bering-Chukchi-Beaufort stock of bowhead whales, the quota on the number of annual strikes had increased from 20 in 1978 to 68 in 1995 or an increase of almost three animals per year. It was recognised that trends in quotas over the specified time period could not be used to make inferences regarding trends in need for historical reasons.

The Commission had agreed to the annual need of some 169 gray whales requested by the then government of the Soviet Union for the eastern North Pacific stock of gray whales throughout the 1980s. In response to a revised evaluation of need submitted by the Russian Federation, the limit has subsequently been reduced to a quota of 140 animals per year.

Greenland has estimated that the subsistence needs of Greenlanders is some 670 tonnes of whale meat annually (TC/40/AS3). To date, the authorised level of harvesting has been less than 670 tonnes annually. Certain trade-offs had taken place in the process to authorise subsistence whaling by Greenlanders. For example, when the quota for humpback whales was removed in 1987, the quota for fin whales was increased.

The Commission revised the management regime for aboriginal whaling in 1984, and specific guidelines for setting quotas were specified including the estimation of need by the Commission. It was noted that caution was needed in interpreting changes in historic limits on catches or quotas prior to and post-1984.

There was considerable discussion as to whether need should be incorporated into generic or stock specific simulation trials. It was agreed that need could only usefully be incorporated into trials on a stock and case specific basis. It was further noted that unlike the case for commercial whaling, where at least in theory whaling could be opened by any country on any stock, the Commission had firm guidelines as to what comprised an aboriginal subsistence whaling operation. It was unlikely that a large number of additional such fisheries would be authorised in the near future, if ever (IWC, 1989a, p.23). It was agreed that future simulation trials should be stock specific with the question of need being addressed as described above. The question of initial 'need envelopes' for each fishery is discussed under Item 13.1.2 below.

GENERIC VERSUS STOCK-SPECIFIC COMPONENTS OF AN AWMP

It was agreed that it was premature to decide whether the implemented AWMP would consist of a single (i.e. generic) *strike limit algorithm* (*SLA*) conditioned on stock-specific data or two or more *SLA*s that were developed and tuned for specific stocks. Such decisions should be delayed until after the analysis of the information produced during the *Initial Exploration Trials* (see below).

The issue was raised as to whether the development of an *SLA* for the AWMP would benefit from similar competition to that used in the development of the commercial whaling *CLA* or whether a more unified approach was appropriate.

After some discussion, it was agreed that at this early phase in the development process it was reasonable to have independent scientists or teams of independent scientists work on the development and evaluation of candidate *SLA*s. However, the importance of ensuring that the work was overseen by a wider group than merely the developers was emphasised. The importance of informing and exchanging ideas with both the Commission and native groups throughout the development process was recognised and is discussed further below.

SIMULATION TRIALS

There was general agreement that simulation trials should form the basis for evaluating the merits of candidate regimes. This evaluation would be based on performance, as measured by an agreed set of statistics augmented with appropriate graphics. It was noted that at last year's meeting, the Committee had agreed that as far as possible and relevant, the same performance statistics used to compare candidate *CLAs* should be used to compare performance of candidate AWMP procedures. This is discussed under Item 13.1.2.

The duration over which the simulation trials should be run was also discussed. It was agreed that results for a time period of 100 years should be examined but that results for other time periods would also be considered. This is considered further under Item 13.1.2.

The Workshop had noted that although Annex I (Appendix 4) had agreed that initially MSYR and K should be expressed in terms of mature females, it had stated that there were reasons to consider returning to defining them in terms of the component of the population aged 1 year or greater. This is discussed further under Item 13.1.2.

STRIKE LIMIT ALGORITHMS

The various approaches that had been reported to the Committee to date regarding *SLA*s appropriate for the management of aboriginal whaling included *SLA*s based on:

(1) a literal interpretation of Paragraph 13(a) (e.g. Givens *et al.*, 1996; SC/48/Mg6; and Mg7);
(2) the *CLA* used in the RMP (SC/48/Mg3 and SC/48/AS5);
(3) the *CLA* candidate proposed by Punt and Butterworth (Punt and Butterworth, 1989; SC/48/Mg3); and
(4) a modified PBR approach (SC/48/Mg6 and Mg7).

It was noted that these approaches were neither intended to represent a complete list of possible approaches nor a set of specific proposals for candidate regimes. Rather, they should be considered examples of potential approaches for setting strike limits on takes of large whales by aboriginal subsistence whalers.

CRITERIA FOR EVALUATION OF CANDIDATE PROCEDURES

Recommendations regarding evaluation criteria were reported in (IWC, 1996b, p.73). As noted previously, one recommendation was to use the same performance measures in evaluating the candidate *SLA*s as were used in the evaluation of the candidate *CLA*s. However, it was recognised that there are substantive differences between the objectives for commercial and aboriginal whaling (SC/48/Mg5) having to do with (1) maximising yield versus satisfying need and (2) minimising the period of time where a stock is below its MSYL versus only ensuring that a stock recovers over some reasonable period of time.

It was agreed that performance measures could usefully be classified as addressing either risk, need or recovery, although some measures may address more than one of these. A list of potential performance measures was identified (Annex I, Appendix 4).

Several workshop participants commented that based on experience gained during the development of the RMP, only a small number of performance measures should be used. For example, a general guideline of using about seven or fewer statistics was proposed as the limit at which human integration of results has been shown to be reliable. It had also been agreed, as noted previously, that graphical representations of certain trajectories over the entire simulated time period were helpful in understanding how a specific candidate *SLA* performed. Finally, it was noted that the issue of whether to integrate over ranges for one or more variables in calculating average values for performance statistics must be addressed.

During a brief discussion of potential performance statistics a number of points were made. These included:

(1) how to calculate extinction probabilities;
(2) statistics or graphics related to the distribution of catches should be standardised in some way relative to the associated level of need to fully understand how variability in catch interacts with need;
(3) variability in strike limit is not necessarily a disadvantage, as long as need is met;

(4) the inherent variability in aboriginal catches over time is likely to be greater than variability in commercial catches over time due to logistic constraints of the aboriginal hunt;
(5) the results of simulation trials where the initial status is at or above the MSYL will have to be excluded from the estimation of performance statistics pertaining to recovery time; and
(6) given the costs associated with evaluation process (e.g. salary, computing facilities, travel, etc.), some effort should be made to cease development and refinements of *SLA*s that have acceptable performance.

PROCESS FOR SELECTING A CANDIDATE PROCEDURE

Smith *et al.* (1995) and SC/48/AS5 proposed specific processes for selecting a candidate procedure for implementing the AWMP. The following steps were identified:

(1) summarise existing data for stocks harvested by aboriginal whalers (completed);
(2) clarify management and performance objectives of the AWMP (partially done, but will require additional input from the Commission and hunters as the process continues);
(3) specify performance measures (ongoing);
(4) specify simulation trials (ongoing);
(5) specify candidate management procedures (four general approaches have been identified to date);
(6) subject candidate management procedures to stock-specific simulation trials and compute performance measures under a range of scenarios;
(7) if required, modify candidate *SLA*s in light of simulation results and repeat simulation trials;
(8) recommend management procedure(s) to the Commission.

It was recognised that the Commission may wish to address other issues before implementing any AWMP.

Noting the success of the informal meetings between the Chair of the Steering Group for the RMP and Commissioners, it was **recommended** that the Commission and affected aboriginal subsistence hunters be kept informed and solicited for advice throughout the process. A number of issues were identified to be important including: how the AWMP differs from the RMP; why it differs; what its key elements are in relation to the users (e.g. data requirements); and the adequacy of the methods used to evaluate the manner in which objectives are satisfied.

DESIGNING SPECIFIC SIMULATION TRIALS

The issue of designing specific simulation trials was only briefly discussed during the workshop. The Committee established a working group during this year's meeting to develop specific scenarios for *Initial Exploration Trials* (these are **not** to be mistaken for *Implementation Simulation Trials*, see below). These trials will be of value in assessing the merit of the performance statistics suggested and in providing a framework for developers. They are discussed further under Item 13.1.2.

PLANNING OF FUTURE WORK

The Workshop agreed to the following recommendations regarding activities needed to further the development of the AWMP prior to the 1997 meeting of the Committee:

(1) a formal Standing AWMP Working Group (SWG) should be established, consisting of members active in the development of candidate *SLA*s and other suitable people; those nominated at the meeting were Albert, Born, Brown, Donovan, George, Givens, Neve, Pedersen, Punt and Smith;
(2) the SWG should be responsible for providing advice to scientists working on the development of candidate *SLA*s regarding standardisation of computer codes, performance measures and types of simulation trials;
(3) scientists or groups of scientists should be encouraged to develop candidate *SLA*s; and
(4) an intersessional workshop to further the progress towards developing an AWMP should be scheduled for sometime in the next 12 months. Time may be allocated to dialogue between scientists and representatives of native peoples and Commissioners. A final agenda should be developed by the SWG.

The Committee draws the Commission's attention to the financial implications involved in the development process.

The stages in the overall process of the development, evaluation and selection of a specific or set of specific *SLA*(s) outlined under Item 7 will require several years, even if the SWG convenes intersessionally over the next few years and regular Workshops are held.

With respect to a timetable, this was largely dependent on advice from the Commission on priorities for the Committee, its workload and associated financial support. In this regard the Committee draws the Commission's attention to the fact that for some stocks, it has been unable to provide the Commission with adequate management advice under Paragraph 13(a). For some of the stocks, even rudimentary information necessary for management is not available. The Workshop had requested that the Committee considers reinstating the postponed comprehensive assessment process for fin whales and to initiate the comprehensive assessment process for North Atlantic humpback whales. The success of this latter project will be considerably enhanced by the results from the YONAH project. This was discussed under Item 12.

13.1.2 Report of the Working Group on AWMP Trials (Annex P)

The major function of the Group was to develop specific scenarios for *Initial Exploration Trials* (these are not to be mistaken for RMP *Implementation Simulation Trials*). It had been agreed that priority should be given to two types of fishery:

(1) where there is relatively little available information and stock identity problems (e.g. West Greenland minke whales), hereafter called a type 1 fishery; and
(2) where there is a relatively large amount of information (e.g. Bering-Chukchi-Beaufort bowhead whales), hereafter called a type 2 fishery.

The Committee stressed that the primary functions of *Initial Exploration Trials* are to:

(1) aid in assessing the value of the performance statistics (suggested in Annex I Appendix 4) for testing the adequacy of any *SLA*s that may be put forward as candidates;
(2) provide an initial framework for scientists to begin the process of developing potential *SLA*s.

As their name suggests, such trials should be seen as an exploratory tool for use at the beginning of the long-term AWMP development process. The results of such trials should be seen as 'disposable'. The scenarios set for these *Initial Exploration Trials* are not intended to be exhaustive

and additional scenarios will inevitably be developed as the process proceeds. These scenarios, like the performance statistics, can be seen as disposable and will be re-evaluated and modified as the development process proceeds.

It is clear that it will be some time before the equivalent of RMP *Implementation Simulation Trials* will be possible for any AWMP management stock. This will be the final stage in an iterative and consultative development process. It is not possible at this stage to predict how long this process may take. Although the *Initial Exploration Trials* set a framework within which developers may work, designing even an initial *SLA* that complies with the Commission's objectives of meeting need requirements is not a trivial task, particularly for cases with relatively little available information and stock identity problems.

The Group developed some initial trials for the two types of fisheries. The basic population dynamics model is age- and sex-structured with density dependence on fecundity rate. For the initial set of trials developed, uncertainty in stock structure is not considered. The data for an *SLA* will be historical catches, need, absolute abundance estimates and possibly the fraction of calves and mature animals in the population. The proposed trials are spanned by factors representing productivity, current stock size, need and the quality of the data. The initial time horizon considered is 100 years and the trials and performance statistics will be computed using a common control program to be developed by the Secretariat. The development of such a common control program should be given high priority if progress is to be made in a timely fashion.

13.2 Bowhead whales

13.2.1 Bering-Chukchi-Beaufort Seas stock of bowhead whales

SC/48/AS16 addressed the issue of the Borel paradox in the Bayesian synthesis method. This had been the subject of extensive discussion last year (IWC, 1996b, p.74–6). In the context of the Bayesian synthesis, this paradox results in sensitivity to parametrisation, where changes in the parametrisation of the outputs can influence results, but not changes in the parametrisation of the inputs. An additional problem arises from there being two prior distributions on the same quantity which causes prior incoherence. The paper proposes that both problems can be avoided by geometric pooling of the prior distributions and that such pooling would not change the results substantially.

SC/48/AS16 also examined why the results from the 'Backwards' and 'Forwards' variants of Bayesian synthesis differ. Butterworth and Punt noted that computational issues were not the sole cause of the different estimates. They concluded that Backwards and Forwards variants must give different answers, and that Backwards will yield posteriors with higher comparable MSYR percentiles than will Forwards. The authors of SC/48/AS16 agreed that Forwards and Backwards give different results, but pointed out that the example provided by Butterworth and Punt does not establish which variant is better.

SC/48/AS1 compares results from maximum likelihood and Bayesian synthesis approaches for the assessment of the Bering-Chukchi-Beaufort Seas stock of bowhead whales. The maximum likelihood method was modified to incorporate some of the same information as used in the Bayesian synthesis assessment.

Another method (from Restrepo *et al.*, 1992) was used that represents an extension of the maximum likelihood principle. It differs from traditional maximum likelihood in that prior distributions can be specified for some parameters. The method thus claims to incorporate the uncertainty in parameters that cannot be estimated, such as MSYL, without introducing the potential problems of having to set prior distributions for MSYR and K.

It was noted that the method must be considered an *ad hoc* method (which shares some common methodology with bootstrapped maximum likelihood estimators (MLE)). It was cautioned that *ad hoc* methods should be tested through simulation, which would unfortunately be computationally intensive in this case. Variants of the Bayesian synthesis method were also investigated, including: excluding either or both of the K and MSYR priors; changing the year 'hit' in the Backwards variant; and replacing the prior on the adult natural mortality rate by a lower bound only. SC/48/AS1 also directly compared the performance of standard MLE versus Bayesian synthesis by comparing the accuracy of point estimates of simulated plausible scenarios. The comparison is not strictly fair, as the Bayesian synthesis incorporates uncertainty in biological parameters, whereas in these MLE analyses it is assumed the biological parameters are known exactly. The full implications of these comparisons were not clear given the different treatment of the biological parameters. It was noted that comparing estimation methods by comparing fits to simulated scenarios is a useful way to proceed to try to establish how well the estimators actually work.

SC/48/AS12 described the first attempt to estimate the adult survival rate of Bering-Chukchi-Beaufort Seas bowhead whales. It was noted that in previous analyses and assessments, a distribution for this parameter was not really based on data, but was an assumed distribution determined by consideration of presumed maximum ages and similar information. The method was based on photographs of animals that could be individually identified from scarring on backs. It was noted that the estimated survival rate was for older whales, because young animals do not have scars. An important assumption in the analysis was that whales seen in one year had an equal probability of being seen in a future year as did whales not seen. Preliminary estimates of adult survival were similar to the distribution that had been assumed. The point estimate was 0.986 with a 95% confidence interval of 0.941 to 1.000. It was noted that it was important to get high quality photographs to ensure accurate identification. For this reason the Committee **recommends** that the photo-identification library be rescored, as the scoring does not currently distinguish between photo quality and the ease of identifying a whale.

Laake presented results from a re-analysis of the data using the program SURVIVE, and got the same point estimate but a wider confidence interval (0.88 to 1.00) than in SC/48/AS12. George noted that scar accumulation rate appears to be very slow and is, in itself, an indication of great longevity. Attention was also drawn to SC/48/SH15 which estimates natural mortality of female southern right whales. This method was also based on analysis of individuals identified in photographs. It was noted that the simplicity of analysis was attractive and easy to understand, the design of the study was good, and it has led to a high recapture rate. The author presented a natural mortality estimate of 0.0098 ± 0.0067 which accounted for one of several potential sources of positive bias in estimates computed from these data. It was noted that this analysis actually estimates in combination adult survival and reproductive senescence.

SC/48/AS14 reported that hunting efficiency in the bowhead harvest has increased since 1973. The current hunting efficiency is approximately 75% (struck and

landed), compared to a level of 43% from 1973 to 1977. In 1995, 57 whales were struck resulting in 43 whales landed.

The Committee noted that there was a proposed request from the Russian Federation (IWC/48/23) to take five bowhead whales for the native people of Chukotka. The current best estimate for the Bering-Chukchi-Beaufort Seas stock of bowhead whales is 8,200 (7,200; 9,400–95%CI). During the period 1972 to 1975, the Soviet Union announced its intention of taking three bowhead whales in this region. The Committee noted that the catch history indicates that there were no catches by the USSR after 1972 and requests clarification of this matter.

MANAGEMENT ADVICE

Some members expressed serious concerns about the 1994 implementation of the Bayesian synthesis stock assessment method. However, it was noted that other assessment approaches had also contributed to the management advice given at the 1994 meeting. The Committee agreed that there should be further investigation into the concerns identified. However, the Committee agreed that there was no reason to change the management advice given previously.

The Committee noted that the effect of the requested take of five whales in the Chukotka region depended upon stock structure. In previous years, the Scientific Committee has assumed that all whales in the Bering-Chukchi-Beaufort region consist of a single stock. The Committee noted that no information on stock structure in this area is available, and encouraged the collection of such data.

At the 1994 meeting (IWC, 1995a, p.77) under a scenario of the removal of 75 animals annually from the Bering-Chukchi-Beaufort Seas stock, it was estimated that the population would increase over the 1995 to 1998 period at a rate of 1.46% annually (5% bound of 0.31%). The new abundance estimate and the revised estimate of rate of increase are both higher than previously estimated. The Committee **recommends** that a major reassessment should be conducted in 1998.

13.2.2 Okhotsk Sea stock

SC/48/AS21 summarised observations of bowhead whales in the Shantar archipelago of the western Okhotsk Sea. A total of 40 bowheads was estimated from observations from the air and on the water, including two cow/calf pairs. Eight different animals, including the cow/calf pairs, were photographed. Fourteen biopsy samples were collected and these will be compared to the Bering-Chukchi-Beaufort Seas stock. It was noted that there are two possible explanations for why this stock has not recovered more than is apparent. First, the stock was probably depleted to a more severe level than the Bering-Chukchi-Beaufort Seas stock. Secondly, some illegal catches are reported to have occurred on this stock during the 1960s (Yablokov, 1994 and Berzin unpublished, as cited in SC/48/AS21). It was noted that offshore oil and gas development is likely to occur in this region in the future, although currently the only work is in a different area (around Sakhalin Island). In SC/48/Rep 2, this stock was identified as one that may be particularly vulnerable to climate change, primarily because of its low numbers. The Committee **recommends** that because this stock is one of the most endangered baleen whale stocks in the world, research on it should continue and that means for establishing a monitoring programme should be investigated.

13.2.3 Other stocks of bowhead whales

The Committee remains very concerned about the status and small size of the other Arctic populations of bowhead whales. The Davis Strait and Hudson Bay stocks are conservatively estimated at 450 whales each (Zeh *et al.*, 1993) and the Spitzbergen stock may now number only 'in the tens' of animals (Christensen *et al.*, 1990).

13.3 North Pacific gray whales

13.3.1 Eastern stock of North Pacific gray whales

SC/48/AS19 reported on a study of gray whales wintering in Laguna San Ignacio. The number of single whales in the middle lagoon in 1996 was found to be at a similar level to that reported by Jones and Swartz for 1978, and substantially lower than reported by them for 1982. The maximum count in 1996 occurred in early March, compared with maximum counts in mid-February during 1978/82. Fewer cow and calf pairs were also counted in 1996 than in the early 1980s. It was noted that the peak southbound migration past California now occurs about ten days later than in the early 1980s, which is consistent with the later peak count in Laguna San Ignacio. There have been no similar studies in other breeding/calving lagoons, so it is not known if this pattern of decline has been repeated elsewhere.

Northbound calf counts past Pt. Piedras Blancas, California during March to May in 1994–96 were discussed in SC/48/AS4. The estimated proportion of calves in the population for two earlier northbound surveys in 1980 and 1981 was around 5%, very close to the rate observed in 1994 and the preliminary rate reported for 1996. However, the rate in 1995 (2.5%) was significantly lower.

SC/48/AS11 reported on six aerial surveys between 1979 and 1996, to estimate the offshore distribution of gray whales. Fewer than 4% of animals passed more than 3 n.miles offshore. In SC/48/AS10, probability of detection as a function of distance offshore was estimated. The evidence from these papers suggested that for the shore-based counts, detectability is high for a large majority of whales.

The procedures for estimating the abundance of gray whales from counts of the southbound migration were summarised in SC/48/AS2. The issue of unexplained variance was noted, as well as the possible contribution to this from the possibly inappropriate assumption that some correction factors are constant over time.

The preliminary estimate of abundance for 1995/96 was given in SC/48/AS9 as 22,571 whales (CV = 5.24%; 95% CI = 20,400 to 25,000).

A Bayesian analysis of gray whale population dynamics was reported in SC/48/AS3. Point estimates for the equilibrium population ranged from 24,000 to 32,000. The paper showed that conclusions were rather different when the unexplained variation in the population estimates was taken into account than when the quoted variances were taken at face value. The analyses that did not take account of the unexplained variation indicated there was strong evidence of density dependence, while the analyses that did account for the unexplained variation only marginally favoured density dependence. Allowance for the unexplained variation is needed; when it is used, the estimated CV on point estimates increases to 15 or 16% from 3–6% in the original analyses.

SC/48/AS8 presented a stock assessment based on the Bayesian analysis in SC/48/AS3. The derived priors for the ratio of current abundance to that at equilibrium showed spikes at 1.0, corresponding to scenarios in which the equilibrium population size (in the absence of catches) had

been obtained by 1996. The lower tail is more critical. When unexplained variation is ignored, the entire posterior probability distribution for this parameter lies above 0.5, whereas if it is modelled, only 70–80% lies above 0.5. Because many projections suggest that the current population is close to equilibrium size, the replacement yield is then estimated to be close to zero, so management advice cannot sensibly be based on assessment of replacement yield. It was noted that over several different analyses, the lowest 2.5th percentile of the quantity Q1 (90% of MSY – see paragraph 13(a) of the Schedule and SC/48/Mg6) was 407, which in the authors view was as a conservative estimate of the annual number of whales that could be taken sustainably.

The possibility of basing management advice on the result of projections with a given take of 145 whales per year was suggested. It was also suggested that the known catch data before 1968 should be used in fitting models, but the author believed that it was more robust to ignore these data given previous results indicating that the entire catch history could not be reconciled with the current abundance data without major alterations.

Point estimates of the annual rate of increase, using regression type methods, were given in SC/48/AS7. These ranged from 0.024 to 0.026, with the estimate of 0.0253 (SE 0.0031), obtained from a weighted GLM, considered the most appropriate. Assuming the true pattern of increase is logistic, it was found that annual estimates would be required until the year 2007 before density dependent effects could be confidently detected. Under two different models, median estimated replacement yield (estimated as the average replacement yield from 1968 to 1996 using the Allison *et al.* (1995) method) from 100,000 simulations was 599 or 596, with the lower 5th percentile of 488 or 462.

The Russian catch in 1995 was reported in SC/48/AS22. A total of 85 animals were caught out of a limit of 140 (40 females, 44 males, and one was lost after drowning). The sex ratio in the catch was nearer parity than in previous harvests.

SC/48/AS18 noted that the Makah tribe in Washington State had a treaty right to hunt gray whales, dating back to 1854. They now wished to be allowed to hunt five whales per year. The paper noted that there is an aggregation of 'summer residents', which spend 8–10 months off the Washington coast, and that it appears to be increasing. It was noted that it was important to determine whether the proposed take should be considered as a take from a small 'Washington' feeding aggregation, or as a take from the California gray whale breeding stock. However, it was noted that assurances had been given that proposed take would not come from the small summering aggregation.

MANAGEMENT ADVICE

The Committee agreed that there were no serious inconsistencies between assessments made by the two approaches covered in papers SC/48/AS3, AS7 and AS8. There was considered to be no need for changing earlier management advice. In particular it was agreed that the take of five extra whales would have no significant impact given previous management advice.

The rationale for retaining current management advice is that the advice given during the Comprehensive Assessment (IWC, 1993c) was formulated relative to a higher annual take of animals than has been seen in recent years. Since that assessment, additional information suggests that it is implausible that a further detailed assessment at this stage would lead to the conclusion that a take of 145 whales per year would be too high. Recent data and analyses strengthen the view that a take of 145 whales per year is sustainable, and is likely to allow the population to continue its increase. This is supported by a number of factors. In particular, analyses indicate that the population is likely to be above the MSYL (even if it were not, under an annual harvest of 145 animals, the population is expected to increase towards or through the MSYL); a thorough discussion of the ability to estimate MSY and MSYL adequately will take place in 1997. It was noted that analyses using density dependence models estimate that the population may now be above MSYL, and if so the replacement yield will be decreasing. In this case, management advice cannot indefinitely be based on estimates of replacement yield, as was the case for the Comprehensive Assessment of this stock. While not urgent, this issue should be addressed in 1997. It was noted that the next abundance estimate for this stock will be available in 1998.

The Committee **recommends** that a detailed assessment of the current status of California gray whales, and of the management advice, should be made by the Scientific Committee in 1997. It encourages continued research in the breeding lagoons.

13.3.2 Okhotsk Sea stock

Annex F (Appendix 4) summarised observations on Okhotsk-Korean gray whales on their feeding grounds northeast of Sakhalin Island. Russian scientists had observed gray whales in the Okhotsk Sea through the 1980s, with a maximum concentration of 34 in 1989. In a new study, 38 individual whales were photographed during 1994 and 1995, with two matches between years. In addition, nine biopsy samples were obtained, 19 animals were counted from a helicopter, and over multiple days of observation from a tower, up to around 20 animals were seen per day. No population estimate was attempted in this study. There are major oil and gas reserves in the study area, and a large multinational project to exploit these reserves is about to start. A management plan and long-term monitoring programme are therefore needed. There are plans to compare DNA of these animals with California gray whales, and if possible, with DNA extracted from bones of Atlantic gray whales. The whales migrate along Korea and China, with some passing along the Japanese coast. It was noted that habitat degradation was occurring along the migration corridor. The Committee noted that in SC/48/Rep2, this stock was identified as one that may be particularly vulnerable to the effects of climate change primarily due to its low abundance. However, the oil and gas development was considered to be the most immediate and pressing concern. The potential disturbance from increased noise due to seismic marine surveys, ship traffic and exploratory drilling, together with the potential for oil spills, underscore the immediate need to give high priority to research and environmental monitoring, including documentation of ambient acoustic levels under pre-industrial activity conditions, before development commences.

The Committee **recommends** that because this is one of the most endangered baleen whales stocks in the world, research on this stock should continue, and that means for establishing a monitoring programme should be investigated. It further **recommends** that the Commission arrange to bring scientists together from countries with an interest in or within the range of these whales, to identify the research and measures required to maximise the chances of this stock recovering.

13.4 West Greenland fin whales

SC/48/ProgRep Denmark reported that 12 fin whales were taken in West Greenland during 1995. The Committee **recommends** that attempts be made to collect biological information and samples from as many animals as possible that are taken in this fishery.

13.5 West Greenland minke whales

SC/48/ProgRep Denmark reported that 156 minke whales were taken in West Greenland of which four were struck and lost. The Committee **recommends** that attempts be made to collect biological information and samples from as many animals as possible taken in this fishery.

13.6 East Greenland minke whales

SC/48/ProgRep Denmark reported that seven minke whales were taken in East Greenland in 1995. The Committee **recommends** that attempts be made to collect biological information and samples from as many animals as possible taken in this fishery.

13.7 Humpback whales off St Vincent and the Grenadines

In 1996, one humpback whale was struck and lost.

13.7.1 Management advice

The Committee noted that no additional information was available for this stock and agreed to repeat its advice for previous years that a catch of three whales would be unlikely to harm this stock. If whales are caught, every effort should be made to collect as much information as possible, in particular, photographs of the ventral surface of the flukes and tissue samples for genetic studies. The Committee also noted that a comprehensive assessment of northwest Atlantic humpback whales would provide information on this stock.

14. SCIENTIFIC PERMITS

14.1 New criteria for assessing permits

Last year, the Commission had adopted Resolution 1995–9 (IWC, 1996a, p.47) concerning whaling under Special Permit. Amongst other things, the Resolution had requested that the Scientific Committee structure its reviews of all Special Permit programmes to:

(1) identify the relationship between objectives and research needs previously identified by the Scientific Committee;
(2) evaluate the likelihood of the programme meeting its objectives by providing reliable answers to the questions posed;
(3) identify, where a proposal specifies lethal methods, non-lethal methods and alternative sources of data that might be used in meeting the research objectives.

In addition, the Committee agreed to assess Special Permits following the provisions of paragraph 30 of the Schedule.

The Committee was informed that IWC/47/40 presented various studies and their available research techniques using lethal and non-lethal methods. The author concluded that many items (i.e. age determination, morphometrics, pollution burdens, parasite loads) require lethal methods. The Committee agreed that the question of the necessity of lethal methods be further discussed in the event that the Committee has to review specific new research proposals under Special Permit.

With regard to the Resolution 1995–9, which recommends that scientific research intended to assist the comprehensive assessment shall be undertaken by non-lethal means, Yagi pointed out that this represented a total change in direction from the Resolution passed in 1987, which had stipulated that 'the research address a question or questions that should be answered in order to conduct the comprehensive assessment'. (IWC, 1988a). He believed that because the alteration had been made without any scientific argument and no good faith interpretation can be found, the specific recommendation in 1995-9 should not be considered.

14.2 Provision of advice on the effect on stock(s) of scientific permit catches

Last year, the Committee had discussed proposals for providing advice to the Commission on this subject (IWC, 1996b, p.77–8) but had been unable to agree on an approach.

De la Mare, Lankester and Cooke presented a rationale for using the RMP to provide information which the Committee could use in providing advice on the potential long-term effects of scientific permit whaling on stocks, and the results of some simulation runs to compare the performance of assuming a catch of 2% of the lower 95% confidence limit of estimated abundance (part of the proposals made last year in Annex P, (IWC, 1996i) versus catches allowed under the RMP. The simulation results showed that better performance in terms of conserving the stock was achieved by the RMP than by a simple 2% rule. They noted that one of the problems with Annex P from last year is that it is not sufficiently specified to enable its full evaluation within the RMP development framework. They considered that it is important that procedures intended for providing advice about the effects of catches should be evaluated with respect to their long term application. They concluded that the RMP could form the basis for advice to the Commission on the matter of whether total catches over time may exceed the limits set under the RMS.

In discussion of this proposal, Butterworth and Hatanaka questioned the relevance of assuming catches over a one hundred year period when proposals for Special Permit catches were for a specified time. They pointed out that the simulation runs conducted took one section of last year's proposal out of context and were not consistent with its entirety. Cooke responded that the provision of advice on potential long-term effects of a take must take into account the effects of catches which may accumulate over time. Walløe and Butterworth noted that Annex P was intended to accomplish this. De la Mare and Givens noted that although the calculations using the RMP were problematic, they did provide a yardstick for the Committee to use as a basis for its advice.

Yagi and Komatsu stressed that catches under Special Permit, which are aimed at obtaining scientific information within a specified period, cannot be viewed in the same way as commercial catches and they believed that use of RMP simulations over a one hundred year period as a basis to provide advice to the Commission was inappropriate. Cooke noted that the RMP simulations were not intended to generate catch limits but to provide a fully tested framework to evaluate potential long-term effects on the stock.

The Committee agreed that advice to the Commission on the effect on stocks of Special Permit catches needed to include an evaluation of effects over the short and the long term, as appropriate. An *ad hoc* Working Group was established by the sub-committee on Management Procedures and General Matters to attempt to move towards

an acceptable way of providing such advice, using Annex P and (Butterworth and Geromont, 1996) from last year and the proposals from de la Mare, Lankester and Cooke as a starting point.

The Working Group had discussed how the effect on stocks of long-term scientific programmes (or prolongations of shorter programmes) should be assessed and had made some progress but had had insufficient time to consider this sufficiently and had not reached agreement.

For shorter-term programmes (Items (1) and (2) in Annex P) some general agreement was reached, although many details have to be discussed further. The agreement contained the following elements:

(1) a recent (< 10 years old) abundance estimate for the relevant catch area must be available;
(2) this estimate must have been discussed in the Scientific Committee (but not necessarily 'endorsed');
(3) rules for how to use more than one relevant abundance estimate must be established;
(4) all direct catches and not only Special Permit catches should be included in the application of procedure (1) in Annex P (IWC, 1996i);
(5) for research programmes lasting from 1–3 years the effect on stocks may be able to be assessed following procedure (1) in Annex P, but insufficient time was available to reach a conclusion on the circumstances in which it may be applied.

The Committee agreed to consider this matter again at next year's meeting and encouraged members to submit documentation presenting further proposals.

14.3 Review of results from existing scientific permits

14.3.1 Japan – Southern Hemisphere

SC/48/SH12 reported the results of the ninth JARPA survey, carried out south of 60°S in Area IIIE (35–70°) and Area IV. Area IV was surveyed during expected minke whale peak abundance; the Area IIIE survey was a stock identity feasibility study, and samples were taken early and late in the season to study intra-seasonal changes. From 893 primary sightings (of 2,021 minke whales) and 244 secondary sightings (of 564 whales), 273 males and 167 females were randomly sampled from the animals encountered. Whale distribution in Area IV was not very different from that observed during JARPA 1993/94, except that the high densities previously found in Prydz Bay were not apparent, possibly because pregnant females found there previously had migrated into Area IIIE.

There were three sightings of four blue whales during the survey, 25 sightings of 48-50 humpbacks and four sightings of four right whales. Skin biopsies were obtained from 10 humpbacks, 1 blue and 1 right whale. Samples would remain in Japan for analysis and comparison with other material.

SC/48/SH10 reported that between 1989/90 and 1994/95, identification photographs had been obtained from 17 blue, 17 right and 81 humpback whales. A number of studies at the Japanese Institute for Cetacean Research are under way, including southern minke whale biology, physiology and ecology.

Previous genetic analyses had suggested that at least two minke whale stocks occur in Areas IV and V: a 'core' stock in Area V and IVE (and in Area IV W later in the feeding season), and a 'western' stock in Area IVW early in the season. Extension of the analysis into Area IIIE and VIW, using samples from past commercial whaling (SC/48/SH13) indicated that whales from Area IIIE were similar to those from the 'western' stock, but significantly different from the 'core' stock. Whales from Area VIW differed significantly from those in the 'western' stock but not from those in the 'core' stock. However, the conclusions were affected by sampling being concentrated in a small region near the pack ice edge in Areas III E and VI W, and possibly not being fully representative. A simulation exercise concluded that 150-200 samples would be needed to detect differences between such putative stocks.

Comparison with material from lower latitude breeding grounds would greatly assist interpretation of those differences. In that connection Pastene reported on responses to a circular sent to relevant Southern Hemisphere scientists and institutions requesting information on available material. Material, mostly bone and/or baleen, and including some from the dwarf form was available from Argentina, Australia, Brazil, Chile and Peru. Details appear in Annex E (Item 5.2).

Information on oceanographic studies was given in SC/48/SH19. Minke whale density shifted from north to south during summer, apparently correlated with a shift in the upper stratum of the water column (to 50m depth), and the highest densities were found in the inner Ross Sea, where the average temperature, integrated from the surface to 200m depth, was below −1°C.

SC/48/O 22 reported on levels of certain persistent organochlorines in the blubber and food of 20 minke whales taken in 1992/93. Levels were lower than in whales from the North Pacific, possibly because of lower environmental pollution in the Southern Hemisphere and the lower trophic level at which southern minke whales feed (on krill) compared to northern minke (on fish).

A revision of a simple Virtual Population Analysis (VPA) approach for using catch-at-age information in assessment of southern minke whales was presented in SC/48/SH17. The ADAPT estimator used earlier was extended to address concerns raised last year, in particular the external specification of selectivity-at-age values, which can now be used to allow selectivity-at-age to be estimated directly from the data. Using data for Area IV, including recent JARPA data, selectivity in the scientific permit catches was found to be essentially uniform from age 8 upwards, but non-uniform below that. A retrospective VPA analysis gave greatly improved results, although recent recruitment estimates showed poorer precision. Distinctions between alternative natural mortality (M) values could still not be made, and recent trends in recruitment were sensitive to the M value adopted. With a longer time-series of catch at age data and further estimates of abundance it should be possible to distinguish between alternative M values; in the meantime estimated patterns in recruitment might be examined in connection with hypotheses of environmental change.

SC/47/SH24Rev provided an updated analysis of Area IV minke whale earplug transition phase data. Key changes to the original analysis now made the model fit the data much better. The authors concluded that although incomplete, the revision strengthened their conclusion of a real decline in age at maturity from a mean age of 11 in the 1950s to 6 in the 1980s. The analysis was also based on the assumption that the transition phase was directly correlated with age at sexual maturity.

Last year, the Committee noted that the assumption that the transition layer represented a real event (e.g. age at maturation) in the animal's life needed further consideration. On that point, Lockyer reminded the Committee of the history of recognition of the layer's biological significance, first in fin whales and then sei whales in the Southern

Hemisphere and more latterly in Icelandic fin whales. However, she pointed out that even if the correlation was correct, a reduction in age at maturity did not necessarily mean that younger animals could carry to term or raise their young successfully.

De la Mare responded that the analysis presented this year had not fully separated age-related effects from cohort-related effects. Even in old minke whales, which would be expected to be mature, there was only about a 50% probability of detecting a transition layer. He considered this to be evidence that the identification of transition layers involves difficult judgements which may not be reliable.

Kato stated that the correlations between transition phase, skull growth and sexual maturation reported for southern fin whales had been confirmed by Japanese workers. In addition, earlier work on truncation, so-called fringe and cohort effects in southern minke whales, had concluded that the cohort-related effect was negligible and that ageing errors also had no substantial effect.

The Committee agreed to carry over its recommendation from last year (IWC, 1996b, p.82-3) for a major review of JARPA. This will require funding from the Commission (see Item 22).

14.3.2 Japan – North Pacific

SC/48/NP13 described the general results of this research in 1995, extending work begun in 1994 (Fujise *et al.*, 1995). Three vessels were involved in a combination sighting and whale research programme under Special Permit. During the programme roughly 12,000 n.miles of trackline were searched in sub-area 9 (see Fig.1 of Annex J for a map showing sub-areas). In 1995 144 schools of minke whales were sighted, and 100 whales were sampled. The sampled whales were predominately males (91); seven of the nine females carried foetuses. The results of analyses of these animals and the 21 sampled in 1994 were presented in several other papers discussed below.

SC/48/NP21 presented the frequency of alleles from sub-area 9 at two loci using the methods of (Wada and Numachi, 1991), and contrasted these results with those for sub-areas 5, 6, 7, and 11 obtained earlier (Wada, 1991). The author noted that the four alleles of one locus and the two alleles of the other locus were in Hardy-Weinberg equilibrium, and that the frequency of the most common alleles was similar between animals from sub-areas 9, 7, and 11. However, the frequency was quite different from that of sub-areas 5 and 6. The author concluded that these data support the hypothesis of separate J and O stocks, and further that no significant difference was found between whales from sub-area 9 samples and from sub-areas 7 and 11.

In discussion, the power of the latter statistical test was queried, and it was suggested that this would be low because of the limited sample sizes. This was especially so because a small rate of dispersal between animals might serve to reduce the difference in allele frequencies.

SC/48/NP20 extended methods developed in (Butterworth *et al.*, 1996) for estimating mixing rates between two stocks using one locus, by using information on two loci to obtain greater precision. One of these methods was applied to provide estimates of mixing rates between the J and O stocks. The authors also suggested that hypothesis testing may not be the most useful approach for developing implementation trials under the RMP. This is, in part, because there is a low probability of detecting very small differences in allele frequencies, as might be maintained by low levels of dispersal between the stocks. They suggested a Bayesian approach to overcome this problem, which involves setting uniform prior distributions on the proportion of whales in each of two putative stocks, and on the allele frequencies. Using the 1995 data and data collected earlier the authors estimated that 91% of the whales in sub-area 9 belong to the O stock.

It was noted in discussion that this Bayesian approach involves giving zero probability to the possibility of there being only one stock. Nonetheless there is a risk associated with harvesting a coastal population of cetaceans based on estimates of abundance that include areas further offshore (IWC, 1992a, p.307–8).

SC/48/NP5 presented results of mitochondrial DNA (mtDNA) analyses of samples from whales from both the Special Permit catches (sub-area 9) and previous Japanese and Korean coastal whaling operations (sub-areas 6, 7, and 11). Analyses of mtDNA from the control region using restriction fragmental length polymorphism (RFLP) were conducted for samples from all of these areas, while RFLP analyses of the whole mtDNA genome were conducted only for samples from sub-areas 11, 9, and the southern portion of sub-area 7 east of Honshu (denoted 7S). The second method could not be applied to available samples from sub-area 6 because of sample deterioration. The eight haplotypes from the control region analysis were differentially distributed with the most frequent haplotype being the dominant haplotype in sub-areas 11, 9, 7S, and the northern portion of sub-area 7 (denoted 7N), but not occurring in sub-area 6. Haplotype frequencies did not differ significantly by month within each sub-area except in sub-area 11. In that area the dominant haplotypes in sub-area 6 are found in April, but in no other months, suggesting a mixture of two stocks in that month. The 14 haplotypes from the whole genome analysis did not vary significantly among sub-areas 11, 9, and 7S, except again for sub-area 11 in April. The authors suggest that these results support separate J and O stocks, that animals from these two stocks mix in April in sub-area 11, and that animals in areas 7, 9, and 11 (after April) do not differ genetically as far as can be determined statistically.

While the statistical power to detect potentially different stocks with low levels of genetic differentiation was likely to be low, Goto noted that DNA sequencing had shown four or five times greater resolution for humpback whales (SC/48/SH10), so that this approach might be usefully applied here.

SC/48/NP24 used the results of the mtDNA control region RFLP analyses in SC/48/NP5 to estimate mixing rates between the J and O stocks in sub-area 11 in April. The results are compatible with those of SC/48/NP20 (see also Appendix 4 of Annex J).

SC/48/NP9 compared the length distribution, gender, and state of maturity (from testes weight and ovarian inspection) from test whaling operations in sub-areas 8 and 12 (1973–1975), commercial whaling operations in sub-areas 7 and 11 (1977–1987) including locations of catches, and the whale research programme under Special Permit in sub-area 9 (1994–1995). Frequency distributions were compared by sub-area and month. The authors noted that changes in composition suggest a complex size- (age) and sex-related migration pattern. Principal features of this are that young male and female whales migrate into coastal areas in sub-area 7S in April, and disperse to sub-areas 7N and 11 from June to the end of the feeding season, with young females distributed further north as they become larger. Mature males are widely distributed in coastal and offshore waters from May through the feeding season. Mature females enter sub-area 11 and to a lesser extent sub-area 7N

in May, moving further north in the Okhotsk Sea during the feeding season. The authors illustrated the main features of the migration suggested by these data, and some length data from a Russian fishery in sub-area 12 and the northwest corner of sub-area 9 (see Fig. 2 of Annex J). The authors concluded that this pattern is inconsistent with the existence of sub-stocks within the O stock. They also noted that the collapse of the sardine fishery formerly conducted in sub-area 7 may imply a change in the distribution pattern of the whales.

In discussion the authors noted that the whaling ground shown as D on this last figure in fact represents only five minke whales landed at the whaling port of Taiji, which takes other species. Thus, the map gives a false impression of a minke whale ground off that port.

The method of measurement used in the Russian catch length data is unknown, but the largest animals are larger than any previously reported. This suggests that the measurement method may be inconsistent with that used for the Japanese data, making comparison difficult.

It was noted that the sex ratio and length distribution patterns in the sub-area 9 samples and in the sub-area 7 samples in July and August are similar, with a dearth of females in both. The length distribution patterns were examined further by inspecting the sub-area 9 data by month, where there were clearly more smaller males in sub-area 7N than in sub-area 9 during July and August. The Committee agreed that these data suggest migratory movements, and the lack of mature females in sub-area 7 implies that a separate group of interbreeding animals is not present there.

The possibility of size or sex selection of whales at sea was discussed, with various possible factors and experiences in this area and elsewhere being noted. It was suggested that there is little latitude for selection in the North Pacific Japanese fishery, because of the low density of animals, their solitary nature and rapid movements and, since the late 1970s, the use of Zodiacs to pursue whales. It was also noted that any such selectivity should not affect relative comparisons within areas and months.

It was noted that the general pattern of females moving to higher latitudes than males, and larger (older) animals moving to higher latitudes than smaller animals, had also been observed in the North Atlantic and in the Antarctic. Further, Schweder commented that the migration of smaller animals along the coast, as suggested by SC/48/NP9, was also seen in the Lofoten Island area. It was noted that previous *Implementation Simulation Trials* for North Pacific minke whales were not specific on the location of younger animals. In this regard, Hatanaka reported that while few smaller animals were reported from two parts of sub-area 12, more of them were included in the more southerly part of that area.

The possibility was suggested of improving the resolution of these data to help determine the location of younger animals by examining the age rather than the length distributions. However, it was noted that the success rate of determining age was less than 40% for scientific whaling operations, and less than 20% for commercial whaling operations. Further, it was noted that the success rate was lower for younger animals.

SC/48/NP20 provided an example calculation designed to illustrate that the consistency of such changes with the existence of substocks in these areas could be checked. It was noted, however, that the implementation of the population model used in the example calculations (HITTER) imposed certain constraints such as constant age selectivity. Further alternative explanations for the observed distribution patterns (e.g., oceanic productivity and temperature differences) and for changes in such patterns (e.g., changing prey abundance) might need to be considered.

SC/48/NP13 reported the conception dates inferred from the foetus lengths in the seven females sampled in 1994 and 1995 in sub-area 9, noting that they were consistent with the dates inferred from animals in the O stock previously.

SC/48/NP11 reported morphological measurements and observations on whales sampled in sub-area 9. None of these 121 animals had the distinctive colour pattern observed in 29% of the animals previously sampled in the Sea of Japan. Further, the previously developed discriminant function based on body proportions (Kato *et al.*, 1992) classified 97% of 108 animals for which data were available as being more similar to the O than the J stock. There were no whales having the type III flipper coloration in sub-area 9, which sometimes occurred in the Sea of Japan, while no such whales were seen in the Pacific (Kato *et al.*, 1992). This is consistent with the hypothesis of a single stock in sub-areas 7 and 9.

In discussion it was noted that the discriminant function was much more successful in classifying this sample than it had been in classifying the original samples. One possible reason for this is that the sub-area 9 animals may be less variable than those from the J stock. An additional possibility is that the previous data were collected by several individuals during fishing operations, while the latter were collected by the author of SC/48/NP11 and might be expected to include less measurement error.

SC/48/NP12 presented data collected on the parasite fauna of each of the 100 whales sampled in sub-area 9 in 1995. Ten species were identified, and the species composition was compared with information in three previous reports of parasite data. Heavy infestations of the two most common species of parasites (*Anisakis simplex* and *Bolbosoma nipponicum*) were noted to have also been observed in minke whales sampled in coastal Pacific waters. The first had also been reported previously in other cetaceans in the western North Pacific. Three species of cestodes were observed, with two reported previously from minke whales in sub-areas 7 and 11. The authors concluded that the occurrence of these species in minke whales from both offshore and coastal waters suggests homogeneity of whales in this region.

In discussion it was suggested that a detailed investigation of the parasite fauna from coastal animals would strengthen the conclusions. However, it was noted that the age- and sex-specific migration patterns of minke whales in this region make the interpretation of data on parasites particularly difficult to interpret in terms of stock structure.

SC/48/NP22 compared concentrations of mercury and cadmium observed in three tissues in whales sampled in sub-area 9 with those previously reported from sub-area 7. The concentrations for both sexes increased with length up to roughly 6.5m, and were higher and more variable for larger animals. There were few large animals in the sub-area 7 samples, however, making direct comparison difficult. The authors argued that no differences could be detected between the levels of accumulation of heavy metals from the whales in sub-areas 7 and 9, taking account of the nature of length-related accumulation characteristics.

In discussion it was suggested that the levels could be statistically compared between the two sub-areas for smaller animals, although the statistical power of such comparisons was likely to be limited.

SC/48/O 22 compared concentrations of five organochloride compounds in 10 species of cetaceans in many regions of the world. Residual levels of four of these compounds were lower in the Antarctic than in the North Pacific. Furthermore, higher concentrations of PCBs and lower ratios of DDE/PCBs were observed in samples collected in the North Pacific in 1987 in coastal waters than in samples collected in 1994 in more offshore waters.

In discussion the authors suggested that, after taking account the correlation between accumulation of PCBs with body length, the levels of PCB concentrations in minke whales from sub-area 7 (1987) and sub-area 9 (1994) were the same. They concluded that this implies continuous environmental inputs of PCBs in the Northern Hemisphere. However, it was also noted that the animals sampled in sub-area 7 were smaller than those from sub-area 9, which makes this comparison difficult. Some suggested that improved sampling in sub-area 7 would be helpful in interpreting these differences.

SC/48/NP7 provided an estimate of minke whale abundance in the southern part of sub-area 9 from sightings over the 5 July–6 August period in 1994 of 3,102 (CV = 0.44).

The Committee's views on the implications for stock structure of this information may be found under Item 7.3 of Annex J. Smith commented that the information obtained from this research had been helpful in the process of revising the North Pacific minke *Implementation Simulation Trials*.

14.4 Review of new or revised Scientific Permit proposals

14.4.1 Japan – Southern Hemisphere

The Government of Japan (1995) presented the 1996/97 JARPA Research Plan. Although this is largely a continuation of the programme discussed previously by the Committee, the extension of the research Area to the west last year (i.e. into Area III) will be repeated for the second Area (i.e. into Area VI), for the same reasons (i.e. to try to clarify problems in stock structure that had come to light during previous years).

The intention is to use information from a number of approaches (genetics, morphometrics, pollutant burdens, parasite loads) to examine stock structure, since information from genetic studies alone has not proved sufficient for stock differentiation. The sample size of 100 animals was based on a combination of general advice for genetic studies (see SC/48/SH13), an estimate of possible catch levels required for pollutant analyses and the need to obtain information on age distribution (as previous JARPA work suggests that migration patterns are related to age). The proposal noted that existing Area VI data are limited to the area close to the pack ice and thus do not represent those components of the population that do not migrate so far south. In order to maintain sighting effort despite the increased area coverage, an additional sighting vessel will be used. With respect to the effect of catches on the stock, the proposal referred to the analysis in SC/48/O 1 which examined population trajectories assuming the catches planned. It concluded that even under pessimistic assumptions, the stock would continue to increase. Additional data on the sampled animals will be collected with respect to the new objective (to relate pollutant, pathology and reproductive studies) as well as additional oceanographic information.

COMMENTS AND DISCUSSION

In discussion, Smith noted that whilst it was scientifically valid to modify objectives of existing long-term research proposals to take into account results obtained, it made it more difficult to review the objectives in the manner required by the Commission.

Lankester noted that the likelihood that objectives 1 (elucidation of the stock structure to improve stock management) and 2 (estimation of biological parameters to improve stock management) of the proposal would be met would be small. After the establishment of the Southern Ocean Sanctuary any alteration in management in this area is not expected in the foreseeable future. He further noted that the Commission has deferred the implementation of the RMP in sanctuaries.

Yagi stated that, since Japan had objected to the Sanctuary, the reasoning behind Lankester's points is erroneous and the points themselves are irrelevant. He further commented that scientific information from JARPA is expected to contribute significantly to aspects regarding RMP implementation, including the determination of appropriate *Small Areas*. Finally the Commission is committed to reviewing (and possibly abolishing) the Sanctuary in 2004 and JARPA data will contribute to that review. It is also providing valuable monitoring information on species within the Sanctuary.

Slooten commented that without further specification of objectives 3 (elucidation of the role of whales in the ecosystem) and 4 (elucidation of the effect of environmental change on cetaceans) of the proposal it was difficult to evaluate the likelihood of the proposal meeting its objectives.

In response it was noted that the programme had already produced interesting results including papers presented to this meeting (e.g. SC/48/O 22) and the workshop on pollution (e.g. SC/M95/P13) relating to objectives (3) and (4).

Simmonds commented on the pollution studies of JARPA, noting that the Bergen workshop had recommended that the studies should be conducted on species which are found over a wide pollution gradient. The workshop had specifically identified the harbour porpoise, the bottlenose dolphin and the white whale. He also noted that age and sex related patterns of accumulation were well established for cetaceans.

In response Fujise commented that the Committee had noted last year that the Workshop report was not suggesting that other species, such as minke whales, should not be studied in the context of pollutants. It also referred to the value of direct studies, particularly in the Southern Hemisphere (IWC, 1996b, p.57). He noted that the environmental and pollutant studies were well incorporated into the programme and some results had been already provided to the Committee.

The Committee agreed that the information provided on the number, sex, size and stock of the animals to be taken had been specified to the extent possible. Smith expressed his appreciation for the consideration of sample size given in SC/48/SH13. The Committee also noted that the opportunities for participation in the research programme were adequate, as in previous years.

In response to a query, Komatsu reported that there were no plans to change the original time frame of 16 years for the programme.

SC/48/SH3 had referred to analyses presented in SC/48/O 1 that suggested that the proposed catches will have no adverse effects on stocks.

The Committee referred to its discussion of how it might provide advice on the effect of scientific permit catches on stocks under Item 14.2.

With respect to the additional items referred to it under the Resolution, the Committee recalled that it had discussed essentially the same programme for a number of years (IWC, 1990; 1991; 1992b; 1993b; 1994b; 1995a; 1996b) and referred to its decision last year to hold an intersessional meeting to review the overall programme. Although that meeting had been postponed until this year, it believed that it was the most appropriate forum to discuss the long term research programme further.

14.4.2 Japan – North Pacific

SC/48/NP1 described the continuation of a programme to elucidate the stock structure of minke whales in the northwestern North Pacific. A catch of 100 minke whales has been proposed, although the sampling area has moved further towards the coast. No adverse effect on stocks is anticipated. The minke whale feeding ecology study is an additional research objective.

While noting the similarity of this programme to those it has previously reviewed, the Committee had no additional comments to those it had made in previous years, and refers the Commission to its more detailed discussions (Angliss *et al.*, 1995; IWC, 1996b).

14.4.3 Norway

Walløe presented SC/48/NA8, a proposal for scientific permit catches of 21 minke whales to be taken each year for three years in the EC area outside the coast of Norway. The objective of the proposed research was to secure samples from the EC area for genetic investigations designed to address the question of possible stock separation between EC and the neighbouring EB and EN areas. The samples would be used both for mtDNA, genomic DNA and isozyme techniques, and compared to samples obtained from commercial catches from the EB and EN areas. Isozyme analysis cannot be undertaken using non-lethal methods. Other investigations bearing on the same problem will be carried out in parallel with the genetic investigations, e.g. migratory movements by radio tagging.

The whales are to be taken randomly without predetermination by length or sex. Although data can be collected on behalf of scientists from other nations, space and logistic considerations make direct participation in fieldwork difficult. The proposal noted that the current abundance estimate for the 'EC' area is 2,462 (CV = 0.228) and commented that the catches would not have an adverse effect on the stock.

COMMENTS AND DISCUSSION

(A) OBJECTIVES OF THE RESEARCH

Several comments were made concerning the need for an overall focus of the proposed research. Questions were raised about the power analyses referred to with respect to hypotheses and results. There were some comments about the necessity for the isozyme analyses. Many members of the Committee commented that the objectives had not been adequately specified although some members believed they had.

(B) NUMBER, SEX, SIZE AND STOCK OF THE ANIMALS TO BE TAKEN

In response to a query about the basis for the 21 whales to be taken each year from the EC area, Walløe responded that results with respect to power analyses suggested that samples from an additional 60–65 animals to the 60 already available were required. Samples from previous commercial catches were not suitable for isozyme analyses.

(C) OPPORTUNITIES FOR PARTICIPATION IN THE RESEARCH BY SCIENTISTS OF OTHER NATIONS

The Committee agreed that these were adequately specified. Brownell commented that the SWFSC, La Jolla was interested in receiving skin samples for comparative genetic analyses. Walløe responded that Norway would be interested in such collaboration.

(D) POSSIBLE EFFECT ON CONSERVATION OF STOCK

The Committee referred to its discussion under Item 14.2.

Cooke noted that if the RMP with catch-cascading were applied using the estimates given in SC/48/NA1, a catch of around 15 animals would be allowed in the EC area. If these animals were taken commercially, the research take could be reduced. Walløe commented that Norway had misinterpreted the rules and had believed that no whales would have been allocated to this *Small Area* under the RMP.

In response to requests in Commission Resolution 1995–9, Taylor stated that molecular genetic methodologies, which can be based on samples collected by biopsy darting, are usually more powerful for stock identification than enzyme analyses, which require lethal sampling. Goto noted the requirement for multi-approach analyses to include a genetic approach for stock identification, and the difficulty of undertaking biopsy sampling on fast swimming oceanic species such as the minke whale.

Taylor suggested that data on the success of biopsy sampling for different species in different Beaufort conditions could help resolve the issue of feasibility of biopsy techniques.

There were a number of comments supporting each of these views. Comments were also made about the feasibility or otherwise of obtaining biopsy samples from minke whales. In conclusion, some members believed that lethal research was a necessary part of the research proposed, other members believed it was not.

On the day after the discussion, Walløe informed the Committee that the Norwegian proposal for a scientific permit catch had been withdrawn by the Norwegian Commissioner.

15. RESEARCH PROPOSALS

15.1 Research fund accountability

The Committee took into account the paper on research fund accountability prepared by the Secretariat (IWC/48/16) noting the comments it had made last year in this regard (IWC, 1996b, p.84).

15.2 Review research results from 1995/96

In accordance with the decision last year (IWC, 1996b, p.84; IWC, 1996k), the *ad-hoc* Working Group under Bannister (Hammond, Martin, Reilly, Walløe) met during the meeting to review projects completed or in progress. It reported as follows.

15.2.1 Southern Hemisphere Minke whale assessment cruise, 1995/96

The report of the cruise is given in SC/48/SH2 and the results were discussed in Annex E. It was agreed that the work had been satisfactorily carried out.

15.2.2 Evolution, genetic structure and molecular ecology of the North Atlantic fin whale

Progress on this ongoing project had been reviewed last year, when two papers presenting preliminary results had been received. As discussed in Annex F, Item 10, the work is continuing and the final results are expected to be available for review next year. The Committee noted the importance of this work to its consideration of the West Greenland fishery, where stock identity problems are a major difficulty in providing management advice.

15.2.3 Genetic analysis sub-project – Years of the North Atlantic humpback whale

A report covering progress on this project was available in SC/48/NA12.

15.2.4 Humpback whales off southern Madagascar

A report on further work under this project was available in SC/48/SH14, and is reviewed in Annex E. The two documents now received (including Best *et al.*, 1996) represent the full report on the project, which has been satisfactorily carried out.

15.3 Review proposals for 1996/97

The Intersessional Group, appointed last year from among the convenors (Bannister, Hammond, Martin, Reilly, Walløe) had received only one proposal, which had been forwarded to it intersessionally in accordance with the procedure agreed last year.

It reviewed the proposal according to the agreed criteria:

(1) relevance to the work of the committee;
(2) scientific quality of the project;
(3) its chances of success;
(4) scientific competence of proposer(s);
(5) feasibility of proposed work schedule;
(6) reasonableness of budget;
(7) multinational context.

The review of the proposal is given below.

Stock identity of eastern North Atlantic humpback whales: analysis of the photographic evidence. P.T. Stevick, J.M. Allen, M.W. Brown, S.K. Katona

This proposal was essentially the same as SC/47/RP5, which had been reviewed and recommended for priority support, but not funded, last year. It differed from last year's proposal only in the addition of one researcher, Brown, and a slight increase in funding requested ($US23,718 c.f. $21,600). The group confirmed its previous view, i.e. that the proposed work was relevant to the Committee's work (in particular with respect to a possible Comprehensive Assessment of North Atlantic humpback whales), the scientific quality of the project was high, its chances of success were high, the proposers were competent, the proposed work schedule was feasible, the budget was reasonable and the international context was appropriate.

It was agreed that the project should receive a High rating.

16. SMALL CETACEANS

16.1 Consideration of criteria for assessing the status of harbour porpoise populations

In 1995 the Committee discussed criteria that might be used to assess the status of harbour porpoise populations (IWC, 1996d, p.168). Following the precautionary principle, it agreed that in no case should bycatch exceed half the maximum rate of increase of a population. At that time, the Committee adopted a value of 1% of the estimated abundance as a reasonable and precautionary level beyond which to be concerned about the sustainability of anthropogenic removals. The Committee noted that this was a somewhat arbitrary approach and recommended that discussion of this topic be continued at this year's meeting.

At this meeting the Committee stressed that, in addressing this topic, there was no intention to discuss issues of management, but rather to restrict discussion to the assessment of harbour porpoise populations in the North Atlantic.

The Committee considered a presentation of the approach used to assess the status of marine mammal populations in the United States (Wade, 1997). The goal of this approach is to maintain populations at levels above their Maximum Net Productivity Level (MNPL), assumed to lie between 50-70% of carrying capacity. This approach uses information on abundance, bycatch and population growth rates to estimate a parameter known as the Potential Biological Removal (PBR) level. The method accounts for precision of the abundance estimate in an explicit fashion, and bias and precision in other factors in an indirect manner. Bycatch levels that consistently exceed the PBR value are assumed to lead to a depletion of the stock.

The PBR is defined to be the product of three factors: $N_{min}.0.5r_{max}.F_r$

where N_{min} is a minimum population estimate for the stock, r_{max} is the maximum theoretical or estimated rate of increase of the stock at a small size, and F_r is a recovery factor, whose value lies between 0.1 and 1.0. In practice, r_{max} is either the maximum observed population growth rate for a stock or a default value (0.04 for cetaceans) if no specific estimate is available.

To evaluate performance of this scheme, (Taylor, 1993) adapted simulations developed by the Scientific Committee to test the RMP. These simulations are described in detail in (Taylor, 1993) and developed fully in (Wade, 1997). An important outcome of these simulations was that use of the 20th percentile of a log-normal distribution of the abundance estimate as N_{min} met the specific performance goals for an adequate management procedure under US law.

(Wade, 1997) also conducted a second series of trials to tune the value of F_r to ensure that the procedure was robust in the presence of bias in various factors, including underestimation of true bycatch, overestimation of abundance, overestimation of population growth rate, underestimation of the CV of the abundance estimate, underestimation of the CV of the bycatch rate and others. Use of a recovery factor of 0.5 was sufficient to meet performance goals in all of these bias trials. The approach also allows for adjustment of this recovery factor to values as high as 1.0 for stocks that are known to be stable or increasing with current levels of bycatch, and to a value as low as 0.1 for endangered stocks.

The Committee agreed that the PBR approach was useful and discussed its merits at considerable length. It noted that the process used to develop the PBR was analogous to the Committee's approach in developing a *Catch Limit Algorithm* (*CLA*) for the RMP. This version of the PBR equation is similar to an earlier version of the *CLA*. It may be necessary to modify the approach to minimise the interannual variance in PBR by incorporating abundance estimates from several years into the formula. Hatanaka and Nomura noted that the PBR approach is derived from the

requirements of US law under the Marine Mammal Protection Act which, in general, prohibits the deliberate taking of marine mammals and considered that, given this policy, it may have advantages in its simplicity and accessibility to non-scientists. They noted, however, that in some areas harbour porpoises were subject to directed takes under completely different management philosophies and that in such situations the PBR approach was neither relevant nor viable.

The discussion then focused on the need or desirability of 'tuning' the PBR equation to meet the needs of the Committee. In SC/48/SM29, Smith and Palka analysed the performance of the PBR equation in terms of the probability of classifying the status of a single stock in terms of the sustainable level of bycatch. They demonstrated that the probability that the PBR equation correctly classifies the status of that population varied asymmetrically with the uncertainty in bycatch and abundance. They concluded that this made it difficult to determine the best balance between the intensity of sampling programs for estimating bycatch and abundance. Furthermore, for low levels of precision of the bycatch estimate, they showed the counterintuitive result that the performance of the PBR equation became poorer with improving precision of the abundance estimate. They concluded that the gains due to the simplicity of the PBR formula were offset by the difficulties in implementing sampling programs and in explaining the counterintuitive behaviour. They suggested an alternative formula that does not have the asymmetry. However, this alternative formula also has poorer performance with increasing precision of the estimates of both abundance and bycatch, although the degree of this is much less than the PBR.

In SC/48/SM28, Smith and Palka suggested five desirable characteristics of a criterion for classifying the status of a population:

(1) what the criterion is to measure should be explicitly identified;
(2) the criterion must use data that are available;
(3) uncertainties in estimated quantities should be accounted for in the criterion;
(4) uncertainties in quantities for which no estimates are available should be accounted for in robustness simulation trials; and
(5) the performance of any criterion should vary predictably with uncertainties in the information available, with better performance from better data.

They reviewed available approaches in terms of these characteristics and noted that, while the PBR approach does not possess characteristics (3) and (5), a simple extension of the approach would possess these attributes. However, the implementation of such alternative approaches to the point of development of the PBR approach would require selection of several parameters using simulation trials.

Wade and DeMaster replied that the CV of bycatch was used in the selection of the 20th percentile, and that variation in this parameter had little effect on the performance of the method. There was considerable discussion on this point. Several Committee members noted that other factors, such as bias in estimates of bycatch and uncertainty in stock structure, could have considerably more effect on the algorithm than variation in CV of the bycatch.

The Committee reviewed several other papers that addressed this topic (SC/48/SM28, SC/48/SM31, SC/48/SM49 and SC/48/SM50) without reaching agreement on whether use of the PBR equation was useful in assessing the status of harbour porpoises in the North Atlantic, within the context of the IWC. There was general agreement that the method used by the Committee last year was unsatisfactory. The Committee agreed that the PBR approach represented an advance over the current method, and most members felt that the PBR equation could be provisionally applied in this case. Bycatches will continue as any methodological approach is developed, and there is an urgent need to adopt some assessment scheme, even on a provisional basis. As there was no consensus on the use of the PBR equation, however, it was not applied to North Atlantic harbour porpoise stocks at this meeting.

The Committee briefly reviewed available information on the abundance and magnitude of bycatch of harbour porpoises in several areas of the North Atlantic (IWC, 1996d, p.169–70; Kock and Benke, In Press). In each of four areas for which data were available (Gulf of Maine, Kiel Bight, Celtic Shelf and southern North Sea), estimates of known bycatch were greater than 2.5% of the best estimate of abundance, levels that the Committee agreed may not be sustainable.

16.2 Consideration of methodology to assess the magnitude of bycatches for harbour porpoise populations

The Committee agreed to review new information on the methodology used to estimate bycatch of harbour porpoises, recognising that other organisations, such as ICES and ASCOBANS, were undertaking similar reviews.

Estimates of bycatch generally incorporate two independent measures: an estimate of the bycatch rate (preferably obtained from an independent observer scheme) and a measure of total fishing effort. The Committee discussed these two components in turn.

The methodology used to estimate bycatch rate of harbour porpoises in the US sink gillnet fishery in the Gulf of Maine was presented in SC/48/SM38. This program employs independent fishery observers who monitor the harbour porpoise bycatch rate aboard sink gillnet vessels. Palka noted that the objectives of any observer programme will dictate the design and implementation of that programme. For example, if the goals of a fishery observer programme include the collection of information on fish catches and discards, it may be necessary to increase observer coverage to ensure that both objectives are achieved.

Several general considerations apply to any observer programme. First, it is important to obtain a representative sample from the fishery. In addition, it is necessary to decide what level of precision is required, so that sampling intensity can be determined and allocated. A trade-off exists between precision of the estimate of bycatch rate and cost, so it is important to determine a realistic goal in terms of the CV of this estimate. Only in exceptional circumstances will it be possible to conduct a complete census of the bycatch by placing observers on each vessel. Observer coverage can be allocated proportionally to total fishing effort, optimally with respect to bycatch rate, or by a combination of both techniques. It is also necessary to adapt the sampling programme to changes in fishing activities, to ensure that the objectives of the programme are met. Consideration needs to be given to the suite of data that is collected by observers (IWC, 1996d, p.165–6), given the objectives of the programme.

The Committee discussed the potential for observer effects (changes in fishing practices as a consequence of carrying an observer) in such sampling programmes noting that they will lead to underestimates of bycatches. These effects often occur in fisheries that use active gear, such as

purse seines or trawls. Several Committee members noted the potential for similar effects in passive fisheries, such as gillnets, including non-random placement of observers in relation to expected bycatch rates and changes in the time, area, or numbers of nets fished when a vessel carries an observer. The Committee concluded that any observer programme should strive to maximise precision and minimise bias.

The Committee then turned its attention to the second component of estimating bycatch - measuring the total amount of effort in a fishery. Measures of fishing effort serve at least three purposes: scaling bycatch rates to an estimate of total mortality for the fishery; allowing comparison with other studies; and describing bycatch in terms of gear use. It is preferable to obtain several independent measures of fishing effort, to allow verification, but this is seldom possible. Under some circumstances, particularly with artisanal fisheries, it may be necessary to use other measures of effort, such as days absent. The Committee concluded that direct measures of fishing effort are highly desirable but seldom attainable. Each fishery must be evaluated independently and there is no substitute for a thorough knowledge of fishing practices when designing programmes to estimate bycatch.

At its 1995 meeting, the Committee noted that several other methods of estimating bycatch have been used in the past, including using data from strandings, interviews and dock-side reporting (IWC, 1996d, p.165). Such methods have also been reviewed recently by (Northridge, 1996), who noted that programmes incorporating independent observers provide the most reliable means of estimating bycatch. Nomura and Perrin emphasised that observer programmes require cooperation from fishery participants, which may be difficult to obtain under some circumstances. They can also be expensive. Nevertheless, the Committee concluded that bycatch estimates derived from independent observers are desirable and that other methods are less reliable.

The Committee **recommends** that an assessment of the potential marine mammal bycatch should be made for new fisheries using independent observers before such fisheries are developed commercially. In addition, the Committee **recommends** that wherever estimates of harbour porpoise bycatch rates exist from observer programmes, member states should provide relevant data on fishing effort to allow estimation of total bycatch.

The Committee received several recent studies of harbour porpoise bycatches in the North Atlantic, including studies from Sweden (SC/48/SM/25), the Gulf of Maine (SC/48/SM/30) and Germany (Kock and Benke, In Press). All of these programmes estimated bycatch using independent observers. In addition, it considered the BY-CARE program, involving researchers from the United Kingdom, Denmark, Ireland and Sweden. The objectives of this programme are: to develop methods to assess the magnitude of bycatches in selected EU fisheries; to develop a framework for assessing the ecological importance of this bycatch; to investigate variation in bycatch related to gear type, environmental factors and season; and to develop a framework for assessing potential methods to reduce bycatch.

16.3 Global review of the genus *Lagenorhynchus*

The six *Lagenorhynchus* species were considered under the topics taxonomy, distribution, stock identity, migrations, abundance, directed and incidental takes, status, life history and ecology. A full account of the discussions and conclusions is given in Annex H. The following is a brief summary of the most important conclusions.

16.3.1 Taxonomy

Investigations into the molecular relationships among currently recognised *Lagenorhynchus* species, summarised briefly in SC/48/SM32, suggest that the genus is not monophyletic but rather a paraphyletic assemblage of morphologically similar species. The two North Atlantic species form one group that should retain the name *Lagenorhynchus* (*L. albirostris* is the type species for the genus).

Cytochrome b sequence analysis indicated a sister species relationship between *L. obliquidens* and *L. obscurus*. Much older divergences (3.8–9.6mya), about the same as divergences between any of the recognised *Lagenorhynchus* species and other genera, were found between the *obscurus-obliquidens* pair and the North Atlantic species pair (SC/48/SM32). (Van Waerebeek, 1993) suggested on the basis of cranial morphology that *L. obscurus* from Peru and Chile, New Zealand and southern Africa differ from one another at the subspecific level.

16.3.2 Pacific white-sided dolphin, Lagenorhynchus obliquidens

This species is widespread and abundant. An estimated 49,000 to 89,000 were killed in driftnet fisheries from 1978–1990, but recent takes have been much lower. No current concerns with regard to the status of Pacific white-sided dolphins were identified.

Dramatic shifts in distribution of Pacific white-sided dolphins have been observed off southern California, British Columbia and southeastern Alaska. It is uncertain whether these shifts represent responses to changes in water temperature or to changes in prey distribution or both. There is no evidence to suggest an increase in aggregate abundance of dolphins.

16.3.3 Atlantic white-sided dolphin, L. acutus

The only area where substantial numbers of Atlantic white-sided dolphins are known to be taken on a regular basis is the Faroe Islands. The catch in 1994 was reported as 258 (IWC, 1996d, p.176) and varied between 0–603 from 1983 to 1990. In US waters the average annual estimated bycatch in Gulf of Maine groundfish gillnet fisheries was 102 (CV = 42%) during 1991-93 (SC/48/SM39).

SC/48/SM1 discussed 43 specimens taken in the Dutch pelagic trawl fishery for horse mackerel and mackerel at the edge of the continental shelf southwest of Ireland. Addink reported that the Dutch fleet consisted of 12–13 vessels, and only one observer is involved in documenting cetacean bycatch and collecting specimens. *L. acutus* is apparently one of the most frequently taken cetaceans in this fishery. A report of work sponsored by the European Community on the bycatch in this fishery exists, and is expected to contain information relevant to a consideration of this species' status in the eastern North Atlantic, but has not yet been released to the public. No assessment of status was possible from the currently available data.

Recognising that a large amount of specimen material is available in both Europe and North America, it was felt that useful insights about this abundant, but surprisingly little known, species could be obtained. The Committee therefore **recommends** that available samples be analysed as soon as practicable.

The Committee noted that it would be valuable to have better and up-to-date information on directed and incidental takes of this species in Canada, Iceland and the Faroe Islands. In this regard, it also noted that publication of any results from the NASS surveys would be welcomed.

16.3.4 White-beaked dolphin, L. albirostris

These dolphins are regularly hunted with rifles in northern Newfoundland and Labrador. The annual landed catch was crudely estimated as 366 dolphins in the early 1980s, and the mortality rate from this hunt could be well above 10% (Alling and Whitehead, 1987). The Committee called attention to the need for better documentation of this directed hunt, which should be coupled with population surveys and other relevant studies.

There is little evidence of incidental catch of this species in the western North Atlantic, but better information on the bycatch of *Lagenorhynchus* dolphins in Canada, Iceland, Norway and other range states is needed.

16.3.5 Dusky dolphin, L. obscurus

Large numbers of this species (from the low thousands to 17,500) have been taken annually in gillnets and by harpooning in Peru since the early 1980s (Read *et al.*, 1988; Van Waerebeek and Reyes, 1990; 1994a; b). The distinction between directed and incidental take was blurred because of the commercial value of cetacean meat used to provide an incentive for fishermen to set nets deliberately to catch cetaceans. The most recent data refer to 1991–93 when approximately 17,500 small cetaceans, about 53% of them dusky dolphins, were landed per year (Van Waerebeek and Reyes, 1994a; b).

A law published in April 1996 declared seven species of small cetaceans, including the dusky dolphin, to be protected in Peruvian waters. Directed takes have declined as a result of this legislation, but there is no reason to believe that incidental takes in gillnet fisheries off Peru have also done so. The ban on commercial sale of products from small cetaceans means, however, that it is no longer possible to obtain data on incidentally caught animals (SC/48/SM2). The Committee noted the substantial reduction in dusky dolphin mortality in Peruvian waters and encourages Peruvian authorities to implement an observer programme to monitor bycatches of cetaceans in the gillnet fisheries. The Committee also recognised and wished to reiterate the long-standing need for assessment surveys of small cetaceans in the fishing grounds off Peru.

Substantial bycatches of dusky dolphins have occurred in midwater shrimp trawls off Patagonia (SC/48/SM22). The peak catch in 1984 was estimated at 442–560 animals, but the annual take has decreased with a decline in midwater trawling in recent years. The estimated total bycatch in 1994 in trawl fisheries for hake and shrimp off central Patagonia was 57–219, of which only 36 were from the midwater trawl shrimp fishery (SC/48/SM22). The use of midwater trawls for shrimp at night, which is when dusky dolphins are usually caught incidentally, is now illegal in Patagonia.

Approximately 50–150 dusky dolphins were killed annually in gillnets off Kaikoura, New Zealand, in the period 1984-88 (SC/48/SM32), but the take apparently has declined since the 1980s owing to changed fishing practices.

16.3.6 Peale's dolphin, L. australis

Peale's dolphins have been taken by harpoon for crab bait in both Chile and Argentina in recent years and their abundance has simultaneously fallen (Lescrauwaet and Gibbons, 1994; SC/48/SM42, SM43). Nevertheless, the crab fishery has now almost collapsed in many areas and dolphin mortality is assumed to have dropped as a result. The species is now said to be returning to areas such as the eastern Beagle Channel and waters near Cape Horn (SC/48/SM42). In the absence of recent abundance estimates and quantitative data on removals, the Committee was unable to evaluate the status of Peale's dolphins in the Tierra del Fuego/Magellan Strait region.

16.3.7 Hourglass dolphin, L. cruciger

This dolphin is apparently widespread in pelagic Antarctic and sub-Antarctic waters, but it remains one of the least known of all cetaceans. No information on its status is available, but it is not subjected to significant takes.

16.4 Review of other presented information on small cetaceans

16.4.1 White whales

DeMaster presented harvest data provided by the Alaska Beluga Whale Committee. He also reported the results of surveys for white whales in Cook Inlet, Alaska. The median count from aerial surveys of Cook Inlet was 388 whales, although this was not corrected for those whales that were submerged or missed by observers (SC/48/SM8). Information from VHF radio telemetry (SC/48/SM9) and other observations of behaviour suggested a correction factor of approximately 3 to account for availability bias. A correction factor for the reduced sightability of grey (i.e. young) animals is needed. The most recent estimate of removals from this stock was 72 animals in 1995 (SC/48/ProgRepUSA), representing perhaps 6–9% of the stock.

16.4.2 Vaquita

The Committee reviewed recent information on vaquita. No vaquita mortality occurred in 122 observed gillnet hauls in the upper Gulf of California in December 1995, although it was not possible to estimate what proportion of total fishing effort this represented. Recent sightings of the species in the delta of the Colorado River and observations of anadramous and estuarine prey in the stomachs of vaquita suggest that this environment may be a critical habitat for this highly endangered small cetacean.

Perez-Cortes described the continuing implementation of the Management Plan of the Biosphere Reserve in the upper Gulf of California, which contains measures that will assist in the conservation of this species. A copy of the plan was formally presented to the Committee during the plenary session and the Committee wishes to record its gratitude. Several members of the Committee expressed continuing concern over the vulnerability of this species, particularly given some of the observations in SC/48/SM34. The Committee, therefore, reiterated its deep concern and again **recommends** that immediate action be taken to eliminate bycatches of vaquita in all fisheries in the upper Gulf of California.

16.4.3 Gillnet fishery mortalities

The bycatch of common dolphins in a UK and Irish set gillnet fishery in the Celtic Sea was discussed in SC/48/SM48. Bycatch rate (1.4 per 1000km of net) was estimated by independent observers. Total fishing effort was estimated indirectly from UK and Irish government fishery statistics. Total mortality from this fishery was estimated as 234 dolphins (95% CI 0 to 515).

SC/48/SM11 reported preliminary estimates of cetacean bycatch in two California gillnet fisheries for 1995. Nine

species of small cetaceans were killed in this fishery, the primary species being short-beaked common dolphins, Risso's dolphins, northern right whale dolphins and Cuvier's beaked whales.

Estimates of the bycatch of small cetaceans in artisanal gillnet fisheries in Ecuador were presented in SC/48/SM36. Data on bycatch rates were obtained from independent observers and reports from fishermen. Fishing effort was estimated from data on fleet size and number of days absent. An annual mortality of 6,374 small cetaceans was estimated for the Ecuadorian EEZ, but it was not possible to stratify this estimate by species. This mortality accounts for 4.8% of the estimated abundance of small cetaceans in this area.

The Committee noted that for the first time observers had monitored the unloading of vessels operating gillnet fisheries that take franciscanas incidentally in southern Brazil (SC/48/SM12). The coverage was 20% in 1994 and 5% in 1995. The extrapolated annual take was 461 dolphins. This is roughly eight times higher than previous estimates based on stranded carcasses. Although it is not clear from the paper exactly how some of the data (e.g. size and maturity of entangled dolphins) were collected and how possible seasonal variation in bycatch was addressed, the Committee recognised the value of the work and **recommends** that it be continued and refined.

16.4.4 Eastern Tropical Pacific

Dolphin mortality in the tuna purse seine fishery in the ETP in 1995 was 3,274 (SC/48/SM4). For the first time, the annual figure is the actual figure, not an estimate, as 100% of the 545 vessel trips fishing on dolphins was observed. The mortality decreased by 20% from that in 1994.

The Committee agreed that there may be reason to be concerned about the two endemic subspecies *Stenella attenuata graffinani* and *S. longirostris centroamericana* as these have low abundance compared to the offshore subspecies of spotted and spinner dolphins and are possibly also impacted by artisanal gillnet fisheries within the range of these stocks (SC/48/SM35, 36).

16.4.5 Bycatch reduction measures

Gearin described an acoustic alarm experiment in the 1995 northern Washington marine salmon setnet fishery to develop methods to reduce bycatch of harbour porpoises (SC/48/SM10). The experiment was patterned on that of (Kraus *et al.*, 1995) in New England (except that it was not a double-blind experiment because each net was in a fixed position and was used both as treatment and control) and employed pingers designed by (Lien and Hood, 1994) for use in Newfoundland. Nineteen porpoises were caught in the control nets but only one in the nets with alarms (121.7–124.7dB; broadband centred at 20khz), a statistically significant result. A caveat was that the effort and catch were not uniform through time and that changes in porpoise abundance could have caused a bias. The Committee encouraged continuation of the experiments.

Serchuk summarised the results of four short-term experimental fisheries conducted in autumn 1995 and spring 1996 to evaluate the effectiveness of acoustic alarms (pingers) in reducing the bycatch of harbour porpoise during routine commercial fishing operations in the US Gulf of Maine sink gillnet fishery. Vessels participating in the experimental fisheries were required to equip their nets with pingers meeting specific standards when immersed in water and to take scientific observers aboard their vessels upon request.

As noted last year (IWC, 1996d, p.170), results of a scientifically designed field experiment in autumn 1994 were very encouraging and suggested that acoustic alarms offered an effective means to reduce bycatch. The experimental fishery in autumn 1995 conducted in the same area as the 1994 experiment enjoyed similar success; no porpoises were taken in 225 observed hauls during 64 trips. However, in two of the three subsequent experimental fisheries conducted in spring 1996 very different results were obtained; bycatch rates were not significantly different from those in nets without alarms over the previous five years. Possible explanation for these results include pinger malfunction, improper pinger usage, habituation and variable porpoise behaviour relating to foraging.

The Committee emphasised the importance of controls and other design features used in the autumn 1994 field experiment and research to find out exactly why pingers do or do not work – as well as the obvious need to monitor fisheries using pingers to find out if they work on a continuing basis.

16.4.6 Other

SC/48/SM5 presented an updated analysis of trends in the abundance of harbour porpoise in central and northern California for the period 1986–95. The results were qualitatively similar to those obtained for the 1986–93 time series, but encounter rates were higher in 1995, and the estimated rate of decline changed from 9.4% to 5.9% per year. The decreasing trend was no longer significant at $P = 0.10$.

The Committee welcomed these results and noted that the study pointed to the difficulty of using trend data to assess status.

SC/48/SM26 presented the results of an investigation of a potential calving and nursing area for harbour porpoises in the North Sea off Schleswig-Holstein. Based on high proportions of calves in strandings as well as in aerial surveys the authors concluded that the areas around the islands of Sylt and Amrum are important calving and nursing areas for North Sea harbour porpoises.

SC/48/SM27 reported on analyses of the phylogenetic relationship within the genus *Tursiops* based on mtDNA sequence data. Results indicated that the genus is paraphyletic and that there are species-level differences between all offshore animals sampled and inshore animals from the western North Atlantic and Gulf of Mexico. The results also suggest that most of the genetic variation within *Tursiops* appears to be contained within offshore populations.

SC/48/SM40 presented information on exploitation of cetaceans in Venezuela. There is evidence that at least 11 of the 20 cetacean species found in the Caribbean off Venezuela have been taken. The authors found that exploitation of a species is independent of its size, but that it is associated with its ranging patterns, pelagic species being less likely to be taken. The records examined do not permit determining if the extent of use by fisheries has any effect on local cetacean populations.

16.5 Progress on previous year's recommendations

16.5.1 Harbour porpoise

The Committee reviewed the list of recommendations from last year's report under the following headings:

MAGNITUDE OF BYCATCHES

Several new estimates of bycatch using statistically-based observer programmes were presented. SC/48/SM25 reported a bycatch estimate of 53 for 1995 (95%CI = 22–85) for Swedish fisheries in ICES area 4456. SC/48/SM30 reported bycatch for 1994 in the US Gulf of Maine sink gillnet fishery as 2,000 porpoises (95% CI = 1,400–2,900, CV = 18%). In addition, the 1995 observed bycatch was reported for German North Sea fisheries ($n=2$) and German Baltic Sea fisheries ($n=6$) from a voluntary reporting programme (Kock and Benke, in press). The Committee noted the plans included in the BY-CARE programme to improve estimates of bycatch for the North Sea and adjacent waters, and that data allowing estimation of bycatch have been collected from Swedish waters (SC/48/SM25).

ABUNDANCE

The Committee noted that new surveys collecting data for abundance estimation have been carried out in the Gulf of Maine (Palka, 1996) and in the Baltic Sea.

STOCK IDENTITY

SC/48/SM7 presented preliminary results of mtDNA sequence analyses and development of microsatellite markers for northwest Atlantic harbour porpoises. Sequence analysis of a portion of the mtDNA control region from porpoises from the Gulf of St. Lawrence, Newfoundland and the Bay of Fundy, has revealed a significant amount of genetic heterogeneity among populations, much of which can be attributed to the distinctiveness of the Newfoundland samples. This would suggest that these three populations are not panmictic. Eight polymorphic microsatellite markers have been identified, of which two have been genotyped. Genotyping of the remaining six loci will allow examination of population structure in this region of the North Atlantic.

Researchers from the US, Germany, Denmark and the UK involved in studying the genetic basis of stock structure of harbour porpoises successfully initiated a joint collaboration to pool genetic data sets and examine population structure across the entire North Atlantic. The Committee welcomed the results of this study and noted their relevance to its recommendation of last year concerning the stock structure of North Atlantic harbour porpoises.

SC/48/SM13 reported on the results of a morphometric comparison of harbour porpoises from the Barents Sea and North Sea. The authors considered their results to be inconclusive on the question of stock discreteness.

The Committee was informed that a formal group has been established to develop a multinational and multidisciplinary research programme with the objective to improve understanding of harbour porpoise population structure in the North Atlantic. This programme would collaborate with IWC, ICES, ASCOBANS and other institutions and organisations, especially to provide population structure information that is necessary to assess the impact of human-induced mortalities.

POPULATION BIOLOGY PARAMETERS

A number of studies were presented this year concerning criteria for assessing the status of harbour porpoise populations.

REDUCTION OF BYCATCH

The Committee noted that there has been progress but that more is needed. As a matter of priority, research should be carried out to gain an understanding of the mechanisms of net and alarm perception and avoidance. Although alarms have been shown to work in one situation (Kraus *et al.*, 1995) they appear not to work in others. Further scientific experiments are needed to assess their effectiveness or otherwise. These experiments should be carefully designed and include controls. Two studies of the effectiveness of acoustic alarms to reduce bycatch in a practical fishery situation were presented this year. The Committee noted the plans included in the BY-CARE programme to conduct trials of acoustic alarms and passive reflectors in selected Danish North Sea gillnet fisheries.

Table 3

Areas where estimates of bycatch, directed takes and abundance for harbour porpoises are missing or incomplete and where attention is needed.

Area	Bycatch	Directed takes	Abundance
Black Sea	x		x
Baltic (Poland)	x		x
Central North Sea (ICES areas 4b & c)	x		
Norway	x		
Ireland & Scotland (Atlantic coast)	x		x
Irish Sea	x		x
Iceland	x	x	x
Greenland	x	x	x
Newfoundland/Labrador	x		x
Gulf of St. Lawrence	x		x
US Mid-Atlantic	x		

16.5.2 Vaquita

In 1995, the Committee expressed extreme concern over the status of this species and recommended that immediate action be taken to eliminate bycatches in all fisheries (IWC, 1996d, p.173). Progress is reported under 16.4.2.

16.6 Priority topics for 1997, 1998 and 1999 meetings

In the absence of specific instructions from the Commission, the Committee proposed the topics given in Table 4 for review on the basis of scientific priority.

Table 4

Priority topics for 1997, 1998 and 1999 meetings.

Year		Topic	Rationale
1997	A	Review of small cetaceans in coastal waters off Africa	UNEP and CMS initiatives in this area and lack of current knowledge of cetaceans in this region
	B	Further consideration of criteria for assessing the status of harbour porpoise populations	Review of intersessional progress on a priority topic that could not be completed in 1996
	C	Global review of *Stenella coeruleoalba*	Magnitude of bycatches and directed takes; epizootic in the Mediterranean; availability of new research results
1998	A	Global review of the white whale and narwhal	Magnitude of directed takes, evidence of decline in exploited population; availability of new research results
	B	Review bycatch mitigating measures	Availability of new research results
1999	A	Global review of the genus *Tursiops*	Availability of large amounts of new research results
	B	Global review of the genus *Lissodelphis*	Availability of new research results (e.g. the former North Pacific high seas driftnet fishery)

The Committee recognised the desirability of involving coastal and range states in its work on these topics. It agreed to encourage such participation through the relevant sub-committee convenor.

16.7 Other business

The Committee considered the proposal by the Secretary that the Commission should apply for admission to the Coordinating Party on Fishery Statistics. It **recommends** endorsement of this proposal to the Commission.

A proposal for a workshop on the impacts of water development projects on river dolphins in South Asia, sponsored by the IUCN/SSC Cetacean Specialist Group, was considered and endorsed.

17. WHALE SANCTUARIES

Ohsumi introduced a paper entitled *The Necessity of Employing Lethal Methods in the Study of Whale Resources* (Ohsumi, 1995), in which he reviewed the use of nonlethal and lethal techniques in whale research. He concluded that for certain research objectives, lethal methods were either preferable or essential.

The paper was discussed briefly and reference was made to earlier considerations of this subject, largely in the context of discussions of scientific permits (e.g. IWC, 1992b; 1993b; 1994b). It is clear that there is a wide range of views over the relative merits of lethal and nonlethal research techniques in the Committee.

17.1 Southern Ocean

SC/48/O 7 reported on acoustic work carried out on an Australian icebreaker undertaking physical/biological survey off the waters of East Antarctica. A simultaneous visual survey for cetaceans was undertaken; it is reported in SC/48/SH22 and discussed under Item 9.

A simple, low cost hydrophone array was developed to cover the bandwidth 200Hz to 35kHz. For practical reasons, the equipment was unable to detect low frequency sounds such as those made by mysticetes. A high frequency click detector was also used on part of the survey.

A preliminary analysis of recordings covering the bandwidth 200Hz to 22kHz shows that sperm whales were encountered on 14 occasions and that the equipment could detect this species at ranges of 6 miles while steaming at 10 knots. Also recorded were large numbers of whistles and clicks which are as yet unidentified. A full analysis of the data will be completed by the end of 1996.

Anderson noted that SC/48/ProgRep Australia includes information on the first year of the 'National Implementation Programme for the Southern Ocean Sanctuary', which involves cetacean work on Platforms of Opportunity (POPs).

Koch reported that, as noted last year (IWC, 1996b, p.54), Germany was incorporating a cetacean component into a krill/fish/squid survey to be carried out off the Antarctic Peninsula. This is discussed under Item 5.4.

The Committee welcomed the research discussed above and noted the potential value of integrated studies that included cetacean surveys and oceanographic/primary production surveys. Acoustic surveys seem particularly suitable for POP studies. This is discussed further under Item 6.1, including the need to determine how to maximise the value of cetacean work carried out on POPs.

Best commented that as the boundaries to Sanctuaries are merely a human construct, it should be recognised that important information on migratory species that spend part of their lives inside the Sanctuary can be obtained in more accessible study areas outside the Sanctuary.

The Committee noted that last year (IWC, 1996b, p.93) it had requested some advice from the Commission with respect to commonly agreed objectives for the Sanctuary in the context of a recommendation from a Commission Working Group in 1995. The Commission made no comment on this last year and the Committee **draws the attention** of the Commission to this.

17.2 Indian Ocean

Reilly introduced SC/48/O 8, which described the cetacean results from a POP study in the western Tropical Pacific from March-July 1995. A total of 589 sightings of at least 21 cetacean species were made.

The most commonly identified species were sperm whales and spinner dolphins. Blue whales (17 sightings) were highly localised being recorded only between the Maldives Archipelago and the southern tip of India. The localised distribution in an area of potentially high productivity may be similar to the pattern documented for this species in the eastern tropical Pacific and deserves further investigation. *Delphinus* cf. *tropicalis* was highly localised and common off the coast of Oman (16 sightings). This distribution in areas of 'upwelling-modified' water is similar to the habitat preferences of *D. delphis* and *D. capensis* in the eastern tropical Pacific. *D.* cf. *tropicalis* was readily distinguishable in the field from both *D. delphis* and *D. capensis*; and this suggests that the taxonomic status of *tropicalis* should be further investigated. Mixed aggregations of spinner and spotted (*S. attenuata*) dolphins with yellowfin tuna (*Thunnus albacares*), common in the eastern tropical Pacific, were recorded for the first time in the tropical Indian Ocean. Beaked whales tentatively identified as southern bottlenose whales were recorded in the central Arabian Sea at 7°N, providing further evidence of a pantropical range for this species.

The Committee welcomed this study, noting that with experienced observers and careful planning, valuable information can be obtained from suitable POPs.

18. WHALEWATCHING

18.1 Report of Intersessional Working Group

In 1994, the Commission requested the Committee to:

> identify and assess the potential impacts of whalewatching on cetaceans; examine the current status of methods of assessment of impacts; and provide advice on future whalewatching based on an assessment of impacts.

Last year the Commission had reviewed the preliminary report submitted by the Committee (IWC, 1996b, p.93) and had noted the possible need for different guidelines for toothed and baleen whales, and for different areas, such as feeding, breeding and transit regions (IWC, 1996a, p.33–4). Last year, the Committee had identified a number of topics that required further discussion and established a small intersessional correspondence group to consider the future work of the Committee in this regard. An expanded group met during the present meeting and its report is given as Annex Q.

The Working Group undertook three main tasks:

(1) to review the set of generalised 'rules of encounter' circulated for comment last year;
(2) to review other available reports and information related to whalewatching; and
(3) to assess possible future work by the Scientific Committee.

The Committee noted that there is at present no direct statement from the Commission as to what its objectives may be in developing guidelines for the management of whalewatching. For the purposes of discussion it has been assumed that the primary objective is to ensure that development of whalewatching is ecologically sustainable and meets, to the extent possible, the requirements of the industry and expectations of the wider community.

The Committee **recommends** that the Commission consider the following proposed objectives as the basis for further consideration of issues relating to the management of whalewatching:

(1) ensuring that whalewatching does not significantly increase the risk to the survival or ecological functioning of local populations or species or their environment; and therefore, in the short-term, that whalewatching does not result in significant adverse change in population dynamics such as birth or mortality rates, or impede normal patterns of habitat use or activity, including feeding, resting and reproduction;
(2) the development and maintenance of viable and responsible whalewatching activities.

Last year, the Committee had considered proposed general rules of encounter developed at the 1995 Workshop on the Scientific Aspects of Managing Whalewatching (SC/48/O 18). The Committee reviewed these and agreed that detailed rules should be developed on a case by case basis. From a scientific perspective, prerequisites for the development of a management framework able to provide for sustainable whalewatching include: an understanding of the biology of the species concerned; an understanding of the characteristics of operations and craft; and some means of providing even a very preliminary assessment of the 'carrying capacity' for whalewatching in an area, preferably in the context of broader regional planning for a range of other marine activities.

The Committee agreed that three general principles should be taken into account as more detailed case-specific rules are developed. The first is directed at a more strategic level to managers whilst the second and third are directed more at operators. They include an expansion of the preliminary rules of engagement previously circulated to Commissioners and are given in detail in Table 5.

Table 5

Proposed General Principles for whalewatching

(1) Manage the development of whalewatching to minimise the risk of adverse impacts:
(i) implement as appropriate measures to regulate platform[1] numbers and size, activity, frequency and length of exposure in encounters with individuals and groups of whales;
- management measures may include closed seasons or areas where required to provide additional protection;
- ideally, undertake an early assessment of the numbers, distribution and other characteristics of the target population/s in an area;
(ii) monitor the effectiveness of management provisions and modify them as required to accommodate new information;
(iii) where new whalewatching operations are evolving, start cautiously, moderating activity until sufficient information is available on which to base any further development;
(iv) implement scientific research and population monitoring and collection of information on operations, target cetaceans and possible impacts, including those on the acoustic environment, as an early and integral component of management;
(v) develop training programs for operators and crew on the biology and behaviour of target species, whalewatching operations, and the management provisions in effect;
(vi) encourage the provision of accurate and informative material to whalewatchers, to:
- develop an informed and supportive public;
- encourage development of realistic expectations of encounters and avoid disappointment and pressure for increasingly risky behaviour.

(2) Design, maintain and operate platforms to minimise the risk of adverse effects on cetaceans, including disturbance from noise:
(i) vessels, engines and other equipment should be designed, maintained, and operated during whalewatching, to reduce as far as practicable adverse impacts on the target species and their environment;
(ii) cetacean species may respond differently to low and high frequency sounds, relative sound intensity or rapid changes in sound;
- vessel operators should be aware of the acoustic characteristics of the target species and of their vessel under operating conditions; particularly of the need to reduce as far as possible production of potentially disturbing sound;
(iii) vessel design and operation should minimise the risk of injury to cetaceans should contact occur; for example, shrouding of propellers can reduce both noise and risk of injury;
(iv) operators should be able to keep track of whales during an encounter.

(3) Allow the cetaceans to control the nature and duration of 'interactions':
(i) operators should have a sound understanding of the behaviour of the cetaceans and be aware of behavioural changes which may indicate disturbance;
(ii) in approaching or accompanying cetaceans, maximum platform speed should be determined relative to that of the cetacean, and should not exceed it once on station;
(iii) use appropriate angles and distances of approach; species may react differently, and most existing guidelines preclude head-on approaches;
(iv) friendly whale behaviour should be welcomed, but not cultivated; do not instigate direct contact with a platform;
(v) avoid sudden changes in speed, direction or noise;
(vi) do no alter platform speed or direction to counteract avoidance behaviour by cetaceans;
(vii) do not pursue[2] head off, or encircle cetaceans or cause groups to separate;
(viii) approaches to mother/calf pairs and solitary calves and juveniles should be undertaken with special care;
- there may be an increased risk of disturbance to these animals, or risk of injury if vessels are approached by calves;
(ix) cetaceans should be able to detect a platform at all times;
- while quiet operations are desirable, attempts to eliminate all noise may result in cetaceans being startled by a platform which has approached undetected;
- rough seas may elevate background noise to levels at which vessels are less detectable.

[1] Any vessel (with or without engine), aircraft or person in the water.
[2] Chase (as opposed to follow), causing the whale to change its course or speed.

The Committee noted that more research was required to determine appropriate minimum distances for different species. It agreed that the optimal approach in developing regulatory frameworks would be in the broader context of coastal zone or regional management, in which whalewatching was considered with other uses of the sea.

The Committee **recommends** these general principles to the Commission as the basis for initial general advice for the Commission to provide to coastal states in order to assist them to develop a management framework for whalewatching.

The Committee reviewed a number of documents related to whalewatching (SC/48/O 35; SC/48/O 26; SC/48/O 33; and SC/48/O 25) and its impact (SC/48/AS19; SC/48/NA16; SC/48/SM32; and SC/48/SH18) and was informed of a number of studies that are planned, underway or near completion on whalewatching and assessment of effects on cetaceans (Annex Q).

The Committee had no new information with which it could assess the implications of short-term behavioural reactions or their linkage with longer-term reactions. It noted, however, that for many of the potential effects of whalewatching on cetaceans, sound was the modality involved. The short-term responses on which assessments of possible impact would be based were primarily exhibition of some behaviour or a change in patterns of behaviour. An understanding of the behaviour of individuals and groups and indicators of disturbance is critical in developing methods for assessment of short-term responses to whalewatching and other human activities in the marine environment and in providing information of use to operators in the field.

The Committee noted that with the exception of the reported impact from one dolphin feeding programme in Australia (but see below), there were at present no documented cases in which changes that had occurred in distribution or behaviour could be linked directly to the impact of whalewatching operations. It reiterated that the development of well designed long-term monitoring programmes that would allow improved assessment of the longer-term effects was essential.

The Committee noted the continuing strong growth in the industry in some areas. It drew attention to the proposed Principle 1 relating to a precautionary approach to the development of operations in new areas.

The working group had identified the range of approach distances that were in use or planned for implementation under a range of national legislation or guidelines and noted the considerable variation apparent between areas for the same species, and emerging differences in rules and operating constraints developed for different species and for different operations. There was little specific information on assessments of the effects of different regimes on cetacean behaviour.

The Committee thus had no new information on which it could base more specific advice to the Commission on either assessments of the range of approach distances, or numbers or types of activity that might be appropriate in a range of areas, including feeding grounds, migratory pathways and breeding and calving areas. If the Committee is to provide useful advice on issues relating to whalewatching to the Commission, it will need to have a more focused discussion than was possible this year and will need to have more material on the assessment of effects presented for review. The Committee noted that there were several studies currently underway directed at assessing the responses of cetaceans to a range of operations. Accordingly it has identified the following priority areas for further work and for consideration at the 1997 and subsequent meetings:

(a) a more detailed review of the approach distances, effort and activity limitations in place in existing operations for a range of species, and information on the basis for such controls;
(b) an assessment of current studies of the effects of different approach distances and platforms;
(c) a review of the quantitative methods used to assess the short-term reactions of cetaceans and the basis for judgements of adverse effects;
(d) comparative studies on different approaches/distances and other controls which may be required on areas important for feeding, resting and reproduction.

Noting that the dolphin feeding programme at Monkey Mia, western Australia, was the only operation for which there was an assessment of a direct adverse impact on juvenile survivorship from a long-term provisioning programme, but that it not been able to review the basis for the assessment, the Committee also considered that if possible, a more detailed report should be made available for review at its next meeting.

The Committee draws the Commission's attention to its plans for future work and **requests** that the Commission indicates whether it considers that any other subjects require the Committee's attention.

19. MEDITERRANEAN SEA

Last year the Commission passed to the Committee a request from Monaco to provide advice on research priorities in the Mediterranean Sea.

The Committee had before it no documents or information to assist in providing the advice sought at this year's meeting. It noted that the matter was relevant to its discussions under Item 5.1.2.

20. OBJECTIVES AND PRIORITIES FOR THE SCIENTIFIC COMMITTEE

20.1 Long-term

Last year the Committee had begun to review its priorities and objectives and a draft specification was drawn up (IWC, 1996j). SC/48/O 37 reviewed the draft in the context of the Convention, the Commission's Rules of Procedure and the Committee's Rules of Procedure.

Article III of the Convention specifies that the Commission may establish committees and may (in Article IV):

> (1) 'encourage, recommend....[and]... organise studies and investigations....'; (2) 'collect and analyse statistical information concerning...whale stocks and the effects of whaling thereon'; and (3) 'study, appraise, and disseminate information concerning.....whale stocks'.

Paragraph 2 of Article V, which specifies that Schedule amendments 'shall be based on scientific findings', provides the rationale for this.

Scientific matters are also referred to in Article VIII, which authorises the take of whales 'for purposes of scientific research', and requires that biological data be collected from whale fisheries; the results of such research and that called for in Article IV are to be made available regularly.

The Scientific Committee was established under the Commission's Rules of Procedure. As presently specified (section M, Paragraph 4), its duties are, to (1) review the scientific literature; (2) review current research programmes; (3) review scientific permits; (4) consider such additional matters as may be referred to it; and (5) submit reports and recommendations to the Commission.

The Scientific Committee's own Rules of Procedure, formulated in the mid 1970s, specify general responsibilities (Article C) – to include standing sub-committees, defined by area, species or other subject, including one on small cetaceans. Their priority, apart from the one on small cetaceans, is for those stocks of large cetaceans which are harvested or under consideration for harvesting. The sub-committees are to meet in the early portion of the annual meetings (Section d, Paragraph 3). The Committee is to receive annual Progress Reports and may request special reports. The current rules also specify responsibilities for review of scientific permits.

Last year's draft specification outlined the two responsibilities and related activities given in Table 6.

It then went on to describe a number of specific tasks currently addressed by the Committee, related to four objectives that arise from those responsibilities. The objectives are broader in scope than envisaged in the current Rules of Procedure. These are given in Table 7.

The Committee concurred with SC/48/O 37 that given the changing needs of the Commission, particularly its current consideration of additional requirements affecting the Scientific Committee's responsibilities - and especially its suggestion of a more proactive role related to the Revised Management Procedure – it is now appropriate to consider the issues raised in (IWC, 1996j) more formally.

In particular, the Committee **informs** the Commission that it is engaging in a review of its directions and objectives, that this will involve some restructuring of its business and that in due course, following further review at its meeting next year, it will provide a revision of its Rules of Procedure for the Commission's endorsement.

In addition to the above the Committee considered a proposal to restructure its work in a process-driven way, rather than on the present rather *ad-hoc* basis. Some

Table 6

Draft specification of the Scientific Committee's general responsibilities.

1: Provide scientific advice on status of stocks and on the implications of harvest levels.	
1	Provide advice on aboriginal subsistence whaling.
2	Prepare to implement RMP as directed by the Commission (*Rep. int. Whal. Commn* 45:43).
3	Conduct comprehensive assessments.
2: Provide scientific advice on other factors affecting cetaceans.	
4	Advise on effects of environmental change on cetaceans (*Rep. int. Whal. Commn* 43:39-40, 44:35-6, 45:49).
5	Advise on scientific permit proposals.
6	Advise on small cetaceans (*Rep. int. Whal. Commn* 43:51, 44:34-5, but see 45: 41-2).
7	Advise on possible effects of whalewatching (*Rep. int. Whal. Commn* 45:49-50).
8	Advise on issues related to a sanctuary in the Southern Ocean (*Rep. int. Whal. Commn* 45:46).

Table 7

Draft specification of the Scientific Committee's objectives.

1: Study the status of cetaceans and their interactions with biotic and abiotic factors in the environment.	
1.1	Population structure, abundance and dynamics.
1.2	Individual animal biology, behaviour and feeding ecology.
1.3	Effects of environmental change.
1.3.1	Pollution workshop (SC/47/Rep2).
1.3.2	Climate change workshop (SC/48/Rep2).
2: Development of improved methods of giving scientific advice and for conducting scientific research on cetaceans.	
2.1	Develop aboriginal subsistence whaling management procedure (*Rep. int. Whal. Commn* 45:42)
2.2	Abundance estimation (SC/47/O 2).
2.3	Population/stock structure (SC/47/Rep3).
2.4	Population assessment methods (e.g. Bayesian synthesis, HITTER/FITTER).
2.5	Photographic identification.
2.6	Improve advice to member governments on research programmes (plenary discussion).
2.7	Newer technology (e.g. satellite tagging, passive acoustics).
3: Ensure catch and scientific data are archived and accessible to the Committee and others.	
3.1	Sightings database project (SC/47/O 2).
3.2	Catch and effort database project (Secretariat).
3.3	Biological data.
3.4	Marking data.
4: Collaborate with other international research programmes to ensure development of information relevant to Scientific Committee objectives.	
4.1	Maintain existing international cooperation (Agenda Item 5).
4.2	Establish collaboration with selected international research programmes: e.g. Southern Ocean GLOBEC (SC/47/O 20), CCAMLR sponsored projects. This may be of particular value in the context of the newly designated IWC-SOWER programme.

important matters do not easily fit into the current sub-committee structure, and are considered by *ad-hoc* working groups; other matters are sometimes referred to broadly inappropriate sub-committees, or are the subject of unwieldy discussion in plenary.

The present structure is very different from the species-driven structure of some years ago, reflecting changes in issues which the Committee has to discuss to provide advice to the Commission. It is essentially a mixture of species/area related and process related topics. Based on a view of the issues or processes most likely to dominate business in the next few years, a suggested list of eight sub-committees was proposed for discussion:

(1) Aboriginal subsistence whaling;
(2) Abundance estimation;
(3) The influence of environmental factors on cetaceans;
(4) Development of an Aboriginal Whaling Management Procedure;
(5) Comprehensive Assessment of Southern Hemisphere humpback whales;
(6) Comprehensive Assessment of North Pacific Bryde's whales;
(7) Review of Special Permit programmes;
(8) Small cetaceans.

There was general agreement in the Committee for a restructuring along the lines proposed, although some issues of detail were raised. Points raised in discussion, but without (except where indicated) coming to firm conclusions, included:

(1) the need to overcome the feeling of alienation that may arise when highly technical issues effectively become the preserve of small specialist groups (e.g. RMP development, abundance estimation for northeast Atlantic minke whales), and concerns that moves from a species - to a topic - based sub-committee structure might perpetuate rather than resolve such matters;
(2) the need to increase the opportunity for scientists with diverse technical expertise to interact positively, preferably within the same subgroups;
(3) process-driven stratification avoids the duplication inherent in species-orientated groups;
(4) the large number of groups likely will necessitate groups working concurrently; a fact that members may have to accept, although it may result in considerably more discussion when reports are presented in plenary;
(5) conversely, there could be attempts to hold 'joint' meetings of groups where common items are to be discussed; separation of some items (e.g. Special Permits) should be avoided and they should be covered in the relevant assessment group;
(6) removing emphasis on a species-driven approach has resulted in some species or stocks not being considered at all for several years – for example the North Atlantic right whale is perhaps the most endangered large whale species, but it has not been considered by the Scientific Committee in detail since 1983, and not at all since 1989, despite a large and active research programme on the stock. A mechanism is needed to ensure that such species and stocks are considered on a rotational basis, similar to the approach adopted by the small cetacean sub-committee for some years. In deciding what to consider under this heading, a distinction should be made between comprehensive assessments of toothed and baleen whales, with consideration given to an assessment of sperm whales;
(7) in addition to the above, perhaps there could be a catch-all group which could include, *inter alia*, techniques such as sampling and genetic testing of whale tissues;
(8) there is a need to address how hypotheses concerning stock structure are framed and interpreted, including interpretation of marking data, morphology, pollutant loads and parasites;
(9) to reduce the annual load, some sub-committees could meet in alternate years; except when the Commission requires specific answers in a particular year.

The Committee agreed that at this time it should generally adopt the proposals for restructuring the sub-committees outlined in the listing above together with a 'rotational' sub-committee (as in (6)) for large baleen whales. Responsibility for the detailed arrangements, particularly the appointment of convenors, should be left to the outgoing and incoming Chairmen. Provision should be retained for appointment of *ad-hoc* groups as necessary. It was recognised that the actual structure adopted for 1997 would be short-term and subject to review at that meeting. The question of individual items and priorities to be set for next year is referred to in Agenda Item 20.2.

Discussions under Item 8.3.1 had been extremely difficult. This led the Committee into a more general discussion of factors that should be considered for its future conduct of business. A number of issues were considered:

(1) intersessional Working and Correspondence Groups should make use of e-mail. The Secretariat should inform the Scientific Committee so that members not directly involved in such groups can join a 'mailing' list;
(2) where intersessional groups are undertaking major tasks, it might be useful for groups to write (and for the Secretariat to circulate) a Progress Report from the group during the intersessional period;
(3) when sub-committees or Working Groups produce highly technical reports, consideration should be given to (i) including a non-technical executive summary and (ii) the Chairman of the sub-committee giving a more illustrative presentation than has customarily been the case.

20.2 Work plan for 1996/97 and initial agenda for 1997 meeting

The Committee agreed that in view of the lack of time for full discussion of this item, the Chairman and convenors should review relevant items raised during the meeting for consideration in this context, in particular taking into account the discussion under Items 12 and 20.1.

21. DATA PROCESSING AND COMPUTING NEEDS FOR 1996/97

The Committee agreed that the following computing work should be carried out by the Secretariat during the coming year with encoding of catch data from South Georgia and Items (i), (ii) and (iii) being given the highest priority:

(i) run additional combination trials, analysis of which is to go into the special issue on Management Procedures (see Item 7.4);
(ii) document the single stock control program;
(iii) develop a common control program for aboriginal subsistence whaling trials as specified in Appendix 1 of Annex P (see also Item 13.1);

(iv) complete the conditioning of and run the North Pacific minke whale *Implementation Simulation Trials* as specified in Appendix 5 of Annex J (see also Item 8.1.1);
(v) validate the 1995/96 Southern Hemisphere minke whale cruise data and incorporate them into the sightings survey database;
(vi) add summary information about each dataset in the sightings database to appear on screen whenever the dataset is accessed (see Item 7.3.1);
(vii) validate the programs for implementing the 'backwards' Bayesian synthesis method;
(viii) continue the encoding of Southern Hemisphere catch records for the period 1900–31 and validate the 1930s data which has already been coded;
(ix) code and validate marking data prior to 1955;
(x) code pre and post IDCR data 1978/9–86/7 and the Japanese dedicated survey data 1978/9–82/3 (see Item 7.3.1).

The Committee agreed that validation of abundance estimation software should be included on next year's agenda.

21.1 Access to IWC-DESS

The Committee briefly discussed a suggested understanding on access to data and use of software in the IWC database (Annex R). The Committee was unable to discuss this matter in any detail in the time available. It agreed to discuss this further at next year's meeting.

22. FUNDING REQUIREMENTS FOR 1996/97

Items requiring funding for the coming year were identified and are listed in Table 8. The total of the items identified is £249,000. The Committee understood that it was to maintain its expenditure within the existing research budget of £140,000. The convenors met to consider the items in Table 8 in terms of the Committee's priorities and anticipated schedule of work. They suggested reductions in amounts for some items and delay or elimination of others, and produced the amended list also given in the Table. The rationale used by the convenors is given below.

(1) The funding for the newly designated Southern Ocean Survey Cruise under the SOWER programme (Southern Ocean Whale and Ecosystem Research Programme) is based on the funding for the previous IWC/IDCR cruises that had evolved over the years to be as efficient as possible. It would be very difficult to reduce this further without major reconsideration that would necessarily involve reconvening the cruise planning group and reopening the already extensive discussions concerning cruise priorities given under Item 9.2. It was also noted that any changes might also affect consideration of the closely linked blue whale cruise discussed under Item 2 below. It was noted that the IWC contribution represented only a small proportion of the total cost of the cruise.
(2) The funding for the blue whale cruise under the SOWER programme was based on the budget and experiences of the cosponsored cruise that took place last year. As part of a detailed research plan, the planning group had requested £40,000 for the purchase of rigid-hull inflatable boats to facilitate a number of key activities particularly photo-identification, biopsy and acoustic studies (Annex E, Appendix 2). However, a minimum level of improvement in logistic ability could be achieved by the purchase of new outboard motors for the existing (small) boats for £8,000. The convenors therefore reluctantly reduced the proposed funding for this cruise to £28,000 from the requested £60,000. Again it was noted that the IWC contribution represented only a small proportion of the total cost of the cruise.
(3) The JARPA review meeting was proposed last year, when the Commission decided to postpone it for one year (IWC, 1996a). The cost for the review is now put forward as the expense of bringing 10 people at £2,500 each (£25,000) because the convenors found it was not possible to identify savings for any particular part of the plan without a full reconsideration of the plans made at

Table 8

Funding requirements for 1996/97

	Item		Original requests (£)		Amended requests(£)	Agenda Item
1	Southern Ocean cruise		54,800		54,800	9.2.2
2	Blue whale cruise:	boat	40,000	motors only	8,000	9.1
		cruise	17,000		17,000	
		meeting	3,000		3,000	
	Blue whale cruise total		60,000		28,000	
3	JARPA review		25,000		25,000	14.3.1
4	AWMP - meeting		10,000		3,000	13.1.1
5	Database work:	(a) Database completion and further entry	32,000		5,000	
		(b) Database additional costs	6,000		6,000	
		(c) Sightings analysis	43,000		18,000	
	Database total		83,000		29,000	7.3
6	Photo-Identification		200		200	9.3.1.3
7	Research Proposal 1		15,800		0	15.3
	TOTAL		249,200		140,000	

the 1995 meeting, which the Commission had agreed in principle last year.

(4) A proposal was made by the AWMP working group (Annex I) to hold an intersessional meeting during the coming year. The convenors considered that the original cost request of £10,000 (four invited participants at £2,500 each) could be reduced substantially (to £3,000) by scheduling the meeting immediately prior to the next Annual Meeting.

(5) The full set of IWC-DESS database contract work for the year was proposed at £83,000 (Annex D). The convenors attempted to find reductions that would allow some progress to be made on this important set of tasks (albeit at a lower level than planned), and yet allow the Committee to remain within the anticipated total of research funds available. As detailed below, the convenors proposed reducing the funding for this contract to £29,000.

   (a) Work to complete development of the database software and for further data entry and validation (arising from previous requests from the Scientific Committee) was proposed at £32,000. It was decided to defer further data entry and fund only the completion of the current system (£3,000) and costs related to training the Secretariat staff (£2,000).

   (b) Costs in addition to those anticipated were required during the past year. This was primarily because the contractor's original costings for setting up the Database/Estimation Software System assumed that all data to be entered would be fully validated and adequately documented. Deficiencies were encountered in the course of setting up the system resulting in £6,000 of additional costs. The convenors agreed that this was not the fault of the contractor, and that this cost should be reimbursed.

   (c) The original request from the contractor was for £43,000 to conduct sightings analyses that had been requested by the Scientific Committee. The convenors agreed that it would be possible to give priority to estimation of Southern Hemisphere humpback whales required to complete the Comprehensive Assessment of those stocks, and to delay funding of analyses of IWC/IDCR survey data and further development of estimation methods. This resulted in a reduction to £18,000.

(6) The Committee agreed that nominal funding (£200) should be provided to begin a Centralised Antarctic Catalogue of whale photographs. This amount was regarded by the convenors as the minimum possible to accomplish the tasks listed in Item 9.3.1.3, and so was put forward unreduced.

(7) The unsolicited research proposal had been highly rated in the Research Proposal review process (Item 15), but as in past years the convenors agreed that unsolicited proposals should be given lower priority than items arising directly from Commission requests and the Committee's work.

In plenary discussion of the budget proposed in Table 8, a number of issues arose. After considering the information summarised above, the Committee accepted the additional cost for the previous year's database work under Item 5b as reasonable, and **recommends** that the additional expenditure be met.

There was a suggestion that the decision not to fund the unsolicited research proposal should be reconsidered, given its relevance to a possible future Comprehensive Assessment of North Atlantic humpback whales, as discussed under Item 12. It was agreed that this could be discussed further next year when the priorities for future Comprehensive Assessments are evaluated. Smith verbally identified three other projects that would require funding that would also advance progress toward this Comprehensive Assessment, including: completion of catch history; computerisation of photographs from the entire north Atlantic catalogue; and development of computerised photographic matching techniques. The Committee endorsed this work in principle and agreed that further consideration should be given to it at next year's meeting if more detailed specifications are forthcoming.

The Committee agreed to forward the estimate of expenditures given in Table 8 for 1996/97 on the basis that it represents its best attempt at advancing the Committee's work as effectively as possible, in the present circumstances of a 'no increase' budget. It **recommends** that the Commission funds the work identified.

23. PUBLICATIONS

The Committee noted that in accordance with usual practice the Editorial Board should comprise Donovan, Reilly, Bannister, Brownell, Hammond, Martin and Walløe.

Walløe expressed concern over SC/48/NA14, involving an analysis of NILS-95 survey data. It appeared that the data had been obtained without consultation with the scientists, a clear breach of the Commission's approved guidelines. The Committee agreed that the document cannot be considered for publication.

Donovan reported that work on finalising the Special Issue on Management Procedures was progressing and that publication in the autumn was expected.

24. ELECTION OF OFFICERS

The Committee unanimously elected Bannister as Chairman and Zeh as vice chairman.

25. OTHER BUSINESS

Apart from one editorial matter raised under this Item, there was no other business.

26. ADOPTION OF REPORT

The report was adopted at 1900hrs on 18 June 1996. Items 23–26 were finalised by the Editorial Board.

The Committee expressed its appreciation to Reilly for his firm but patient Chairmanship over a period of rapid change in the Committee's responsibilities. It thanked the IWC Secretariat for their customary hard work and cheerfulness throughout the meeting.

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