Report of the Scientific Committee

The Committee met in the Moat House Hotel, Bournemouth, UK, from 29 September-11 October 1997 under the Chairmanship of J.L. Bannister. A list of participants is given in Annex A.

1. CHAIRMAN'S WELCOME AND OPENING REMARKS

Bannister welcomed participants to the meeting. He referred to the sad news of the deaths of three former Committee members since the last meeting: Dr Douglas Chapman, Dr Stephen Leatherwood and Dr Age Jonsgård. Dr Leatherwood had been particularly active in the sub-committee on small cetaceans, and was well known to members through his wide activities in the Society for Marine Mammalogy, as Chair of the Cetacean Specialist Group of the IUCN Species Survival Commission and as co-author of the Sierra Club Handbook of Whales and Dolphins (Leatherwood and Reeves, 1983). Dr Jonsgård was a prominent member of the Norwegian delegation in the 1960s and 1970s, being well-respected for his work on baleen whales, especially North Atlantic minke whales. Dr Chapman had a profound influence on the Committee's work over almost thirty years; a tribute appears as Annex X. The meeting observed a period of silence in memory of all three former colleagues.

2. ADOPTION OF AGENDA

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

3. ARRANGEMENTS FOR THE MEETING

3.1 Appointment of Rapporteurs

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

3.2 Meeting procedures and time schedule

The Committee agreed to a work schedule proposed by the Chairman that took particular account of last year's discussions (IWC, 1997e: Items 20, 21 and 12).

3.3 Establishment of sub-committees

Following last year's discussions, two Standing Working Groups (aboriginal whaling management procedures, AWMP - convened by Bannister; effects of environmental change on cetaceans - Reilly) and five sub-committees (aboriginal subsistence whaling - Walløe; abundance estimation - Polacheck; Southern Hemisphere humpback whale Comprehensive Assessment - Bannister; other great whales - Zeh; small cetaceans - Martin) had been established. The AWMP Standing Working Group had met during the three days prior to the meeting. Two intersessional planning meetings for the Environmental Standing Working Group had been held; their results are given as SC/49/Rep5 and 6.

Several further Working Groups were established at the meeting including those on Revised Management Procedure management issues (RMP); whalewatching; Scientific Committee rules and procedures; and issues arising out of the JARPA review meeting. The latter had taken place in Tokyo in May to consider the results arising thus far out of the Japanese Antarctic Research Programme; its report is given as SC/49/Rep1.

Reports of all the above are given as Annexes as indicated or incorporated under the relevant Agenda Items.

Documentation (SC/49/O 21, NA1 and NA17) available to at least two sub-committees referred to genetic studies being undertaken on the identification of meat samples. The genetic studies leading to the reported results are significant to the Commission's work in two respects: (1) control, forensic and enforcement issues relevant to management; and (2) individual identification of animals at the species and stock level.

The Scientific Committee Chairman emphasised that (1) above is not within the competence of the Committee. It would be dealt with as necessary by the Commission, probably in the context of discussions on the Revised Management Scheme (RMS). On the other hand, item (2) does lie within the Committee's area of responsibility. Accordingly, he advised sub-committee chairmen that discussions within their sub-committees should be restricted solely to aspects related to item (2).

This matter had already arisen in the context of the attendance of at least one proposed Invited Participant. In correspondence prior to confirming the invitation to participate, the Scientific Committee Chairman had emphasised that the invitation would be issued on the understanding that control and forensic issues would not be discussed within the Committee.

The Committee recognised that in practice, the borderline between the two aspects above may sometimes be blurred, but every attempt was made during its discussions to ensure that as far as possible only matters relevant to the Committee's competence (i.e. 2 above), were discussed.

3.4 Computing arrangements

Allison outlined the computing facilities available which included several personal computers. In addition, printing facilities were available for delegate use.

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 Committee reviewed its guidelines for national progress reports. It agreed to a revised set of guidelines (Annex S) designed to improve their value to the Committee and make report production easier for compilers. The Committee reaffirmed its view of the importance of such reports, recalling their origin in Article VIII, Paragraph 3 of the Convention. It **recommends** that the Commission urges member nations to provide such reports following the revised guidelines. It was agreed that the outline of the guidelines will be sent on disc both to the usual compilers and to Contracting Governments. In addition they will be posted on the IWC website: *http://ourworld.compuserve.com/homepages/iwcoffice.*

4.3 Data collection, storage and manipulation

4.3.1 Catches and other statistical material

Table 1 lists data received by the Secretariat since the 1996 meeting.

Allison reported that a copy of the Southern Hemisphere catch database had been forwarded to CCAMLR at its request.

4.3.2 Progress of data coding projects

Allison reported that all available marking data from the International Scheme in the Southern Hemisphere since 1940 had now been encoded and validated. Work was continuing on coding and validation of Southern Hemisphere catch data for the period 1910-39. In particular, catch data from South Georgia from 1913/14 - 1921/22 had been entered during the past year. In addition, data from the 1995/96 SOWER sightings cruise had been validated and incorporated into the sightings database and validation of the 1996/97 data had begun.

4.3.3 Progress on program verification projects

Allison reported on progress with the computing work identified last year (IWC, 1997e, pp.108-9): (i) 8,100 additional combination trials had been run, an analysis of which is presented in SC/49/Mg3; (ii) documentation of the single stock control program had almost been completed; and (iii) a common control program for aboriginal subsistence whaling (to run the *Initial Exploration Trials*) had been developed. There had not been sufficient time to develop the program for conditioning and running the North Pacific minke whale trials specified last year (IWC, 1997e, pp.246-9). However the tables of catches by Small Area, sex and month required for these trials had been prepared.

Progress made on the sightings database contract, including calculation of abundance estimates from the 1995/96 IWC/IDCR minke sightings survey, is reported and discussed under Items 10.2 and 19.

4.3.4 Whale marking, including artificial and natural marks

The Committee agreed that its earlier practice of merely listing the names of those progress reports containing some information on marking was unhelpful and should be discontinued. It noted that the new format referred to in Item 4.2 should allow a more useful compilation of such data in the future.

5. COOPERATION WITH OTHER ORGANISATIONS

The Committee received reports from IWC observers attending meetings of other organisations. Information from them and from representatives of those organisations is given below.

5.1 CMS

The CMS Secretariat in Bonn provided information on CMS activities during the year in SC/49/O 34. The report of the IWC observer at the 5th meeting of the Parties of the Convention on the Conservation of Migratory Species of Wild Animals (CMS) is given as IWC/49/10I.

Table 1

List of Data and Programs received by the IWC Secretariat since the 1996 meeting.

Date received	From	IWC ref.	Contents
Catch data			
28-9-97	Norway: N. Øien	D163	Individual catch records from the Norwegian 1996 commercial catch.
30-9-97	Japan		Individual catch records from the Japanese 1996 and 1997 North Pacific and 1996/97 Antarctic Special Permit catch.
17-12-96	P. Clapham	D135	Californian catch data 1919-26 (Moss Landing and Trinidad).
3-3-97	Japan: H. Kato	D141-3	Update of Japanese Southern Hemisphere commercial minke whale biological master, 1967-87. (Access restricted).
25-3-97	Japan: Y. Fujise	D149	JARPA minke catch and age data 1987/88 - 1995/96. (Access restricted).
29-9-97	M. Cawthorn	Dc129	Catch and effort data for Cook Strait land station, New Zealand 1964.
Sightings data			
8-8-96	Japan: H. Kato	Dc127	Photographs from 1995/96 blue whale cruise.
11-11-96	Japan: T. Miyashita	D133-4	North Pacific Sightings data 1982-94. (Access restricted).
13-3-97	P. Ensor	D145-8	1996/97 SOWER cruise data (sightings, effort, weather, ice edge and cruise tracks).
4-3-97	P. Best		1996/97 SOWER blue whale cruise data.
4-4-97	Japan: Y. Fujise	D150-8	JARPA sightings data 1987/88 - 1995/96. (Access restricted).
4-7-97	Japan: L. Pastene	Dc128	List of individuals photographed for natural markings during 1995/96 JARPA survey.
Programs			
23-5-96	Norway: H. Skaug	D140	IMK 1996 minke whale abundance software as described in SC/48/NA9.
9-11-96	G. Givens	D132	Updated versions of Baysyn and Bergs programs (2.3 versions).
20-12-96	T. Polacheck	D136	UNIX version of line transect simulation software.
13-1-97	J. Cooke	D139	$g(0)$ program used in calculation of results presented in 1996.

Perrin gave a summary of cetacean issues of potential interest to the Scientific Committee considered at two CMS meetings in April in Geneva, a meeting of the Scientific Council and a meeting of the Conference of the Parties.

The report of a CMS-supported survey of dolphin abundance and fishery-cetacean interactions in Malaysian and Philippine waters of the Southern Sulu Sea was received and will be published in a special issue of *Asian Marine Biology* dedicated to Dr Stephen Leatherwood.

Progress reports on ASCOBANS and ACCOBAMS were reviewed; these are discussed under Items 5.1.1 and 5.1.2.

The Scientific Council drafted and the Conference of Parties approved a resolution to liaise and cooperate with other organisations to keep abreast of the issue of possible climate change due to global warming and its potential effects on migratory species. Perrin was appointed liaison councillor for the IWC.

Argentina presented a draft review of the status of small cetaceans in southern South America and emphasised the importance of concluding a regional agreement under CMS. The conservation status of most of the species in the region is unknown.

A CMS consultancy for a review of the status of marine mammals in West Africa has been commissioned and will commence shortly.

The Committee thanked Perrin for acting as observer on its behalf.

5.1.1 ASCOBANS

Jensen, Secretary to the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) presented a written report on its progress (SC/49/SM3). She welcomed the extensive cooperation between the IWC and ASCOBANS, and in particular acknowledged the contribution of the IWC Scientific Committee to the work of the ASCOBANS Advisory Committee. She provided detailed information to the sub-committee on small cetaceans and this is discussed in Annex M.

The report of the IWC observer at the 4th meeting of the ASCOBANS Advisory Committee held in Texel, The Netherlands, 30 June - 2 July 1997 is given as IWC/49/10N.

The ASCOBANS Advisory Committee is not solely a scientific body but addressed a number of scientific issues of interest to the IWC. In particular, it considered the following items where input from the work of the IWC Scientific Committee played an important role: bycatch issues; status and monitoring of cetaceans; stock identity issues; and pollutant issues. Specific cooperation with ASCOBANS on these issues is discussed further in Annex F (pollution) and Annex M (small cetaceans).

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

The importance of continuing cooperation with ASCOBANS was noted and the Committee agreed that the Secretariat should attend the 2nd Meeting of Parties in Bonn, 17-19 November 1997 and the next meeting of the Advisory Committee in Hel, Poland, 22-24 April 1998.

5.1.2 ACCOBAMS

The Agreement on the Conservation of Cetaceans of the Black and Mediterranean Seas is a new regional agreement under CMS, covering the Black, Mediterranean and adjacent Seas, established at a meeting in Monaco in November 1996. Nations from this region are not well represented in the IWC. The Committee agreed that it is important to develop good contacts between the IWC and ACCOBAMS to facilitate and encourage research on cetaceans in this area. This might be initially achieved at Secretariat level.

To date there is no information on any forthcoming ACCOBAMS meetings.

5.2 ICES

The report of the IWC observer at the 84th Statutory Meeting of the International Council for the Exploration of the Sea (ICES) is given as IWC/49/10B.

The following issues discussed by the Marine Mammals Committee (MMC) were of particular interest to the IWC Scientific Committee: impacts of fisheries; acoustic disturbance and contaminants on marine mammals in the North and Baltic Seas (discussed by WGSEAL, the Study Group on Seals and Small Cetaceans in European Seas); and the report of the Study Group on Long-Finned Pilot Whales.

The future of the MMC was discussed in the context of the overall restructuring of ICES but no firm conclusions were reached.

A theme session 'Bycatch of marine mammals: gear technology, behaviour and kill rates' took place immediately prior to this IWC Scientific Committee meeting.

The Committee thanked Haug for attending the meeting on its behalf. It noted that the overlap of issues being addressed by the IWC Scientific Committee, ASCOBANS and ICES strengthened the need for continued cooperation.

The Committee agreed that Haug should attend the next meeting on its behalf.

5.3 IATTC

The report of the IWC observer at the 55th meeting of the Inter-American Tropical Tuna Commission is given as IWC/49/10D.

With respect to scientific matters, the IATTC discussed issues of dolphin mortality rates. The projected mortality for 1996 was projected to be fewer than 3,000 and not thought to be biologically significant on a stock-by-stock basis.

Further discussion on IATTC related matters is given in Annex M.

The Committee thanked Tillman for attending the meeting on its behalf. It noted the value of continued cooperation and agreed that Tillman should attend the next meeting as IWC observer.

5.4 CCAMLR

The report of the IWC observer at the 15th meeting of the Scientific Committee of the Conservation of Antarctic Marine Living Resources is given as IWC/49/10E. The most important topic was the illegal fin-fishery for Patagonian toothfish (*Dissostichus eleginoides*) taking place in the southwest of the Indian Ocean sector of the Southern Ocean. The unreported catches for *D. eleginoides* in this region may have been as large as, or even larger than, the total catch declared to CCAMLR. The CCAMLR Scientific Committee is extremely concerned about this problem and has informed its Commission's Standing Committee on Observation and Inspection accordingly.

The CCAMLR Scientific Committee proposed that high priority should be given to carrying out a new synoptic survey of krill in Area 48 (Southwest of the South Atlantic sector of the Southern Ocean). The primary objective of this survey would be to provide an updated estimate of krill biomass and its variance for use in the krill yield model to estimate precautionary catch limits for the Area. The

Working Group on Ecosystem Monitoring and Management (WG-EMM) has formed a Steering Group to advance this proposal.

Regarding CCAMLR-IWC collaboration, at its Annual Meeting in 1996 the IWC recommended that a joint CCAMLR-IWC Working Group be established to consider collaborative work in the Southern Ocean for understanding the effects of environmental change on whale stocks. The CCAMLR Scientific Committee felt that establishing a Working Group was premature. It would prefer first to involve an IWC expert in the work of WG-EMM and then discuss potential collaboration. Accordingly, it was proposed to invite the IWC to send an appropriate representative to the next meeting of WG-EMM.

The Committee thanked Ichii for attending the meeting on its behalf and agreed that he should attend the next meeting as an IWC observer. As noted in Annex F, there are a number of areas where cooperation with CCAMLR is very important.

The Committee received a brief verbal report from Reilly, who had attended the WG-EMM meeting referred to above. He would report formally at the next IWC Scientific Committee meeting since the WG report had not yet been considered by CCAMLR. He noted that discussions in that group had played an important role in the development of SC/49/Rep5 (see Item 6).

5.5 IOC

The report of the IWC observer at the first Southern Ocean Forum of the International Oceanographic Congress, held in Bremerhaven, Germany in September 1996 is given as IWC/49/10A. It was attended by experts and representatives from national governments and inter-governmental organisations (including the IWC) with an interest in the Southern Ocean, its resources and role in the climate system and global change, pollution, data collection and monitoring of the ecosystem.

The Secretary of the IWC was able to present the IWC's developing activities first under the IDCR and now the SOWER programmes. A subsequent meeting of the IOC Executive invited all organisations to strengthen cooperation, and to submit views and proposals to an intersessional advisory group. The Committee agreed that the Secretary should forward copies of relevant extracts from its report.

The Committee thanked the Secretary for attending the meeting on its behalf, noting the importance of cooperation with the IOC in the context of its discussions under Item 6.

5.6 NAMMCO

The report of the IWC observer at the 7th meeting of the Council of the North Atlantic Marine Mammal Commission is given as IWC/49/10K.

The following issues were of relevance to the IWC Scientific Committee: the status of long-finned pilot whales in the central and northeast Atlantic; abundance estimates from the NASS (North Atlantic Sighting Surveys) programme; pollution; and status of harbour porpoises.

The Committee thanked Fischer for attending the meeting on behalf of the IWC.

In discussion it was noted that given the scientific issues of common interest (e.g. see Item 8.2 and Annex E), and recalling earlier agreement on the need for scientific cooperation (e.g. IWC, 1994a, p.42) it would be valuable if in future the IWC Scientific Committee could send an observer to the NAMMCO Scientific Committee meetings. It was agreed that Øien should attend the next meeting on its behalf.

5.7 FAO/COFI

The report of the IWC observer at the 22nd session of the Committee on Fisheries of the Food and Agriculture Organisation of the United Nations is given as IWC/49/10H.

A number of issues related to the challenges facing world fisheries were discussed. The most important identified were: (i) excess fishing capacities; (ii) wastage, i.e. bycatch and discards; and (iii) the degradation of the aquatic environment. These have relevance to issues beginning to be addressed under Item 6 and Annex F of this Committee's report.

A motion to establish a Marine Stewardship Council was introduced but appeared to have little support amongst member countries.

The Committee thanked Mae for attending the meeting on its behalf. Yagi agreed that a Japanese scientist would attend the next meeting to be held in Rome in early 1999, on the Committee's behalf.

5.8 UNEP

Borobia provided information on the United Nations Environment Programme activities under the Global Plan of Action for marine mammals with respect to cetaceans and cooperation with the IWC.

UNEP's support for research on small cetaceans relates to work in Latin America, Africa and Southeast Asia.

A training workshop on the biology of and methodologies for collection of data on marine mammals was held in Guayaquil, Ecuador, 4-7 March 1997, sponsored jointly by UNEP, IATTC and the Comisión Permanente del Pacífico Sudete (CPPS). The workshop was held in response to recommendations of the Meeting of Experts on the Implementation of the Regional Plan of Action for the Conservation of Marine Mammals in the Southeast Pacific (15-17 January 1995, San José, in Costa Rica).

UNEP has supported its Regional Secretariat (CPPS) in Lima, Peru, in commissioning national reviews for Chile, Peru, Ecuador, Colombia and Panama to assess best methodologies for long-term monitoring of incidental mortality of marine mammals, particularly dolphins, in the region. Through the process, an update of current status of bycatch is expected. The reports for Chile, Peru and Ecuador have been completed in draft form, while those for Colombia and Panama are being finalised.

A workshop on marine mammal and fish mortality is planned by the Secretariat of the Regional Seas Kuwait Action Plan, with the Regional Organization for the Protection of the Marine Environment (ROPME) in cooperation with UNEP, FAO and other partners in the Marine Mammal Action Plan to assess mortality events in the ROPME Sea area (Bahrain, UAE, Oman, Iran, Kuwait, Qatar and Saudi Arabia). Among the terms of reference for the workshop are discussions on the interest in formulating a regional conservation strategy for marine mammals, as in the case of other similar regional Action Plans developed under the auspices of UNEP's Global Plan of Action for Marine Mammals.

Work supported by UNEP over the last few years in Africa is discussed under Item 14 and in Annex M.

Two volumes of interest have been published containing the results of: (1) a Symposium and Workshop on the Biology of Small Cetaceans and Dugongs in Southeast Asia,

held in June 1995 in the Philippines, in collaboration with CMS and the Marine Laboratory of Silliman University; and (2) Proceedings of the First International Symposium on Marine Mammals of the Black Sea, held in 1994 in Istanbul, Turkey. Both reports are available from UNEP.

UNEP reiterates its desire to cooperate with the IWC Scientific Committee, particularly in relation to the revision of the Marine Mammal Action Plan, given the past endorsement by the IWC of its cetacean component and the valuable input provided to the process by the IWC by attending the Action Plan annual meetings. It is hoped that the updated Action Plan will be available at next year's IWC meeting.

The report of the IWC observer at the 9th meeting of the Planning and Coordinating Committee (PCC) of the Marine Mammal Action Plan, held in Bonn, 5-6 June 1997, is given as IWC/49/10L.

The PCC received a review of Aquatic Mammal Legislation and a further draft of the Revised Marine Mammal Action Plan. A number of revisions for the latter were discussed. It was hoped that a draft could be submitted to the IWC Scientific Committee next year for comment/endorsement. The IWC observer provided information on IWC Scientific Committee work on a number of items on the PCC agenda, including aboriginal subsistence whaling and polar issues.

The Committee thanked Donovan for attending the meeting on its behalf. It agreed that the Secretariat should act as its observer at the next meeting.

5.9 Southern Ocean GLOBEC

The report of the IWC observer to the Southern Ocean GLOBEC (Global Ocean Ecosystem Dynamics program) Steering Group meeting held in San Diego, 1-3 August 1997 is given as IWC/49/10O.

The primary purpose of the workshop was to consider the plans for a major field programme to be carried out in 1999/2000. The programme welcomed and encouraged the IWC to collaborate in this effort. This is discussed in more detail under Item 6 and in Annex F. Noting those discussions, the Committee reiterated the importance of the IWC cooperating with Southern Ocean GLOBEC. It thanked Reilly for attending and agreed that he should continue to attend SO-GLOBEC meetings on its behalf.

5.10 IUCN (World Conservation Union)

The report of the IWC observer at the first World Conservation Congress of the International Union for the Conservation of Nature and Natural Resources (IUCN), held in Montreal, 13-23 October 1996 is given as IWC/49/10C.

Much discussion centred on the '1996 Red List of Threatened Animals'. The congress adopted a resolution calling for a review of Red List Categories and Criteria, taking into account the dynamic nature of marine ecosystems. Other resolutions of some relevance to the Committee considered aspects of marine protected areas, reduction of fisheries bycatch and studies of multi-species management.

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

5.11 CITES

The report of the IWC observer at the 10th meeting of the Conference of Parties of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), held in Zimbabwe in June 1997 is given as IWC/49/10M.

Issues of direct concern to the IWC were proposals for the downlisting of five whale stocks from CITES Appendix I to Appendix II (gray whales; Okhotsk Sea-West Pacific minke whales; Southern Ocean minke whales; central and northeastern Atlantic minke whales; Bryde's whales). In the event the proposals were not accepted.

The IWC observer recommended continuation of the strong links between the IWC and CITES Secretariats. He also encouraged the IWC Scientific Committee to develop links with the 'Animals Committee' of CITES.

There was some discussion in the Committee about perceived inappropriate or out-of-context quotations from the Scientific Committee's report during the CITES meeting. In particular, a concern was expressed that minority, non-peer reviewed Appendices to the report were being cited in a manner which implied that they were reviewed published papers.

The Committee noted that such practices were unfortunate and not confined to CITES. However it agreed that the practice of including authorised Appendices was integral to its reporting and noted that their endorsement or otherwise is stated in its reports.

The Secretary noted that it was the practice of the Secretariat to send the full text of the relevant parts of the Committee's reports to CITES.

Other aspects of the discussion in the Committee were of more relevance to the question of IWC publications. They would be taken into consideration in a document to be presented to next year's Committee meeting.

5.12 CWP

The Co-ordinating Working Party on Fishery Statistics (CWP) is an interagency body whose major aim is to promote the collection of reliable fisheries statistics that are internationally comparable. The IWC was admitted to the CWP at its 17th session held in Tasmania from 3-7 March 1997. A report of this meeting is given as IWC/49/10P.

Allison summarised some issues of potential interest to the Scientific Committee. The topic of bycatch and discard data had been discussed and all CWP agencies noted progress in addressing this issue. The group also discussed the exchange and dissemination of data particularly in electronic form and the provision of data in a common format.

The Committee noted that the Secretariat would take into account discussions during its meeting in preparing and submitting data to FAO. In addition it is hoped that membership of the CWP will lead to increased exchange of data with the other member organisations.

6. ENVIRONMENTAL CONCERNS

6.1 Report of the SWG (Standing Working Group)

6.1.1 Response to Commission's Resolution 1996-8

The SWG's primary work was to review two proposals designed to further the Committee's work related to cetaceans and the environment. These proposals had been prepared intersessionally in response to the Committee's recommendations (IWC, 1996d; 1997d; 1998) and to directions of the Commission. In particular, in Resolution 1996-8, the Commission:

> Directs the Scientific Committee, through its Standing Working Group, to consider and, as appropriate act on the specific recommendations of the two IWC Workshops... [on environmental concerns]... and, Endorses the recommendation of the Scientific

Committee that the Standing Working Group consult intersessionally, including if appropriate, through an intersessional meeting of the Standing Working Group.

The UK had subsequently provided a sum of £6,000 to advance this work. In consultation with the Chairman of the Committee, a Steering Group convened by Reilly was established to conduct the work. The cost to support a meeting of all members of the Steering Group would have exceeded the £6,000 donation, so it was agreed to convene two smaller groups: one in Europe (convened by Reijnders) to address recommendations arising from the Pollution Workshop (IWC, 1998); and another in the USA (convened by Reilly) to address recommendations arising from the Workshop on Climate Change and Cetaceans (IWC, 1997d). Accordingly, Reijnders convened the former meeting in Texel, The Netherlands, and Reilly convened the latter in La Jolla, California.

6.1.1.1 THE PROPOSAL FOR FUTURE WORK ON CETACEANS AND POLLUTANTS (SC/49/REP6)

SC/49/Rep6 is a proposal designed to begin to implement Recommendation 1 of the Pollution Workshop (IWC, 1998), which the Committee agreed summarised the conclusions of that meeting (IWC, 1996d, pp.55-7).

The Committee had agreed that there are sufficient data on the adverse effects of pollutants on the health of other marine mammal and terrestrial species to warrant concern for cetaceans. However, a considerable amount of fundamental research is needed before it will be possible adequately to address the question of the effects of chemical pollutants on all cetaceans. While noting that it is often not appropriate to extrapolate from one species to another, the Committee agreed that it is clear that if any progress was to be made within a reasonable timeframe, a multidisciplinary, multinational focused programme of research was required that concentrates on those species/areas where there is most chance of success. It agreed that three species were particularly suitable: the bottlenose dolphin; the harbour porpoise; and the white whale.

The proposal agreed to focus on the early links in the cause-effect relationships, and in particular the relationship between levels in certain tissues and indicators of certain effects. It was agreed to concentrate on those compounds for which analytical techniques and/or indicators were well developed, in particular PCBs and heavy metals.

The proposal involves a multinational team of agencies and laboratories. Potential sources of samples from the focal species in areas exhibiting a wide range of pollutant levels were identified. Sample sizes will be determined to maximise the likelihood of obtaining statistically significant results. The relevant tissues and general information on the required sampling techniques, storage and analysis techniques are identified, along with the required associated biological data. Many aspects of the proposed research are relevant to other detailed recommendations in the Workshop report. The proposal identifies a number of laboratories, coordinators and institutions that should be asked to participate in the programme, and a number of international and intergovernmental bodies to be approached for support.

A project of this scope requires careful planning. The first stage of the proposal is to hold a meeting of representatives from the interested collaborators. Aguilar offered to host such a meeting in Barcelona. The Committee agreed to establish a Steering Group (Aguilar, Donovan, Bjørge, Reijnders (Convenor)) to carry out the tasks necessary to ensure a successful meeting as documented under Item 11 of SC/49/Rep6. A sum of £15,000 is required to cover travel and subsistence costs for participants. The Committee noted that whilst this is a relatively modest sum, the overall cost of the project will be high and it is unlikely that the IWC alone will be in a position to fund the multi-year project. The Steering Group will work to identify and pursue additional sources of funding. The Committee welcomed the proposal outlined in SC/49/Rep6. It **recommends** that the Commission provides funding for the proposed meeting and endorses the approach outlined in SC/49/Rep6.

In concentrating on Workshop Recommendation 1 and the focal species, the Committee noted that it was not implying that research on other species should not be carried out, nor that other groups should not work on the other recommendations made in the Workshop report.

Indeed, it hoped that the approach outlined in this proposal may prove useful to researchers working on other species. In particular with respect to baleen whales, it was noted (O'Shea and Brownell, 1994 - see Workshop report - IWC, 1998) that levels of pollutants are low in baleen whales and much below threshold levels currently considered to elicit adverse effects in mammals. Therefore, baleen whales are not considered at this stage suitable priority species to establish the sought after cause-effect relationship between cetacean health and chemical pollution. However, the work in progress on North Pacific minke whales (Fujise, pers. comm.) appears promising and further work and presentation of results is encouraged.

6.1.1.2 THE PROPOSAL FOR FUTURE WORK ON CETACEANS AND CLIMATE CHANGE (SC/49/REP5)

The Committee agreed with the authors of SC/49/Rep5 that the first three recommendations from the Workshop on Climate Change and Cetaceans (IWC, 1997d), provided the basis for development of proposals to advance that work. These were:

(1) Research programmes should either be designed to include directed collection of environmental data, or should be linked to existing programmes which already collect environmental data. Specific links to such programmes should be investigated by the IWC.
(2) The Scientific Committee and the Commission should consider ways to facilitate the development and execution of a multidisciplinary multinational focused programme of research that concentrates on key species and key areas, with the long-term goal of being able to usefully predict the effects of climate change on cetacean populations.
(3) Joint CCAMLR-IWC and GLOBEC-IWC working groups should be established to consider collaborative work in the Southern Ocean.

Considering discussions last year within the Scientific Committee and the Commission, the Committee agreed to the following summary statement of objectives:

Define how spatial and temporal variability in the physical (e.g. sea surface temperature, salinity, mixed layer depth, upwelling, extent of ice cover) and biological (e.g. prey availability) environment influence cetacean species in order to determine those processes in the marine ecosystem which best predict short, and eventually long-term, changes in cetacean distribution, abundance, stock structure, extent and timing of migrations and fitness.

The Committee considered the programmes of Southern Ocean GLOBEC and CCAMLR, and their relevance to its work. In July and August 1997, Reilly had represented the Commission and the Committee at meetings of the Steering Group for SO-GLOBEC and of CCAMLR's Working Group on Ecosystem Monitoring and Management (WG-EMM). At both meetings, possible collaboration with the IWC was

discussed at some length and both encouraged and invited the IWC to join in field activities to address common interests. These potential collaborations form the core of the work proposed in SC/49/Rep5.

SO-GLOBEC's focus is on ecological processes at the mesoscale related to krill, its environment and its predators. They are planning a major field programme for 1999/2000 at a site near the Antarctic Peninsula, with intensive krill studies including 3-dimensional mapping and following of swarms and other aggregations. The IWC was encouraged to bring a whale component to this multidisciplinary, multinational programme. To help accomplish this, SO-GLOBEC agreed to participate in a joint liaison group with the IWC Scientific Committee.

CCAMLR's WG-EMM focuses on the management of krill resources, from an ecological perspective that includes consideration of krill predators. CCAMLR is planning a number of activities for the near future that the IWC potentially could join to advance its work on cetaceans and climate change. These activities include a synoptic survey to quantify total krill biomass in CCAMLR Area 48 (including parts of IWC Areas I and II) in 1999/2000, and long-term monitoring of krill, its environment and predators within three Integrated Study Areas (ISAs). They have not to date included whales in their programmes, with the view that whale-related activities should include the IWC. At its recent meeting WG-EMM discussed various levels of IWC participation in these field activities. This was judged to be of mutual benefit and WG-EMM agreed to the IWC proposal to set up a joint liaison group with the IWC.

The Committee **agreed** that the research activities planned by SO-GLOBEC and CCAMLR present a unique opportunity for the IWC to conduct research on distribution of whales in relation to their environment at a range of scales all within the same geographic area. The smaller scale process studies planned by SO-GLOBEC provide an opportunity for studies of the distribution and foraging of individuals and pods of whales in relation to fine scale patterns of krill distribution and physical oceanographic processes. CCAMLR's ISA programme allows the IWC to join long-term multidisciplinary monitoring of the relationships between krill and its predators, which would be crucial to studying any effects of climate change. Similarly CCAMLR's synoptic krill survey provides an opportunity to examine species composition, distribution and abundance of whales in relation to krill distribution and abundance in an area comparable in size to that covered during an individual year of the IDCR minke whale surveys. Furthermore, the three study areas are in the same part of the Antarctic, with the SO-GLOBEC site located within CCAMLR's Antarctic Peninsula ISA, which is within CCAMLR Area 48. The nesting of smaller within larger study areas provides the unprecedented opportunity to bridge observations of whale interactions with their environment from small to large scales. This should substantially enhance our ability to determine the effects of climate change on whales, by providing a base-line understanding of the animals' links to their habitat and prey. This will then put the Committee in a more informed position to consider possible effects on whales of climate-driven changes in the whales' environment as predicted by models and climate studies.

SC/49/Rep5 describes the research proposals in detail. In summary these will involve:

(1) retrospective data analysis, and modelling of whale-environment interactions in the study areas, to help structure a framework for field studies.

In conjunction with SO-GLOBEC's process-related studies:

(2) line transect sighting surveys for whales on the GLOBEC krill/oceanography vessel;
(3) attaching radio transmitters to whales to document movements of individual whales in the immediate vicinity of krill patches;
(4) additional line transect surveys, and perhaps environmental studies, in an area encompassing, and slightly larger than, the GLOBEC site.

In conjunction with CCAMLR's large-area synoptic krill survey:

(5) conduct line transect surveys on the CCAMLR krill vessels.

And, in a year soon following the major field programmes of 1999/2000:

(6) adding whale monitoring to one or more of CCAMLR's ISAs.

After some discussion the Committee endorsed the proposal given in SC/49/Rep5 and **recommends** that it be endorsed by the Commission. This will allow the complex planning with both CCAMLR and GLOBEC to proceed. In that regard, funding for the coming intersessional period would be required only to support participation in planning activities (£10,000). Again the Committee noted that the programme itself will have considerable future cost implications in terms of personnel, vessels and data analyses.

6.1.1.3 OTHER ISSUES

The Committee received a number of papers relating to environmental concerns and these are discussed in more detail in Annex F.

SC/49/O 28 addressed issues of PCB metabolites in cetacean tissues and understanding of multi-factorial effects in marine mammal epizootics, while Simmonds and Mayer (1997) provided a review of recent marine mammal mortalities in Europe. Both studies stressed the complex interactions of an array of likely causes, but noted an emerging understanding that social, environmental and evolutionary contexts are important.

A number of papers addressed topics related to habitats including case studies and methodological developments for determining habitat use patterns, including: applications to improve abundance estimation; minke whale food habits; possible environmental causes of gray whale recruitment variability; collection of sightings data on oceanographic and other survey vessels (and sightings of marine debris); and advice to the Working Group on Whalewatching.

Much progress is being made in defining and quantifying cetacean habitats from examination of sightings survey data in relation to environmental information. SC/49/SH1 and SH2 presented interesting studies that examined minke whale sightings from IDCR cruises to investigate patchiness of sightings, and relationships to the Weddel Gyre as indicated by surface temperatures.

SC/49/SH16 reported preliminary results from a cetacean sighting survey conducted as part of the German CCAMLR survey of krill, fish and oceanography. SC/49/SH5 reported results from a 1996 multidisciplinary study in waters off east Antarctica, which noted that the distribution of minke and humpback whales, and the pattern of cetacean sightings in general, were influenced by what appeared to be a long-term seasonal pattern of linked oceanographic and biological events. SC/49/SH6 introduced the Australian Southern

Ocean Pelagic Environment Monitoring Program, which includes a cetacean sightings component as part of its long-term, multidisciplinary approach. The Committee noted that dedicated multi-year funding for cetacean components of such programmes was integral to their success.

SC/49/O 22 and Ballance and Pitman (In press) reported results of studies of cetacean distribution, relative abundance and habitat relationships of cetaceans in the western tropical Indian Ocean - part of the Indian Ocean Sanctuary. SC/49/O 23 reported habitat patterns for California Current cetaceans, including partitioning of oceanographic and geographic components of these patterns. Both SC/49/O 22 and SC/49/O 23 used a statistical modelling approach (canonical correspondence analysis) that achieved notable success in explaining the variance of the cetacean encounter rates. In the Indian Ocean study, 41% of the overall variance was explained by the habitat model, with six taxa over 50%, including 76% for blue whales. In the California Current study, 48% of the overall variance was explained by a combination of oceanographic and geographic models, with a range that included over 70% for Dall's porpoises. The Committee noted the importance of quantitatively determining the strength of habitat relationships using analytical models in order to explain these complex linkages.

SC/49/O 15 introduced a new analytic approach which enables flexible spatial models to be fitted to line transect data, using spatial and environmental explanatory variables, themselves using waiting distances to the next sighting as the response variable. The Committee agreed that the initial results, which used only positional and no environmental data, are very promising and encouraging (see also Item 7.1.2).

The Committee agreed that the development of models such as those in SC/49/O 22, O 23 and O 15 is essential to furthering understanding of cetaceans within the complex physical and biological processes occurring in the marine environment. It noted the relevance of such studies to the interpretation and design of sighting surveys. The Committee **recommends** that such studies continue.

Fiedler *et al.* (1997) described an investigation of blue whale habitat and prey near the Southern California Channel Islands. The study included oceanographic and krill components, as well as sightings surveys and tracking of individual whales' movements in relation to krill. The study demonstrated the feasibility of the type of field programme proposed in SC/49/Rep5, in conjunction with SO-GLOBEC.

The Committee considered a series of papers describing studies of food habits of minke whales. SC/49/NA5 and NA6 considered diets of minke whales in the North Atlantic from data collected during Norwegian scientific whaling operations, and SC/49/NP2 reported diet studies of minke whales in the North Pacific, using data from Japanese research whaling. SC/49/NA5 calculated an annual consumption of 1.8 million tonnes of prey biomass by minke whales in a 180-day period. SC/49/NA6 reported a switching of dominant prey items which reflects observed changes in the relative and absolute abundance of the prey during recent decades. In discussion, it was noted that a similar switch of prey species for minke whales had occurred in the coastal waters of Japan in the mid-1970s. SC/49/NP2 reported differences in diet by area; in Areas 7 and 8 fish predominated as prey, while in Area 11 the whales fed almost exclusively on krill. The whales fed more intensively in the morning and evening. The Committee **recommends** that food habit studies should attempt to include independent examination of available prey, and quantification of variance of estimated diet parameters.

There was brief discussion of studies of minke whales in the Antarctic which showed that blubber was getting thinner (SC/M97/18). It was commented that this may signify that food availability is changing in the area.

Notice was drawn to SC/49/AS13 (also discussed under Item 11.3.1), which reported annual gray whale calf production for 1994-1997, and noted the correspondence of the highest and lowest estimates with, respectively, years of late and early ice formation on the feeding grounds. The authors put forward the hypothesis that following early ice formation and therefore shortened opportunity for feeding, fewer calves are successfully recruited, and in contrast, following late ice formation and extended feeding opportunity, proportionately more calves are successfully recruited to the population. The Committee regarded this study to be of interest because the observed pattern could be an indication of how whale populations respond to short-term environmental variability, and thus could help advance understanding of whale population dynamics. However, it drew attention to the short data series and the small number of variables investigated.

SC/49/SM32 reported that inshore species of dolphins (bottlenose and humpback) off the east coast of southern Africa were under severe pressure from some human-induced sources, including habitat destruction and overfishing of preferred prey species. A clearer understanding of critical habitat and linkages between physical and biological parameters and seasonal movements of species is important in the context of determining effective conservation and fisheries management practices.

The Committee **agreed** that under this Agenda Item, the Standing Working Group should in future consider fishery effects on cetacean habitat and prey, but not the bycatch issues since these were considered in detail by other sub-committees.

6.2 Action arising

6.2.1 Future activities

The Committee identified a list of continuing topics for Annual Meetings and agreed that it would be useful to select priority topics from it in specific years. It agreed that such priority topics should be determined after consultation with other sub-committees through their Chairs. This would have the advantage of: (1) emphasising the links between the work of the SWG and the other work of the Committee; and (2) obtaining most benefit from invited participants attending the meeting. The Chairman and Secretariat would ensure that information on priority topics is circulated after the meeting. The Committee **agreed** that if the two proposals discussed under Items 6.1.1 and 6.1.2 were endorsed by the Commission, actions arising from them would be among the priority topics for the next Annual Meeting.

6.2.2 Future workshop

The Committee considered the issue of conducting line transect surveys from Platforms of Opportunity (POP), especially surveys to study habitat and prey-use patterns in conjunction with oceanographic cruises. It supported the idea of an IWC workshop to develop data collection and analysis methods for such studies, as included in SC/49/Rep5. Such a workshop would be an essential part of developing the field programme proposed for 1999/2000 in conjunction with CCAMLR and GLOBEC (see Item 6.1.1.2).

The Committee **recommends** that as discussed in 6.1.1.2 such a workshop be held and notes that its value extends beyond the specific work proposed in SC/49/Rep5. It agreed that an intersessional group under Reilly should work towards developing more detailed information including a draft Agenda, suggested venue and budget and potential participant list. Its members are identified in Annex P.

6.2.3 Implications for SOWER cruise activities

SHORT-TERM

The Standing Working Group (Annex F) had responded to a request to provide guidance on the forthcoming SOWER cruises on the question of oceanographic data. It was agreed that for a number of reasons (including available equipment) it was not possible to conduct oceanographic surveys during the next cruise that would provide useful, cetacean-related, data, although data of general oceanographic value could be collected following previous protocols.

LONG-TERM

The research outline described in SC/49/Rep5 refers to IWC vessels being used, at least for the year 1999/2000, and by implication this might be considered to refer to vessels used during SOWER cruises. Notwithstanding that these vessels are kindly provided to SOWER by the Government of Japan, which of course has to decide their research priorities, the Committee agreed that a Working Group should be established under Reilly to consider this issue further. This is discussed under Item 10.5.

6.3 Arctic issues

SC/49/O 32 reviewed the increasing incidence of ozone depletion in general and recent recorded declines over northern polar regions in particular. Recent work had indicated that although phytoplankton in the Antarctic appeared to have some mechanisms of defence against UV-B, this was apparently not the case in the Arctic. Changes in species composition of phytoplankton assemblages could have significant effects on zooplankton abundance and implications for cetaceans. This issue was noted as important for future consideration by the group and the review presented here was welcomed as a useful contribution.

7. COMPREHENSIVE ASSESSMENT OF WHALE STOCKS - REVISED MANAGEMENT PROCEDURE (CA/RMP) - GENERAL ISSUES

7.1 Items arising from the 1996 meeting

Palka reported on the work of the intersessional correspondence group set up last year by the Committee (IWC, 1997e, p.69) to test the performance of abundance estimation procedures over an appropriate range of sighting survey factors. Recognising that the remit had been purposely broad, the group had selected for initial investigation the important case of line transect shipboard two-platform surveys with sighting heterogeneities and where $g(0) < 1$. They conducted a simulation experiment to investigate this case and preliminary results are provided in SC/49/O 18. The Committee noted that the work conducted had been very useful and provided an important tool for further methodological development. Noting that an essential part of the oversight role of the Scientific Committee for abundance estimation under the RMP is the evaluation of the adequacy of the statistical estimators being used, the Committee **recommends** that this intersessional correspondence be continued and encouraged interested members to participate. It was anticipated that this would be an ongoing group, with the topics investigated and participation changing in response to the specific issues being addressed. Palka agreed to convene the intersessional group whose members are identified in Annex P.

7.1.1 Estimation of 'additional variance' - intersessional group

Additional variance is the extent by which variability of successive abundance estimates exceeds the contribution from sampling variability that can be estimated from the results of each survey separately (IWC, 1994b, p.75). The causes of additional variance include underestimation of sampling error because one or more components of variance are ignored or are non-measurable, and because the survey area differs from the range of a biological stock (IWC, 1994b, p.75).

Last year (IWC, 1997e, p.67), the Committee had considered estimates of additional variance for Southern Hemisphere minke whales based on using IWC/IDCR abundance estimates south of a common northern boundary at the half-Area level. It had recommended 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 for each. This work had not been completed, primarily because the relevant data had not been extracted.

The Committee agreed that additional variance was important as a general issue for interpreting trends in abundance and should continue to be considered in this context in the future. It agreed that the calculations specified at last year's meeting were of interest and **recommends** that the appropriate data be extracted by the Secretariat so that they can be carried out (see also Item 18).

7.1.2 Future Committee work on abundance estimation

ROLE OF THE SCIENTIFIC COMMITTEE IN OVERSIGHT OF DESIGN, CONDUCT AND ANALYSIS OF ABUNDANCE SIGHTING SURVEYS

The guidelines for conduct and analysis of abundance surveys within the RMS (IWC, 1997l, pp.227-35) identify a range of levels of oversight. The Committee agreed that this oversight should be seen as a process, with greater oversight at the beginning of sighting survey programmes. Similarly, more intense oversight would be required when methods of conduct or analysis of sighting surveys proposed to be used are novel, or new to those conducting the surveys, or when changes of methods of conduct or analysis are anticipated. When well developed and tested methods of conduct and analysis are used, less oversight would be required. Additional oversight of the analysis of sighting survey results may be required in cases when data are not collected under Committee Guidelines or when other unique issues are identified.

It was noted that while the Commission had approved the Scientific Committee's Guidelines, they also had identified an additional requirement that scientists be nominated to participate in, and report on, sighting survey conduct for use in the RMP. The Committee agreed that while such participation might sometimes be necessary to meet scientific requirements, this would not always be the case, especially in long established surveys and in multiple vessel surveys. Nonetheless, participation by Committee members in such surveys was seen as valuable in general.

The question of whether the Committee's oversight of surveys conducted for management purposes might also be useful in the case of aboriginal subsistence whaling was

raised. The Committee agreed that this should be considered in the context of the development of the AWMP and referred it to that group.

MINKE AND BRYDE'S WHALE SURVEYS

Relative to oversight of the proposed Norwegian surveys, the Committee noted its previous intensive oversight of survey and analysis methodology (e.g. IWC, 1997c, pp.261-90). At this stage, the Committee **recommends** that oversight should focus on (1) analysis methods, especially if alternate methods are adopted (e.g. SC/49/O 8) and (2) the problem of combining surveys over time.

Walløe welcomed the Scientific Committee's assistance with the analysis methods. He indicated that the position of one of the team leaders on each of the two survey vessels was open to non-Norwegian scientists and welcomed applications from experienced Committee members and other qualified scientists. Financial support is available. There is also the possibility of having additional observers onboard.

With respect to oversight of Japanese surveys, the Committee noted that close collaboration continues with the SOWER cruises, but that the Committee has not been involved with the North Pacific surveys. Thus, for the proposed Japanese North Pacific minke whale survey, the Committee **recommends** that oversight should initially include survey participation by knowledgeable Committee members, since a new survey methodology is planned. Subsequently, oversight should focus on analysis methods. For the Japanese Bryde's whale survey, oversight should initially include assistance with the design of the proposed four years of surveys. Because the Scientific Committee has not evaluated the conduct and results of this series of surveys previously, and because there is a proposal for beginning a systematic series of four surveys, it would be valuable to include Committee participation onboard at least one of the sighting vessels in the next survey. In subsequent years, oversight should focus on analysis methods related to combining data over years.

Yagi welcomed the Scientific Committee's oversight and participation in these two planned surveys. He noted that there is a need to define a procedure by which Scientific Committee members can apply for participation in the surveys. Smith convened a Working Group (including Miyashita and Øien) to outline a possible mechanism. He reported back to the meeting with a proposal for a process for nominating scientists to participate in sighting surveys under the RMP/RMS. After a brief discussion, the Committee **recommends** that the process described below (i-iv) be adopted and included in the Guidelines (IWC, 1997l, pp.227-35).

(i) The Committee will determine whether the proposed survey is to use 'standard' methodology or whether it involves novel aspects of survey design, conduct or analysis (IWC, 1997l, p.228).

(ii) For surveys proposing to use survey methodology that is new or that has not previously been applied to the species and regions involved by the proposing country, the Committee will generally require that scientists familiar with the methodology requirements, and especially the implications of violations of survey protocol, participate in the survey. Based on review of the proposed survey design, the Committee will define the required qualifications. To ensure independent oversight in these cases, the Committee **recommends** that the Commission should normally pay expenses associated with this oversight role, including travel, per diem and salary, as required.

(iii) For surveys that are using accepted methodology for which the proposers have previous experience for the species and in the regions being surveyed, the Committee would welcome participation by independent scientists knowledgeable in sighting survey conduct and analysis, but would generally not identify specific experience requirements for such participants.

(iv) In either case, the Committee should arrange for a review of the candidates nominated by those proposing the survey or by members of the Scientific Committee.

REVIEW OF SOUTHERN HEMISPHERE MINKE WHALE ABUNDANCE ESTIMATES

A comprehensive review of the methods used to estimate abundance of Southern Hemisphere minke whales was last undertaken in 1990. Three years ago, the Committee recommended that another review should take place which included re-estimating abundance from all IDCR surveys. Last year, the Committee specified a list that should be undertaken to facilitate such a review (IWC, 1997f, p.152). These analyses have not yet been completed. A substantial amount of additional work remains, and this cannot be completed by next year's meeting. The Committee believes this review to be an important component of its oversight role and **recommends** that it be conducted in 1999.

NASS ICELANDIC DATA

Additional analyses proposed for the NASS-95 and NASS-87 and possibly for the NASS-89 data should be pursued pending resolution of the data availability questions raised under Item 8.2.2. Walløe indicated that Borchers would be contracted to conduct an analysis intersessionally that could be reviewed at the next Annual Meeting. The Committee considered that this work should receive high priority (see also Item 8.2.2).

The Committee agreed that it should review Borchers *et al.* (1997) if revised estimates of minke whale abundance based on NASS aerial survey data are presented, especially because the new estimates differ substantially from its own earlier estimates. It noted, however, that should such estimates be required for use under the RMP, access to the primary data would be required. The matter is discussed further in Item 8.2.2.

SUMMARY OF WORK RELATIVE TO THE RMP

The Committee noted that the oversight being recommended involved considerable time and financial commitments. The work involved includes: (1) arrangements for participation in two Japanese cruises; (2) analysis of earlier Japanese sighting survey data and survey planning; (3) simulation evaluation of line transect abundance estimation methodology; (4) continuing work of the Steering Group to address the questions posed by the Scientific Committee last year about the northeast Atlantic sighting survey estimator; (5) development of methods for combining survey data over years; and (6) re-analysis of Southern Hemisphere minke whale abundance. A Working Group under Smith was established to outline the level of resources required. Their report is given as Annex N.

The Committee agreed that activities (1) and (2) in Annex N should be handled by a North Pacific Survey Steering Group to be convened by Smith with membership listed in Annex P. This work needs to be completed within the next 12 months and the required resources are needed this year. It also agreed that activity (4) should be guided by the Steering Group on Northeast Atlantic Minke Whales and that this work needs to be completed before next year's meeting. Activities (3) and (5) involve the testing and validation of existing abundance estimation methods rather than the development of new methodology. The Committee agreed that activities (3) and (5) should be coordinated by the

Abundance Estimation Methodology Steering Group convened by Palka with membership listed in Annex P. It noted that there are implications for the Secretariat's time in verifying data and validating computer programs to be used in calculating estimates of abundance which may be used under the RMP. It agreed that verification of North Pacific Bryde's whale abundance data should be completed as soon as possible but that verification of the NASS-89/90 and NILS-95 data for minke whales in the North Atlantic was of a lower priority (see Item 18).

The Committee noted that the work identified in Annex N had significant financial implications (£34,000) and agreed that this should be **brought to the attention** of the Commission. In doing so, the Committee draws the Commission's attention to the fact that these resources are for oversight of sightings surveys and abundance estimation and not for research.

SUMMARY OF RESEARCH ITEMS RELATED TO ABUNDANCE ESTIMATION

Annex O provides a summary of research items identified in sub-committee discussions related to analyses of sightings data, particularly regarding the IWC-DESS (Database and Estimation Software System). The Committee focused discussion on sub-items 1-6 under Item I in Annex O, tasks which need to be completed or are planned to be completed before next year's meeting. It agreed that some of this work was routine and essential and other work was developmental, but that all was of high value to the Committee. Some elements (Items 1, 2 and 6) were agreed to be of higher priority than others. This work was referred to Item 19 for consideration.

SPATIAL MODELLING

SC/49/O 15 describes an approach being developed to estimate abundance from line transect survey data that attempts to model large-scale spatial trends and smaller-scale spatial correlations. The Committee noted that spatial modelling approaches do not require random sampling and can possibly be adapted to obtain unbiased estimates of abundance from non-random designs such as those used in JARPA. The Committee recognised the potential value and importance of incorporating information on the spatial structure for improving abundance estimates and encouraged further development of methods which can reliably incorporate spatial information (see also Annex O and Item 19).

PERPENDICULAR DISTANCE BASED METHODS

A programme of research was proposed to develop flexible and robust detection function models and estimation methods for independent observer line transect survey data when $g(0)$ is less than unity (SC/49/O 16). It was noted that this proposal is a continuation of the work requested previously by the Committee (IWC, 1997e). The Committee endorsed the present proposal and hopes that the work will be completed for presentation at the 1999 meeting.

7.1.3 Combination trials - intersessional group

A comprehensive set of trials had been conducted to investigate whether any of the effects of combining sources of uncertainty were non-additive (IWC, 1992c, p.273). In 1994, the Committee had noted that the *CLA* had not been completed at the time that investigation had been conducted (IWC, 1995b, p.106). It had therefore established an Intersessional Working Group to make further calculations to investigate whether any of the effects of combining uncertainties were non-additive, and document the results to help in formulating future *Implementation Simulation Trials*.

A summary of the report of the Intersessional Working Group (SC/49/Mg3) is given in Annex D. The Committee agreed that, overall, the study confirmed that two-way interactions are generally unimportant. However, some multi-way interactions could be important, particularly those which involve additional variance combined with severely negatively biased catches and low estimated CVs for the abundance estimates. The Committee agreed that the results in SC/49/Mg3 should be taken into account in the specification of future *Implementation Simulation Trials*.

7.2 *CLA* program and tuning

7.2.1 Behaviour of the CLA

SC/49/Mg2 (summarised in Annex D) examined the behaviour of the *CLA* in terms of the catch limits calculated under different patterns of historical catches and abundance estimates. In particular, the Committee noted the result that, in some cases involving multiple abundance estimates, the catch limit increases markedly as the observed CV of the abundance estimates becomes smaller than (approximately) 0.1. The Committee noted its previous discussions regarding the performance of the *CLA* when the observed CV is low (IWC, 1994b, pp.75-6) and agreed that additional attention needs to be given to such abundance estimates before they are used in the RMP.

7.2.2 CLA Program

After the 1991 Commission meeting, the Secretariat was requested to select the sizes of the integration steps in the *CLA* so that the catch limit is calculated to within '1 whale' and to 'tune' the *CLA* so that the median final depletion for the D1 (development, MSYR = 1%) trial was 0.72K (accurate to 0.001K). This led to a value for the 'tuning parameter' of 0.4102.

SC/49/Mg1 reported on comparisons between the current (published) IWC coding of the *CLA* (MANAGE, IWC, 1994e, pp.153-67), and two alternative computer programs (rmp and MCrmp) in terms of the catch limits calculated for North Atlantic minke whales for some selected *Small Areas*. The rmp program (see Fenstad *et al.*, 1993 for details) provided virtually identical results to the MCrmp program (which is based on a simple Monte Carlo integration program and should therefore be reliable, although computationally intensive). Only when the IWC coding of the *CLA* was changed to include the use of double precision arithmetic and was applied with extremely fine integration steps were the differences between the catch limits from the three programs less than the desired one whale.

The Committee noted that although re-coding the MANAGE program in double precision and using small step sizes gave catch limits accurate to one whale in the five cases considered in SC/49/Mg1, this was not conclusive assurance that it would do so in other trials or implementations. Nor does the agreement among the rmp, MCrmp and double precision MANAGE programs for these five trials confirm that they will perform identically in all cases.

Changes which had been made to the code for the common control program and for the *CLA* since 1991 are given in Annex D, Appendix 2. The Committee noted that the value of the tuning parameter had not been changed from 0.4102 so that if MANAGE is applied to the D1 trial as now defined (Annex D, Appendix 2) the median final depletion is not exactly 0.72K as before.

The Committee **recommends** that the Secretariat re-code the MANAGE program using double precision arithmetic and select the step sizes for the numerical integration using the procedure in Annex D, Appendix 3. Once this is completed, the Committee **recommends** that the Secretariat re-tune the *CLA* so that the median final depletion for the D1 trial is 0.72K (accurate to 0.000001K). This work, which is estimated will take approximately 3-4 weeks to complete, should be afforded a high priority (see Item 18).

The Committee also **recommends** that the Secretariat investigate methods (including those used in Fenstad *et al.*, 1993) to calculate catch limits under the *CLA* more efficiently. It would be desirable if the same computer program could be used for calculating catch limits and for simulation studies. The Committee **recommends** that this work be completed before the next Annual Meeting and that the Secretariat should consider contracting out this task (see Item 18). To aid this procedure, an intersessional Working Group was appointed under Hammond. Its composition is given in Annex P.

7.3 Commission Resolution 1996-6

7.3.1 Arrangements to ensure that total catches over time are within the limits set

The Committee noted that this was primarily an enforcement issue. It further noted that the catch history included in any RMP *Catch Limit Calculations* must include all known non-natural removals and not just catches through whaling (IWC, 1994d, p.146). The RMP does not specify whether catch limits apply only to whales taken in whaling operations or to all non-natural removals.

In consideration of the implications of catches exceeding the limits set, the Committee noted that the RMP contained features which should reduce the deleterious effects of this by reducing catch limits over time. However, the *CLA* deliberately responds fairly slowly to signals in the data, so some negative effects would result. No trials had been conducted to investigate the effects. The Committee identified two situations in which catches may exceed catch limits:

(1) catches exceed limits and the actual catches are known;
(2) catches exceed limits but the difference is not known.

The situation in which catch limits differ from catches was identified as an issue to consider during the development of the RMP (e.g. IWC, 1991, p.94) but no trials were developed to investigate it. Situation (2) can be considered as essentially the same as the situation in which catches are unbiased but the estimates of absolute abundance are positively biased. Trials for the latter were conducted during the development of the RMP and showed that it is robust to this uncertainty (within the limits tested). However, these trials had not included both positively biased abundance estimates and unreported future catches, and the inference was based on the assumption that the extent of relative difference between the catch limits and the removals remained constant over time. The Committee agreed that trials could be specified to assess the implications of these two situations should the Commission wish, but noted that structuring such trials would depend upon the degree of misreporting or excess catches.

7.4 Carry-over of catches

The Government of Norway had requested the Committee to provide advice on the scientific aspects of a specific proposal for the carry-over of catch limits:

> 'any unused portion of the catch quota for any Small Area shall be carried forward from that year and added to the catch quota for the same Small Area of any subsequent years within the same block period'.

Walløe noted that a provision for carry-over of catch limits was being requested because the effects of weather conditions and operational conditions within a *Small Area* can lead to the whalers being unable to fulfil their quotas.

The Committee agreed that a single rule based on the Norwegian proposal allowing carry-over of catch limits under the RMP was preferable to a set of rules which attempted to cover all situations.

The Committee noted that for the specific proposal from Norway it would always be the case that the catches for a *Small Area* cannot exceed the total catch limit for that *Small Area* for any given period between *Catch Limit Calculations*. It agreed that a general rule should be limited to this case. Annex D, Appendix 4 provides an enabling clause for such a carry-over provision for inclusion in the RMP. Annex D, Table 1 lists the results for the base-case single stock trials for what amounts to the 'worst case' scenario for this rule, i.e. all of the catch is taken in the final year of the 5-year period for which catch limits are set. The Committee agreed that the impact of this rule was small and hence its performance acceptable.

The Committee **recommends** that the enabling clause and associated annotation in Annex D, Appendix 4, be incorporated in the RMP.

7.5 Other issues

The Committee noted that a number of minor additions and changes had been made to the RMP documentation and annotations in recent years. It appointed an intersessional group convened by Donovan (members listed in Annex P) to finalise editorial aspects of the RMP and associated guidelines for inclusion in the special issue on the development of the RMP.

8. CA/RMP - PREPARATIONS FOR IMPLEMENTATION

The Committee noted that *Implementation Simulation Trials*

> involve identifying the range of plausible hypotheses relevant to recommending an *Implementation* or *Implementation Review* for the RMP and formulating simulation models which conform with these hypotheses (IWC, 1995d, p.214).

It agreed that its work would be facilitated if there was a list of questions which was explicitly considered during a Comprehensive Assessment. This would simplify the process of constructing *Implementation Simulation Trials* because many of those involved in Comprehensive Assessments are not familiar with the requirements for *Implementation Simulation Trials* and *vice versa*. Butterworth agreed to draft such a list for the next Scientific Committee meeting.

8.1 North Pacific minke whales

8.1.1 Results of initial trials

At last year's meeting, the Committee had developed a set of *Implementation Simulation Trials* for North Pacific minke whales and recommended that the Secretariat develop a computer program to implement these trials and then conduct them (IWC, 1997e, p.70). Allison reported that she

had been unable to complete this task due to time constraints. The Committee's priorities for computing tasks for the coming year are discussed under Item 18.

8.1.2 Amendment to Implementation Simulation Trial *specifications*

8.1.2.1 STOCK IDENTITY

The current set of *Implementation Simulation Trials* for North Pacific minke whales (IWC, 1997k, pp.216-25) divides the North Pacific into 13 sub-areas (Fig. 1). The trials consider two hypotheses regarding the number of breeding stocks of minke whales in the North Pacific: (1) that there are three stocks, the J stock ('home' area - Sea of Japan and perhaps also the Yellow Sea and East China Sea), the O stock ('home' area - the Okhotsk Sea, the east coast of Japan) and the W stock (West Pacific); (2) that there are only the J and O stocks.

The Committee considered the new information regarding stock structure for North Pacific minke whales in the context of whether it implied that changes had to be made to the specifications of the current set of *Implementation Simulation Trials*. Details of the papers presented (SC/49/NP9, 10, 11, 12, 14, 17 and SC/49/O 21) and the authors' conclusions are given in Annex D.

The Committee recalled that the current set of trials includes the hypothesis that some J stock animals are found in Sub-Area 12 during summer (IWC, 1997k, p.218). It agreed to modify the catch mixing matrices for the J stock (options 'A', 'B' and 'C') to allow males to be present in Sub-Area 11 during August by introducing a specific mixing parameter to account for this. It was agreed that the sex-specific mixing proportions in table 3 of SC/49/NP11 would be used in place of the values currently used when conditioning the trials. The hypothesis that females migrate north to Sub-Area 12 in April and only return after August was considered highly unlikely because this would imply that breeding of the J stock (for which conception dates peak in September) occurs in Sub-Area 12, for which there is no evidence.

Some members noted that SC/49/NP17 and SC/49/O 21 did not provide information that could be used to evaluate stock structure as the geographic location of the samples referred to was unknown.

8.1.2.2 UNCERTAINTY REGARDING CATCHES

As part of the current specifications for the North Pacific minke whale *Implementation Simulation Trials*, a time series of catches by month, sex and sub-area had been constructed by the Secretariat. Appendix 5, Annex D, outlines the assumptions made in order to assign all the historical catches to month, sex and sub-area. These assumptions included using the top end of the range of values for the catches by the People's Republic of China (IWC, 1994c, p.126). The Committee agreed that the assignments made were satisfactory.

The Committee noted that during the development of these *Implementation Simulation Trials*, possible catches by China-Taiwan, the Philippines and the Democratic People's Republic of Korea had been ignored because of the absence of any evidence that these were substantial in comparison with known levels of catch (IWC, 1997k, p.204). The Committee confirmed that it agreed with this approach.

The Committee considered the implications for plausible ranges of historical catches of the results in SC/49/NP17 and SC/49/O 21. Brownell referred to additional information from Anon. (1997) and Mills *et al.* (1997) which indicated that incidental catches up to a level of 128 per year had been taken in Korean fisheries. The Committee agreed to add an additional set of four trials in which it is assumed that an incidental catch of 150 whales per annum had occurred in Sub-Area 6 since 1988; the sex and timing within the year of these catches is to be selected by the Secretariat using the

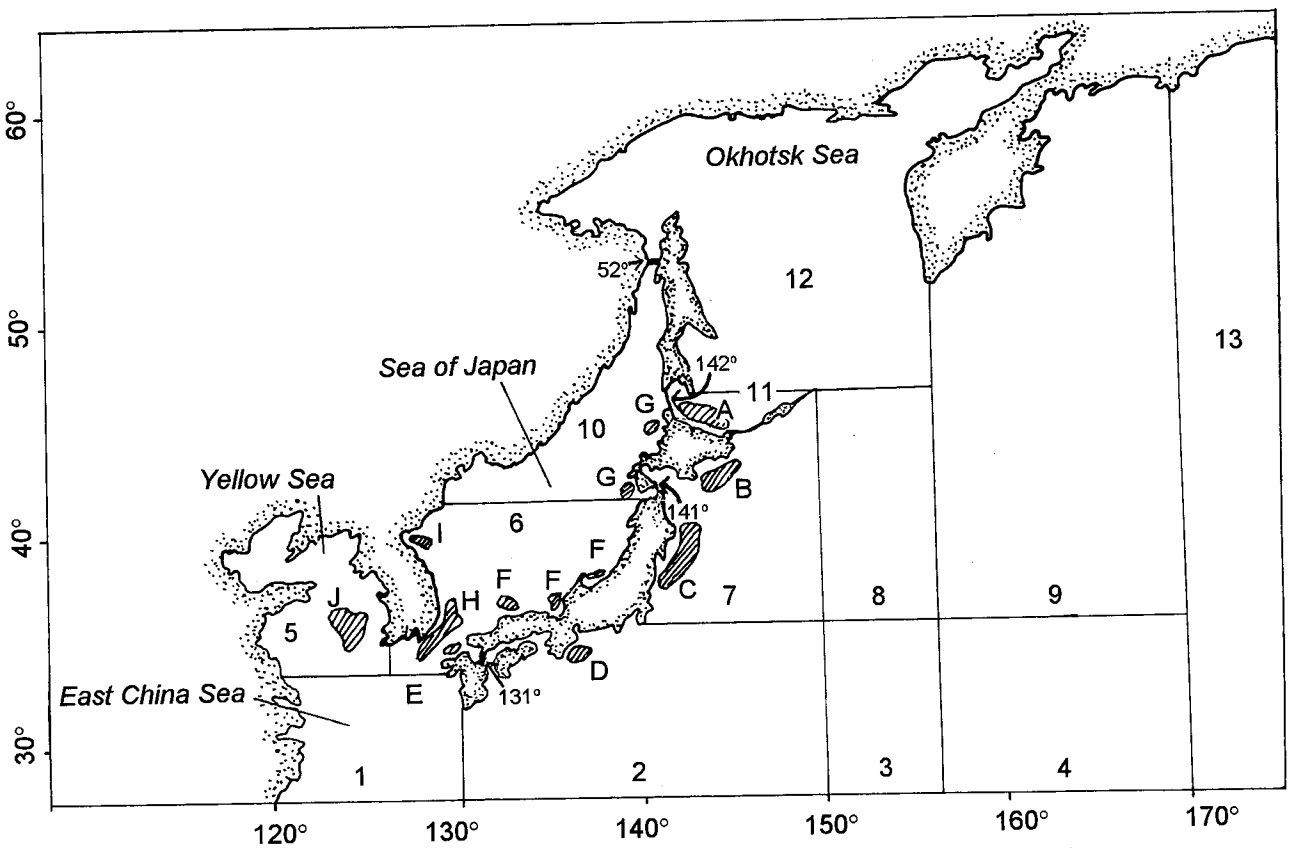

Fig. 1. Whaling grounds and the 13 sub-areas used for the *Implementation Simulation Trials*.

procedures in Appendix 5, Annex D. The future catches in Sub-Area 6 for these trials will also be assumed to be 150 whales per annum. The trials will be variants of the four base-case trials (IWC, 1997k, p.223).

The Committee noted that its work in specifying trials would be enhanced if it could receive reliable information on Korean incidental catches. It **requests** the Commission to urge the Government of Korea to provide this information.

The Committee established a Working Group to consider all the available information on incidental catches (estimated and observed) to specify a time series of total incidental takes (if possible by sex and month) in Japanese fisheries. The Committee agreed its report should be appended to the report of the Working Group on the RMP (Annex D). The Committee agreed that these catches will be added to the catches by Japan and will be used in all trials. Wade argued that the genetic data presented in SC/49/O 21 suggested that an additional trial regarding historical catches may need to be specified.

8.1.2.3 SIGHTINGS SURVEYS

Japan is proposing to conduct a feasibility study for sightings surveys of North Pacific minke whales in 1998, to test the independent Norwegian observer survey methods used (IWC, 1997c, pp.261-90; Schweder *et al.*, 1997b). The specific analysis methods have not been determined but consideration would be given to the methods under development presented in SC/49/O 8. The area to be covered would be the Sea of Okhotsk and the waters around the Kurile Islands, pending obtaining entry permits from Russia. It was noted that the proposed survey method for the minke whale feasibility study was new to Japan, although the methods have been accepted by the Committee. The analysis methods of SC/49/O 8 are also new. Consideration of this survey relative to the Committee's guidelines and oversight role under the RMS is given under Agenda Item 7.1.2.

The Committee **strongly recommends** that the surveys include waters within the Russian EEZ in order to provide necessary coverage. It **recommends** that the Commission requests the relevant authorities of the Russian Federation to grant permission for the vessels to operate in their EEZ.

8.2 North Atlantic minke whales

8.2.1 Northeastern

8.2.1.1 DNA PROFILE REGISTER

SC/49/NA1 contained the specification of a DNA profile register for minke whales proposed by Norway. It was noted that this has been proposed for the purposes of controlling the products of a whale harvest which falls under the responsibility of the Technical Committee (see Item 3.3). Nevertheless, there were two scientific issues on which the Committee felt it could provide advice: the type of genetic information which was most appropriate to include in such a register; and the value of such data for future research activities.

The proposal had arisen out of plans in Norway to establish a human forensic DNA database next year; such databases already exist in other countries. The major requirements of a DNA profile register for whales are that it should be: individual-based; practical; reproducible; and preferably reproducible internationally. A further desirable property is the ability to identify unknown animals to species/stock. Proposed components were: microsatellite markers for individual recognition; mitochondrial markers ('maternal DNA'); and Y-chromosome markers ('paternal DNA'). Ideally the genetic analysis and administrative components of a register should be separated. Norway is in the process of developing a register for North Atlantic minke whales and welcomed suggestions from the Committee for improving its scientific value.

The Committee established a Working Group to discuss detailed aspects of the genetic information proposed to be registered. Their report is given as Annex Q. The Working Group noted that proposed methods for individual identification were sound and provided a number of specific comments in relation to the screening and choice of STRs (Simple Tandem Repeats). The Group briefly discussed a number of other scientific aspects of the proposal including questions of the potential utility of mtDNA and other genetic markers for species and stock identification.

Yagi supported the proposal and informed the Committee that Japan also had plans to establish a DNA register for minke whales. It was important that information stored by different countries or groups had elements (e.g. microsatellite markers) in common so that maximum use could be made of the data for scientific purposes. The Committee noted that such collaboration was already established (e.g. SC/49/NP12) and would be continued.

There was some discussion about the storage of tissue as well as genetic data. In Norway, the plan is to store tissue samples and extracted DNA for future genetic analysis, including the development of techniques for obtaining the most information from the Y-chromosome. It was noted that storage of tissue for the future was an element in other research programmes endorsed by the Committee, e.g. the YoNAH project for North Atlantic humpback whales (SC/49/NA8).

Although the proposed register in Norway was primarily intended for commercially harvested minke whales, it would also be valuable for animals taken in aboriginal/subsistence hunts for minke whales and for other species, especially in the North Atlantic. Born indicated that material from whales taken by Greenland would be made available where possible.

In summary, the Committee **agreed** that the data held in such registers would be very valuable for future scientific research and supported the proposal that they would be available for this purpose.

8.2.1.2 RESULTS OF ANALYSES AGREED AT THE 1996 MEETING

Last year, the Committee agreed that the following additional analyses should be undertaken with respect to the estimates of abundance for northeast Atlantic minke whales from the NASS 1989/90 and NILS-95 surveys (IWC, 1997e, p.76):

(1) additional simulation tests to more fully explore the statistical properties of the Norwegian Computing Center (NCC) estimator and for the purpose of further confirmation that the software was adequately verified;
(2) to reconcile any differences between comparable estimates obtained from the NCC and Cooke implementations by identifying the main causes of any such differences;
(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 distributions of radial distances.

It had been agreed that the Chairman should establish an intersessional Steering Group (working via e-mail) to determine the details of these analyses. Unfortunately its formation was delayed until March 1997. The members of

the group were Butterworth, de la Mare, Hammond, Laake, Palka, Polacheck (chairman), Schweder, Skaug and Zeh. An invitation to be included as a recipient of the e-mail correspondence was extended to all members and one additional member accepted. Time and resources were limited for completion of the tasks, particularly in light of the delay in establishing the group.

TASK 1: SIMULATION TRIALS

The Steering Group noted the extensive work that had previously gone into the verification of the NCC software and agreed that the focus of the simulation trials should be on the statistical properties of the estimator. In doing this, it noted that any additional tests would simultaneously provide further information on verification. The Committee **agreed** with the Steering Group's judgement that substantial validation of the computer programs had already been undertaken and reported (IWC, 1997e, p.74). The Committee also **agreed** that further work on validation would only be necessary if simulations trials revealed anomalous behaviour.

Taking into account the computational intensity and time required for completion of analyses with the full NCC implementation, the Steering Group agreed to a two stage series of additional simulation trials. The first stage, which was computationally less demanding, focused on the statistical properties of the primary parameters of interest. The second stage trial was to be a more realistic test which incorporated additional variability and unknown parameters. Time and resource constraints meant that only the first stage trials could be completed prior to the 1997 Scientific Committee meeting.

In the results from the first stage trials, the mean of the estimated values for three parameters for the hazard probability function was substantially biased, while the bias for the other parameter was relatively small. The cause of the large biases in some of these parameters was not apparent. However, because of limited time, the link function had not been recalculated. The values used in the estimate from NILS-95 made last year were used which could have introduced some bias. It was further noted that a large amount of covariance exists among the estimated parameters and that there were imbalances in the amount of effort under the different simulated environmental conditions (mimicking the imbalance in the NILS-95 survey). In this regard, it may not be surprising that some individual parameters are poorly estimated. It was also noted that one must be careful not to over-interpret the results of simulations involving only one scenario as biases may go in different directions in different cases.

While the estimates for some of the individual parameters of the hazard probability function had high bias, the net effect on the abundance estimates was small in the simulation trial. The net effect in terms of estimating abundance is reflected in the estimates of effective half strip width (*ehsw*) which had a positive relative bias of 7%. The Committee noted that the size of this estimated bias was much less than those for some of the internal parameters of the model and pointed towards robustness of this key output of the estimator. A positive bias in *ehsw* would imply that abundance estimates, themselves, would be negatively biased as abundance estimates are inversely proportional to the *ehsw*.

TASK 2: DIFFERENCES BETWEEN IMPLEMENTATIONS

The absence of Cooke as a member of the Steering Group hampered progress on this issue. The version of his implementation available from the IWC Secretariat was the one that was used to analyse the large number of simulated datasets reported in Cooke (1997) and was not able to handle covariates. As such, it was not possible for the Steering Group to undertake a fully comparable analysis. The Steering Group considered that it would have been worthwhile, in the absence of an implementation that could handle covariates, to have obtained estimates without covariates that would have been directly comparable to the equivalent subset of Schweder *et al.* (1997a). However, the resources were not available within the Steering Group. In correspondence with the Chairman in April, Cooke indicated that completion of computer implementation was taking longer than anticipated but that he expected to complete the programming work in June. As such the Steering Group decided to wait for a further progress report before addressing this question further. No further report was received prior to the 1997 meeting.

Cooke described progress on work undertaken outside of the Steering Group to incorporate covariates into his software implementation. The work was not finished but some preliminary updated results were presented which applied this implementation to simulated datasets. Noting the preliminary status of the results, discussion was postponed until more complete results were available. Cooke stated that he would undertake to finalise this work and prepare a paper for the next Committee meeting fully documenting the results.

During the last substantive session of the meeting of the sub-committee on abundance estimation, Cooke provided its Chairman with a draft working paper containing a progress report on the work undertaken during the meeting in response to a sub-committee request to obtain comparable estimates without covariates. The sub-committee thanked Cooke for his efforts, but emphasised that it was critical that members have adequate time to review documents and that the issues being addressed in these calculations were complex. It further noted that previous discussions of this topic had required that sufficient time be made available prior to results being discussed. The Committee **agreed** that the material should be considered it at its next meeting, thereby allowing adequate time for Cooke to provide a full paper to be distributed prior to that.

TASK 3: LACK OF FIT TO THE BERNOULLI DATA IN MARGINAL DISTRIBUTIONS OF RADIAL DISTANCES

No substantive progress was made on this task during the intersessional period, however, a number of approaches that might be useful were identified: (1) undertake statistical analyses to test whether the observed lack of fit is in fact statistically significant; (2) examine the results from the simulation trials to see if a similar lack of fit exists; (3) consider an alternative formulation for the hazard probability function; and (4) use of other estimation procedures to validate the overall estimates. Results of analyses with respect to (1) were carried out during the meeting (Annex E, Appendix 4) and indicated a significant overall lack of fit. The lack of fit was mainly in the tails (small and large values of the radial distance) while the fit in mid-ranges of the radial distance was considered adequate. Possible reasons for this lack of fit are: (1) the parametric model may not be flexible enough to fully fit the data in the tails; (2) additional sources of heterogeneity existed that were not accounted for in the analyses or the ones that were included did not fully represent the factors being modelled; and (3) a large number of diagnostic tests had been conducted and in such cases of multiple testing some

significant results would be expected merely due to chance. It is difficult to determine the source of a lack of fit simply from the diagnostics. It was asserted that because of the complexity of the model and the influence of covariates it was not surprising that some lack of fit was found in some sub-components of the model. Recognising that all models are an approximation, the important issue is whether the overall estimator produces reliable abundance estimates.

CONCLUSION

The Committee noted that progress had been made intersessionally on the three questions posed last year and that some additional work had been conducted during the present meeting. Nonetheless, definitive answers had not yet been reached. The Committee **recommends** that the Steering Group continue its work intersessionally. It should take into consideration the progress made, and define and pursue a course of analyses that in its judgement would allow definitive answers to these questions to be available at the next Annual Meeting. The Committee further **recommends** that issues arising out of the working paper that Cooke had presented at the end of the sub-committee's meeting be referred to the Steering Group for its consideration. The Committee, noting that the Steering Group's work had been impeded by Cooke's absence during the previous year, noted that he intended to participate this year. The financial and Secretariat computational assistance implications are discussed under Agenda Items 18 and 19.

8.2.1.3 SIGHTING SURVEYS

SC/49/NA2 provided a cruise report of the 1996 and 1997 surveys of the Norwegian minke whale six-year abundance estimation project. Part of the area intended to be surveyed in 1996 could not be surveyed because the vessels were not given permission to enter the Russian exclusive economic zone. In 1997, the area to be surveyed was covered adequately. Observers were the same in 1996 and 1997 and they were organised into teams of two individuals as recommended by the Committee last year. The double team procedure was used throughout the cruise. One of the vessels used in 1996 was not available in 1997. However, the two used in 1997 are expected to be used in future surveys.

PROPOSED SIGHTING SURVEYS

Last year, the Committee made four recommendations and nine suggestions for possible changes in future Norwegian sighting survey methodology (IWC, 1997e, p.77). Norwegian scientists described their further consideration of these issues. They noted that they had increased emphasis on training and coordination; established constant teams; arranged for continuing use of two vessels of similar design (although these have small forward masts); randomised tracklines; improved methods for measuring whale angle (including dropping the *fisk* variable); clarified methods to accommodate varying ice edge position; and standardised on two independent platforms with all teams tracking sighted whales. They had also evaluated the possibility of increasing the area covered in each year's survey, thus allowing greater ability to repeat surveys of certain areas in multiple years, and had determined that the present design is preferable. Norwegian scientists are currently evaluating the survey block structure by evaluating observed spatial variability in historical sighting and catch data. They are also evaluating methods of testing the precision and bias sighting distance and angle estimates. To date, they have not succeeded in obtaining additional surfacing rate information. However, they have recognised the need for this additional information, especially collected in the context of the survey operations.

It was noted that the recent Norwegian surveys were being conducted by two vessels with different parts of the Eastern and Central Medium Management Areas being survey each year. Complete coverage of the area was to be obtained over a six-year period as Norway had outlined earlier. Although the coverage is being varied systematically to minimise sources of potential bias, the Committee noted that analytical questions still exist on how these multi-year surveys will be combined to produce a single estimate of abundance, with its associated variance, suitable for the RMP. Walløe indicated that Norway planned to submit documents addressing these analytical issues to the Committee at its 1999 Annual Meeting.

Noting the problems that Norway has encountered in obtaining permission to conduct the sighting survey in Russian waters and the importance of achieving the planned coverage, the Scientific Committee **strongly recommends** that the Commission requests the authorities of the Russian Federation to grant permission for survey vessels to operate in Russian waters as required.

8.2.2 Central

ICELANDIC SIGHTING SURVEY DATA

New estimates of minke whale abundance based on the NASS-95 and on the NILS-95 surveys are included in the report of the Scientific Committee of NAMMCO (1997). A re-analysis of 1987 Icelandic minke whale aerial survey data by Borchers *et al.* (1997) yielded a much larger estimate than that obtained previously. Attention was also drawn to the NAMMCO 1995 estimate of minke whale abundance in the CM *Small Area* based on NASS-95 data and the estimate in Schweder *et al.* (1997a). Each had covered only roughly half of the CM *Small Area*. Walløe suggested that the Committee use the NASS-95 data to obtain a complete estimate for the CM *Small Area*. He had received reassurances that Iceland would make the NASS-95 data available to the IWC for a limited period of time provided that: (1) a specified Icelandic researcher is involved in all analyses; (2) publication of results is subject to approval by Iceland's Marine Research Institute; and (3) appropriate acknowledgements are given, with the data referred to as Icelandic NAMMCO NASS-95 data.

The Committee expressed their appreciation to Walløe for following up on the availability of the NASS-95 data. However, there was insufficient time available to review the estimates given in NAMMCO (1997) at this meeting.

With respect to the shipboard estimate for the CM area, Borchers indicated that the results were not in a publishable state and further work was required to verify it. As regards its potential use in the RMP, it was noted that the RMP requires that the primary data be submitted to the Secretariat six months in advance of the meeting in which an estimate is considered. It was suggested that the intent of the RMP was that such data continue to be available to the Scientific Committee, for possible reconsideration and subsequent re-analyses for validation and other needs, including consideration of new methodology or area definitions. The Committee **agreed** that it would be useful to attempt to make an estimate for the entire CM area for 1995.

Attention was also drawn to the minke whale estimates of abundance for the Central Area adopted by the Scientific Committee in 1992 using the NASS-87 and NASS-89 data. Walløe stated that the relevant data have also been offered by Iceland for a limited period for reconsidering these

estimates. The Committee **agreed** that it should reconsider its earlier estimates in order to finalise the basis for the proration and to address the estimation of the variance to provide a more sound basis for implementation of the RMP, although data access issues noted below would need to be resolved. The priority for this work should be considered in light of the Committee's workload. It was noted that the Central North Atlantic estimates were also relevant to consideration of the East Greenland aboriginal fishery.

It was suggested that the minke whale aerial survey estimate and documentation be reviewed during the next Annual Meeting. However, it was noted that an estimate intended for use in the RMP required access to the primary data. Walløe indicated that his discussions with Iceland had not included the question of the availability of the aerial survey data.

A number of issues related to access of data arose in discussion of this Item. They can be separated into two areas, although they are clearly inter-related:

(1) those concerning the specific issue of the use of Icelandic data for (a) reviewing previously agreed Scientific Committee estimates and (b) reviewing estimates not previously considered by the Committee;
(2) the more general issue of data availability and the 'Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme' (IWC, 1997l).

The Committee recognised that there are more than scientific implications involved with respect to ownership and use of data collected by nations that either have left the Commission or never been members. In this context, the Secretary reminded the Committee that such data are at present not required to be submitted under the Schedule.

With respect to the Icelandic data, the Committee requested the Secretary to discuss the matter informally with the Icelandic authorities. In such discussions he should take the following factors into account.

(1) The Committee welcomed the offer of limited access to the requisite Icelandic data, recognising that these data were collected by Icelandic scientists and the surveys funded by Iceland.
(2) However, it noted that some of the specified conditions would be problematic and it was hoped that suitable agreement could be reached. These problems concerned:
    (a) specification of a limited time period for access (recent experience with the need to re-analyse survey data meant that it was important to retain the ability to re-examine the data at a later date); and
    (b) publication of the results must be subject to approval by the Marine Research Institute, Reykjavík (MRI) (although it was unclear precisely what was intended to comprise 'publication', this condition suggested the prospect that the Committee might invest considerable time and effort without being able to use the results).

In discussion of the general issue a number of points were raised.

(1) The Committee's present Guidelines (IWC, 1997l, pp.227-35), whilst specifying when data shall be provided, do not comment on how long they should be available. Most members believed that it had been intended that the data should be available with no time restrictions once they had been lodged with the Secretariat.
(2) Questions arise as to the situation where a country supplies data but subsequently leaves the Commission.
(3) Is there a case for allowing slightly more limited restrictions where data of great interest to the Committee are owned by a non-member nation?
(4) What is the Committee's policy on reviewing published estimates if the raw data are not available?

The Committee recognised that, particularly in the context of the RMP and associated guidelines, these are important issues. It reached no conclusions with respect to modifying text in its Guidelines at this meeting. It **draws the Commission's attention** to this general issue and agreed this should be examined fully at next year's meeting, when the results of the Secretary's discussions with the Icelandic authorities will also be known.

The question of data availability and requirements with respect to estimates of abundance to be used in the context of aboriginal subsistence whaling was also raised. It was agreed that this should be discussed during the AWMP development process.

8.3 Southern Hemisphere minke whales

8.3.1 Implementation Simulation Trials

This Item had been included on the Agenda at the request of Japan. In previous years (IWC, 1997e, pp.70-1; IWC, 1996a, p.25) there had been some discussion in the Commission as to whether this topic should be addressed given the adoption of the Southern Ocean Sanctuary. However, no clear instruction had been given.

Hatanaka reiterated Japan's views that: (1) it had objected to the Sanctuary; (2) discussion of this topic might also provide useful advice when the Sanctuary decision is due to be reviewed; and (3) that he interpreted the lack of Commission advice to indicate that the topic should remain.

The Committee **draws the Commission's attention** to the fact that it has agreed to retain the Item on its Agenda but not enter into substantive discussions on it until advised to do so by the Commission.

8.3.2 Abundance estimates

SC/49/SH8 described analyses of the 1995/6 IWC sighting survey. The survey was conducted using two vessels in Area VI, and covered the region from 170°W-140°W, north from the ice edge to 60°S. Abundance estimates by stratum were given, totalling 38,000 whales. An error in interpretation of ice edge data was detected subsequent to the preparation of the paper. Correction for this would increase the abundance estimates by approximately 1,000 whales and Borchers plans to provide a revised estimate to next year's meeting. This was the third sighting survey under IDCR/SOWER in Area VI. Previous surveys covered a greater longitudinal range, making comparisons in abundance over time difficult. In particular, the 120°W-140°W sector that included 70% of the total 1990/91 abundance estimate was not surveyed in 1995/96.

The inclusion of sightings identified as 'like-minke' increased the estimates from IO and closing mode data by 15% and 17%, respectively. This is a greater increase than seen prior to 1990/91 and there is a need to investigate the extent and causes of this apparent increase. This issue was one of the ten analysis needs identified for the Southern Hemisphere minke whale abundance estimates during last year's meeting (IWC, 1997g, p.152).

8.4 Western North Pacific Bryde's whales

The Committee had completed the Comprehensive Assessment of North Pacific Bryde's Whales at its 1996 meeting and had recommended development of RMP *Implementation Simulation Trials* for the western Pacific stock. The Commission had accepted this recommendation (IWC, 1997a, p.32).

In order to implement the RMP for the western North Pacific stock of Bryde's whales it is necessary for the Committee to ensure that the RMP is robust to the uncertainties for this specific case, and then to specify the sequence of catches and abundance estimates to be used for any *Catch Limit Calculations*.

Stock identity

Last year it was noted that

> there remains concern about the validity of the geographical boundaries for this stock, and the sub-committee recommended that sensitivity trials using various positions of the stock boundaries, especially to the south, be carried out during RMP Implementation Simulation Trials. (IWC, 1997i, p.166).

The Committee considered the question of whether it could be assumed that at most one stock of Bryde's whales fell within the boundaries specified for this stock by the Comprehensive Assessment (IWC, 1996f, p.157; Annex D, fig. 2) or whether an alternative boundary could be specified for which this assumption would be reasonable. If the single-stock assumption could be made and the other uncertainties (e.g. those concerning the historical levels of unreported catches) were within the limits of the robustness trials considered for the RMP, some members argued that it would not be necessary to specify *Implementation Simulation Trials* for this case, as the trials already conducted for the *CLA* would have served this purpose.

The Committee noted that the proposed stock boundary incorporated both feeding and breeding grounds and that the trials for the RMP were

> largely based on simulated management of baleen whales with breeding grounds in lower latitudes and feeding grounds in higher latitudes (IWC, 1994d, p.148).

It also noted that

> while it is believed that the framework for calculation of catch limits specified here [in Annex H of IWC (1994a)] will be sufficiently flexible for species in *Regions* not directly matching the conditions simulated so far, this needs to be affirmed by the additional simulation trials required before implementation of the RMP in such cases (IWC, 1994d, p.148).

The Committee considered the new information presented to the meeting. Details of the papers presented (SC/49/NP5 and NP6) and the authors' conclusions are given in Annex D.

The Committee considered the question of whether the available information supported the current boundaries (Annex D, fig. 2) or the slightly differing alternative suggested in SC/49/NP3 (Annex D, fig. 3). The modifications of the latter were intended to deliberately exclude whales local to Taiwan, the Philippines, New Guinea and Kochi (Annex D, fig. 3). It was noted that local forms of Bryde's whales appear to be associated with island groups and that the proposed boundaries currently encompass several other such groups (e.g. the Hawaiian Islands). The suggestion was made that a *Small Area* to be defined for the RMP implementation purposes might be chosen to exclude all such areas. However, it was noted that it seemed unlikely that all the island groups would be able to support separate local populations, as witnessed in SC/49/NP6 which found that the whales from the Ogasawara Islands are not genetically different from those in the central western North Pacific.

Another point raised was that the analyses of SC/49/NP5 consider samples from a relatively small fraction of the total area within the boundary and collected over different years. SC/49/NP6 had analysed biopsy samples from several other parts of the area, but not in the same way. It was agreed that a combined analysis would be useful.

The Committee noted that none of the data presented to the meeting could refute the single stock hypothesis in Annex D, fig. 3. It agreed, however, that this was not the only plausible stock structure hypothesis, especially given the small number of samples in the southern part of the proposed stock area. The Committee noted that last year it had not specified the range of plausible hypotheses (particularly those related to stock identity). The issue of collecting further data was raised but the Committee agreed that it is currently difficult to specify exactly which genetic data to collect.

Some members felt that the Committee was in a position to move forward towards the specification of *Implementation Simulation Trials*. Other members felt, however, that further data analysis and collection were needed before plausible alternatives to the single stock hypothesis could be specified. Yet other members felt that the construction of *Implementation Simulation Trials* would lead to a better understanding of which data might need to be collected.

Uncertainty regarding historical catches

Last year two alternative series of historical catches were used in HITTER analyses (IWC, 1997i, p.168). These reflected two views: one that the official catch data were accurate; and another that unreported Soviet catches may have occurred. Further arguments to support these views were presented (Annex D, Appendices 6 and 7). The Committee encouraged scientists from the Russian Federation to investigate this issue. It also agreed that these different views would need to be considered when specifying *Implementation Simulation Trials*.

Abundance estimates

SC/49/NP15 described two Bryde's whale sighting surveys conducted primarily in August and September 1996. Roughly 2,000 n.miles were surveyed aboard each vessel, working in closing mode at roughly 12 knots. Coverage was from 120°E-140°E and 0°-25°N. Primary sightings were made of 22 and 6 schools of Bryde's whales in the two surveys, respectively. These surveys were designed to be used in the RMP, and the data are planned to be lodged with the IWC Secretariat.

SC/49/NP4 presents abundance estimates updated from SC/48/NP17 for Bryde's whales in the western North Pacific derived from 27 line transect sighting surveys conducted between 1988 and 1996 (including the two surveys described in SC/49/NP15) and incorporating two suggestions from last year (IWC, 1997i, p.164). The data from all years, vessels and areas were pooled to estimate an effective strip half width of 1.124 n.miles to derive this common estimate, combined with sighting and effort data aggregated across years. Population abundance estimates were derived for each 5° square. Squares with no effort or no sightings were assumed to have zero abundance. The sum of the estimates of abundance for all 5° squares was 21,901 (CV = 0.188) which was somewhat less than estimated previously (SC/48/NP17).

A number of difficulties were identified with the analyses (see Annex E) and the Committee noted the need for more detailed exploratory analyses and presentation of the basic survey data (e.g. by vessel, sub-area and time periods). Given these concerns, the Committee **agreed** that the estimates in SC/49/NP4 would not be appropriate for implementation of the RMP. Further analyses taking account of the heterogeneity among surveys and the spatial and temporal pattern of the surveys are required, as well as an estimate of the actual sampling variance that takes into account covariances across areas and surveys. However, the Committee did **agree** that the estimates would be adequate for use in *Implementation Simulation Trials* since these trials are designed to evaluate the robustness of the RMP to uncertainties (including estimates of abundance) in a specific proposed implementation. As such, they only require approximate estimates of abundance.

The Committee noted that the analyses required to derive acceptable estimates for implementation of the RMP from the survey data in SC/49/NP4 may not be standard because of the non-representative sampling design and large amounts of heterogeneity. To avoid the possibility of prolonged iteration of analyses and review in successive meetings, the Committee established an intersessional Working Group convened by Smith to facilitate the development of an acceptable estimate. This can be seen as part of the Committee's oversight role (see Section 7.1.2). The RMS Survey Guidelines (IWC, 1997l) define operational procedures for development of abundance estimates, including specific timing requirements for the submission of data to the Secretariat. The Committee **recommends** that these requirements be met.

Future work

It was agreed that if progress is to be made, it was important to specify work that should be carried out to facilitate the specification of *Implementation Simulation Trials* at the next meeting.

An *ad-hoc* Working Group on preparation for the specification of *Implementation Simulation Trials* for western North Pacific Bryde's whales was established under Hammond. Its report is given in Annex R. The Committee **recommends** that the seven tasks relating to stock structure identified in Annex R be conducted. It also **recommends** that a summary of the available information about the spatio-temporal nature of feeding and breeding be produced. Resulting documentation of all these tasks is expected to be presented at next year's meeting. The Committee established an intersessional e-mail group (Convenor - Punt, members as in Annex P) to facilitate these tasks and to encourage circulation of material before next year's meeting.

The Committee agreed that adequate time should be scheduled for discussion of this topic at next year's meeting. A two day meeting prior to the main Committee meeting was preferable but, if this was impractical, time would be made available during the main meeting.

The Committee agreed that Bryde's whales should be added to the list of priority species (currently comprising blue, humpback and right whales) for the SOWER blue whale cruise (Annex H).

Proposed surveys

SC/49/NP16 described proposed surveys in the North Pacific in 1998/99 aimed at providing abundance estimates for Bryde's whales for potential use in implementing the RMP. In response to concerns raised in Annex E, a preliminary revised plan was developed which includes conducting a more spatially comprehensive survey using three ships operating in closing mode using the usual basic survey methodology. A tentative four year plan to cover the region from 120°E-150°W and from 2°S-45°N was described in which the first year would cover up to 150°E, and subsequent years would survey more eastern blocks of 20° longitude width.

The Committee suggested that further consideration be given to the deployment of the three vessels and the resulting spatial distribution of the survey coverage, particularly to avoid the potential for time bias. Appropriate survey design is extremely important for interpretation of the entire series of earlier and proposed survey data. The possibility of using independent observer mode for Bryde's whales should also be considered. Given uncertainties in stock structure, biopsying of animals closed with should be considered over the whole period. The Committee looked forward to reviewing more detailed survey plans at its next meeting. Substantially more detailed information is required under the RMS Survey Guidelines (IWC, 1997l) including details of field protocols, survey design and proposed methods of analysis.

The Committee **strongly recommends** that the surveys are conducted in the relevant exclusive economic zones (EEZs) in order to ensure the necessary coverage of the stocks. Therefore, the Committee **recommends** that the Commission requests the relevant authorities of the Russian Federation, the Republic of the Philippines, the Republic of Indonesia, the Federated States of Micronesia and the Republic of the Marshall Islands to grant permission for the survey vessels to operate in their EEZs.

9. COMPREHENSIVE ASSESSMENT - SOUTHERN HEMISPHERE HUMPBACK WHALES (SEE ALSO ANNEX G)

9.1 Progress on short-term assessment work

9.1.1 Catch and marking data coding

Allison reported that catch data from South Georgia from the 1913/14 season up to about 1922 had been coded but not validated. No new information on catches from the *Olympic Challenger* or Soviet whaling fleets had been provided. Marking and recovery data from the Discovery scheme had been entered and validated as far back as the 1940s, and it was planned to continue coding these data as far back as the 1930s (when the scheme started). For the Soviet marking scheme, only data on recoveries had been provided so far.

The Committee **recommends** that the acquisition and entry of revised Soviet catch data should be given top priority for the coding and validation of data before the next Scientific Committee meeting. If no such data are available, then priority should be given to completing coding and validation of the Discovery marking data, and lesser priority given to the continuing entry of the South Georgia catch data.

In the meantime, sources of new or revised catch or marking data should be sought. In particular, it is **recommended** that the Secretariat should enquire about the availability of the original marking data for the Soviet marking scheme.

9.1.2 Biopsy sampling

A table of existing tissue samples from Southern Hemisphere humpback whales is given in Annex G. It indicates total holdings of some 816 samples, of which 135 are from higher latitudes.

9.1.3 Photo-identification

9.1.3.1 ESTABLISHMENT OF A CENTRALISED SOUTHERN HEMISPHERE HUMPBACK WHALE DIRECTORY

Annex G, table 2 provides a listing of available photo-identification material for Southern Hemisphere humpback whales. Photographs of a total of 3,413 humpback whales are believed to be available, most of which are represented by fluke photographs. The Committee recognised the value of this information in terms of coordinating research workers and documenting the existence and growth of catalogues. It **recommends** that the IWC Secretariat create and maintain a centralised directory of Southern Hemisphere humpback whale catalogues. The Revised Guidelines for Progress Reports (Annex S) will facilitate this task.

9.1.3.2 ESTABLISHMENT OF A CENTRALISED ANTARCTIC HUMPBACK WHALE CATALOGUE

Following last year's recommendation that a centralised Antarctic catalogue should be established, and that an individual should be appointed and funded to investigate various aspects of its feasibility, Carlson reported that the most extensive holding of Antarctic photographs was at the College of the Atlantic (Bar Harbor, Maine, USA), where some 160 flukes were represented, mostly from the Antarctic Peninsula region. The College had expressed a willingness to consider giving copies of its holdings to a centralised catalogue, but wished to maintain and augment its own Antarctic catalogue.

The Committee discussed the desirability of committing time and resources to creating an independent Antarctic catalogue, recognising (a) that most usable photographs were now held in one location already, (b) the acquisition rate of photographs (especially fluke photographs) from any Area except possibly the Antarctic Peninsula was low, and (c) the size of the current holdings is probably inadequate to provide the required information on stock mixing (except for Areas IV/V). The Committee therefore **recommends** that the Commission does not proceed to put the Antarctic catalogue out to contract at this stage, but that Carlson be nominated and funded (as last year) to: (a) assess and collate the JARPA material; (b) approach participants in past IDCR cruises for personal photographs of Antarctic humpback whales; and (c) discuss with the College of the Atlantic whether it would consider, if asked, the possibility of its taking responsibility for a comprehensive Antarctic catalogue, and augmenting this with catalogues of lateral markings/dorsal fins. Carlson will report back to the Committee at next year's meeting.

9.1.3.3 OTHER MATTERS

The Committee discussed the relative usefulness of photo-identification and genetic studies for the Comprehensive Assessment of southern humpback whales. Data gathered as part of YoNAH had shown the overall merits of a genetic approach to estimating abundance (Palsbøll *et al.*, 1997a). Genetic markers can be used for virtually all the analyses that are carried out using photo-identification, with the added advantage of being able to stratify data by sex. For southern humpback whales it was felt that more could be achieved in studying population separation and linkage with the present sample size and accumulation rate of biopsies than with the existing sample size and accumulation rate of photographs.

The Committee agreed that restrictions on the biopsying of cow-calf pairs could not be considered scientifically justified. For humpback whales, the reactions of cows and calves to the biopsy dart are the same or less than for any other class of whale, while their responses to the boat are no greater than in the case of photo-identification (e.g. Sanpera and Jover, 1989; Brown *et al.*, 1994).

9.2 Progress in long-term assessment work

9.2.1 Stock identity

Historically, Southern Hemisphere humpback whales were divided into five groups, mainly on the basis of discontinuities in catches and sightings in the Antarctic (see review in Donovan, 1991): Group I: 70-80°W; Group II: 10-35°W (ill-defined); Group III: 10-40°E; Group IV: 80-100°E; and Group V: 150-180°E. Links with breeding grounds to the north of each feeding ground were demonstrated or assumed for Group III with Madagascar, Group IV with Western Australia and Group V with both Eastern Australia and New Zealand. Other links were speculative. Most data on the degree of stock mixing existed for Groups IV and V. There was relatively little interchange between the two Groups, either on the feeding or breeding grounds; 96% of whales marked in Area IV and 87% of whales marked in Area V, for instance, were recaptured in the same Area. The boundary between the two Groups in the Antarctic could shift seasonally within one whaling season, and might vary from season to season.

Recognising that the purpose of determining the boundaries of feeding populations was to attempt to allocate summer catches to specific breeding populations, the sub-committee (Annex G) had examined (a) the positions of all humpback whale sightings made on IDCR cruises between 1978/79 and 1995/96, and (b) plots of 9,418 humpback whale catches made by all four Soviet fleets. Realising that whereas the IDCR data were associated with known and evenly distributed effort by longitude (at least south of 60°S), the Soviet data were only a relatively small subset of a larger dataset, and the associated distribution of effort was unknown, the following features were noted:

(a) the discontinuity between Areas IV and V was clear in both IDCR and catch datasets, centred at around 130°E;
(b) relatively large numbers of humpbacks were present throughout Area VI in both datasets;
(c) little sign of a discontinuity appeared between Areas V and VI, or (except possibly in Annex G, Appendix 3) between Areas VI and I;
(d) a lack of catches in the vicinity of the Antarctic Peninsula was not apparent in the sightings data;
(e) the historic concentration of catches in the centre of Area III (Mackintosh, 1942) was not apparent;
(f) the catch data indicated a concentration relatively far north on the border between Areas II and III.

Items (d) and (e) might be the consequence of missing catch data, as the sightings did not show the same features. Item (b) might partly represent the summer feeding ground of whales from a previously unrecognised breeding area in the central South Pacific, possibly diffusely scattered amongst island groups. Conversely, the presence of a previously undescribed concentration of humpback whales on the border between Areas II and III could represent the summer feeding ground of whales that overwintered off Angola and Gabon: these had previously been (tentatively) linked with a feeding ground in the Eastern Scotia Sea. The lack of clearly

defined discontinuities between Areas V, VI and I was partly supported by the genetic data (see below). The Committee expressed its appreciation to Russian and Ukrainian scientists for their efforts in compiling the catch data, and to Brown and Allison for providing extractions of sightings and catches.

The Committee considered two papers on the genetic evidence for stock separation. In SC/49/SH12, the authors analysed the mtDNA control region sequences of 69 humpback whales from Antarctic Areas IV, V, VI and I, and (for contrast) 95 from the western North Atlantic. A total of 56 haplotypes was recognised. As might be expected, a significant degree of heterogeneity was found between the western North Atlantic and all other regions. Within the Antarctic, only Area IV was significantly different from other Areas, supporting the historical division between Areas IV and V. No significant difference could be found between Areas I, V, and VI, possibly as a consequence of low power due to small sample sizes, or restricted geographical coverage.

In SC/49/SH26, samples from 152 humpback whales (including those from SC/49/SH12) from seven Southern Hemisphere localities were analysed, representing three feeding grounds in the Antarctic (Areas IV, V and VI) and four winter breeding grounds (Western Australia, Eastern Australia, Tonga and Colombia). The samples were not sequenced in the same laboratories and the portions of the mtDNA control region that had been sequenced were not completely overlapping. Consequently the level of genetic resolution possible was decreased and the results are likely to underestimate the degree of divergence between regions in the Southern Hemisphere. A total of 55 unique haplotypes was identified. In general, samples from the Antarctic feeding grounds were less discrete genetically than the samples from the wintering grounds. Although some degree of heterogeneity was found within Group IV, both Western Australia and Area IV were consistently different from most Group V and VI regions to the east. Area VI did not differ significantly from most of the other localities and there was some evidence that the Colombian wintering grounds were not closely linked to the three Antarctic Areas. This was consistent with photographic evidence linking humpback whales off Colombia with Area I.

In discussion, it was noted that a low sampling intensity, when combined with the high genetic diversity recorded in this and the preceding paper, could give rise to Type I errors, i.e. recognising a difference between sampling areas where one did not exist in fact. This might explain the apparent difference between Western Australia and Area IV found in this paper. Another possibility is that the results reflect within-season and between-season variability. A recent (unpublished) match between a whale photographed in Tonga with one in east Australia, and earlier published records of marked whales linking Tonga with both Area V and Area I, indicated how widely animals from one breeding ground might disperse in summer.

In considering future genetic analyses, the Committee **recommends** that samples should be collected from three main strata: the breeding ground; the feeding ground; and the intervening migratory corridor. As a first approximation, for each putative stock a total of 40-60 samples per stratum was suggested, spread out over time and space to the greatest extent possible. Requirements for further sampling will be evaluated using power analysis, dependent upon the level of stock distinction required. Since they are less distinct, feeding grounds should be sampled more intensively than breeding grounds.

9.2.2 Historical catch and other data

SC/49/SH36 reviewed historical catches at whaling grounds in the southwest Atlantic, including South Georgia. Between 1904/05 and 1929/30, a total of 39,599 humpback whales is estimated to have been taken, of which some 33,000 were killed in the first ten years, producing rapid depletion. An almost simultaneous decline in catches off the west coast of Africa (where some 19,000 humpback whales were taken in the first six years of whaling) has been posed as circumstantial evidence of stock linkage with animals in the southwest Atlantic.

The paper also referred to a longstanding open-boat shore-based fishery in Brazil that pre-dated modern whaling, with annual catches reaching 300 whales in some cases, some of which were humpback whales.

9.2.3 Abundance estimates and trends

9.2.3.1 SHORE-BASED SURVEYS

New evidence from strandings, sightings and fishery interactions indicate that humpback whales use the coast of southeastern Brazil as a migratory route (SC/49/SH21).

Shore-based surveys undertaken between 1988 and 1991 of the northern and southern migrations of humpback whales at Cape Vidal on the east coast of South Africa (SC/49/SH32) showed that of the migration characteristics, only the offshore distribution differed between the two migrations, whales being sighted further offshore on the southern migration. Daily densities of northward-migrating whales showed periodic waves, with a significant periodicity at 10.2 day intervals; these were less apparent on the southern migration. Biopsy sampling throughout the northern migration might reveal whether the waves were composed of animals of different sex.

A shore-based survey of the northern migration of humpback whales from Point Lookout on the east coast of Australia was held between May and August 1996 (SC/49/SH35). After adjusting for whales missed outside the watch period and for those missed during watch periods, the authors estimated that about 2,900 (CV 0.06) whales passed during 1996. They provided an estimated annual rate of increase of 12.3% (CV 0.068) over the period 1981-1996. On their next survey the authors intend to test the assumption of no difference between migration speeds at night and during the day.

A second shore-based survey on the east coast of Australia had been carried out between June and August 1996, in which 655 humpback whales had been seen in 425.5 hours of observation (SC/49/ProgRep Australia). This encounter rate, when compared with those of previous such surveys, indicated an annual rate of increase of 11.2 ± 1.2% per year from 1984.

A survey planned for Western Australia this year had not occurred because of a lack of funds, although it was hoped that the survey would now take place in 1998. The last coastal survey of this population had been in 1994.

The Committee welcomed the reports of the results of these surveys and noted the estimates. It was suggested that the authors of SC/49/SH35 should consider ways of estimating the actual variance of the estimates. It **recommends** that monitoring of the abundance of Southern Hemisphere humpback populations should continue or be initiated where no survey programme exists.

9.2.3.2 ANTARCTIC SURVEYS

During the JARPA programme, line transect estimates of population size indicated significant rates of increase for humpback whales in Area IV from 1989/90-1995/96, and for

Area V from 1990/91-1994/95 (SC/49/SH13). The most recent estimates of abundance were 8,415 (CV 0.327) for Area IV and 4,143 (CV 0.158) for Area V.

It was noted that the relative size of the estimates for the two Areas (~2:1 in favour of Area IV) was similar to the ratio expected from a comparison of coastal survey estimates from the west and east coasts of Australia. The Antarctic estimates were both higher than equivalent coastal estimates, which is what might be expected if there was significant absenteeism from the migration to the breeding grounds, as has been postulated by some.

Sightings of 84 groups of 158 humpback whales were made during a krill hydroacoustic and oceanographic survey between 80° and 150°E on the RV *Aurora Australis* from January to March 1996 (SC/49/SH5). The Committee looks forward to receiving an abundance estimate from this survey next year.

In November/December 1996, a cetacean sighting survey on the RV *Polarstern* was carried out as part of a dedicated krill, fish and oceanography survey in the South Shetland Islands region of Area II, a poorly surveyed but historically important feeding ground for southern humpback whales (SC/49/SH16). Of the shipboard observations, only 68 could be identified to species level, of which 10 were humpback whales: all 74 of the aerial sightings could be positively identified, of which 8 were humpback whales. The importance of collecting individual identification photographs and (especially) biopsy samples in a future cruise to the region was stressed.

Estimates of abundance from the second circumpolar set of IDCR cruises (1985/86-1994/95) were presented to the meeting, calculated using the IWC's DESS package (SC/49/SH33). For about 80% coverage of the waters south of 60°S, a total estimate of 13,921 humpback whales (CV 0.28) was obtained. The authors considered this to be a very preliminary estimate for a number of reasons (see Annex G).

The Committee agreed that such an analysis is very important, as it represents the only source of abundance information for some populations of southern humpback whales. Attention was drawn to the substantial estimate for Area VI, where previously humpback whale abundance had been assumed to be low. The Committee **recommends**: (i) that future work on these data should include a re-analysis of the data from the earlier set of circumpolar cruises; and (ii) an extrapolation north of 60°S using JSV data (or transit legs of IDCR) for all circumpolar estimates; incorporation of the JARPA survey data should be considered.

Three sets of sightings data for large whales in the vicinity of South Georgia in the southwest Atlantic indicated an apparent lack of evidence for any recovery of large whales in this region. Humpback whales now appear to be relatively more common around the Antarctic Peninsula than at South Georgia (SC/49/SH38).

The Committee expressed concern at the apparent rarity of humpback whales at South Georgia, given that this was a highly important whaling ground for the species at the start of this century. The comment was made that this may reflect the virtual extirpation of the feeding stock in this area, fidelity to which may have been maternally directed. If so, the South Georgia region may not be easily repopulated by whales from other areas. The Committee **recommends** that in future any such expeditions should include humpback whales as targets for biopsy and photo-identification.

9.2.3.3 OTHER SURVEYS

Two alternative estimates of abundance for humpback whales at the Abrolhos Banks, Brazil, were submitted based on resightings of photo-identified animals. A Petersen mark-recapture approach produced estimates of abundance of 1,556 (95% C.I. 815-3,260) for 1989/94-95 and 1,100 (95% C.I. 553-2,350) for 1995-1996 (SC/49/SH31). A Bayesian approach (SC/49/SH29) produced a mean estimate for 1995 of 1,634 whales (95% C.I. 1,379-1,887).

The Committee welcomed these alternative approaches to estimating population size, but expressed some concern over: (1) the relatively small number of recoveries; (2) the failure of the Petersen estimator to take hetereogeneity of capture probabilities into account; and (3) the way differing residence times for different sexes, ages and reproductive classes on the breeding grounds had been modelled. Information now available from the results of the YoNAH programme on population structure and segregation on the North Atlantic breeding grounds, may be useful (Clapham, pers. comm).

A recent increase in incidental sightings of humpback whales in New Zealand waters (SC/49/SH42) was reported. The Committee welcomed this report from a historically important migratory route.

9.3 Work required to complete the assessment

9.3.1 Stock divisions, including work allocated last year

Last year, the Committee had considered that eight tasks were needed to complete a Comprehensive Assessment of Southern Hemisphere humpbacks (IWC, 1997g, p.136). Responses to five of these tasks had been received as follows:

(1) *Review of publications by Omura and Mackintosh* (SC/49/SH40).
(2) *Sub-divisions of Soviet and other catch data* (Annex G).
(3) *Summary of existing genetic information* (SC/49/SH12 and SH26).
(6) *Review of early catch data, especially Area II* (SC/49/SH39).
(8) *Obtain YoNAH and North Pacific results as analogy* (Palsbøll *et al.*, 1997a; Baker *et al.*, In review).

Of the remaining tasks, only for (5) had no work been done (*Analysis of existing photo-identification data*).

For item (4) *Review of all marking data,* a review of published analyses of Area IV-V intermixing had been received (SC/49/SH39). During the meeting Allison provided a summary of marking data currently available to the Secretariat, showing feeding/breeding ground linkages for Areas other than IV and V. Mikhalev told the meeting that he had been unable to locate original marking data for the Soviet scheme, but was currently preparing revised mark recovery data for the *Slava* and *Sovietskaya Ukraina.*

For item (7) *Review of distribution data from IDCR, JARPA and JSV,* papers on the first two datasets had been received (SC/49/SH13 and Appendix 2). JSV data were now at the Secretariat. As noted above (Item 9.2.3.2), these data should be used in analyses with IDCR abundance estimates.

To aid in planning, a small Working Group under Bannister was established to construct their best idea of putative breeding grounds, feeding grounds and migratory linkages for southern humpback whales (IWC, 1996d, fig.1, p.70); they also included biologically plausible alternatives. Their report is included as Appendix 4 of Annex G.

Based on the catch positions of previous Soviet Antarctic catches, mark-recovery information from the International Marking Scheme, and the distribution of sightings on IDCR cruises, seven concentration areas (= feeding grounds) were

recognised in the Antarctic, and seven corresponding breeding grounds in lower latitudes. These were specified as follows:

Group A: 70°W - 20°W: linked to Brazil
[mainly in old Area II, 60°W-0°]
Group B: 20°W - 10°E: linked to Angola/Gabon
[the border areas between old Area II and III]
Group C: 10°E - 60°E: linked to Mozambique/ Comores/Madagascar
[mainly in old Area III, 0°-70°E]
Group D: 60°E - 120°E: linked to Western Australia
[mainly in old Area IV, 70°E-130°E]
Group E: 120°E - 170°W: linked to Eastern Australia/ Tonga/New Zealand
[mainly in old Area V, 130°E-170°W]
Group F: 170°W - 120°W: linked to Oceania
[old Area VI, 170°W-120°W]
Group G: 120°W - 70°W: linked to Colombia
[mainly old Area I, 120°W-60°W].

The Committee agreed to three tentative alternative models for allocating catches in high latitudes to these breeding stocks. A 'naive' model assumed that whales from each breeding ground migrated to a specific feeding ground and that these did not overlap. A 'fringe' model assumed that whales from each breeding ground migrated to a 'core' feeding ground, but that whales between the core areas could be equally from stocks on either side. An 'overlap' model assumed that most (80%) of whales from a breeding ground went to their specific feeding ground, but that some (10% in each case) moved to adjacent feeding grounds on either side.

The Committee noted that the use of genetics might help in establishing the degree of mixing of breeding stocks on feeding grounds, especially where marking data are not available, but such an analysis would be complicated if there were shifts in the location of the feeding grounds from year to year.

9.3.2 Catch history, including revised Soviet information

Borodin wished the following statement to be placed in the report

> Last year (IWC, 1997e, pp. 82, 137-8) the Russian delegation made a statement about the necessity for independent experts with primary information of the Southern Hemisphere (vessel logbooks, scientific reports, etc) to present these materials on a national level so that they may undergo an expert review. This was not done. This year we repeat our statement and the need for this statement to be included in the CA/SHH reports.

The Committee reiterated its statement from last year (IWC, 1997e, p.81), that the main obstacle to furthering the progress was the lack of an agreed catch series. It welcomed Mikhalev's statement that attempts were being made to obtain accurate positional data for past Soviet catches: this was urgently needed if catches on the feeding grounds were to be efficiently allocated to breeding grounds.

The Committee **recommends** that revised catch data from the *Olympic Challenger* be included in the IWC database as soon as possible.

Dawbin (1997) refers to original catch data available for South Georgia from 1910-1915 at the Natural History Museum, London. This was a period of significant humpback whale catches, for some of which the Secretariat did not have individual catch data at this time, and should attempt to obtain.

The historical shore-based fishery on the coast of Brazil could have made substantial catches of humpback whales annually throughout the nineteenth century. This might be an important gap in the catch history of Area II humpback whales, and the Committee **encourages** Pinedo to consult relevant Brazilian sources to extract any information on the catch and effort in the fishery, and submit it to next year's meeting.

The Committee discussed the possible use of indices of relative abundance. It was agreed that these might be useful as independent evidence of population trends, for comparison with any model-derived population trajectories. The most useful data would probably result from low latitude operations where humpback whales were a major target species and where stock identity would be less problematic. The Committee concluded that a review of existing indices of relative abundance (CPUE and sightings) for southern humpback whales should be undertaken and new indices developed where necessary. Discussions at the CPUE Workshop held in 1987 (IWC, 1989a) should be taken into account.

9.3.3 Biological parameters, including independent information on reproductive and survival rates

The Committee was unaware of any independently-derived estimates of biological parameters that could confirm the plausibility of the currently observed increase rates. Several photo-identification programmes in low latitudes, such as those off Brazil, Western Australia and Colombia, had the potential to produce estimates of calving interval, age at first parturition and survival rate, but given the low resighting rates on breeding grounds, this may be very difficult. The Committee **recommends** that researchers in these programmes should evaluate the likelihood of their obtaining these estimates, and report back to the Scientific Committee.

In the absence of current estimates of demographic parameters, the Comprehensive Assessment could either use historical data from whaling operations, or current data from other humpback populations, i.e. the North Atlantic or North Pacific. Neither option was ideal, as problems with sampling bias had been identified for demographic parameter estimates derived from both whaling and photo-identification data. In addition, population growth rate (and status) of humpback whales in the North Atlantic appeared to be substantially different from the rates of increase (and probably status) estimated for some southern humpback populations. While the situation in the North Pacific was less clear, it seemed more like that in the North Atlantic.

The Committee **recommends** that the subject of the currently observed increase rates of southern humpback whales should be considered next year in conjunction with a review of demographic parameters for southern humpback whales and a comparison with the population growth rates and demographic parameters estimated for North Atlantic (and North Pacific) populations.

9.4 Recommendations on future action, including possible future special meeting

The Committee concluded that it was impossible to undertake a Comprehensive Assessment of any southern humpback whale stock until an agreed catch history was available. In this connection the acquisition of detailed Soviet catch data was of utmost importance. The Committee **recommends** that Mikhalev submit a progress report on the retrieval of these data at the next meeting.

It also **recommends** that the Secretariat: (1) investigates the availability of original individual catch data for the *Olympic Challenger*, and that the catch from this expedition

should be removed from the database where it was known to be false, and retained or added where catches could be confirmed; and (2) contacts authorities at the Natural History Museum regarding the availability of catch data for South Georgia from 1910-1913.

In the absence of appropriate catch series, the next priority is to improve knowledge of stock identity and mixing. A substantial number of biopsy samples exist (Annex G, Table 2), some of which have yet to be processed. Their analysis could assist greatly in clarifying the numbers of breeding stocks and their possible distribution on feeding grounds. The Committee therefore **recommends** that all existing tissue samples from southern humpback whales be analysed as soon as possible. It encourages Baker, Pastene and Rosenbaum (and any other people intending to analyse such samples) to coordinate their efforts so that comparable (and the most efficient) methods are used.

Recognising the major problem of the accurate allocation of high latitude catches to low latitude breeding grounds, and that greater sampling is required to address this problem, the Committee **recommends** that biopsy sampling of humpback whales should be encouraged, particularly in high latitudes (and especially between 70°W and 60°E, the feeding grounds for Groups A-C) and in lower latitudes of the South Atlantic and central South Pacific (the breeding grounds for Groups B and F).

The Committee **recommends** that a review of existing indices of relative abundance for southern humpback whales should be undertaken and new indices developed where necessary. Findlay undertook to do this.

At this stage the Committee felt it premature to consider holding a special meeting (as had been suggested last year). It will review progress next year.

10. COMPREHENSIVE ASSESSMENT - OTHER GREAT WHALES

The Committee considered species/stocks under this Agenda Item to identify available and needed information and to prioritise future Comprehensive Assessments.

10.1 Southern Hemisphere blue whales

SC/49/SH43 reported on the 1996/97 blue whale cruise, the second to be undertaken as part of the IWC's research programme on Southern Hemisphere blue whales, and the first to take place under the new Southern Ocean Whale and Ecosystem Research Programme (SOWER). As in the first cruise, its principal objective was to investigate development of a reliable shipboard method to distinguish between 'true' blue whales and pygmy blue whales. The research area south of Madagascar was chosen as one where many blue whales had in the past been sighted by Japanese scouting vessels and caught by Soviet whalers. The following techniques were to be used: acoustics; biopsy sampling; photography (still and video); and photogrammetry. Dive time and other respiratory data were also collected.

There were 95 sightings of 110 probable[1] pygmy blue whales; no probable[1] 'true' blue whales were seen. During 263 hours of acoustic monitoring, most occurring near sightings of probable pygmy blue whales, sounds attributable to them were heard on only four occasions and recorded at only 2 of 97 acoustic stations (SC/49/SH17). Biopsy sampling proved difficult, with nine samples obtained from pygmy blue whales using various techniques. Videotaping (496mins) and photography (65mins) of pygmy blue whales proved more successful, although photogrammetry was not possible because the whales rarely fluked up. Dive time experiments and oceanographic stations were carried out successfully.

The Committee expressed its appreciation to the Government of Japan for providing the vessels and logistical support, and to Best for his leadership of the cruise. It was noted that results from analyses of the videos collected on the cruise will be presented at next year's meeting and that recommendations from the cruise report will be incorporated in the 1997/98 blue whale cruise off Chile. Data from the first part of the cruise might be used to estimate abundance in waters south of Madagascar, although the searching strategy had not been aimed specifically at estimating abundance.

SC/49/SH17 reported acoustic results from the cruise. The authors noted that the sounds attributed to pygmy blue whales were distinctly different from blue whale sounds recorded in the Antarctic or elsewhere. They believed that they allowed discrimination between 'true' blue whales recorded subsequently on the Antarctic SOWER cruise and pygmy blue whales south of Madagascar.

In discussion it was noted that, as in the first blue whale cruise south of Australia, the small percentage of time when blue whale sounds were detected limited the utility of acoustic research techniques for this species. It was also unclear whether the differences in blue whale sounds cited by SC/49/SH17 reflected species, regional or seasonal differences.

SC/49/O 2 responded to the Committee's comment (IWC, 1997e, p.78) that there is a need for more recordings of blue whales from high latitudes. SC/49/O 2 described two cruises in the eastern North Pacific to investigate precision of whale call locations as determined via the US Navy Sound Surveillance System (SOSUS). SOSUS provides ongoing acoustic monitoring over a broad geographic range and is well designed to detect the loud, low frequency calls of blue whales. However, the precision of locations of such calls estimated by SOSUS had not been investigated. The attempt to correlate blue whale sightings with SOSUS call locations was unsuccessful; no blue whales were seen. However an autonomous array of six bottom-moored hydrophones recorded blue whale calls also recorded by SOSUS, with differences in location from the two systems averaging 4.2km of latitude and 0.8km of longitude.

The Committee agreed that variability in whale vocalisation rates and difficulties in obtaining visual data from which acoustic detection probabilities could be estimated made it impossible to obtain abundance estimates using these acoustic techniques at this stage of development. However, the study showed that it is possible to locate and track blue whales at great (hundreds of km) distance and record calls that can be compared with calls from different seasons and locations. These techniques for continuous monitoring could be used in remote ocean areas where visual surveys are impractical. They might, for example, be used to find blue whale breeding grounds in lower latitudes. A summary of planned research of this sort using bottom-moored hydrophone arrays is given as Appendix 2 of Annex H.

SC/49/SH7 summarised blue whale research during the 1996/97 SOWER Antarctic cruise in the eastern half of Area II. Research protocols used during the SOWER blue whale cruise were also used during the Antarctic cruise. Surfacing behaviour was recorded on high resolution digital video.

[1] Were identified as such by the topmen.

Acoustic recordings were made for approximately 49 hours. Dive time observations were conducted on 17 groups during 15 hours. Biopsy samples were collected from four 'true' blue whales and one pygmy blue whale. Photographs for natural marking studies were obtained from 17 'true' blue whales and one pygmy blue whale.

The Committee recognised that the SOWER Antarctic cruise was primarily a minke whale assessment cruise designed for abundance estimation and that blue whale work was done as a result of chance encounters with groups of blue whales. It **strongly endorsed** the efforts made on the cruise to increase the amount of blue whale work and to follow the protocols used during the blue whale cruise.

It was noted that the most recent attempt to estimate blue whale abundance from IDCR data was in 1992 (Butterworth *et al.*, 1993) and that new consolidated estimates incorporating data from this cruise and IDCR cruises are planned. JARPA and SOWER blue whale cruise data could also be used for abundance and trend estimates. The Committee **encouraged** this work.

SC/49/SH37 gave results of observations of respiratory behaviour made during both the SOWER blue whale cruise and the Antarctic cruise. The observations had been undertaken to determine whether differences in patterns of blowing and diving were useful for distinguishing between blue and pygmy blue whales. Pygmy blue whales south of Madagascar tended to alternate dives lasting 3-11 minutes with surfacing sequences during which 4-13 blows were counted during 1-3 minutes. This alternation was not evident in the Antarctic animals. However, the authors believed that the difference was more likely to be reflecting different behavioural states (migrating in Madagascar *versus* surface feeding in the Antarctic) than species differences. Best also noted the usual problem with this approach to estimating characteristics of respiratory behaviour, such as dive time, namely that short dives are more likely to be observed than long ones.

SC/49/SH10 provided results from observations of blue whales during the 1996/97 JARPA survey. Natural markings for 5 blue whales from 4 schools were photographed and 1 biopsy sample was collected. Observations of the behaviour of blue whales were conducted on 2 schools (2 animals) in the western part of Area VI and on 1 school (1 animal) in the west-south stratum in Area V.

The Committee recognised that, as in the case of the SOWER Antarctic cruise, blue whale work was done opportunistically as the purpose of the cruise was to survey minke whales. It welcomed the blue whale data collected. It **encouraged** the greatest possible standardisation of methods with those used in the SOWER cruises.

SC/49/SH13 examined changes in the distribution and abundance of blue whales in Areas IV and V by use of whale sightings data that were collected by the JARPA surveys (1989/90-1995/96). Abundance appeared to be increasing in Area V, but the increase was not statistically significant because the standard errors were large. It was noted that SC/49/O 11 contained a good summary of photographs and biopsies of blue whales and other species from JARPA surveys which provides a starting point for a similar summary of data available for Comprehensive Assessments.

SC/49/SH5 reported on an unusual aggregation of blue whales feeding in an area where krill were also aggregated off East Antarctica. The sightings, of 26 animals, occurred on a single day during the cruise.

SC/49/SH9 presented information on sightings, historical catches and strandings off the west coast of South America. The Committee agreed that this paper provided good background information for the upcoming SOWER blue whale cruise off Chile.

Mikhalev (Appendix 3 of Annex H) drew attention to a recent review by Doroshenko (1996) on pygmy blue whales taken by Soviet whaling flotillas in the Indian Ocean during the Antarctic seasons 1962/63-1971/72. These data are in general agreement with the numbers of pygmy blue whales reported recently (e.g. Zemsky *et al.*, 1995; Mikhalev, 1996; 1997). However, Mikhalev noted some difference between the various studies that, in part, related to the classification of the whales as either blue or pygmy blue whales. Mikhalev noted that at the time of the whaling operation (1963/64-1964/65) the Soviet Union reported catches of 290 'true' and pygmy blue whales. This figure was very greatly in error as the actual catch was 9,338.

SC/49/SH25 reported on a genetic analysis of 'true' and pygmy blue whales from the Southern Hemisphere. In response to a request from the Scientific Committee last year, all available blue whale samples had been considered in this analysis. A part of the mitochondrial control region was amplified and sequenced. A small but consistent genetic difference was found between the two forms, and two of the pygmy blue whale samples had been collected well within the range of 'true' blue whales, indicating that geographic location is not a reliable determinant of type. This genetic work is continuing with analysis of specimens from California. Only 14 of the 35 samples analysed in SC/47/SH25 were identified to type at the time of sampling. It was noted that there is still a need for museum specimens of known 'true' blue whales, preferably of soft parts, even in buffered formalin, and baleen rather than bone, to include in the genetic analysis. Additional samples from known pygmy blue whales would also be useful. The Committee **recommends** that further attempts be made to obtain known tissue samples from both sub-species.

It was also noted that some whalers are indeed skilled at distinguishing between 'true' and pygmy blue whales. A pygmy blue whale identified by the topman at the ice edge during the Antarctic cruise, where the expectation was that animals would be 'true' blue whales, was later confirmed to type genetically. Kato noted that in analysing the videos taken during the SOWER cruises to identify morphological or behavioural differences usable for differentiating between 'true' and pygmy blue whales from a ship, he will enlist the help of experienced whalers. In this regard it was noted that videos of the head and diving behaviour and lateral photographs or photographs of the flanks and dorsal fin would be useful. Other researchers with such data are encouraged to inform the Secretariat of their availability.

Geographic variation in blue whales on a larger scale was addressed in SC/49/O 9. Length data from whaling records and photogrammetric surveys showed that California/Mexico blue whales are significantly shorter than those from the western and central North Pacific and therefore are a discrete geographic population. The California/Mexico blue whales are morphologically similar to pygmy blue whales from the Southern Hemisphere, supporting the idea that blue whales which migrate from warm seas to cold feeding grounds at high latitudes are larger than those restricted to mid-latitudes. However, conclusions concerning blue whale population structure cannot be reached without further work using molecular genetics and other techniques.

Regarding future work, the Committee **agreed** that complete catch data and abundance and trend estimates would be required for a Comprehensive Assessment, but that

these could not be interpreted until the questions of sub-species and stock differentiation currently under investigation were resolved.

10.2 Southern Hemisphere minke whales

SC/49/SH7 reported on the 1996/97 SOWER Antarctic cruise, the 19th in the series of cruises designed to estimate minke whale abundance in the Antarctic. The cruise covered the area 0°-30°W from 60°S to the ice edge in the eastern half of Area II and was the third in this specific region, previous surveys being conducted in 1981/82 and 1986/87. The area is characterised by difficult ice edges and the survey strategy was, therefore, to work from east to west with a restricted longitudinal range. The cruise starting time was delayed a week to optimise ice conditions. The configuration of the ice edge proved to be almost as predicted. Thirty days were spent in the research area with four days scheduled for experiments including two days allocated for blue whale research. Sightings of 458 minke whales were reported.

Abundance estimates for Southern Hemisphere minke whales from the series of cruises are discussed under Item 8.3.2.

SC/49/SH11 provided further Reduced Fragment Length Polymorphism (RFLP) analysis of mitochondrial DNA to elucidate stock structure of Antarctic minke whales. Previous analysis of genetic material obtained in Areas IV and V under JARPA had suggested that at least two stocks of minke whales occurred in this region: namely a 'core' stock in Area V and IVE (and in Area IVW later in the feeding season), and a 'western' stock distributed in Area IVW early in the season. This analysis was extended to examine samples taken during the 1995/96 JARPA survey in Areas IIIE and IV - mtDNA analysis was conducted on 335 minke whale samples in four area/time groups: IIIE-early; IIIE-late; IVW-early; and IVW-late. Analysis of Molecular Variance (AMOVA) showed some degree of mtDNA heterogeneity among the four groups. A comparison with representative samples of the hypothesised 'western' and 'core' stocks showed that group IVW-late resemble whales from the 'western' stock while groups IIIE-early and IVW-early resemble whales from the 'core' stock. This pattern does not contradict the view that at least two stocks are distributed in IVW and IIIE, but suggests that the distribution may change within and between seasons. Two explanations were given by the authors: (1) stocks migrating into Areas IIIE and IVW do not mix, but the distribution (geographical and temporal) of a given stock changes within and between years; and (2) heterogeneity found in Areas IIIE and IVW is explained by the mix of different stocks, with the mixing proportion changing within and between years.

SC/49/SH10 reported on 1996/97 JARPA research in Area V and the western part of Area VI in the Antarctic. Samples from minke whales in Area VI were collected early and late in the feeding season to address questions of stock identity and intra-seasonal changes.

10.3 Right whales

Last year (IWC, 1997e, p.85) the Committee had appointed an intersessional Steering Group to plan a workshop to initiate a worldwide comparative assessment of right whales. The report of this group appears in Appendix 4 of Annex H. It noted that right whales have not been considered in any detail by the Committee since 1983, and since that time knowledge of them worldwide has increased greatly. New information is available on previous Soviet and other catches. Data on size and trends of several populations are available from long-term monitoring programmes in both hemispheres, and right whale vital rates have been estimated from photo-identification data. Photo-identification studies and studies of distribution have recently started in several additional areas. Genetic material has now been collected from a number of areas and is available for studies of stock separation, social structure and genetic diversity.

A striking aspect of current understanding of right whales is the increase in Southern Hemisphere stocks since the cessation of whaling and a corresponding lack of detectable increase currently in Northern Hemisphere stocks. An attempt to explain this contrast should be a major focus of a worldwide right whale assessment.

The group proposed a meeting in March 1998 in Cape Town to include public keynote lectures followed by an invitation-only workshop. The meeting agenda and costs are given in Appendix 4 of Annex H. The Committee **recommends** that the Commission co-sponsor the proposed meeting. Best agreed to serve as convenor. The Committee expects to receive a report on this meeting, if held, during the 1998 Scientific Committee meeting. Funding requirements are estimated at £25,000.

SC/49/SH23 examined biopsy samples from southern right whales on two wintering grounds, off the Auckland Islands in the New Zealand sub-Antarctic and Western Australia, and a feeding ground south of Western Australia. A variable section of the mitochondrial DNA control region was amplified and sequenced, yielding 7 unique nucleotypes, 2 found on both wintering grounds and 5 unique to only one. The differentiation of nucleotypes between the wintering grounds was significant. The feeding ground sample included the most common nucleotype found in both wintering grounds and two unique to the Auckland Islands samples.

In discussion it was noted that the Western Australia sample, at least, was localised in time and space. It would be important to be sure that the relatively reduced number of haplotypes was not a consequence of multiple samples from the same animals.

Clapham summarised preliminary results of a genetic comparison of right whales from Argentina, South Africa and South Georgia using the mtDNA control region. K_{ST} and AMOVA analyses both showed a significant difference between South Africa and Argentina, with South Georgia intermediate between the two. However, caution is warranted in view of the small sample sizes involved.

SC/49/O 11 summarised identification photographs and biopsy samples from right whales collected on JARPA cruises, a total of 89 photographs of 19 whales and 6 biopsy samples was obtained between 1991/92 and 1995/96. All the mtDNA control region sequences obtained from these samples were different. Bannister reported a match between a 1996 photograph taken at 64°S during the JARPA survey with a whale photographed as a probable yearling in 1978 off southern Western Australia, as a sub-adult in 1981, and subsequently with a calf in 1987, 1990, 1993 and 1996. This female, a partial albino, is particularly easy to recognise.

Four right whales were sighted and photographed, with biopsy samples obtained from two, during the 1996/1997 SOWER Antarctic cruise. Best reported a match between one of the photographs and a female previously photographed three times with calves, the first in 1984, on the South African coast. SC/49/SH38 reported on sightings and photo-identification and biopsy work on the South Georgia whaling grounds. Two animals from South Georgia had been matched with animals photographed at Peninsula Valdes, Argentina.

SC/49/SH34 presented compiled information on sightings of southern right whales along the southeastern Brazilian coast. Large numbers of female-calf pairs and strandings of calves might indicate that this is an important calving area.

Six biopsy samples were obtained from a group of right whales during 1997 cetacean surveys in the southeastern Bering Sea, the largest group observed in recent years in the eastern North Pacific. Sightings and photographs of right whales were also made during the 1997 JARPN cruise.

10.4 Other species and/or stocks

Sperm whales

SC/49/O 7 discussed the remarkable genetic and morphological uniformity of sperm whales worldwide and the very different social groupings and movement patterns of males and females; these factors create large difficulties in determining stock structure and abundance.

A number of papers described sightings and acoustic detections of sperm whales during pelagic cruises. Ballance and Pitman (In press) noted that sperm whales were more frequently sighted, in terms of number of schools, than any other cetacean during a survey in the pelagic western tropical Indian Ocean. SC/49/O 24 presented results from sighting surveys conducted during a pelagic resources survey aboard a research vessel of opportunity off the southern coast of Brazil. The surveys were the first attempt to collect quantitative information on the distribution and density of cetaceans in these waters. Sperm whales accounted for over 45% of all sightings in both spring 1996 and winter 1997 cruises. In the south, they were concentrated over the continental slope, suggesting the importance of this feature as a possible migration route and/or feeding ground, perhaps part of the ground referred to in the 19th century as the 'River La Plata' sperm whaling ground. SC/49/O 33 described visual observations of sperm whales in the Indian Ocean Sanctuary from a vessel platform of opportunity; main concentrations of sperm whales were found around the Seychelles and the Horn of Africa.

SC/49/SH15 described an acoustic survey from the German Government research vessel *Polarstern* in the Southern Ocean Sanctuary. The equipment used was a simple towed hydrophone with an automated recording system. Similar equipment was used on the survey reported in SC/49/SH24. Both surveys were conducted from platforms of opportunity with simple equipment which can be operated by a single person. There were insufficient detections of sperm whales to obtain accurate abundance estimates from either, but the results indicate distribution. Ship noise was a problem. A visual survey was also conducted from the *Polarstern* (SC/49/SH16). Leaper noted that he had been informed by Kock that the German Government would welcome proposals for future work of this sort from the *Polarstern*.

Sperm whales, usually solitary, were also seen during Antarctic cruises (SC/49/SH7, SC/49/SH10). Kasamatsu and Joyce (1995) discussed the current status of Antarctic sperm whales and other odontocetes studied in Antarctic waters using data gathered in sightings surveys conducted from 1976/77 to 1987/88. Temporal variation in density demonstrated the different migration patterns of sperm whales and other species. Spatial distributions during mid-summer demonstrated different peaks of occurrence for each species by latitude suggesting possible segregation between species. Sperm whales occurred in the southern half of the study area in Antarctic waters. Several longitudinal peaks of occurrence and apparent distribution gaps were identified. The authors provide an abundance estimate for male sperm whales south of the Antarctic Convergence in January of 28,100 (CV 0.18). Based on this, the biomass of sperm whales was calculated to be 0.77 million tonnes. The authors suggested that odontocetes have a much greater role in the Antarctic ecosystem than previously considered.

The Committee did not discuss the detailed analysis but noted that there are a number of problems with using standard line transect theory to estimate sperm whale abundance.

For the North Pacific, sperm whale sightings were reported in SC/49/NP8, SC/49/NP9 and SC/49/NP15.

SC/49/O 25 advocated collection of behavioural data, using standardised forms for a given species, in conjunction with biopsies. The data on social behaviour is particularly important in interpreting biopsy data for social species such as the sperm whale. The Committee **recommends** that the data described as Level 1 information in Appendix 5 of Annex H be recorded for every biopsy sample. Both Level 1 and Level 2 data are being collected on SOWER cruises.

In consideration of the high level of interest and activity in sperm whale research indicated by the papers discussed at this meeting, as well as other research summarised in Appendix 6 of Annex H, the Committee agreed that sperm whales should be discussed at the 1998 Committee meeting. An intersessional Steering Group convened by Brownell (with members as listed in Annex P) will examine the current state of knowledge of sperm whales in preparation for a future Comprehensive Assessment and report on progress next year. Discussions in 1998 should focus on: (1) stock definitions; (2) relative male depletion; and especially (3) methodology for abundance estimation. The latter should include the use of acoustic techniques, consideration of whether the abundance of males, females or both should be estimated and of sex-specific $g(0)$ estimates.

North Atlantic humpback whales

SC/49/O 19 and SC/49/O 20 dealt with scoring and screening North Atlantic humpback photographs from the YoNAH project for use in capture-recapture estimation of abundance. The project is a two-year multinational effort combining photo-identification and genetics to study humpback whales across much of their North Atlantic range. SC/49/O 20 found agreement between judges on overall measures of quality and distinctiveness to be better than agreement on overall scores estimated from specific measures, although both are satisfactory. Methods of examining the interactions of photographic quality, animal distinctiveness and sample size when estimating abundance using photographic capture-recapture methods were presented in SC/49/O 19. Photographic quality was found to affect the repeatability of the quality evaluation and to be correlated with the evaluation of distinctiveness. Distinctiveness did not have a significant effect on recapture rate. Removing the lowest quality photographs and those of incompletely photographed flukes provided the best balance between bias and precision of the capture-recapture estimate.

Palsbøll *et al.* (1997a) described some of the genetics results of the YoNAH project. It describes the first attempts to use genetic markers (microsatellites) as the primary means of individual identification in a large population. Results included documentation of fidelity to specific feeding grounds, panmixis in the West Indian breeding range, and long migratory movements (including between Norway and the West Indies). The genetic data also allowed an estimate of abundance using capture-recapture methods and, further,

permitted sex-specific abundance estimates to be calculated. The latter revealed an over-abundance of males in the breeding range. A number of advantages of genotypic over photo-identification data were noted, including the permanence of genetic tags and the applicability of the technique to species in which individuals cannot be identified photographically because of insufficient variation in markings.

In discussion, it was agreed that the reason for the shortage of females in the estimates is not clear, but that possible reasons include: (1) sampling bias; (2) sex-based segregation on the breeding ground; and (3) females not migrating to the breeding ground.

The Committee recognised genetic tagging as an exciting new approach, but noted that it could not replace photo-identification in all cases. For example, the cost of processing genetic samples is still relatively high and it is arguably easier to obtain photographs for certain species and areas. The Committee noted that biopsy darting is often no more disturbing to the whales than photography. Using both techniques, as in YoNAH, helps in validating both. The large scale, ocean basin, approach of YoNAH has also proved to be extremely valuable. Sampling the breeding and feeding grounds in the same year has considerable advantages over collecting between-year samples in one or the other.

The Committee recognised that YoNAH is now at a stage where results are emerging at an increasing rate. Capture-recapture analyses of photographic data have yielded estimates of oceanwide abundance in 1992 and 1993 of over 10,000 (Smith *et al.*, In review; table 5 of SC/49/O 19), substantially higher than previous estimates (Katona and Beard, 1990). Appendix 7 of Annex H summarises further key aspects of the current status of knowledge of humpbacks in the North Atlantic. The most important of the YoNAH analyses are expected to be completed by December 1998. It is clear that a great deal is known about this species in the North Atlantic. In the past, this has been one of the criteria for conducting a Comprehensive Assessment. The Committee therefore **recommends** that a Comprehensive Assessment of North Atlantic humpbacks be conducted in 1999 or 2000. The Committee has adopted different modes for Comprehensive Assessments in the past. For North Atlantic humpbacks, it seems appropriate to focus on a single meeting and ensure all the necessary information is available.

North Pacific humpback whales

Baker *et al.* (In review) presented an analysis of nuclear and mtDNA variation from 205 humpback whales from eight regions of the North Pacific. The results supported the hypothesis of at least two stocks. These are a central stock, including the Hawaiian wintering ground and Alaskan feeding grounds, and an eastern stock, including the coastal Mexican wintering grounds and the California feeding grounds. Additional analyses of microsatellite variation in whales from southeastern Alaska and California indicated at least partial reproductive isolation, as well as maternally directed segregation between two feeding grounds. Overall, the results provide additional evidence of the significance of genetic management units within oceanic populations of humpback whales (e.g. Farrell, 1986; Baker *et al.*, 1993; 1994). The Committee noted the relevance of this work to management.

It was noted that relatively few studies have been carried out in the western North Pacific feeding grounds. Available information suggests that the Committee is still some distance away from being able to undertake a Comprehensive Assessment. However, there has been a major effort by North Pacific photo-identification researchers to look at population structure, abundance and behaviour. The Committee urges those responsible to present results to the 1998 meeting.

Fin whales

Bérubé *et al.* (1997) described the population genetic structure of fin whales in the North Atlantic and Mediterranean Sea and compared them with fin whales in the Sea of Cortez. Mitochondrial and nuclear loci all showed significant divergence between the Sea of Cortez and the other areas, with low nucleotide diversity in the Sea of Cortez as would be expected for a small resident population. Diversity in the Mediterranean Sea is higher, but still significantly lower than in the North Atlantic. The population genetic structure in the North Atlantic is consistent with the existence of several sub-populations with overlapping ranges. Samples from Spain differed from those from the Gulf of Maine and Gulf of St Lawrence, but West Greenland and Iceland could not be unequivocally assigned to either the eastern or western North Atlantic. This is of importance to consideration of West Greenland aboriginal subsistence whaling issues (see Item 11.4).

The Committee agreed that population structure and abundance (see Item 11.4) must be more thoroughly understood before continuation of the Comprehensive Assessment process begun in 1991 (IWC, 1992a).

Northern Hemisphere minke whales

Most discussion of these stocks occurred under Item 8.

SC/49/O 10 critically reviewed published information and included new specimen and sighting records to reassess the distribution of minke whales in the northeast Atlantic south of Cape Finisterre (Galicia) and in the Mediterranean.

SC/49/NP8 reported on the Japanese Research Programme under Special Permit in the North Pacific (JARPN) in 1996, and SC/49/NP9 on the 1997 JARPN work. SC/49/NP13 provided results on parasitic infections in minke whales obtained from samples taken during the 1996 JARPN survey. The programme is discussed under Item 12.

Bryde's whales

SC/49/NP6 investigated the phylogenetic relationship of Bryde's whales off Kochi, southwest Japan, and whales in other waters. Results indicated genetic distinction among the whales off Kochi, in the western North Pacific and off the Solomon Islands. The authors concluded that Bryde's whales off Kochi probably separate from the whales in the western North Pacific, at least at the sub-specific level, and that Solomon Islands whales do not belong genetically to the Bryde's whale.

Kato noted that more attempts were being made to obtain samples (sloughed skin) in the waters off Kochi. The Committee appreciated these efforts to resolve these taxonomic questions.

SC/49/NP7 presented a case for a putative new species of baleen whale from the Indian Ocean and Solomon Sea. The paper had been prepared in response to a request from the Committee. Eight anomalous whales, believed to be Bryde's whales, were taken by Japan under Special Permit during the 1976-77 and 1978-79 seasons, six from the Solomon Sea and two from southwest of Java. At the time of capture, these whales were noteworthy because of their small size and sexual maturity. Wada and Numachi (1991) evaluated the genetic diversity of the anomalous whales using allozyme

analysis and concluded they belonged to an unknown species of rorqual. The Committee then recommended additional details and analyses be presented on the original anomalous specimens. SC/49/NP7 presented such information, including details of osteological comparisons with museum specimens and other characteristics related to the specific characteristics of *B. edeni*. The author compared the mitochondrial D-loop DNA of *B. edeni* and the anomalous specimens and concluded the latter were a new species for which he proposed a name.

The Committee expressed its appreciation for the work the author had done in response to its request. However, it agreed that Bryde's whale taxonomy is highly complex and more work is clearly needed. It therefore agreed that the erection of a new taxon at this time is premature and that the evidence presented in SC/49/NP7 does not support the author's conclusions. In addition, the naming of the new species in SC/49/NP7 does not follow the internationally agreed standards for the description of a new species. The Committee agreed that the formal description of a new species should first appear in a refereed journal, not as an IWC Scientific Committee meeting document.

In order to prevent a repetition of this in the future the Committee agreed to modify the Guide for Authors with respect to submission of documents at meetings. Thus under Item 2 a new paragraph will be added as follows.

> 'If an author submits a paper to a meeting describing a new taxon, it must not propose a name. If a paper proposing a name is submitted, it will not be circulated or considered by the meeting. If such a paper is inadvertently distributed it will be withdrawn and not included in the meeting record.'

Ohsumi and Hatanaka expressed reservations about this procedure.

Discussion of the taxonomy of Bryde's whales and the findings in SC/49/O 21, SC/49/NP5 and SC/49/NP6 are given in Annex H, Item 7.3.

Mikhalev (Annex H, Item 7.3) presented data on Bryde's whales of the Arabian Sea. The current investigation concerns whaling from 1963-1966. The catch data are now being reported for the first time. During three voyages of the factory ships *Slava* and *Sovetskaya Ukraina* a total of 848 Bryde's whales was taken. Highest concentrations of Bryde's whales were in the Gulf of Aden, near the equator between 50°E and 56°E, and in the region of the Maldive Islands and Sri Lanka. Length frequency data, embryo sizes and biological parameters of females, including sexual maturity, are included, along with information on stomach contents (primarily schooling fish). The Committee welcomed this document and agreed it should be considered for publication in the IWC report series.

SC/49/NP15 was designed as a sighting survey to cover previously unsurveyed waters and clarify the southern limit of the distribution of Bryde's whales in 0°-25°N and 120°-163°E. Cruise tracks and sightings are given in the paper. Biopsy sampling of Bryde's whales was attempted but proved difficult; only two samples were obtained. SC/49/NP8 and SC/49/NP9 reported on Bryde's whale sightings during JARPN cruises. Kato reported on a study of Bryde's whales in the coastal waters of Kochi Prefecture. The study included line transect surveys and photographic identification.

Acoustics

The use of acoustic techniques was discussed above under Items 10.1 and 10.4. Potential uses of acoustics for studying whales were summarised and discussed further.

SC/49/O 2 described two cruises to investigate the precision of whale call locations as determined from the US Navy Sound Surveillance System (SOSUS). Attempts to confirm SOSUS whale call locations using vessel-based visual observations were unsuccessful. However, there was good correspondence between blue whale calls reported via SOSUS and blue whale call tracks derived from data received at an autonomous array of six bottom-moored hydrophones. Potential uses of acoustics for studying whales were discussed including: (1) using a towed hydrophone as a second platform in an 'independent' observer team in a line transect sighting survey; (2) using fixed arrays moored for extended periods of time to locate potential concentrations of whales that could then be investigated with traditional methods; (3) using fixed arrays to describe broad scale spatial and temporal distribution of call types that could be compared to results from genetic studies; (4) using fixed arrays to help locate winter breeding grounds for species of whales where this information is lacking; and (5) using spatial distributional data from fixed arrays to assist in survey design for traditional visual surveys and habitat utilisation studies. With respect to (1), there are still a number of methodological issues that need to be solved, including accurate estimation of the distance to the calling animals and reliable estimates of calling rates.

Fox outlined plans for a comprehensive database of cetacean sonograms along with other relevant associated data. He is responsible for and has the necessary resources to create and maintain such a database and it would be publicly accessible on the world wide web. The development of such a database requires collaborative effort and he is seeking cooperation from researchers with verified sonograms. The Committee noted that such a database would be a highly valuable resource as lack of information for verifying the source of detected songs has been one factor limiting the use of acoustics in whale research. The Committee agreed to cooperate with this project and assist, to the extent possible, in its general design by suggesting and reviewing the specifications for the type and standards for the data to be included. The Committee established an intersessional e-mail correspondence group convened by Fox (members in Annex P) to assist in the development of this database.

10.5 Future SOWER cruises

10.5.1 1997/98

The planning meetings for the 1997/98 blue whale and Antarctic cruises were held in Tokyo in August and are given as SC/49/Rep3 and SC/49/Rep4 respectively. A number of additional topics were discussed. These are summarised below (and see Annex H, Item 8.2).

It was agreed that no oceanographic sampling would be conducted during the Antarctic cruise. However, CTD stations would be occupied on an opportunistic basis during the blue whale cruise (see Annex F). The 100 XBTs held by the National Institute of Far Seas Fisheries would therefore be stored for use on subsequent cruises following the advice of the Standing Working Group on Environmental Concerns.

It was agreed to conduct some IO mode surveys in transit to the research area to increase the quality of IO mode data collected in the early part of the survey.

The 90 minute per day time limit for biopsy sampling attempts on species other than blue whales will also apply to the Antarctic cruise.

In the absence of specific advice, the priority for biopsy sampling of odontocete species for baseline pollution studies on SOWER Antarctic cruises will remain hourglass dolphins.

As ice conditions in the 30°-40°W sector are problematic, a cruise track design based on the locus of points equidistant from the ice edge may improve the distribution of survey coverage in the southern stratum. This method has been used on previous IDCR surveys and standardised modifications are well established. Ensor will provide full details to the pre-cruise meeting.

Noting the intention to return to the Area I/II vicinity for SOWER research in 1999/2000, it was agreed to change the original priority to cover the full range of 70°W-25°W for the 1997/98 cruise. The westernmost part of this range could, at the cruise leader's discretion, not be covered in 1997/98 to ensure full coverage of the eastern half. Areas thus perhaps omitted could be covered instead in 1999/2000.

10.5.2 Longer term

The blue whale components of the current SOWER programme will probably move to the Antarctic region after 1997/98, the third cruise to discriminate pygmy blue whales and 'true' blue whales. Discussion of future research plans was considered by a Working Group convened by Reilly. To assist those discussions, Borchers produced figures showing areas and years for each circumpolar series (Figs 1a, b and c of Annex H) in order to review progress on the 3rd circumpolar series. Last year's discussion of this matter is given in IWC (1997e, p.79).

Reilly reported verbally on the conclusions of the Working Group. The Committee agreed that the proposed work outlined in SC/49/Rep5 should come under the umbrella of SOWER and that it would be a major part of the 1999/2000 effort. It further agreed that there was considerable merit in completing the 3rd circumpolar survey; one year's break in surveys will not compromise the overall objectives. The Committee also agreed to establish an intersessional e-mail correspondence group under Kato (for members, see Annex P) to determine the schedule for the remaining circumpolar cruises and to report to next year's meeting (see also Item 6.2.3).

10.6 Mathematically based techniques for recognition analyses

Last year the Committee began to consider the possibility of using digital signal processing techniques for automated photo-identification. It welcomed further work along the lines discussed (IWC, 1997e, p.81) and had recommended that scientists with specialist expertise be encouraged to participate at this year's meeting.

This year the Committee had received one paper (SC/49/O 31), on extraction of sperm whale fluke contours from photographs, but the author was unable to be present at the meeting and no other specialists were present. The Committee welcomed the paper and reiterated its view that this matter should be pursued. The Committee therefore repeats last year's **recommendation**, i.e. that the matter should be included for discussion at the next meeting and that scientists with expertise in automated signal processing for pattern recognition and related techniques, e.g. computerised matching systems, be encouraged to participate. It **requests** that member nations include such scientists on their delegations and notes that this subject will be taken into account when discussing Invited Participants at the next meeting. Zeh will compile a list of possible invitees for consideration.

11. ABORIGINAL SUBSISTENCE WHALING

11.1 Aboriginal subsistence whaling management procedure (AWMP)

11.1.1 Report of intersessional workshop

The need for a workshop had been identified by the Scientific Committee last year (IWC, 1997e, p.88). The Standing Working Group and other interested members met for three days prior to the main Scientific Committee meeting. Their report is given as Annex I. The Committee's deliberations below are largely a summary of that Annex and the interested reader is referred there for a more detailed discussion. It was noted that last year, the Commission had reiterated the importance it attached to the development of the AWMP and endorsed the Committee's workplan (IWC, 1997a, pp.23-4). A glossary of terms is given as Annex I, Appendix 2.

INITIAL EXPLORATION TRIALS - GENERAL

The Committee noted that the development of trials currently involves considering the assumptions underlying the trials used during the development of the *CLA* in order to understand lessons learned from that experience. It recognised that construction of an exhaustive reference guide to the RMP literature would be valuable but it would be an enormous task.

COMMON CONTROL PROGRAM

The common control program is the computer code used by developers to run *Initial Exploration Trials* and calculate performance statistics; the only portion of code an AWMP *SLA* developer must supply is the code implementing his/her candidate *SLA*. Allison reported that the common control program had been essentially completed, along with an updated description of it and the input files for the *Initial Exploration Trials* (IWC, 1997m, pp.246-9). The Committee thanked Allison for the careful completion of a task that proved considerably more complex than the Committee had allowed for last year (IWC, 1997m, p.245). It was noted that realistic estimation of the time required to complete computing tasks, and their prioritisation within the overall work of the Committee, are issues that can cause difficulties for both developers and other users of software. The Committee agreed to establish a formal mechanism to address these issues (see Item 18).

STATISTICS AND PERFORMANCE PLOTS

The Committee agreed that it was important to limit the number of trials to be run and statistics to be presented to those that provided useful information for determining the actual and relative success of candidate *SLA*s.

In SC/49/AS10, graphical and statistical techniques were used to evaluate the usefulness of the *SLA* performance evaluation statistics agreed last year (IWC, 1997m). On the basis of these investigations, the Committee reviewed those statistics. It agreed to the deletion of some, and the demotion of others to optional (i.e. not required to be reported) status. The revised list of agreed statistics is summarised in Annex I, Table 1. The rationale is given in Annex I (Item 2.2.1).

Interpretation of the vast quantity of results of simulation trials is greatly facilitated by the standardisation of their graphical presentation, as illustrated in the RMP development process. The Committee welcomed the work of Zeh who had developed FORTRAN and S-Plus software to create graphical summaries of simulation output from the common control program. It was agreed that this program should be freely available and distributed by the Secretariat to AWMP *SLA* developers. In discussion, Zeh agreed to

incorporate suggestions for improvements in content and display of the graphs and any consequential amendments arising out of decisions taken elsewhere in the report. The statistics that can be displayed with the Zeh software are indicated in Annex I, Table 1.

REVIEW OF SIMULATION FRAMEWORK

Last year, when agreeing the simulation framework for *Initial Exploration Trials*, a number of modelling issues were identified that would require investigation in the future (IWC, 1997m, p.244, table 1). The Committee considered these and determined what progress could be made on them (and any others identified) at this meeting.

DENSITY DEPENDENT SURVIVAL RATE

At present in the common control program, density dependence is assumed to act on fecundity and calf survival rate. For North Atlantic fin whales, this can lead to undesirable features (e.g. oscillations) in population trajectories (IWC, 1992a). They might be avoided by allowing density dependence to act on non-calf survival rate. The Committee considered this was too complex an issue to address at this early stage of the development process. However it noted that the simulation trajectories should be examined to determine whether they represented a real problem that needed to be addressed.

DENSITY DEPENDENCE ON THE MATURE RATHER THAN THE 1+ COMPONENT

The specific issue comprises a small component of a wider and long-standing Committee concern over the appropriate component for calculation, expression and reporting of MSYL and MSYR, and depletion and recovery statistics. The overall issue has been addressed at some length in the Committee in the past but with no clear resolution (e.g. IWC, 1994f).

Discussion within the Committee has perhaps inevitably tended to confound a number of issues including those listed below.

(1) Is it biologically more reasonable to expect density dependence to act on the mature female or the 1+ component of the population?
(2) When discussing whether MSYL lies between 0.4 and 0.8*K* (or indeed whether MSYR lies between 1% and 4%) did the Committee consider whether it was more appropriate to consider them to refer to the mature female or 1+ component of the population?
(3) Historical 'accidents' (e.g. in computer programming choice/ability) leading to a possible artificial agreement based on not changing 'established' precedents.
(4) The need to make 'conservative' decisions with respect to management (i.e. taking into account the effective role these 'parameters' play in the population dynamics model, irrespective of best approximations of biological reality).

An additional issue was raised in the Committee, viz. the need to consider whether to ensure, as far as possible, comparability (e.g. with respect to risk) with the RMP developed for commercial whaling. This has also become known as the 'common currency' issue (IWC, 1996e, p.111).

With respect to (1) above the Committee recognised that the issue was complex and related *inter alia* to whether density dependence was assumed to act on fecundity, survivorship or some combination of both. The Committee agreed that it was probably not profitable to spend time developing large numbers of possible alternative biological scenarios to determine which is more likely: nor would it be possible either to provide an exhaustive list or reach a definitive conclusion.

With respect to (2), examination of the Committee's earlier discussions (e.g. IWC, 1994f) again provides no definitive conclusion. The Committee agreed that it was probable that when considering production curves, most people have in mind total population rather than only its mature component. It was also recognised that if the range 0.4-0.8*K* is assumed to apply to the mature female component then at the upper end of this range $MSYL_{(1+)}$ might be greater than 1*K*!

With respect to (3), Punt noted that the original code for the RMP common control program was based on an age-aggregated model (IWC, 1989b) for which MSYR and MSYL refer to the mature (i.e. recruited) component of the population. Later, the common control programme was based on an age-structured model. Largely for consistency with the previous trials, it was again assumed that density-dependence acted on the mature/recruited component of the population and that MSYR and MSYL refer to that component (IWC, 1991) i.e. $MSYL_{mat}$ and $MSYR_{mat}$. Later still, first for North Atlantic minke whale *Implementation Simulation Trials,* and subsequently Southern Hemisphere and North Pacific minke whales, the Committee agreed to assume that MSYR, MSYL and density-dependence all refer to the mature female component of the population, although the detailed rationale behind that assumption is not documented.

With respect to (4), Cooke and de la Mare (1994) argued *inter alia* that using $MSYL_{mat}$ and $MSYR_{mat}$ in the case of the RMP development process was justifiable on the grounds that it represented a 'conservative' or 'worst case' scenario.

The broad issue was discussed at considerable length within the Working Group and the Committee. A number of points were raised for and against both options (e.g. see Annex I, Table 2). It became clear that complete agreement on a single conclusion would not be reached.

However, the Committee agreed that in the *Initial Exploration Trials*, density dependence should be assumed to act on the mature female component of the population (as in the RMP trials). Previous experience reveals that this is unlikely to exert a major influence (Taylor and DeMaster, 1993).

With respect to the wider issue, although the Committee had been unable to reach consensus on a straight 1+/mature choice, it was able to reach agreement on a pragmatic way forward.

As a matter of principle, the Committee recognised the value of comparing aspects of the RMP and any future AWMP, particularly with respect to 'risk' as previously discussed by the Committee (e.g. IWC, 1996d, p.73). However, it saw no value in being constrained to always making the same choices as those made during the RMP development process for the sole purpose of facilitating comparison, where there are legitimate scientific reasons for making alternative choices. The primary goal is to develop an AWMP that best satisfies the Commission's objectives. It noted that, should different choices be made, it should be possible to facilitate comparison with the RMP by developing simulation trials expressly designed for the purpose. Such trials would be purely for comparative purposes and might not reflect real situations for which the AWMP is implemented.

The Standing Working Group had developed two possible approaches to further its work in the short term (Annex I, Item 2.3.2) and had requested guidance from the Committee.

The Committee agreed to approach (2). Thus *Initial Exploration Trials* should be carried out using only the 1+ component, (the component which, on balance, appeared scientifically preferable). Trials using the mature component would be postponed until further in the development process when candidate *SLA*s are more fully specified and comparison with the RMP would be more appropriate and rewarding. This has the advantage of not increasing the number of trials, but provides no early information on the consequences of the choice.

Finally, the Committee considered the issue of reporting the depletion and recovery statistics, for which the choice between the 1+ and mature component is also relevant. It was agreed that the components used to compute and report performance evaluation statistics should be those given in Annex I, Table 1.

PROTOCOL FOR GENERATING OTHER SOURCES OF DATA

No new simulated data were proposed for inclusion at this stage.

TIME TRENDS IN MSYR AND K

These issues had been considered during the development of the RMP (e.g. IWC, 1992b). It was agreed that these trials were too complex to be considered at this stage.

AGE- AND LENGTH-STRUCTURED POPULATION DYNAMICS MODELS (PDMS)

It was agreed that this did not require further attention at this stage.

BLOCK QUOTAS AND CARRY-OVER

The Committee noted the value of block quotas and carry-over in aboriginal fisheries in harsh environments where annual variations in weather and ice-conditions, for example, can affect the success of the hunt. It agreed that developers should try to incorporate these features into *SLA* candidates, although this is not mandatory.

ALLOWING FOR TEMPORAL AUTO-CORRELATION AMONG SURVEY ESTIMATES

Initial Exploration Trials condition on past survey data and thus temporal auto-correlation is not an issue for such data. However, there are several sources of potential correlation between future surveys for several aboriginal stocks, and the Committee agreed that the issue merits eventual consideration.

MULTI-SPECIES ISSUES

When Greenland presented its 'need' request to the Commission, it expressed it as a number of tons of whale meat per year, with 'need' not assigned to species. In recent years Greenlanders have hunted minke, fin and humpback whales. Catch limits for minke and fin whales are set at present. The Committee recognises both the importance and complexity of this issue.

The Committee agreed that it would be valuable to begin consideration of a new fishery type, considering the case where the population to be harvested was small. It identified a number of issues that need to be addressed and agreed that development of these type 3 trials should be included on next year's agenda.

CONFOUNDING OF BIAS FACTOR AND K

SC/49/AS10 commented that if all factors are fixed, apart from the survey bias factor in the trials, the results will be potentially misleading because the effect of changing the bias factor is that K also changes. This occurs because changing the bias must change the ratio of the true to believed present abundance; since it would not be sensible to alter the value of the present abundance estimate, the common control program changes the true abundance, which in turn leads to a different solved value for K. Thus, it is not correct to assume that the results can be used to determine the effect of survey bias alone. There was some consideration of a methodological change to the common control program that would enable K to remain unchanged whilst allowing future surveys to differ greatly (in bias) from historical ones. The Committee **agreed** to continue using the current protocol, but encouraged the development of alternatives or other innovations for future trials. It also **agreed** that current depletion (year 0) should be compiled and reported by the common control program.

100 YEAR TIME HORIZON

The Committee **agreed** to retain the 100 year span as compulsory, and 20 and 50 year spans as optional.

FACILITATING AWMP COMPARISON AND TUNING

Each candidate *SLA* is likely to achieve a different balance among the objectives specified by the Commission for an AWMP. This makes it difficult to compare candidate *SLA*s. Tuning, or rather more specifically equivalence tuning, is a way to provide *SLA* developers with the opportunity to adjust their *SLA*s to strive towards a pre-specified balance of risk, catch and recovery. The purpose of equivalence tuning is to provide an explicit reference point for future comparisons. It will help the Committee avoid mistakenly rejecting a 'good' *SLA* because it is tuned to a risk, catch and recovery balance which produces undesirable results, by comparison with a possibly inferior *SLA* that is differently tuned.

During the RMP development process, the candidate *Catch Limit Algorithms* (*CLA*s) were tuned to achieve the same median final depletion (relative to K_{mat}) on a specified trial to facilitate comparison. SC/49/AS10 suggested an alternative approach to tuning candidate AWMPs which considers need and recovery as well as final depletion (i.e. all the Commission's objectives). This approach involves selecting the values for the parameters of the *SLA*s (or parameters when retrofitting an *SLA*) to match as adequately as possible the strike limits set by a pre-specified target *SLA* which has been given perfect and complete knowledge of the stock dynamics and the operating model parameter values (termed '*H*'). The target *SLA* is not intended to represent ideal *SLA* performance but rather to illustrate a particular balance between need satisfaction, risk and recovery to which candidate *SLA*s may all be tuned. An *SLA* might be tuned to *H* in many different ways. By adopting the above approach, the creativity inherent in tuning is left to the developer.

H itself is not intended to be a basis for *SLA* comparison, nor are candidate *SLA*s required to provide strike limits such as those given by *H* except for tuning purposes. However, if the Committee decides that there is an *H* that is reasonable in a management context, then it might be that deviations from that *H* could be introduced as a performance measure. A proposed specification of *H* for tuning purposes is described in Annex I, Appendix 4. At this point, it is not required to precisely reflect Commission concerns since it is used only for tuning purposes. Whether the suggested *H* fully reflects

the Commission's desired balance of risk, catch and recovery is unclear, since the balance has not been expressed in a quantitative form. The Commission's goals are matters for subsequent performance tuning of the winning algorithm(s). However, Commission comment on *H* would be extremely useful.

The Committee agreed that it was worthwhile to follow this tuning approach, since the *Initial Exploration Trials* are at an early stage, where promising innovations might be pursued. It should be applied by all developers.

DESCRIPTION OF POTENTIAL PROCEDURES

A number of approaches are discussed in Annex I, Item 3, although none are as yet developed to the stage where they can be considered as candidate procedures.

INITIAL EXPLORATION TRIALS - SPECIFIC

FISHERY TYPE 1

Last year (IWC, 1997m, p.243) the Committee defined fishery type 1 as a

> case where there is relatively little available information and stock identity problems (e.g. West Greenland minke whales) and where the Committee has had considerable problems in providing advice under Para. 13(a).

It reviewed progress with the existing trial structure (Annex I, Table 3). The trials consider a wide range of potential behaviour. If the strike limit is set equal to the need level, the resulting trajectories of stock size range from extinction to stabilisation only marginally less than *K*. Annex I, Appendix 5 shows the total 1+ stock trajectories, when catch = 0 and when catch = need, for all the type 1 trials from last year (IWC, 1997m, p.243-9). It agreed that a number of trials could be deleted because their behaviour is captured adequately by others.

On the basis of Greenlandic length data (Annex I, Appendix 6) the Committee agreed that the implicit assumption in the trial scenarios agreed last year that catches are taken from the mature component of the population is invalid. It agreed that for future *Initial Exploration Trials* for fishery type 1, harvesting will be assumed to act on the 1+ component of the population. For simplicity, the revised trials will also assume that selectivity for the historical catches was uniform above age 1. Alternative prescriptions should be considered later in the development process.

Similarly, on the basis of Greenlandic data on the sex ratio in the catch, it was agreed that for trial purposes future catches will be assumed to have a sex ratio of 35:65, male:female. It was also agreed to introduce an extra trial (M1a) to examine the implications of a reverse, 65:35, male:female sex ratio for future catches.

Last year, the Scientific Committee agreed that MSYR for the fishery type 1 trials refers to the 1+ component of the population. This differs from the assumption made in the RMP *Implementation Simulation Trials* for the North Atlantic minke whales. The Committee selected this component of the population (and the specific choices for *MSYR*) because it considered they more closely corresponded to biological reality. It agreed that they provided an adequate test of candidate *SLA*s for fishery type 1.

The Committee identified two major areas where further trial development was necessary:

(1) Stock structure uncertainty, identified as a characteristic of fishery type 1. However, the current set of *Initial Exploration Trials* do not explicitly consider the question. The Committee recognises that this is a complex issue. It agreed that its initial exploration of stock structure uncertainty should at least capture the problem that the survey estimates used when setting strike limits could, erroneously, be based on surveys of an area which includes either more than just the stock from which the removals are taken, or only a part of that stock. Details of the trials are given in Annex I (Appendix 3, Section G). At present, these initial trials do not consider stochastic and density-dependent mixing, or sub-stock structure. They do consider the impact of *MSYR* and the initial size of the stocks on performance. For certain trials the RMP is used to manage the stock not managed by the AWMP; for most trials it is assumed that there are no catches from this stock. The Committee recognised that the question of stock identity and sub-stock structure will require further consideration (see IWC, 1997e, p.193).

The Committee **agreed** that both the new and the revised trials listed in Annex E, Appendix 3 be adopted.

FISHERY TYPE 2

Last year (IWC, 1997m, p.243) the Committee defined fishery type 2 as

> a case where there is a relatively large amount of information and Para. 13(a) has largely been met (e.g. Bering-Chukchi-Beaufort whales).

The Committee reviewed progress with the existing trial structure. The set of trials agreed last year is given in Annex I, Table 4. Two developers (SC/49/AS10; SC/49/AS7) considered the trials for fishery type 2. On the basis of these results, it was agreed to delete a number of trials because their behaviour is captured adequately by the remainder.

The Committee considered whether it was necessary to consider separate trials to examine the impact of additional variance and survey bias, rather than trial B2 which incorporates both factors. Instead of creating separate trials to examine these impacts, a new trial was designed based on B7 (rather than trial B1) in which these factors are examined simultaneously. This trial (B7a) provides a greater challenge for candidate *SLA*s than the current trial B2. The Committee agreed that the extent of additional variance considered in the new trial B7a is adequate.

The Committee agreed to modify the need envelope for fishery type 2 to make it consistent with that for fishery type 1. The refined need envelope increases from 68 in year 0 to 204 in year 100.

The values for the biological parameters are the same for all fishery type 2 trials. However, this implies that the values for these parameters are not necessarily entirely consistent with the specifications related to MSYR, MSYL and P_0. The Committee noted that the problem can be resolved by selecting the parameter values after conditioning on fixed values for MSYR, MSYL and P_0. It did not consider this to be a high priority item. Punt and Givens will examine the issue intersessionally.

The Committee **agreed** that the common control programme be modified to provide summary statistics related to the value of *K* in terms of the mature female and total (1+) population components.

The Committee **agreed** that both the new and the revised trials listed in Annex I, Appendix 3 be adopted.

PLANNING FOR FUTURE SELECTION OF *SLA*s

The Committee recalled the objectives (summarised below) given by the Commission:

(a) ensure that the risks of extinction to individual stocks are not seriously increased by subsistence whaling;

(b) enable aboriginal people to harvest whales in perpetuity at levels appropriate to their cultural and nutritional requirements, subject to the other objectives: and
(c) maintain the status of stocks at or above the level giving the highest net recruitment and ensure that stocks below that level are moved towards it, so far as the environment permits.

Highest priority shall be accorded to the objective of ensuring that the risks of extinction to individual stocks are not seriously increased by subsistence whaling.

The Commission is **encouraged** to clarify aspects of management and performance objectives as described below.

The Committee **agreed** that the performance measures, as amended in Annex I, were satisfactory for the purposes of *SLA* evaluation at this time.

SC/49/AS10 and SC/49/AS7 referred to an approach where endorsement of the best *SLA*s occurs in stages, so that additional optimisation may occur at intermediate stages. The Committee agreed that investigation of such approaches is worthwhile. Staged evaluation and selection had occurred informally during RMP development, and a similar process is appropriate here. It further noted that as *SLA* development progressed, the diversity of candidate algorithms might be reduced, in which case formal optimisation methods might also prove useful.

QUANTITATIVE STRATEGIES FOR OPTIMISING AND MERGING *SLA*s

SC/49/AS4 described quantitative methods for optimising and merging *SLA*s. The goal of merging *SLA*s was explicitly recommended during RMP development (IWC, 1991). Unlike the common practice of comparing performance statistic values with idealised values, the approach of SC/49/AS4 involves comparing a candidate *SLA*'s strike limits with strike limits given by an idealised *SLA*, say *H*. A parameterised function which mathematically combines one or more candidate *SLA*s is set up in an effort to mimic the target *H*. The parameters of this function are numerically optimised to give the best fit to *H*, averaged over a collection of trials. Distance between the fit and *H* can be assessed in whatever manner best expresses management objectives; however the choice of *H* itself is the most important route for expression of management objectives.

SC/49/AS4 showed that the merged version of two candidate *SLA*s performed considerably better than either of the original candidates. Sensitivity results showed that conclusions about which *SLA* was preferred (an original one or the merged one) were unchanged regardless of changes to any of the necessary assumptions: the merged *SLA* was always preferred. The author noted that the merging method was not proposed to automate the selection of 'winning' *SLA*s. Rather, the approach can be used by individual developers or by the Standing Working Group or the Committee to create new candidate *SLA*s that have a high likelihood of performing better than existing candidates. The Committee can still select the 'winner' by whatever means it deems appropriate. The merging approach offers greatest potential performance enhancement when there is a large, diverse pool of candidate algorithms that might be merged, and hence such a candidate pool was encouraged.

The Committee agreed that the approaches in SC/49/AS4 were promising.

When discussing SC/49/AS4, the issue of algorithmic complexity was raised. Based to some extent on past experience, concern was expressed that use of the merging approach might lead to a merged *SLA* that was not only impossible to explain to the Commission or hunters, but also virtually impossible to completely de-bug. In response it was noted that it was unclear whether a successfully tested *SLA* that performed adequately in all cases but contained unintended codings should be considered faulty or successful. It was also noted that the merging approach might not require highly sophisticated *SLA* candidates to obtain enhanced performance. The merging process itself is in fact not complex, requiring a minor additional printout from the common control program and only a few lines of code in the widely-used commercial S-Plus software package.

Nevertheless, the Committee agreed that unwarranted complexity was important to avoid at all stages of *SLA* development. Simplicity should be a goal whenever it can be achieved without leading to inappropriately sub-optimal adherence to Commission risk, need and recovery objectives.

In discussion, several suggestions were made for further development of the ideas in SC/49/AS4. The Committee welcomed the innovative approaches described in SC/49/AS4, which it hoped might offer avenues towards the resolution of several management procedure evaluation issues for which, in the case of RMP *CLA* development, no simple solution was known.

In conclusion, the Committee actively **encouraged** further work on the ideas from SC/49/AS4, which it believed to be highly promising and useful for several aspects of AWMP development. It agreed that developers could use such techniques in their creation of *SLA* candidates.

DIALOGUE WITH COMMISSION AND HUNTERS

In previous discussions, the Committee had recognised the importance of continuing dialogue with the Commission and hunters throughout the development process (IWC, 1997e). The Committee reaffirmed this and discussed ways in which this might be facilitated.

It noted that the formal mechanism is for the Scientific Committee to report to the Aboriginal Subsistence Whaling sub-committee of the Commission. Hunter representatives are usually members of national delegations to the sub-committee. The Committee **agreed** that it was appropriate for the Chairman of the Standing Working Group to present its work at the Monaco meeting. It also agreed that it would be appropriate for the Commission's sub-committee to consider whether an informal question and answer session might be a useful addition to the formal presentation. It **draws this to the attention** of the Commission.

With respect to more direct contact with hunters, the Committee noted that well established links between members of the Scientific Committee and aboriginal subsistence communities already existed in some cases (e.g. Alaska and Greenland). It encouraged the development of similar mechanisms for other aboriginal whaling operations. The Committee **agreed** that it would not be averse to a representative discussing issues related to the development of the AWMP with interested communities and/or harvest managers if a request was made by the appropriate member governments through the Commission.

SPECIFICATION FOR THE NEED ENVELOPE

Last year, the Committee agreed that for the purposes of *Initial Exploration Trials*, it would be sufficient to develop 'need envelopes' for aboriginal fisheries (IWC, 1997e, p.194-5). AWMP *SLA*s will be designed to perform

satisfactorily for any trajectories of need that fall within the need envelope. At its 1996 meeting, the Commission approved this approach.

In discussion of Annex I, Schweder reiterated the concern he had expressed last year with regard to the question of need (Schweder, 1997). In particular, he noted that an alternative to the 'need envelope' approach agreed by the Committee and endorsed by the Commission last year, was to investigate a more general consideration of community needs in aboriginal societies in view of their dynamic nature. In this regard, if AWMP development was to be based on general considerations and generic knowledge of need in developing aboriginal societies, it would be necessary for the Commission to request assistance from the social sciences. He noted that for the need envelope approach it is primarily the upper bound and the relative weights within the envelope that matter.

The Committee referred to its earlier comments that specification of need was a matter for the Commission not the Committee. It re-emphasised the importance of advice from the Commission on this matter if it is to make progress in the AWMP process. It believes that specification of need envelopes by the Commission in the form suggested in Annex I Fig. 1, will be sufficient at this stage of the process and **requests** that the Commission provide it with its preference for the upper boundary of the need envelope for fishery type 1 and fishery type 2 cases, given their knowledge of the situation for the West Greenland minke and bowhead whale fisheries. The figure shows three options for each fishery type. Advice from the Commission on this issue is extremely important, in that it will provide reasonable limits to the scope of scenarios that must be addressed.

The Committee stresses that the need envelope is intended to place upper bounds on the scenarios it is to consider. Many different trajectories can be envisaged within the need envelopes and examples are given in the figure. Specification of the upper bound is not intended to suggest that the Commission will set strike limits at a constantly increasing rate over the next 100 years.

MULTISPECIES CONSIDERATIONS

As discussed earlier, the Committee recognised that, historically, need by hunters in West Greenland has been fulfilled by harvests of more than one species. This issue is one that clearly needs to be addressed by the Committee. The Committee's work will be facilitated by advice from the Commission and hunters.

At present, the *Initial Exploration Trials* for fishery type 1, which are loosely based on West Greenland, assume that the estimated need of 670 tons of whalemeat (TC/40/AS3) consists solely of minke whales. This is not in accordance with previous and current harvesting patterns. The Committee **requests** the Commission to provide it with an estimate of the maximum proportion of total need which minke whales might be expected to supply for the harvest off West Greenland. Clarification of this issue should achieve a better balance between need satisfaction, risk and recovery. The Committee notes that, in the future, it may request the Commission for further information along these lines for other species (e.g. fin whales).

HUNTING STRATEGIES

The Committee **requests** that the Commission advise it on whether it should examine the implications of alternative harvesting strategies to those normally assumed. For example, it seeks information on whether it is possible for hunters to select for whale size and/or sex and on the degree of flexibility in the location of whaling grounds along the coastline.

BLOCK QUOTAS/CARRY-OVERS

At present, incorporation of block quotas and carry-over into candidate *SLA*s is recommended but not mandatory. The Committee **requests** that the Commission indicate how much emphasis it should place on developing an AWMP which incorporates block quotas and a mechanism for carry-overs.

CATCH VARIABILITY CONSIDERATIONS

The Committee **requests** that the Commission provide it with a general indication of the importance of variability in catches. For example, would it prefer an AWMP that achieves a slightly higher level of total need satisfaction averaged over a longer time period at the expense of greater variability in strike limits or would it prefer to sacrifice some satisfaction of total need to ensure less variability in catches?

COLLECTION OF BIOLOGICAL MATERIAL

The Committee noted that the collection of biological material from the catch can lead to a more successful approach to management. However, it recognised that the selection of which data need to be collected needs careful consideration. It is important only to ask hunters to collect data which can be justified as important in a management context. The Committee also recognised that hunters' participation in the collection of biological material is an important way in which they can participate in the management process.

At this stage, the Committee **agrees** that the following are most important for developing a satisfactory AWMP: sex; length; catch position; and tissue sample for each whale.

The Committee acknowledged and appreciated that such data had been provided by hunters from some aboriginal fisheries. Tissue samples are particularly important for those fisheries for which stock identity is a problem. It was recognised that DNA fingerprinting may also allow for mark-recapture population abundance estimates in the future, in conjunction with biopsy sampling.

The Committee **requests** the cooperation of the Commission, member governments and hunters in facilitating the collection of these data.

The Committee recognised the important interaction between management procedure and data requirements. Investigation of *SLA*s may well provide important information on research requirements.

WORKPLAN

The Chairman of the Standing Working Group had expressed concern at the small size of the SWG compared to the previous year. He believed that it was important for the SWG to have a wide range of expertise available. The Committee **agreed** that the following points were appropriate to consider, particularly in the light of the RMP development process:

(a) some continuity of membership;
(b) several 'groups' of developers;
(c) experts in the management field who are not developers;
(d) broad areas of expertise.

The Committee recognised the contribution that invited participants can make to this process, noting that this would be greatly enhanced if they can be invited on a longer-term basis rather than one-off attendance.

The Committee recognised that during the development of the RMP, the Scientific Committee and the Commission established a fund to help support the work of some participants. It **recommends** that the Commission consider establishing a similar scheme for AWMP development.

The Committee reaffirmed its view of last year that its aim was to produce an AWMP that satisfactorily meets the Commission's objectives as quickly as possible. The Committee noted that improvements beyond this point would not be justified in terms of time and cost.

11.1.2 Action arising

11.1.2.1 SHORT-TERM

A number of tasks related to the further development of the common control programme for the single stock trials and the programme which summarises its output were identified (Annex I, Appendix 7). It is expected that this work, and the work needed to update the programme for summarising the results graphically, will take approximately two months for the Secretariat to complete. Full details of the computing tasks which the Standing Working Group requested the Secretariat to conduct during the intersessional period are given in Annex I, Appendix 7. These are considered in the context of the overall workload of the Committee under Item 18.

The Committee welcomed Givens' offer to develop a world wide web site, hosted by Colorado State University, USA which would allow interested parties to download the most recent versions of the software (including the common control programme and the associated routines, as well as the code for the current versions of some of the candidate *SLA*s). There will be a direct link from the IWC site to the new site, which would be managed by Allison and Givens. This will require that the software is checked to ensure that it can be placed on the world wide web, e.g. that it does not infringe copyright restrictions. The IWC site will include an updated list of the software available including release date. Instructions on how to use the software should be included on the Colorado site. The Committee also agreed to establish an AWMP e-mail group chaired by DeMaster (see Annex P) to facilitate intersessional communication about computing and other issues. A similar mechanism had successfully been established for the Abundance Estimation Group by CSIRO and Punt kindly offered to establish the group at CSIRO.

The Committee agreed that the development of the trials for fishery type 3 (small populations) should be considered at the next meeting. DeMaster indicated that he and Breiwick would attempt to consider this intersessionally.

The Committee **recommends** that the Secretariat develop the requisite expertise in S-Plus by attending an instructional course. The cost of this was estimated to be £1,000 for one person and is discussed under Item 19.

11.1.2.2 LONG-TERM

The Committee believed that it had made substantial progress at this year's meeting. However, it noted that the short intersessional period before the next meeting made it unlikely that substantial progress could be made by developers. Therefore the Committee did not feel an intersessional meeting of the Standing Working Group was necessary but noted that it would require time to meet during the Scientific Committee meeting. However, it agreed that an intersessional meeting between the 1998 and 1999 Scientific Committee meetings would be required.

The current steps that have been identified for selecting a candidate *SLA* for implementing the AWMP are IWC, (1997e, p.196):

(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 - see above);
(3) specify performance measures (on-going);
(4) specify simulation trials (on-going);
(5) specify candidate *SLA*s (on-going);
(6) subject candidate *SLA*s 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 *SLA*s to the Commission.

With respect to a timetable, the Committee reiterated its comment (IWC, 1997e, p.197) that this was largely dependent on advice from the Commission on priorities for the Committee, its workload and associated financial support.

11.2 Bowhead whales

11.2.1 Bering-Chukchi-Beaufort Seas stock

11.2.1.1 ASSESSMENT

SC/49/AS1 and SC/49/AS2 covered different aspects of the methods for performing a Bayesian assessment of the Bering-Chukchi-Beaufort Seas bowhead population. SC/49/AS1 compared 'forwards' and 'backwards' variants of the analysis. These variants lead to different results. Four estimation procedures based on Bayesian synthesis were compared by simulation. Estimation procedures based on the backwards generally outperformed those based on the forwards variants. SC/49/AS2 explored related issues regarding the Bayesian assessment of the bowhead population. The authors made several specific recommendations for the bowhead assessment. These included using a standard Bayesian method, documenting the basis for priors more clearly, using a prior for MSYR which is uninformative, using a prior for the current population size rather than for K and determining juvenile survival rate implicitly from the other parameters and the model.

The authors of SC/49/AS6 noted that it was written in response to a suggestion to use the conditional maximum likelihood Monte Carlo approach (MCA). However, it was noted that comments in SC/49/AS1 and SC/49/AS2 indicated that the approach is not being advocated for the bowhead analysis. The authors compared MCA to other approaches in a few simple examples. Their results indicated that MCA could perform poorly in some circumstances. They concluded that the method was inappropriate to the bowhead application.

In SC/49/AS5, the authors presented additional investigations into two issues regarding the Bayesian synthesis assessment method, (1) the Borel paradox and (2) comparisons of backwards and forwards variants of the population projection. The Borel paradox is an issue in the Bayesian synthesis assessment because some parameters have more than one prior distribution specified for them. The authors modified the Bayesian synthesis by geometric pooling of these two prior distributions. An example using a

simple population dynamics model showed that geometric pooling caused the results not to change under reparameterisation.

Forwards and backwards variants of the analysis lead to different results. The authors compared deterministic forwards and backwards analyses using the simple model with an analysis using a stochastic model, and found that the forwards analysis gave results more similar to the stochastic model analysis. They suggested that the forwards variant may therefore provide a better approximation to the real world which certainly has stochastic population dynamics. Another method was introduced, termed 'full pooling', which was geometric pooling of the joint, rather than marginal, densities of the parameters. Full pooling was found to resolve the difference between the forwards and backwards analyses in the simple model example.

The Committee agreed that, of the Bayesian synthesis approaches currently under consideration, full pooling is the only method that provides a theoretical resolution of the forwards/backwards difference. In its opinion the mathematical reasons for the forwards/backwards problem had finally been identified, and a mathematical solution to this problem and the Borel paradox was provided by SC/49/AS5.

A more fundamental issue was raised in discussion: whether it was appropriate to specify more than one prior on a parameter, when not doing so eliminates the need for geometric pooling. While geometric pooling may be an appropriate approach for combining information from two 'expert' sources, problems arise when one of the sources is not actually reflecting expert information, but rather an absence of it. Careful consideration needs to be given to the specification of prior distributions. It was suggested that a preferable method would be for biologists to specify parameters in a way which would allow inspection of the entire joint parameter space that results, which would clarify the consequences of the prior given for a particular parameter.

It was noted that fisheries literature indicated that analyses using stochastic models may prove to be computationally difficult. It was also noted that results might go in either direction, such that either forwards or backwards might be closer to the results from various stochastic models. One suggestion for choosing between the methods could be how well each fits the data. Some members believed that the specific stochastic model considered in SC/49/AS5 had some biologically undesirable properties.

The Committee agreed that for the purposes of assessment at the next meeting, the analyses should be done with deterministic models. However, stochastic models should be investigated in future.

In SC/49/AS22, an age- and sex-structured Leslie matrix model was used in a standard Bayesian analysis of the Bering-Chukchi-Beaufort Seas bowhead stock. Model parameters were drawn from uniform prior distributions, and the population was projected from 1978 to 1993. The rate of increase (ROI), and beginning and ending population sizes, corresponded well to published estimates. Some output quantities were dependent upon the prior distribution for equilibrium population size, while others, such as RY, MSYR and ROI, were relatively unchanged.

The author indicated that preliminary investigations had shown that a similar analysis using a forward projection from 1848 would be possible. It was suggested that output quantities from such an analysis would provide an interesting comparison with the results of analyses using more informative prior distributions. The Committee welcomed this contribution, particularly with respect to ensuring that the bowhead assessment is a robust analysis.

The Committee welcomed the fact that the sub-committee appeared to be settling on a set of Bayesian approaches that were not as different as in past years.

SC/49/AS9 proposed and discussed ways to construct an indirect likelihood function to summarise indirect data, which can then be combined with the likelihood from direct statistical data to form the basis of an ordinary likelihood analysis. This method was termed 'likelihood synthesis'. The theory was illustrated by two examples, including a bowhead whale example, from which the authors concluded that likelihood synthesis analysis could replace Bayesian synthesis for the bowhead assessment. Likelihood analysis differs from Bayesian analysis in not requiring prior distributions to be specified. The authors suggested that SC/49/AS9 provides a method that is no more complex than Bayesian synthesis.

The Committee agreed that the likelihood synthesis was a promising new analysis framework and encouraged the authors to continue their development of the method for the bowhead assessment.

Based on the above, a Working Group was established to consider the various assessment methodologies available and to agree on the data and approaches to be investigated for assessments at next year's meeting. The Committee endorsed the **recommendations** of the Working Group as given in Annex J, Appendix 2. It was further agreed to establish another intersessional correspondence group (convenors Buckland/Breiwick; for members see Annex P) to prepare for next year's assessment. Breiwick also agreed to send data files containing catch and comprehensive abundance data to those interested.

SC/49/AS19 considered the evaluation of aerial photographs of bowhead whales for use in capture-recapture analyses. The authors reported that: (1) a workshop was held at the National Marine Mammal Laboratory in July 1996 to establish an improved protocol for scoring image quality and whale identifiability in aerial photographs of bowhead whales; (2) a new scoring protocol was developed and proven to provide moderate agreement between independent evaluators in their scoring of photographs; and (3) owing to a significant fraction of whales that were probably unidentifiable due to a lack of marks, efforts to use capture-recapture techniques used for other cetacean species to determine abundance will have to be modified for bowhead whale populations.

The Committee agreed that a re-analysis of the data used in Whitcher *et al.* (1996) to estimate adult bowhead survival rate, as well as any new information after rescoring using the above protocol, would be extremely beneficial when assessing the status of this stock. However, additional photo-identification studies are needed to provide adequately precise estimates of survival. It **recommends** that the photo-identification study tentatively planned by US researchers be undertaken in 1999, if at all possible.

The Committee noted that in the subsistence harvest for 1996, 44 whales were struck, of which 39 were landed. Preliminary values for the spring harvest in 1997 were 34 whales struck of which 19 were landed. The efficiency of the harvest (as measured by the ratio of landed to struck) in 1996 was the highest ever reported for years 1973-1996. The Committee congratulated the hunters for their continued efforts to improve efficiency. A pregnant whale landed in 1996 had a large healed injury from an earlier harvest attempt. Thus at least some struck and lost animals may survive and even calve again. The pregnancy rate for all

mature females harvested between 1980 and 1996 was 21%. George noted that the pregnancy rate estimated from the autumn harvest was possibly less biased than that from the spring due to the smaller likelihood of missing small foetuses. Finally, a large male taken at Wainwright reportedly carried a triangular stone harpoon point embedded in the blubber. This provides further evidence of the long life-span of bowhead whales (e.g. George *et al.*, 1995).

Borodin summarised IWC/49/AS1 which discussed the importance of reviving bowhead whaling in Chukotka. The paper notes that at least five bowhead whales are needed to satisfy the cultural and nutritional needs of indigenous people of certain coastal villages. For the indigenous people, this would revive a more than 2,500 year cultural relationship with the bowhead whale. The Government of Russia was therefore requesting an annual take of five whales.

The Committee discussed studies that can provide useful information regarding the movement and possible sub-stock structure of bowhead whales. It **recommends** that studies of bowhead whales off Chukotka be continued and, as needed, initiated. These include: (1) observational studies of migrants; (2) genetic studies; and (3) satellite tagging studies. There was general agreement that joint studies on genetics (including bone samples and biopsy samples) and satellite tagging be undertaken as soon as possible. Albert reported that a cooperative study was being undertaken between North Slope Borough, Alaska (NSB), Russian scientists and two native groups in Chukotka. A satellite tag suitable for bowheads is being developed by NSB and Øien (Norway). Brownell reported that the results of a joint project to compare the genetics of bowhead whales landed at Barrow, Alaska, with bowhead biopsy samples from the Okhotsk Sea will be presented at next year's meeting.

Breiwick agreed to coordinate intersessional work to finalise the catch series for the Bering-Chukchi-Beaufort Seas stock.

SC/49/AS14 summarised recent findings concerning the visual system of the bowhead whale, based on samples from the subsistence harvest at Barrow. The study suggests that vision is more important to bowhead whales than previously thought.

11.2.1.2 MANAGEMENT ADVICE

The results of the simulations described in SC/49/AS23 suggested that management advice will be little affected whether the next abundance survey occurs in 1998, 1999 or 2001. The Committee agreed that year was a relatively unimportant factor, while stock level was the primary determinant of the estimate of RY in the immediate future. The CV of the abundance estimate was of intermediate importance. The Committee thus **agreed** that (1) the choice of when to conduct the next bowhead survey relative to the proposed four year window would not influence management advice, and (2) future analyses similar to those reported in SC/49/AS23 were probably not necessary in the immediate future.

The Committee agreed that there was no reason to change the management advice given previously (IWC, 1997e), i.e.

> . . . 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%).

It noted that a major reassessment for bowhead whales would be carried out during next year's meeting.

Finally, the Committee wished to acknowledge the efforts of its Russian colleagues in conducting research and providing reports on stock structure. These actions are entirely consistent with the previous request of the Committee to encourage the collection of information on stock structure in this area (IWC, 1997h, p.157). The Committee agreed that such research was critically important to the assessment of this stock and, therefore, should be continued if at all possible.

11.2.2 Other stocks

The Committee confirmed that a bowhead whale from the Hudson Bay stock was harvested by Canadian aboriginal hunters on 15 August 1996 (Reeves and Heide-Jørgensen, 1996). Last year the Scientific Committee noted its concern about the status of this small stock. The Committee **recommends** that no additional whales be removed from this stock until it can be shown that any proposed level of harvest will have no more than a negligible impact on the probability of the stock recovering and the time to recovery.

11.3 Gray whales

11.3.1 Eastern stock

11.3.1.1 ASSESSMENT

SC/49/AS24 presented revised standard Bayesian analyses of the eastern Pacific gray whale population. The analyses used the specific model chosen from SC/48/AS3 that was shown to provide the best fit to the data, using a Bayes factor comparison. The first analysis had similar specifications as in Wade (1996), and projected forwards from 1967. Differences from the previous analysis included incorporating catches up to 1995, projecting to 1997, expanding the prior on equilibrium population size to Uniform (17,000, 80,000), and expanding the prior on MSYL to Uniform (0.5, 0.8). Results were similar to those in SC/48/AS8, particularly for the quantities to be considered when forming management advice:

$Q_0 = \{0$ if $P < 0.1K$; min(RY-1, 0.9MSY) if $0.1K = P = \text{MSYL}*K$; and 0.9MSY if $P > \text{MSYL}*K\}$ and
$Q_1 = \{0$ if $P < 0.1K$; min(MSYR$*P$, 0.9MSY) if $0.1K = P = \text{MSYL}*K$; and 0.9MSY if $P > \text{MSYL}*K\}$,

where P is the estimated total 1+ stock size in 1997, and MSY, MSYR, MSYL and K are expressed relative to the total 1+ stock component. The lower 5th percentiles for Q_0 and Q_1 were 442 and 454, respectively; the posterior means were 685 and 659, respectively. Sensitivity to the selection of a starting year was examined by repeating the analysis but projecting forwards from 1900, which can also be seen as investigating sensitivity to the assumption of a stable age distribution and an equal sex ratio in 1967, the starting year of the first analysis. In this case the results for Q_0 and Q_1 were similar but slightly lower with 5th percentiles 413 and 396, respectively, and posterior means of 662 and 623, respectively.

SC/49/AS24 included additional analyses using four estimates of calf numbers from the northbound migration in the spring of 1994-1997. The additional information provided by the calf estimates considerably improved the estimates of equilibrium population size, which were 25,130 or 30,140, depending upon the starting year of the trajectory. Although analyses using the calf data provided different

estimates of equilibrium population size and related quantities, other quantities were not substantially changed. The author indicated that his use of calf data should be considered preliminary at this time, but noted that the initial results appeared promising.

SC/49/AS3 examined the sensitivity of an assessment to changes in some of its specifications. The assessment that formed the base-case for the examination was a slight variant of that applied at last year's meeting by Wade (1996). The results are relatively insensitive to the choice of first year, the age structure of the population at that time and the year for which a prior on absolute abundance is specified. Of the quantities considered, estimates of RY and RY*{ = RY if the stock is below MSYL; MSY otherwise} are the most robust and those of current depletion of the population (relative to *K* and MSYL) the least. Some analyses attempted to fit the entire period of historical catches by allowing for process error and underestimation of historical commercial and aboriginal catches, but these factors were unable to completely resolve the inconsistencies noted by previous workers between the historical catches and the recent trend in abundance.

The Committee **agreed** that the analysis using calf data was worth pursuing; such an analysis may represent the best and most complete use of the available data. It also noted that use of calf data in the analyses did not substantially change estimates of management quantities. Therefore, it was **agreed** that the stock should be assessed using an analysis without calf data and with a starting year for the projection of 1967.

SC/49/AS13 reported on the results of four consecutive gray whale cow/calf surveys conducted from Pt Piedras Blancas during the northbound migration between 1994 and 1997. In 1994 and 1995, aerial surveys were also conducted to determine the offshore distribution of the migration. Day/night migration rates were measured with thermal sensors. Indices of calf production (calf estimate/total population estimate) were 4.5%, 2.6%, 5.1% and 6.5% for the years 1994-97, respectively.

Fluctuation in the reported calf index may result from changes in the time of ice formation in the Arctic. The authors stated that the apparent fluctuation in recruitment seen at Piedras Blancas may reflect an increase in sensitivity to the normal range of environmental conditions experienced by the stock as it approaches its carrying capacity. This is discussed further under Item 6 and in Annex F.

SC/49/AS12 reported on day/night migration rates past Granite Canyon in January 1994-96, determined with thermal sensors. No differences in respiration intervals or swimming speeds between day and night strata were found. However, pod sizes were significantly greater during the day, as was average distance offshore. Migration rates were significantly higher overall during the night but the disparity in rates was concentrated in the second half of the migration. The overall swimming speed was estimated to be 6.3km/hr (3.3kts).

The Committee recognised that accounting for differences in migration rates by time of day is one of several important correction factors used to estimate abundance (see Laake *et al.*, 1994).

SC/49/AS18 provides an assessment of gray whale counts by shore-based observers. Agreement on pod sizes occurred in 65% of the cases but observers on the standard watch tended to underestimate the number of whales in a group. The pod size corrections were compared with those in earlier studies. Reilly (1981) found that pods of size 2 or 3 needed no correction whereas single whales and pods of 4 or more did. Laake *et al.* (1994) found that the size of the corrections diminished as the size of the estimates increased, which is the opposite of the pattern observed in the present study. Thermal sensor data (DeAngelis *et al.*, 1997) found a 70% agreement in pod size estimates, more than the 44% reported in SC/49/AS18. The authors noted that their conclusions are tentative because there were only a small number of comparisons between survey methods and aspects of the data require further examination.

SC/49/AS25 reported on the results of the second year of gray whale studies at San Ignacio Lagoon that aim to document the whales' use of the lagoon for comparison with previous studies and to detect and analyse any changes. Eleven censuses were completed in the period 11 February-29 March 1997 to determine abundance and distribution. In addition, photo-identification work was carried out. The maximum combined count (253 whales) was obtained in the last week of February (127 single whales and 126 cow-calf pairs). This represents an increase of 22% over the number counted in 1996 (207) but is still 36% lower than the highest count in 1985 of 395 whales (Jones and Swartz, 1986). The abundance of single whales declined constantly during the study period while the number of cow-calf pairs increased until the first week of March and then gradually declined. Whale counts were always greater within the lower zone nearest the entrance of the lagoon and decreased towards the upper zone of the lagoon. A total of 157 single whales and 150 cow-calf pairs were photo-identified. Whales use three other lagoon areas and unless all are simultaneously monitored, it is difficult to determine whether the apparent decrease from the previous high level is due to changes in abundance or in utilisation patterns.

The Committee welcomed this study and **recommends** that such studies continue.

SC/49/AS8 reported the results of shore-based observations of gray whales in waters adjacent to the Chukotka Peninsula, begun in 1990. Counts were made by 30 observers from 15 observation posts, both from shore and from whale boats. In 1994, observations were conducted mainly from April - November, and in 1995 all year round, using binoculars. The 1994 and 1995 data indicate that gray whales appeared earliest in the northern sector of the Gulf of Anadyr. The authors further comment on the spring distribution and migration, summer distribution and autumn distribution and migration. They conclude that gray whales of this stock occupy the entire ice-free area of the Bering Sea, Chukotka Sea and East Siberian Sea. Further expansion of the whales' summer range appears to be limited by ice and foraging conditions. The authors plan to undertake further gray whale studies in this area but noted that there are funding problems.

The Committee agreed that Russian scientists should be strongly encouraged to continue the collection of biological data on available specimens. Data relevant for inferences about density dependence were considered to be very useful.

IWC/49/AS2 gave an overview of gray whale harvesting off Chukotka. Gray whaling has taken place for at least 25 centuries in this area. Harvesting in the early 20th century is poorly documented, but 66 whales were taken in the period 1923-1932. The authors present statistics for the aboriginal whaling of gray whales in the period 1948-1968. In 1969, traditional whaling ceased; the modern whale catcher *Zvezdny* then took gray whales for use by Chukotkan natives. The *Zvezdny* did not operate after the 1991 season through lack of funding. After a two year hiatus in 1992 and 1993,

Chukotkan natives began to revive their traditional methods and landed 44 whales in 1994. The authors review the hunting methods used and summarise morphological and physiological studies carried out by TINRO (Vladivostok) in 1996.

SC/49/AS15 reported the results of gray whale studies in coastal waters off Chukotka Peninsula in 1996. Twenty-six whales were examined; information on sex, size, age, physiological condition and rostrum-eye length (related to length) was obtained. A review of the history of gray whale hunting by Chukotka natives was given in SC/49/AS16.

11.3.1.2 MANAGEMENT ADVICE

The Committee noted that although the assessments in SC/49/AS3 and SC/49/AS24 used slightly differing methods, and only the latter analysis used calf data, the results were very similar (see Annex J, Appendix 3). The Committee **agreed** that management advice could be formulated on the basis of results from the approaches in SC/49/AS3 and AS24, noting their similarity.

The lower 5th percentiles for estimates of Q_0 using the methods in SC/49/AS3 and AS24 were 490 and 482 respectively. The Committee agreed that because the stock was not severely depleted, and indeed could be well in excess of the MSYL, a quantity such as Q_0 is more appropriate for use in management advice than RY. As the stock approaches its unexploited equilibrium level, RY approaches zero even though a catch as great as MSY would pose little risk to the stock. An alternative quantity, Q_1 which, for severely depleted stocks, reserves a greater proportion of replacement yield for population growth and hence provides lower catch limits than Q_0, was found to give similar but slightly lower numbers. However, the assessment results show that the stock may already be above MSYL.

The last full assessment of this stock was in 1990 (IWC, 1993c), and substantial new information has become available since then. Based on data and analyses examined this year, the Committee **agreed** that a take of up to 482 whales per year is sustainable (the lower of the two 5th percentile estimates of Q_0), and is likely to allow the population to stabilise above MSYL. The Committee **agreed** not to provide estimates of rates of increase towards MSYL under such a harvest since such estimates were no longer considered appropriate, given that the assessment results show that the stock may already be above that level.

11.3.1.3 FUTURE WORK

The Committee noted it would probably be several years before it would be asked to carry out a major re-assessment in order to provide management advice to the Commission.

The Committee believes it is important to undertake research in the interim, particularly as it believes there are a number of reasons why it is important to address the research programme that should be carried out in the intervening period. In particular, it recognises the general importance of studying this stock. It is the best (if not the only) example of a stock once depleted to very low levels and now probably recovered to somewhere near carrying capacity. It was **agreed** that continued monitoring of the stock is extremely important to the Committee's understanding of general issues of population dynamics, including its discussions of density dependence, MSYL, MSYR and *K*. An intersessional group convened by Brownell (for members see Annex P) was established to consider future research, including techniques to be used and experimental design. The Committee looks forward to a report at its next meeting.

11.3.2 Western stock

A sighting of two gray whales on 22 July 1997, in the inshore waters of Kochi (33°06′N, 133°08′8″E) (SC/49/AS17) was the most southerly sighting of gray whales in the area in the last 40 years. The whales were judged to be less than 11-12m in length. The authors suggest that the occurrence of apparent juvenile whales on the Pacific side of Honshu is compatible with a hypothesis of possible segregation during migration between calving and feeding grounds.

In response to last year's recommendation for research on the western stock of gray whales (IWC, 1997e, p.91), a joint Russian-American effort was expanded during 1997 to investigate status on the summer feeding grounds. In 36 hours of direct whale observation from the eastern shore of Sakhalin Island a total of 212 whale groups were seen, although many were multiple sightings of the same whales. The data collected will expand the catalogue of photo-identified whales in the area and will provide baseline information for year-to-year assessments of habitat use, numbers, individual site fidelity and behavioural response to seismic operations.

Zhu noted that a gray whale may have stranded in Chinese waters last year. The Committee **recommends** that Chinese scientists report any available information about gray whale presence in this area.

As last year, the Committee **recommends** that because this is one of the most endangered baleen whale stocks in the world, research on the stock should continue, and 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, this stock to identify the research and management measures required to maximise the chances of it recovering.

11.4 West Greenland fin whales

The Committee noted that fin whale abundance estimates for the central Atlantic have been reported in NAMMCO (1997). The estimation methods are described in Borchers *et al.* (1997) but the document was not available at this meeting and the raw survey data have not been released to the IWC. The Committee **recommends** that these estimates be reviewed at the next Annual Meeting, but draws attention to its discussions on data availability and related matters under Item 8.2.2.

The Committee noted that new genetic analyses were presented in Bérubé *et al.* (1997). They were discussed by a Working Group whose report is given in Annex T. The Committee agreed that the new analyses did not contradict the belief it expressed at the last assessment of this stock (IWC, 1995c) i.e. that the animals found off West Greenland probably do not comprise a separate stock.

The Committee therefore **agreed** to repeat its most recent advice on this stock. It is unable to provide management advice under Schedule Paragraph 13a, given the lack of information particularly regarding stock identity. The small estimate of stock size and approximate lower confidence interval (1,096, 95% CI, 520-2,106) are a cause for concern.

The Committee **strongly recommends** that studies of stock identity, such as those in Bérubé *et al.* (1997) continue and are intensified. Noting the high variance associated with

the estimates of abundance, the Committee also **recommends** that further surveys be carried out, designed to address the issue.

11.5 West Greenland minke whales

SC/49/NA7 described a re-analysis of the 1993 cue-counting aerial survey for minke whales off West Greenland using recently revalidated and corrected data. SC/49/NA7 provides two separate analyses: (1) a standard stratified analysis; and (2) one based on recently developed spatial modelling approaches. The two analyses resulted in abundance estimates that differed by about 20%, while the CV from spatial modelling was 5% lower. The abundance estimates from both analyses may be negatively biased because the mean surfacing rate used in the analyses was higher than the rate found in recent radio-tracking studies off coastal Norway. It was also noted that the estimates of variance did not include any uncertainty for the estimated mean dive time which would make them negatively biased. The stratified analysis estimate (6,385 minke whales, CV = 41%) was an update of an estimate previously accepted by the Committee and not significantly different from it (Larsen, 1995).

Concerns were expressed over the reliability of the spatial modelling approach, especially with respect to extrapolation. In such situations, the estimates could not be considered reliable, but the results can provide useful hypotheses about distribution for consideration in future surveys. The authors had made some suggestions for the design of future surveys, including extension of the survey area around the southern tip of Greenland. It was also suggested that the division of the East and West Greenland Small Area at Cape Farewell may need to be reconsidered. This is in accord with the view of several authors that this is an artificial boundary (e.g. see review in Donovan, 1991).

The Committee noted new genetic analyses presented in SC/49/NA4. They were discussed by a Working Group whose report is given in Annex T. The Committee **agreed** that the new analyses did not contradict the belief it expressed at the last assessment of this stock (IWC, 1995c) i.e. that as for fin whales, minke whales off West Greenland do not comprise a separate stock.

Given the above, and the fact that the revised abundance estimate was not significantly different from the one considered in 1995, the Committee **agreed** to reiterate the advice it had given when it last assessed this stock (IWC, 1995c) i.e. that although there is no information upon which to determine the status of the stock in relation to MSYL, it believes such a stock is above the minimum level below which aboriginal catches should not be taken. However, it can offer no advice on the size of catches which will allow the stock to move towards MSYL.

The Committee **recommends** that studies of stock identity, such as those in SC/49/NA4, continue and are intensified. It also **recommends** that further surveys be carried out, taking into account the issues addressed in SC/49/NA7.

11.6 East Greenland minke whales

According to the current stock boundaries, the minke whales taken by East Greenlanders are considered part of the Central Stock. The abundance of minke whales in this stock area is discussed under Item 8.2.2. The Committee has not previously given specific advice on this stock in relation to aboriginal hunts conducted off East Greenland. The Commission has in the past noted the information on abundance provided by the Committee on this stock and established a catch limit of 12 animals (e.g. IWC, 1995c).

11.7 Humpback whales off St Vincent and The Grenadines

The Committee noted that new abundance estimates for humpbacks in the North Atlantic had been considered under Item 10.4. However, the relationship between whales taken in the Bequia breeding/calving area and other humpback whales in the western North Atlantic is unknown (IWC, 1994a, p.59). A large number of humpbacks have been photographed and biopsied in the central Caribbean and on the feeding grounds to the north (Palsbøll *et al.*, 1997b) in recent years. As noted previously (e.g. IWC, 1997e, p.92), fluke photographs and tissue samples from any whales harvested off Bequia would be extremely valuable for determining stock affinity. As no whales have been successfully taken in this fishery since 1993, the Committee **recommends** that efforts be made to find recent photographs of whales taken off Bequia and to collect tissue samples and fluke photographs from any future catch. Without such information, management advice will continue to be based on assumptions about stock structure.

The Committee **agreed** to repeat its advice from previous years i.e. that a catch of up to three whales annually will be unlikely to harm the stock. If whales are caught, every effort should be made to collect as much information as possible, especially fluke photographs and tissue samples (see above) and the sex, length and approximate catch position (see Item 11.1).

12. SCIENTIFIC PERMITS

12.1 Advice on the effect on stock(s) of scientific permit catches

Last year, the Committee had had extensive discussions of this Item (IWC, 1997e, p.93). It had agreed that the matter should be considered further this year and had encouraged members to submit documentation presenting further proposals. In the absence of such proposals the Committee did not consider this Item but agreed to keep it on the Agenda for next year's meeting, noting that it will only be considered if documentation is available.

12.2 Review of results from existing permits

12.2.1 Japan-Southern Hemisphere

12.2.1.1 REPORT OF THE JARPA REVIEW MEETING - CHAIRMAN'S SUMMARY OF SC/49/REP 1

The Working Group met at the Mariners' Court Hotel, Tokyo, on 12-16 May 1997. The review meeting was convened by Schweder. Reilly was elected chairman.

Bannister participated in the opening, where he outlined some of the considerations that had led to the structure of the draft agenda, in particular the need to reflect in the discussions two separate components arising from the review meeting's terms of reference:

(1) the specific research carried out, and its results;
(2) the contribution made by those results to the stated objectives of the research programme, and to the aims of the IWC as expressed in its Resolutions.

The review meeting completed all but the final task, i.e. judging the merits of the results in terms of the Commission's resolutions. That more general task was forwarded to the full Committee.

Five components of JARPA were reviewed: sighting surveys and abundance estimation; stock structure; biological parameter studies; marine ecosystem studies; and those addressing environmental change. For each component the Group considered the following: its background, including original and additional research objectives; methodology of data collection; data analysis; results; and potential of results in the context of the objectives of JARPA and of stock management.

THE ORIGINAL RESEARCH PROPOSAL AND LATER ADDITIONS

Ohsumi reported that Japan's original objectives for the research had been:

(1) estimation of biological parameters to improve the stock management of the Southern Hemisphere minke whale;
(2) elucidation of the role of whales in the Antarctic marine ecosystem.

Subsequently, as part of the natural evolution of the programme and in response to developing requirements, two further objectives had been added:

(3) elucidation of the effect of environmental changes on cetaceans;
(4) elucidation of the stock structure of the Southern Hemisphere minke whales to improve stock management.

OUTLINE OF THE JARPA RESEARCH

Fujise presented a brief summary. Two feasibility studies had taken place in 1987/88 and 1988/89, with the full scale 16-year research commencing the following season and alternating each season between Areas IV and V. In 1995/96 and 1996/97, coverage was extended to Areas IIIE and VIW respectively, for a limited period feasibility study of stock structure. He stated that the full programme has two components: a sighting survey whose primary purpose is the estimation of trends in abundance; and a sampling component to allow biological parameter values to be estimated given also the abundance information provided by the sighting survey.

In the programme as originally proposed, it was planned to take 825 animals in any one season from either Area IV or Area V. For two years of feasibility studies, 300 animals (with an allowance of ±10%) were planned to be sampled in parts of Areas IV and V. Following the results of the feasibility studies, considerations of the balance between the expected precision of estimates of the mortality rate and the available research capability led to the decision to set the number of animals to be sampled each season at 300 with an allowance of ±10%. In 1995/96, additional samples of 100 animals with an allowance of ±10% were planned for Area IIIE, and subsequently 100 ± 10% in Area VIW in 1996/97, for studying stock structure (see Item 3, SC/49/Rep1).

Initially, three vessels (plus the mother ship) had been employed, but a fourth had been added in 1995/96 to allow for an increase in searching effort in the sighting survey. This and some other changes during the progress of the programme had been made in response to comments from the Committee. Initially, both dwarf and ordinary forms of the minke whales had been sampled, but sampling of the former had ceased in 1993/94. A total of 1,546 (Area IV), 1,546 (Area V), 110 (Area IIIE) and 110 (Area VIW) ordinary and 16 dwarf form minke whales had been sampled by the end of the 1996/97 season.

OVERVIEW OF PAST DISCUSSIONS OF THE JARPA PROGRAMME AND ITS RESULTS

The review meeting noted that while both the quantity and quality of the scientific work had been commended by the Committee, differing views had been expressed about its relevance to management considerations. A list of specific issues in contention was compiled from past Committee reports and is given in annex F of SC/49/Rep1.

A. SIGHTING SURVEYS AND ABUNDANCE ESTIMATION

BACKGROUND: ORIGINAL AND ADDITIONAL RESEARCH OBJECTIVES

Noting that the objectives for the research did not include the provision of abundance estimates (for input, perhaps, to the RMP) *per se*, clarification was sought on the intent of this component of the programme. Ohsumi stated that though the primary reason for the sighting surveys was their contribution to Objective 1 (the estimation of biological parameters), their pertinence to the RMP and the associated implementation process for Southern Hemisphere minke whales should be seen as a derivative objective.

METHODOLOGY AND DATA COLLECTION

The closing procedures (e.g. to determine school size) were identical to those used in closing mode for the IDCR surveys, excepting for the additional time spent on sampling, and closing being limited to minke whales. The sighting and sampling vessels engaged in such sampling ('SSVs') surveyed along parallel tracklines, but from the 1991/92 season one vessel at any one time was devoted to sighting only, in order to investigate the effect of sampling activity on abundance estimates.

Certain changes in JARPA survey procedures over time were noted but the review meeting considered that adequate comparability over time in data collection had been achieved.

One important difference in survey methodology from that used on the IDCR cruises was noted. On IDCR cruises, survey on one day commences from the position reached at the end of the previous day. However, for the JARPA programme, a target distance per day was established; if this distance has not been achieved by the end of the day, the remainder of the planned trackline for that day is not covered, and survey the next day starts from the 'targeted' (not the actual) position for the end of the previous day. This procedure can lead to under-surveying of higher density areas, because more time is required for closing on and sampling whales, so that less survey distance is covered on the day in question. This has implications for abundance estimates that are discussed immediately below, and for sampling representativeness.

METHODS OF ANALYSIS

Two papers provided analyses of the sighting data to estimate abundance. The key differences between the methods of analysis in SC/M97/1 and SC/M97/23 are that the former stratifies by school size in estimating effective search half-width (w), whereas the latter estimates w for all schools combined and then multiplies an estimate of the total number of schools by another of mean school size. Furthermore, SC/M97/23 stratifies data to a lesser extent,

based on the AIC statistic, to avoid the high variances associated with models that over-fit data. Both analyses assumed $g(0) = 1$.

In addition, SC/M97/23 attempted an approach to adjust for the under-surveying of higher density areas in the JARPA surveys arising from the difference in survey methodology described in the final paragraph of the preceding section. This involved scaling the number of sightings made each day upward by the ratio of the target distance for that day to the searching distance actually achieved. Concern had been expressed previously in the Committee that estimates of minke whale abundance from JARPA reported at that time had been considerably lower than IDCR estimates. One of the motivations for this part of the analysis given in SC/M97/23 was to investigate whether that factor was a primary cause of the difference.

ESTIMATES OF ABUNDANCE AND TRENDS

The authors of SC/M97/23 suggested that:

(1) their unadjusted estimates are in broad agreement with those of SC/M97/1; and
(2) their adjusted estimates (with one exception) are not systematically lower than comparable IDCR closing mode abundance estimates, although confidence in this conclusion would be enhanced if analysis of the JARPA surveys in seasons other than the two analysed had yielded similar results.

In respect of (1), the review meeting felt that no strong inferences could be drawn given the limited number of comparisons.

In discussions arising from (2), a number of concerns were raised as to whether the 'adjusted' approach applied to the JARPA analysis is an appropriate means of correcting for the higher-density-under-surveying effect to yield comparable estimates of absolute (or even relative) abundance. These concerns arose primarily from considerations of the mechanisms that lead to clustering of whales, and hence areas of higher and lower density. The review meeting considered that further research to develop an approach to correct for the effects of clustering was required. A specific suggestion was that this be based on modelling the extent of the clustering each year by a Neyman-Scott process.

POTENTIAL OF THE RESULTS TO ACHIEVE THE OBJECTIVES OF JARPA AND OF STOCK MANAGEMENT

In relation to annex D of SC/49/Rep1, the review meeting agreed that this topic was pertinent to items B 2.1, 2.4, 3.1 and 3.2. Relevance to item 2.4 related to the agreed research requirement of consolidating the Southern Hemisphere minke whale abundance estimates provided by different programmes for different areas of coverage and using different methodologies (e.g. IDCR, JARPA, JSV).

The fact that JARPA provides more frequent repetitions of surveys of the same localities than the IDCR programme would facilitate estimation of the extent of inter-year variability in local abundance, which would in turn lead to improved results from the consolidation exercise.

The review meeting agreed that more research was required to develop a reliable method for adjusting for the higher-density-under-surveying feature of the JARPA survey design. Once this had been achieved, the resultant abundance estimates should be useful both as absolute and relative indices.

B. STOCK STRUCTURE

BACKGROUND: ORIGINAL AND ADDITIONAL RESEARCH OBJECTIVES

One of the original objectives of JARPA was to elucidate the stock structure of minke whales to improve stock management. The stock identification objectives were being addressed by both genetic and non-genetic techniques.

METHODOLOGY OF DATA COLLECTION

Information on stock structure presented at the 1990 Comprehensive Assessment was based on biological samples collected during commercial whaling operations. Because of the nature of this fishery, these samples tended to be from animals distributed along the pack-ice edge and were not evenly distributed within Areas IV and V. In contrast, during JARPA 2,887 minke whales were systematically collected from between 1987/88 and 1995/96, where survey effort was evenly distributed within the study area. A variety of tissue samples and body measurements was taken from each whale.

A simulation exercise had been conducted which indicated that a sample of at least 150-200 individuals using mtDNA was needed to detect significant differences between putative stocks (SC/M97/3).

DATA ANALYSIS

Genetic studies, based on mitochondrial DNA (mtDNA) were conducted to investigate the phylogenetic relationships of ordinary and dwarf forms of minke whale and stock structure in the ordinary form. Two methods (using mtDNA) indicated a clear genetic differentiation between dwarf and ordinary forms. The sequencing analysis also indicated that the southern dwarf, southern ordinary, North Pacific and North Atlantic forms represent independent genetic populations. Further, based on genetic data, the dwarf form was found to be more closely related to minke whales in the North Atlantic and North Pacific than to the ordinary form.

Four studies of stock identity of the ordinary form were reported. In the first study, stock structure was evaluated using chi-square statistics for heterogeneity on the observed haplotype frequencies. The resulting chi-square was significant and supported the alternate hypothesis that sub-structure was evident in Areas IV and V (i.e., the western and eastern strata probably contained minke whales that were genetically distinct, but mixing occurred in the central stratum).

A second and third study considered both geographical and temporal factors. The results of both were consistent with the hypothesis that different stocks occurred in Areas IV and V, where the composition of animals from the two putative stocks changed both longitudinally and temporally during the feeding season.

A fourth study reported the results of an analysis of molecular variance (AMOVA). *A priori* strata were established using four longitudinal sectors and two time periods. Of 137 haplotypes identified, none were unique to any single geographic stratum. The AMOVA test results were significant between Area IVW-early and all other strata. Excluding stratum IVW-early, none of the other contrasts between strata were statistically significant.

It was reported that a comparative study of both dwarf and ordinary forms, involving body colouration, and morphometric and skeletal measurements, is underway.

With regard to the study on stock identity in the ordinary form, a single morphometric analysis grouped 326 animals into three strata (Area IVW-early, Area IVW-late, and Area

IVE-early). A multivariate analysis revealed that the three strata were not separated exactly; nonetheless, whales from Area IVW-early stratum were found to be significantly different from whales found in the other strata.

SYNTHESIS

The authors noted that they were not proposing new stock boundaries at this time, but that their results were consistent with the hypothesis that minke whales collected in the western part of Area IV, early in the feeding season form a stock distinct from whales taken in strata further east or later in the feeding season.

There was discussion among review meeting participants as to what level of genetic distinctness was significant at the stock and species level. It was noted that general standards for species-level differences have been established based on a comparative approach (i.e., the genetic distance between 'good' species in a taxon is typically used as the standard for putative species). Regarding stock structure, the answer is less clear.

Taylor (annex G of SC/49/Rep1) commented that the number of individuals exchanged between populations exists on a continuum in nature. In statistical terms, the amount of difference required before a particular grouping of individuals can be designated as one stock or two is referred to as effect size. It is important that effect size is explicitly stated prior to undertaking research on stock structure, as it is not possible to determine the sample size necessary to reliably detect a specific effect size without specifying it. Taylor recommended that the Committee should develop criteria regarding the effect size required to designate two putative stocks as separate management units.

Several members noted that for the *Implementation Simulation Trials* for the RMP the key issue regarding stock identity was the number of breeding groups and not the number of, or distribution on, feeding areas. However, the distribution and number of breeding groups for the ordinary form of minke whale is poorly understood.

It was noted that only information on mtDNA had been used so far to investigate stock structure of the ordinary form, but that efforts were underway to use existing tissue samples to look for stock structure using nuclear markers. It was also recognised that statistical analysis of the genetic data should consider the inclusion of school size as a covariate because: (1) schools of different sizes are not detected with equal probability; and (2) of the schools encountered, animals from smaller schools are oversampled relative to animals from larger schools.

POTENTIAL OF THE RESULTS TO ACHIEVE THE OBJECTIVES OF JARPA AND OF STOCK MANAGEMENT

Participants agreed that the following points listed in annex D of SC/49/Rep1 were pertinent to items A (Objectives 1 and 4) and B 1, 2.1, 2.4, 3.2 and 3.3. It was noted that research on stock structure is clearly related to Objective 4 of annex D, but is also important regarding the manner in which specific biological parameters are both estimated and interpreted.

There was general agreement in the review meeting that the data presented on stock structure, particularly the new genetic data, were important contributions to the objectives of JARPA and stock management. It was further noted that based on the new genetic information, at least some of the historic management Areas were inappropriate for stock definitions for Southern Hemisphere minke whales.

Two additional lines of research were also recommended. First, development of more theory on the use of genetic information for estimating mixing rates between putative stocks. Second, participants supported an earlier recommendation of the Committee that efforts should be undertaken to collect tissue samples from minke whales on Southern Hemisphere breeding grounds to allow contrasts of distribution and frequency of specific haplotypes from the breeding and feeding grounds.

Regarding the RMP, the new genetic information indicated that there was a temporal component to the stock structure of the ordinary form of the Antarctic minke whale in Area IV, which had not been recognised at the time of the Comprehensive Assessment. In the long term, genetic information could be used in implementing an improved version of the RMP.

It was also agreed that a protocol should be developed that specifies how such data (i.e., on genetic relatedness of putative stocks from the breeding or feeding areas) would be used in either developing specific *Implementation Simulation Trials* or the general management of commercial harvests.

In addition, it was noted that the information discussed during this section of the review meeting did not exclude the possibility that there are more than two genetically distinct stocks of the ordinary form of minke whale in Areas IV and V. Additional analyses, including for example the use of nuclear DNA, could reveal additional stock structure.

To avoid a repetition of past debates within the Committee regarding methods alternative to lethal removals, the proponents of the two different viewpoints summarised their views. These summaries are presented in SC/49/Rep1, annex H.

C. BIOLOGICAL PARAMETER STUDIES

BACKGROUND: ORIGINAL AND ADDITIONAL RESEARCH OBJECTIVES

Estimation of biological parameters, especially natural mortality rates, was originally the main research objective of the JARPA, since knowledge of some of these parameters was at the time considered to be necessary for a rational management of whale stocks by many scientists.

METHODOLOGY OF DATA COLLECTION

From 1987/88 to 1991/92, sampling involved taking up to two whales from the targeted school, but from 1992/93 the protocol was to take one whale from each school. Sampling success from the targeted school was 0.52 ~ 0.75 for the scheme of taking up to two whales from a school, but increased to 0.8 or more for one whale per school. An analysis concluded that no substantial differences in the samples taken from schools of size 2 and above had resulted from the change in sampling scheme.

It was pointed out that the sampling method resulted in over-sampling from small schools, and also that another source of sampling bias results from aspects of the survey and sampling methodology. Although the protocol induces under-surveying in areas of high whale density, it will result in over-sampling where density is high.

DATA ANALYSIS AND RESULTS

Three papers discussed catch-at-age data.

SC/M97/6 presented an extension of methods previously presented to the Committee (Butterworth and Punt, 1996; Butterworth *et al.*, 1996) for joint analysis of catch-at-age and abundance data. The extension involved taking account of assumed separability of the fishing mortality matrix for

the ages of 16 and above in the commercial catch. The method was applied to catch-at-age (both commercial and JARPA) and sightings survey (both IDCR and JARPA) data for both Areas IV and V. The Area IV analysis provided an estimate for natural mortality (M) of 0.057 yr^{-1}, and of the trend in recruitment over the 1947-68 period showing an increase of 5.5% yr^{-1} . A number of possible reasons were advanced for the marked drop in recruitment from 1970 to the mid-1980s evident in the results.

SC/M97/11 presented an interim result for the estimation of the natural mortality rate by the method originally proposed by Tanaka (1990) using the JARPA age data. The paper used the estimated age composition of these data taking account of whale abundance, selectivity and ageing error. Resultant estimates of average natural mortality rate ranged from 0.0165 (SE = 0.13) to 0.167 (SE = 0.116).

SC/M97/21 analysed the age data obtained from JARPA expeditions 1987/88 through 1995/96 in two stages. First, the analyses found that the proportion of young (under 10yr) animals was related to latitude and school size, and further that this dependence varied from year to year. An analysis was then conducted of the matrix of samples by age and year for age groups 10-30. The authors concluded that it is not possible to estimate recruitment and mortality separately, because each term in the model involves pairs of aliassed parameters: mortality is aliassed with the rate of change (first derivative) of recruitment, the first derivative of mortality is aliassed with the second derivative of recruitment, etc. Nevertheless linear combinations can be estimated and some example results were shown.

There was considerable discussion of the implications of the results of papers SC/M97/6 and SC/M97/21. Two opposing views crystallised. The first held that the VPA-type analyses of SC/M97/6 did provide valid results for an extensive list of reasons given in SC/49/Rep1, item 4.3.1. The second held that results of the catch-at-age analyses of both methods were compromised to some extent by the aliassing of estimates of mortality and recruitment parameters. In spite of this difference of opinion, there was consensus on some aspects of the results, as noted below.

The review meeting felt there was merit in pursuing the approaches of SC/M97/6 and SC/M97/21 further, but that estimates from the application of such methods could not be considered reliable until difficulties associated with the estimates of abundance from JARPA (see SC/49/Rep1, item 2.4) had been resolved.

Two papers considered transition phase data, SC/M97/7 and SC/M97/22. They had used different, but overlapping, datasets. Both analyses were restricted to Area IV, but that in SC/M97/7 was based on data from commercial whaling and from the first two JARPA expeditions to Area IV. The analysis in SC/M97/22 used only JARPA data, and from all five expeditions to Area IV. Both analyses showed decline in age at transition phase, but, for the same period of cohorts, 1950-70, the analysis of SC/M97/7 indicated a decline in age at transition phase roughly double that estimated in SC/M97/22.

The review meeting agreed that it was important to resolve the differences between the two transition phase studies, but that the transition phase observations could not be explained as an age related effect alone. A number of participants considered that the overall evidence was sufficient to conclude that there had been a real decline in age at maturity over the cohorts studied.

Results were also presented regarding sexual maturity, apparent pregnancy rate, length and age at sexual maturity, annual ovulation rate and growth.

POTENTIAL OF THE RESULTS TO ACHIEVE THE OBJECTIVES OF JARPA AND OF STOCK MANAGEMENT

With respect to the JARPA objectives, the review meeting agreed that the papers presented gave valuable information on recruitment, natural mortality, decline in age at sexual maturity and reproductive parameters of minke whales in Areas IV and V. However, there are some unresolved problems in the analyses, and further work is necessary.

One of the specific objectives of the programme was to collect random samples for the estimation of biological parameters. The results had demonstrated that this was a more difficult task than had been envisaged. Despite the considerable attention given to the sampling scheme, it has not been completely successful at obtaining random samples. The review meeting further noted that the geographical delimitation of the sampling areas has not resulted in either distinct biological populations being sampled or the entire ranges of the population being sampled. The implications of this for the representativeness of the sample should be given further consideration. However, it was noted that the VPA analyses (as, for example, in SC/M97/6) required representative sampling over only part of the range of ages in the population. There were no indications that this had not been achieved for animals of age 10 and above. The review meeting also considered that the results of the genetic studies should be used to redefine the geographical boundaries for any future analysis. It noted that there was still uncertainty as to whether information that fully represents a biological stock could be obtained, but considered that much progress had been made towards that end. Before JARPA was initiated, whales occurring in Area IV and Area V were managed as different stocks, but a clearer picture about the biological stocks in these Areas was now emerging. Although the present state of knowledge still leaves much to be desired, considerable data reflecting the status of the whale stocks occurring in Areas IV and V have been collected, and have produced many valuable results.

The review meeting noted that there were non-lethal methods available that could provide information about population age structure (e.g. natural marking) but that logistics and the abundance of minke whale populations in Areas IV and V probably precluded their successful application.

With respect to the relevance of the work for stock management, in 1993, the Committee proposed mechanisms for amendment of the RMP (IWC, 1994a). It distinguished between mechanisms for the amendment of case-specific implementations and mechanisms for amendment of the RMP itself. The review meeting discussed the relevance of a better knowledge of biological parameters to management objectives in this context, i.e. it distinguished between short-term improvements, which would be amendments of the case specific implementations, and long-term improvements which could imply more fundamental changes to the RMP itself.

In the short-term perspective the three key considerations identified were: (1) changes in the definition of *Small Areas*; (2) changes to the selection between RMP options such as *catch-capping* and *catch-cascading*, and (3) changes in the range of plausible MSYRs to use in *Implementation Simulation Trials*.

In the longer time perspective better knowledge of biological parameters could lead to modifications of the *CLA* in the RMP.

The review meeting noted that the recruitment data from analyses such as those in SC/M97/6 could be fitted by stock recruitment models to provide estimates of MSYR once

reliable input data are available. Trends in recruitment from SC/M97/6 and SC/M97/21 could be used directly when conditioning future *Implementation Simulation Trials* for Southern Hemisphere minke whales, and if the caveats expressed concerning abundance estimates from JARPA could be resolved, together with some further methodological development in estimating the essential biological parameters, the results from JARPA could be directly relevant for management, both in the short and long term.

D. MARINE ECOSYSTEM

BACKGROUND: ORIGINAL AND ADDITIONAL RESEARCH OBJECTIVES

The second of the two original JARPA objectives was: 'Elucidation of the role of whales in the Antarctic marine ecosystem'.

In the 1996/97 research plan this objective was restated as: 'Elucidation of the role of whales in the Antarctic marine ecosystem through whale feeding ecology'. The research plan concentrates on the feeding ecology of minke whales by the analysis of stomach contents and blubber volume.

METHODOLOGY OF DATA COLLECTION

Data on the feeding ecology of minke whales is obtained from the weight and species composition of stomach contents of the sampled whales. The whole body mass of each whale is measured using a weighing platform.

DATA ANALYSIS

An index of body fat condition has been calculated as the ratio of mean girth to body length. Data analyses of feeding rates (SC/M97/17) used three different methods.

RESULTS

Of the six years included in the study of body fat condition, stomach contents and distribution, two were categorised as years of poor body fat condition and three as years of good condition. Estimated body weight gain during the feeding season in poor years was estimated to be 25% lower than in good years. In Area IV and the northern part of Area V, krill (*Euphausia superba*) was the dominant prey species, but in the southern part of the Ross Sea (in Area V), *Euphausia crystallorophias* was the dominant prey species. Distribution of minke whales showed greater interannual variability in Area V than in Area IV, reflecting a greater degree of variability in sea ice extent in Area V. In Area V, in years of high sea ice extent, the krill-rich slope region of the western part of the area is covered by ice. This leads to poor food availability and results in a very low density of minke whales along the ice edge. The Ross Sea zone was an area of low food availability throughout the study period. Paradoxically, this zone always contained numerous whales, especially pregnant females.

Daily food consumption estimates ranged from 3 to 4% of body mass. The annual consumption estimates of prey for Area IV ranged from 1.42 to 1.78 million tonnes. For Area V, the range was 5.98 to 7.49 million tonnes. The value for Area IV is roughly 25% of the total estimate of krill biomass in the area. Consumption of krill by minke whales in Area V was an order of magnitude greater than that estimated for Adelie penguins and crabeater seals.

No difference was found in the fatness index between the sexes. From seasonal changes in the index and from its distribution by foetus size it was suggested that some whales over-winter in Antarctica and that others arrive on the feeding grounds late in the season. Analyses from earlier commercial catches and from the JARPA samples show a gradual decline in blubber thickness since 1978/79.

POTENTIAL OF THE RESULTS TO ACHIEVE THE OBJECTIVES OF JARPA AND OF STOCK MANAGEMENT

The review meeting agreed that the following points listed in SC/49/Rep1, annex D were pertinent to items A2, B1, B2.3, B2.5, B3.4.

The review meeting noted the striking similarity in the results obtained from the three methods for estimating daily food consumption reported in SC/M97/17. It was agreed that these estimates could be used with confidence for the estimation of total food consumption by Antarctic minke whales.

The review meeting considered that the body condition index presented in SC/M97/18 required further refinement. It was not convinced that the analyses could be used to infer that some whales over-winter in high latitudes and that others arrive late in the feeding season.

The review meeting agreed that the studies being undertaken were contributing to the objective of the 'elucidation of the role of whales in the marine ecosystem through whale feeding ecology'. However, it was suggested that elucidating the role of whales in the marine ecosystem also requires concurrent studies on the distribution and abundance of prey species, and process-oriented studies integrating information from physical and biological oceanography with zooplankton and predator studies would be useful. Such studies should be conducted on a smaller scale, possibly using radio tagging, than that covered by JARPA, perhaps of the order of ten to one hundred kilometres. Such studies should be set up to examine specific hypotheses about ecological interactions. The review meeting agreed that the JARPA studies provided useful information for both the formulation of such hypotheses and for the selection of study areas. The marginal sea ice zone is an obvious candidate for process oriented studies. The review meeting noted that such studies would be of interest to CCAMLR and Southern Ocean GLOBEC.

The review meeting noted the reported decrease in blubber thickness since the late 1970s. Such information could contribute to the specification of a range of krill-surplus hypotheses for use in further implementation trials for the RMP.

E. ENVIRONMENTAL CHANGE

BACKGROUND: ORIGINAL AND ADDITIONAL RESEARCH OBJECTIVES

The 1995/96 research plan added the following objective: Elucidation of the effect of environmental changes on cetaceans.

METHODOLOGY OF DATA COLLECTION

In addition to data collected for studies on environmental change, data have been collected on marine debris and body burdens of pollutants, including organochlorines and heavy metals. Tissue samples, including liver, muscle, kidney and blubber have been collected for these analyses. Marine debris observations have been based on visual observations, but recently nets have been introduced to estimate prevalence of smaller items. Air and sea water samples have been collected to monitor environmental pollutant levels.

RESULTS

The atmospheric and sea-water concentrations of organochlorines such as PCBs in the Southern Hemisphere were lower than in the Northern Hemisphere, except for HCB. Levels of DDT showed no yearly variation, but an increasing trend in PCB levels was detected in the period 1984-1993. This implies the continuing discharge of PCBs into the Southern Hemisphere.

Analyses of hepatic mercury concentrations were grouped by sex, geographical position and by time within season. Hepatic mercury concentration in the younger animals seems to have decreased in the last decade. This suggests that the increased mercury intake had begun to decrease in that decade.

RESULTS AND THEIR POTENTIAL IN THE CONTEXT OF THE OBJECTIVES OF JARPA AND OF STOCK MANAGEMENT

It was noted that organochlorine concentrations in blubber are strongly influenced by seasonal variation. Analyses should therefore include a correction for the effects of increasing blubber thickness during the season.

The review meeting referred to the recommendations of the Bergen Workshop on Chemical Pollution and Cetaceans (IWC, 1998). It considered that the pollutant studies under JARPA were pertinent to these recommendations.

One currently contentious issue in Antarctic research is the relative weight to give to the competing hypotheses that changes in abundance of Antarctic predators are due to either 'krill surplus' or the effects of environmental change. The review meeting recognised that distinguishing between these hypotheses will be difficult. In the meantime, the observations on changes in blubber thickness and variations in recruitment should be used to formulate specific hypotheses on the possible effects on cetaceans of environmental change, for use in constructing scenarios for further RMP implementation trials for Southern Hemisphere baleen whales.

F. OVERVIEW OF RESULTS AND THEIR POTENTIAL IN THE CONTEXT OF THE STATED AIMS AND OBJECTIVES OF THE JARPA PROGRAMME AND OF STOCK MANAGEMENT

CONTRIBUTION TO MINKE WHALE MANAGEMENT

Several main points were agreed to by workshop participants regarding the contribution of JARPA to minke whale management in the Antarctic.

First, under the objective of 'Estimating biological parameters', the information produced by JARPA has set the stage for answering many questions about long-term population changes regarding minke whales in Antarctic Areas IV and V. Not surprisingly, at this halfway point in the JARPA programme there are few definitive answers because of the timescale required to obtain sufficient age distribution and abundance data, and because of unanticipated problems in designing representative sampling regimes and in understanding the stock structure of minke whales in the Southern Hemisphere. For example, JARPA has already made a major contribution to the understanding of certain biological parameters (e.g., direct measures of the age at sexual maturity) pertaining to minke whales in Areas IV and V, yet such analyses have not fully addressed potential problems related to stock structure.

Second, under the objective of 'Elucidating the role of minke whales in the Antarctic ecosystem', JARPA has collected data on body condition that, in conjunction with the data on biological parameters as noted above, should result in an improved understanding of the status of minke whales in these Areas. These data are likely to be useful in testing various hypotheses related to aspects of the 'krill surplus' model.

Third, under the objective of 'Elucidation of the effect of environmental change on cetaceans', there is considerable uncertainty in how biological parameters of minke whales may vary in relation to environmental change. This is exacerbated by lack of knowledge regarding processes related to environmental change (e.g., interdecadal signals, global warming, etc.). For example, long-term trends related to the annual positioning of the extent of the pack-ice during the feeding season have implications regarding the interpretation of trends in various biological parameters. Therefore, more effort is needed to develop mesoscale studies to integrate physical and biological oceanography and prey distribution with minke whale studies.

Fourth, under the objective of 'Elucidation of the stock structure of minke whales to improve stock management', deciding on the amount of genetic data required to meet this objective is difficult because the Committee has provided only a vague definition as to what constitutes a stock. Proper delineation of stocks has implications for interpretations of data gathered for all other JARPA objectives.

Finally, the results of the JARPA programme, while not required for management under the RMP, have the potential to improve the management of minke whales in the Southern Hemisphere in the following ways: (1) reductions in the current set of plausible scenarios considered in *Implementation Simulation Trials;* and (2) identification of new scenarios to which future *Implementation Simulation Trials* will have to be developed.

12.2.1.2 COMMITTEE DISCUSSION

The Chairman thanked Reilly for his hard work in chairing the review meeting and complimented the participants for producing a thorough report. He believed the review meeting had significantly improved the Committee's understanding of the issues involved in the JARPA programme. He reiterated that time constraints had prevented it from completing item 8 on its Agenda. This would be taken up by the Committee under its Item 12.2.1.3.

Before discussing the report the Committee considered two new papers relevant to the catch-at-age issue. SC/M97/6(Rev) and SC/49/SH22 reported analyses arising out of the discussions at the Review Meeting. The former provided results on the qualitative implications of possible biases in the JARPA estimates of abundance, and of trends in natural mortality with time, for estimates of the historic trend in recruitment of minke whales in Area IV. Although these factors can change the values estimated, the authors argued that they were hardly able to alter the qualitative conclusion of the paper of an increasing trend in recruitment until the late 1960s. SC/49/SH22 fitted these recruitment estimates by a slight variant of the BALEEN II model which allowed for an increase in carrying capacity from 1930 to 1960. It showed that patterns of decreasing recruitment after 1970 indicated by the analyses of SC/M97/6 were as might be expected from the joint consequences of catches and supercompensation. It also demonstrated the possibility of estimating MSYR from the results of the SC/M97/6 analyses, and hence provided a potential link between the results of that analysis and information pertinent to RMP *Implementation Simulation Trials.*

Discussion of SC/49/Rep1 in the Committee concentrated on two topics. The first concerned issues of stock structure arising out of, *inter alia*, annex G to the report and the discussions on stock structure summarised under 12.2.1.1 above. The JARPA review report had commended the work

carried out but noted the need for future work. Questions such as what comprises a management stock, how this relates to a biological stock, what inferences can be drawn from the inability to detect significant genetic differences and the relationships between temporal and geographical boundaries, have taxed the Committee for several years in many of its sub-committees. The other issue concerned the problems associated with obtaining representative samples and their implications for the programme.

In view of the importance of this, two Working Groups were established under Polacheck: (1) to address general issues of stock identity and the representativeness of samples in the JARPA report; and (2) to specifically consider a paper submitted to the present meeting on the issue of stock identity and the use of historical samples (SC/49/SH28). The latter report, modified slightly to incorporate some factual information (e.g. with respect to gels) is given as Annex U1. It was agreed that the report of the former group should be incorporated into the main report of the Committee.

In discussing Annex U1, the Committee **agreed** that the computer simulations suggested in SC/49/SH28 to try to address the value of commercial samples to answer stock identity problems were feasible. Provided the relevant information was available, they should be carried out.

However, several issues remain with respect to the commercial samples, not the least being their availability/existence. It was recognised that creating a sample inventory for the commercial catches was a major task. The Japanese scientists agreed that they would undertake this exercise for at least some of the Areas. The Committee welcomed this.

The final issue discussed in Annex U1 concerned questions of the need for further catches in the context of whether genetic studies of commercial samples are found to be suitable and adequate. This is discussed under Items 12.2.1.3 and 12.3.1.

Turning to the more general issues the Committee recalled that the review meeting had provided the following overview of its view on the JARPA objective of estimating biological parameters:

> The information produced by JARPA has set the stage for answering many questions about long-term population changes regarding minke whales in Antarctic Areas IV and V. Not surprisingly, at this halfway point in the JARPA programme there are few definitive answers because of the time-scale required to obtain sufficient age distribution and abundance data, and because of unanticipated problems in designing representative sampling regimes and in understanding the stock structure of minke whales in the Southern Hemisphere. For example, JARPA has already made a major contribution to understanding of certain biological parameters (e.g., direct measures of the age at sexual maturity) pertaining to minke whales in Areas IV and V, yet such analyses have not fully addressed potential problems related to stock structure.

The question was raised as to whether these unanticipated problems had been resolved and if not how this would effect the ability of the JARPA programme to meet its objectives.

With respect to stock structure - the representativeness of the sampling and bias in the JARPA estimates of abundance - unresolved questions still remain. There is an interaction between these questions as abundance estimates and the representativeness of sampling need to be evaluated relative to the stock being sampled.

The Committee noted that the problem of stock identity is common to almost all cetacean assessments. The data collected and the research carried out in the JARPA programme along with historic commercial catch samples are uniquely valuable in attacking this problem.

The Committee identified ten main areas to address these unresolved problems (Table 2). Fujise indicated that work on all of these is either in progress, has recently been initiated or is at the planning stage.

The current JARPA survey design resulted in the under-sampling of high density areas. The method described in SC/M97/23 represented an initial attempt to develop an unbiased abundance estimation method with this design. It was noted that work was planned to test the bias of this method and to further develop unbiased abundance estimators as discussed in Annex E.

Achieving adequate precision in the abundance estimates is critical in order to be able to estimate biological parameters (e.g. natural mortality rates) with adequate precision to meet the JARPA objective. Correcting for the biases may decrease the currently estimated precision. Investigations need to be carried out to determine how this might affect the ability to meet the JARPA objectives. Tanaka stated that if this bias can be accounted for, his method (Tanaka *et al.*, 1992, pp.531-6) can be applied. However, he noted that since there was no finalised method for correcting the bias, it was not certain if the abundance estimates would have sufficient precision over the course of the experiment, although he was optimistic that this would be the case.

SC/49/Rep1 had identified that 'the geographical delimitation of the sampling area has not resulted in either distinct biological populations being sampled or the entire ranges of the population being sampled'. The primary factor was a lack of sampling from lower latitudes that are known to contain a higher proportion of juveniles. Non-representative sampling of whales by school size and areas were also identified. The major identified consequence of the lack of non-representative sampling is that juveniles are under-represented in the sampling to a variable extent, as a result of the lack of sampling in lower latitudes and other factors. Analyses conducted to date, indicate that sampling among the post-juveniles (i.e. ages 10 and above) is consistent with representative sampling with respect to age. If this is the case, it should be emphasised that the JARPA age compositional data are adequate in this regard for estimating some important biological parameters (e.g. natural mortality rates) for these older ages.

Japanese scientists reported that they plan the following process to resolve the problem of sampling biases:

(i) the quantity of the biases will be evaluated using a resampling simulation model;
(ii) post-modelling methods will be applied to determine whether it is possible to resolve or reduce biases;
(iii) if this is not effective, modification of the sampling scheme will be considered, and the effectiveness and practicability of such a modification will be evaluated; while simultaneously,
(iv) comparability between the current and any new scheme will be carefully evaluated.

With respect to Item (iii), Annex U2 contains one approach for a possible modification of the current sampling scheme to be considered if post-modelling is found not to be effective.

With respect to the catch-at-age analyses, the JARPA review meeting concluded

> that there was merit in pursuing the approaches of SC/M97/6 and SC/M97/21 further, but that estimates from such methods could not be considered reliable until difficulties associated with the estimates of abundance from JARPA (see Item 2.4) have been resolved.

The difficulties with the abundance estimates are being addressed (see above). Another concern raised in the JARPA review with respect to the VPA analyses was the problem of 'aliassing' or the confounding of recruitment trends with trends in time in natural mortality rates. This question was addressed further in SC/M97/6(Rev) presented to this year's Committee meeting.

One factor not completely considered with respect to the catch-at-age analyses was the interaction between these analyses and the uncertainty about stock structure. The analyses were made by analysing the data by conventional management units. However, the JARPA review indicates that the genetics data are not consistent with these units. There is a need to consider the implication of alternative stock definitions for the catch-at-age analyses and the ability of these analyses to estimate biological parameters.

With respect to the VPA analyses, the uncertainty about stock structure applies not only to the data collected under JARPA but also to the historical catch-at-age data. In this regard, it would be extremely valuable to obtain genetic analyses of the stored biological samples from the commercial catch.

The Committee noted that JARPA is at the half-way point and has provided substantial improvement in the understanding of stock structure. It is anticipated that as stock structure becomes better clarified, the information will be incorporated to provide analyses of biological parameters by stocks. For some of these analyses, this may not be straightforward.

In conclusion, the JARPA review had identified areas of additional future work that could contribute to resolving some of the unresolved and unanticipated problems in sampling and stock structure that could limit the ability of JARPA to estimate biological parameters. Effort in response to all of these identified areas is being undertaken and this additional work may improve the value of the JARPA data and results. Initial results from the simulation studies being undertaken to examine post-stratification and alternative sampling designs will be presented to the Committee as soon as possible. Based on these results, consideration should be given as to whether the sighting and biological sampling designs should be modified to achieve more representative sampling.

Finally, the Committee agreed that none of the sampling and stock identity problems that had been identified either in the JARPA review or subsequently, would in principle prevent JARPA from achieving its objectives in terms of estimation of biological parameters. All of the identified problems appear to be addressable. Most members were optimistic that the JARPA data, in conjunction with additional work planned, would allow estimation of the biological parameters with reasonable levels of precision. However, others thought that the problems associated with bias and the level of variance in the JARPA abundance estimates, and with interactions between catch-at-age analyses and uncertainty in stock structure, mean that it is not yet possible to determine whether reasonable levels of precision will ultimately be achieved.

In addition, aspects of JARPA relevant to abundance estimation were considered in Annex E. A brief summary of those discussions is given below.

SC/49/SH10 described sighting data collected during the 1996/97 JARPA programme. Work was conducted in Area V and the western part of Area VI over 103 days. Three vessels were engaged in both sighting and scientific whaling, and only one vessel conducted a closing mode sighting survey. The ships maintained roughly simultaneous parallel tracklines despite their different tasks by working in target-distance mode, whereby the survey begins each day at targeted positions rather than where each ship had completed work the previous day (SC/49/Rep1, item 2.2). The ships surveyed 17,755 n.miles of tracklines, with 850 primary sightings of schools totalling 2,508 animals.

A proposal to develop unbiased abundance estimators from the JARPA sightings data was presented in SC/49/SH30. The JARPA survey design results in an undersampling of high density areas. SC/49/SH30 aims to complete the work in two phases. The first phase would be completed and presented to the Scientific Committee for comment at its 1998 Annual Meeting. The Committee agreed that the proposed framework has the potential, in principle, to obtain unbiased abundance estimates using the JARPA data and would be useful for obtaining an improved understanding of those data. It noted that the likelihood of being able to develop unbiased estimates with reasonable levels of precision depends on the degree to which the spatial process can be modelled with the available covariates and to some extent on the stationarity of the process.

12.2.1.3 DISCUSSION OF ITEM 8 FROM SC/49/REP1

The Committee agreed to address this issue by providing a summary of the Commission's resolutions with respect to JARPA and relevant comments from the JARPA report and its discussions under Item 12.2.1.2.

Table 2

Future work to address outstanding issues.

1. Abundance estimates
Development of method to correct bias of abundance estimate
2. Stock structure
Stock definition *
Statistical analysis of mtDNA data considering the inclusion of school size as a covariate
Pilot study on nuclear DNA analysis on JARPA minke samples
Effort to obtain biological materials for genetic analysis from low latitude areas of the Southern Hemisphere **
External morphology/morphometry analysis
Examination of possible stock boundaries (geographical and temporal) in Areas IV and V
3. Biological parameters
Segregation study
Recalculation of biological parameters by biological stocks
4. Marine ecosystem and environmental change
Meso-scale survey plan

* The lack of a working definition of stocks and sub-stocks is a general problem, not for JARPA alone, and therefore, needs to be addressed by the Committee (SC/49/Rep1).

** A preliminary paper was presented last year with the results of a survey of biological material among researchers and institutions of the Southern Hemisphere (IWC, 1997h, pp.132-3).

A. SCIENTIFIC PERMITS (IWC, 1996C)

The Commission had recommended that

(1) scientific research intended to discuss the Comprehensive Assessment and the implementation of the RMP shall be undertaken by non-lethal means
(2) that scientific research involving the killing of cetaceans should only be permitted in exceptional circumstances where the questions address critically important issues which cannot be answered by the analysis of existing data and/or use of non-lethal research techniques

and then requested the Committee to

(i) undertake a comprehensive review of existing programmes and report its view as to whether they remain justifiable in the light of the above recommendations, especially whether lethal research substantially contributes to answering critically important questions that cannot be addressed by other means.

This is discussed under Items 12.2.1.1 and 12.2.1.2.

The Committee was also requested to structure its reviews in the manner given in (a)–(c) below.

(a) Identify the relationship between programme objectives and research needs previously identified by the Scientific Committee (see also SC/49/Rep1, annex D; annex F; item 2.5; item 3.5; item 4.5; item 4.5 B2; item 5.5; item 6.5; item 7).

The relationships are identified in Table 3.

(b) Evaluate the likelihood of the programme meeting its objectives by providing reliable answers to the questions asked (see also SC/49/Rep1, annex D; annex F; item 1.6; item 2.5; item 3.5; item 4.5; item 5.5; item 6.5; item 7).

SC/49/Rep1, annex F summarises the Committee's earlier discussions on this matter. The Committee had no agreed consensus on this in the past.

In SC/49/Rep1 (item 2.5), it was noted that the frequent sighting surveys in the same localities would facilitate estimation of interannual variability in local abundance which would in turn lead to improved overall results from combining them with IDCR/SOWER and/or JSV data, for example. However, improvements in methodology were suggested.

Under SC/49/Rep1, item 3.5, there was general agreement that the stock structure data were of value to management. However additional research was recommended. It was also agreed that the information was relevant to improved *Implementation Simulation Trials* and an improved RMP in the longer term.

In SC/49/Rep1, under item 4.5, it was agreed that the programme provided valuable information on a number of biological parameters (recruitment, natural mortality, decline in age at sexual maturity and reproduction). However, it identified the need for further work particularly in view of the difficulties in obtaining fully representative samples. Although there is much still to be done, it was agreed many valuable results have been obtained. It was noted that the results in the short term could be valuable with respect to several aspects of the RMP, provided certain identified problems were resolved.

Under SC/49/Rep1, item 5.5, it was agreed that estimates of daily food consumption could be used with confidence for estimating total food consumption. However, the Committee had concerns over the use of a body condition index for inferring information on the migration of minke whales with respect to timing of arrival on the feeding grounds and over-wintering in high latitudes. The review meeting agreed that the studies were contributing to Objective 2 (p. 96). However, additional studies were recommended. It was also noted that the information obtained would be of interest to CCAMLR and Southern Ocean GLOBEC.

Under SC/49/Rep1, item 6.5, the review meeting had agreed that the work was pertinent to Recommendations 1, 4 and 5 of the Pollution Workshop. However in the Plenary some concerns were expressed on the extent to which the work on minke whales directly addressed Recommendation 1 (see Item 6).

Under SC/49/Rep1, item 7, the review meeting had recognised that this was a long-term programme that had only reached its half-way point. In several cases therefore, it could be said to have set the stage to answer many questions about long-term population changes. It also noted that while JARPA results were not required for management under the RMP, they had the potential to improve it in the following ways: (1) reductions in the current set of plausible scenarios considered in *Implementation Simulation Trials*; and (2) identification of new scenarios to which future *Implementation Simulation Trials* will have to be developed (e.g. the temporal component of stock structure). The results of analyses of JARPA data could be used in this way perhaps to increase the allowed catch of minke whales in the Southern Hemisphere, without increasing the depletion risk above the level indicated by the existing *Implementation Simulation Trials* of the RMP for these minke whales.

In the Committee's discussions (Item 12.2.1.2), it had considered the implications of identified problems in stock structure and sampling in terms of the ability to achieve stated objectives. Most members were optimistic that JARPA data, in conjunction with the additional work planned, would allow estimation of biological parameters with reasonable levels of precision. Others however believed that the identified uncertainty meant that it is not yet possible to determine whether reasonable levels of precision will ultimately be achieved.

Table 3

Relationship between JARPA research objectives and Scientific Committee research needs.

JARPA Research Objectives	Scientific Committee's priorities
(1) Estimation of biological parameters to improve stock management.	RMP: Relevant to MSYR discussions, *Implementation Simulation Trial* scenarios.
(2) Elucidation of the role of whales in the Antarctic marine ecosystem.	Relevant to work discussed at the Climate Change Workshop, particularly with respect to filling in identified gaps in knowledge (*Rep. int. Whal. Commn* 47: 309-10); multi-species issues.
(3) Elucidation of the effect of environmental changes on cetaceans.	Related to above and the Pollution Workshop.
(4) Elucidation of the stock structure of minke whales to improve stock management.	RMP: Relevant to *Implementation Simulation Trial* discussions and specification of *Small Areas*.

(c) Identify non-lethal methods and alternative sources of data that might be used in meeting the research objectives (see also SC/49/Rep1, annex D; annex F; annex H; item 3.5; item 4.5 B1).

SC/49/Rep1, annex H, provides summary statements supporting/refuting the use of lethal removal pertaining to the collection of stock structure information.

Under SC/49/Rep1, item 4.5 B.1, the review meeting noted that there were non-lethal methods available that could provide information about age-structure (e.g. natural marking) but that logistics and the abundance of minke whales in the relevant Areas probably precluded their successful application.

In the Committee's discussions (12.2.1.2 and Annex U2), the question was raised as to whether there were adequate suitable samples already available from the commercial catches for examining the question of stock identity. It is not yet clear which of the commercial data can be used for this process but a procedure to try to determine this is in place.

B. ANTARCTIC MARINE ECOSYSTEM (IWC, 1993A)

The aspect most relevant to JARPA appears to be:

> that the Scientific Committee should develop practical means to address questions raised by these exchanges where 'these exchanges' refers to contact with other organisations and exchange of information on the effects of global environmental change in the Antarctic that may be relevant to whale stocks (also see SC/49/Rep1, item 5.5; item 6.5; IWC, 1997d).

Under SC/49/Rep1, item 5.5, the meeting noted that the information obtained would be of interest to CCAMLR and Southern Ocean GLOBEC.

C. ENVIRONMENT AND WHALE STOCKS (IWC, 1996B, RESOLUTION 1995-10 AND IWC, 1997C, RESOLUTION 1996-8)

The aspect of Resolution 1995-10 most relevant to JARPA is:

> providing information on the potential effects, both direct and indirect, of pollutants on cetaceans as they become known

The aspects of Resolution 1996-8 most relevant to JARPA are to:

> Increase collaboration and co-operation with other organisations; and
> Consider and act on, as appropriate, the recommendations of the Climate Change and Pollution Workshops and other items identified as requiring additional information, so as to develop non-lethal means of assessing the impact of environmental change on cetaceans (see also SC/49/Rep1, item 6.5; Pollution Workshop recommendations).

Under SC/49/Rep1, item 6.5, the review meeting had agreed that the work was pertinent to Recommendations 1, 4 and 5 of the Pollution Workshop (IWC, 1998). However, the Committee expressed some concerns over the extent to which the work on minke whales directly addressed Recommendation 1 (see also Item 6).

Under SC/49/Rep1, item 5.5, the review meeting agreed that the studies were contributing to Objective 2. However, additional studies were recommended. It was also noted that the information obtained would be of interest to CCAMLR and Southern Ocean GLOBEC.

12.2.2 Japan - North Pacific

A number of papers were presented arising out of the Japanese Research Programme in the North Pacific (JARPN). These include SC/49/NP2, NP8, NP9, NP10, NP11, NP12, NP13 and NP14.

These were considered by the relevant sub-committees and are also considered under Item 8.1.

12.3 Review of new or revised proposals

12.3.1 Japan - Southern Hemisphere

The Government of Japan (1997) presented the 1997/98 JARPA Research Plan (SC/49/SH3). This is a continuation of the programme discussed previously by the Committee, although for the coming season sampling will not only be conducted in Area IV but also in the eastern half of Area III. Samples of 300 minke whales will be taken in Area IV and 100 in Area IIIE: all will be ordinary form minke whales and both samples will have an allowance of ± 10%. Sampling strategies and methodologies will be the same as in the previous research plan.

The objective of sampling again in Area IIIE is to investigate inter-year variability in the occurrence of stocks W and C in Areas III and IV. When Area IIIE was sampled previously (in 1995/96) it was announced that this would be for 'one year only at this stage', but the results of that survey had shown a completely different pattern in stock distribution from that expected from previous commercial samples. The new samples were required to test for further variability in stock distribution in these two Areas.

The Committee refers the Commission to its views expressed in previous years on the applicability of non-lethal methods, the possible effect on the stock and the opportunity for participation by foreign scientists, which were considered unchanged from last year (e.g. IWC, 1997e, p.96).

In discussion, reference was made to Annex U1 with respect to the use of commercial catches, and in particular whether it was possible for samples from these to replace those animals to be taken in Area III. Annex U1 had noted that there was general agreement to use existing samples where they would provide equivalent information relative to a particular experimental objective and design before collecting new samples through lethal removals. It was noted that the inventory and computer simulations could not be completed before the 1997/98 sampling year. Therefore Yagi stated that it was Japan's intention to proceed as proposed with the 1997/98 research plan (SC/49/SH3) including the Area IIIE component.

Donoghue suggested that if no lethal takes were taken this year this would allow time for the work suggested in Annex U1 to be undertaken. In response, Fujise noted that JARPA was being undertaken for a number of purposes in addition to stock identity. In particular, the extension into Area III had been in response to problems about the representativeness of the catch. Even with respect to stock identity he noted that a range of techniques, not exclusively genetic, was being used. Another factor being investigated concerned the identification of 'core' areas and a further elucidation of stock structure in light of the annual variation identified from previous years. Hatanaka pointed out that existing commercial samples from Area III had already been analysed and the results presented to last year's Committee meeting (IWC, 1997g).

12.3.2 Japan - North Pacific

SC/49/NP1 described the continuation of a programme, begun in 1995 after a feasibility study in 1994, to examine: (i) whether sub-stocks of minke whales exist in the Okhotsk Sea - Western Pacific stock (O stock); and (ii) whether an additional minke whale stock (W stock) exists in the central North Pacific, and if it does, the rate of mixing with O stock. One hundred animals will be sampled in two to three areas (of a total of 13 Sub-Areas to be sampled in due course). The

Committee noted that it had addressed the proposal in detail previously. It refers the Commission to its previous comments (see IWC, 1997e, item 14.4.2).

13. RESEARCH PROPOSALS

13.1 Review research results from 1996/97

13.1.1 SOWER cruises

The Reports of the SOWER blue whale and Antarctic cruises are given as SC/49/SH7 and SH43. The results are discussed under Items 8.3, 10.1 and in Annexes E and H.

13.2 Review proposals for 1997/98

The Committee received the Report of the intersessional group established last year to consider Research Proposals (Annex V). They considered three proposals that had requested funding, and reviewed them according to the procedures identified in IWC (1996g).

The Committee accepted their review and discussed the proposals briefly in the context of priorities. The financial implications are also considered under Item 19.

It noted that SC/49/RP2 (Palsbøll and Bérubé) is a two-year, two-species proposal requesting £32,425. The proposal is to identify parent-offspring relationships in Sea of Cortez fin whales and Gulf of Maine humpback whales, which will test an approach, which if successful could provide valuable management information.

The Committee **recommends** funding this proposal. It agreed that if only partial funding is possible it should be offered to cover the analysis of humpback whales which will be directly relevant to its proposed Comprehensive Assessment (see Item 10.4).

SC/49/RP3 (Larsen) is a proposal to develop a rifle-based system for biopsy sampling of fast swimming whales from large vessels in high seas. The Committee noted the need for such a system, for example in the SOWER cruises and **recommends** that it should be funded. It recognised that as it is a developmental procedure a successful outcome could of necessity not be guaranteed.

SC/49/RP1 (Hoelzel and de Boer) is a proposal to study minke whales in the coastal waters of the Shetland Islands (UK) using photo-identification and biopsy sampling techniques and combining this with behavioural observations. The Committee noted that the modest funding required was largely to cover equipment. It noted that some of this was already held by the IWC (e.g. the GPS). It **recommends** the proposal be funded but agreed that if the Commission is unable agree, available equipment in the IWC should be loaned to the proposers. This is discussed further under Item 19.

In addition, the Committee received a proposal (Moore and Stegeman) requesting biopsy samples from past and future IDCR/SOWER cruises for certain pollutant analyses as part of a global assessment of contaminant exposure and impact in large whales. The Committee noted the value of this work but recognised that it would be appropriate for it to be considered intersessionally by the Standing Working Group on Environmental Concerns. It will then be discussed at the next Scientific Committee meeting.

14. SMALL CETACEANS

14.1 Action arising from the 1996 meeting

During its 1996 meeting, in response to continuing evidence of the highly endangered status of the vaquita, the Committee again recommended that immediate action be taken to eliminate bycatches of this species in all fisheries in the upper Gulf of California (IWC, 1997j, p.179). No information was presented to this meeting to indicate that such action has been taken. However, the Committee did welcome news that the Mexican Government had convened the first meeting of an International Committee for the Recovery of the Vaquita (ICRV), which included some members of the IWC Scientific Committee. Read noted that discussions had been open and frank and that considerable progress had been made, particularly in identifying and ranking risk factors.

Rojas-Bracho presented a summary of the report of this meeting, which discussed current information on life history, distribution, abundance and risk factors and made a number of recommendations. An important conclusion was that the most important risk factor faced by the vaquita in the short term is the continuing bycatch in gillnet fisheries. A second meeting is scheduled for early 1998.

The Committee congratulated the Mexican authorities on this welcome initiative and looked forward to receiving a report on further developments at its next meeting. The Committee offered to assist the ICRV in any way possible in its work.

14.2 Priority topics

14.2.1 Small cetaceans in coastal waters of Africa

The Committee considered the objectives that should be met during consideration of this topic, and both the geographical range and list of species that should be covered. Rather than attempt discussion of all small cetaceans in all areas, it agreed that the time available would be most productively used by excluding the Ziphiids (which were discussed by the Committee in 1988) and the Mediterranean Sea (because it is a relatively well-known and separate zoogeographic region). Offshore islands, including Madagascar, would be included in the review. 'Coastal waters' could not be easily defined because in some areas deep oceanic habitat was within a few kms of the coast, whereas in others the continental shelf continued for hundreds of kms offshore. Objectives of the review were for each species in African waters to:

(1) assess current knowledge;
(2) identify large gaps in knowledge;
(3) highlight areas of concern for the conservation status.

14.2.1.1 WEST AFRICA (STRAITS OF GIBRALTAR TO CAPE OF GOOD HOPE)

The Committee considered a number of papers which provided information on the distribution, relative abundance and biology of small cetaceans in these waters of West Africa (SC/49/SM3, 10, 11, 31, 34, 45, 48; SC/49/O 3, 26; Robineau and Vely, In Press). Some also discussed known or inferred bycatches in a wide range of fisheries. These and other recently published papers (Maigret, 1994; Jefferson *et al.*, 1997) demonstrate that current knowledge of small cetaceans in this region is patchy and generally very poor, with the exception of southern Africa. Only sporadic directed takes of small cetaceans are known from the West African coast.

A common theme through many papers (e.g. SC/49/O 3, SC/49/SM11 and 31), reinforced by comments from Committee members familiar with the area, was the extremely high intensity of fishing effort along the west African coast and the likelihood that substantial cetacean bycatch occurs but is not recorded. Both artisanal and commercial fisheries are involved, many of the latter being carried out by foreign fleets which do not land their catch locally. Some areas (e.g. off Southern Morocco; SC/49/O 3)

are clearly extremely rich in fish resources and are very intensively fished, but appear to have unusually low densities of small cetaceans. Bycatch mortality may be sustainable by large populations of offshore species, but could severely deplete coastal animals with small local populations (e.g. *Sousa teuzii* and *Tursiops truncatus*). The Committee expressed its concern at this situation and noted the urgent need for information on both the size of cetacean populations and the nature and level of bycatches.

14.2.1.2 EAST AFRICA (CAPE OF GOOD HOPE TO HORN OF AFRICA)

Here again, information was very sparse outside southern Africa. The East African coast is probably as heavily fished as that of West Africa, but south of central Mozambique local people do not have a maritime history and only utilise the coastal zone. Human-induced mortality of small cetaceans off the islands in the western Indian Ocean could be high, however, both as a result of bycatch and directed takes.

A study of *Sousa* genetics (SC/49/SM25), suggested dividing the species *chinensis* at sub-specific level, and that regional genetic differences are sufficient to regard the populations studied as separate management units. An overview of *Sousa chinensis* in Algoa Bay, South Africa (SC/49/SM23) showed weak site fidelity and a population estimate of between 200 and 400 animals at a density of 0.42 dolphins per kilometre. Life history parameters seemed unlikely to allow population growth within the studied area.

SC/49/SM34 reported that the shark nets off KwaZulu-Natal had killed a minimum of 675 *T. truncatus*, 122 *S. chinensis*, 794 *D. delphis* and 87 other dolphins between 1978 and 1996. The Committee agreed that more information is needed on abundance estimates and bycatches of *Sousa,* which may be vulnerable to local depletion.

Some 200-300 *T. truncatus* are estimated to be taken annually by the schooner fleet operating around the Seychelles (de Lestang, 1993).

14.2.1.3 RED SEA AND GULF OF ADEN

Robineau reviewed the sparse knowledge of small cetaceans in this region based on personal observations and previously published accounts. Eleven species have been recorded, but information on distribution, abundance, biology and threats is very poor. The Committee **recommends** further survey work, particularly in the southern half of the region. It also **recommends**, in view of the location of its next meeting, that small cetaceans in this area should be discussed again in 1998.

The Committee records its appreciation to those scientists, both from member and non-member nations, whose work contributed to this review of small cetaceans in the waters of Africa.

14.2.2 Criteria for assessing the status of harbour porpoise populations

During its meetings in 1996, the Committee spent considerable time discussing how best to determine if a harbour porpoise population was threatened by fishery bycatch mortality. Discussion focused on the algorithm adopted in the USA (which yields a Potential Biological Removal (PBR) level) to facilitate 'the raising of a flag of concern' when a small cetacean stock is deemed possibly unable to sustain anthropogenic removals. Although agreeing that the PBR approach represented an advance over the algorithm currently adopted by the Committee (removals above 1% of estimated abundance raise the flag of concern), the Committee was unable to reach agreement on whether PBR-like methodology could be appropriately applied to harbour porpoises in the North Atlantic. The topic was considered to be of sufficient importance, however, that it was put forward as a priority Agenda Item for this meeting, in the hope that some progress might be made intersessionally or during the meeting itself.

A proposed framework for a case-specific simulation study was presented, designed to assess the status of harbour porpoise in the North Sea and adjacent areas, taking into account *inter alia* stock uncertainty. The initial proposal generated considerable discussion, particularly with respect to its suggested evaluation of conservation status in terms of probability of decline of any stock over a comparatively short time period. Examples of scenarios where this might not address important conservation concerns were raised. For example, where a severely depleted population could be evaluated to have 100% probability of increasing, but the magnitude of the increase would be small, the population would remain in a severely depleted state for the foreseeable future.

Other concerns expressed included: tuning difficulties and the need to run additional simulation trials; deciding when to raise a 'flag of concern'; fully incorporating complexity and uncertainty in parameters such as stock structure and growth rates; pragmatic considerations of the complexity of coding stock identity trials and the time taken to run them. However, whilst recognising these problems, the Committee agreed that the approach suggested was promising and might provide a useful tool for assessing the status of North Sea harbour porpoises.

Subsequently, a revised framework was presented (Annex M, Appendix 3) that took into account some of the concerns expressed and identified areas where further development was required, e.g. with respect to performance parameters.

The Committee agreed that approaches such as that given in Annex M, Appendix 3 provided a valuable framework for future work. It noted that its utility would be considerably enhanced if more specific conservation objectives were identified, but recognised that this was outside the terms of reference of the Committee. In this regard, Reijnders informed the Committee that ASCOBANS will soon be considering the development of management goals for harbour porpoises in the North and Baltic Seas.

With respect to work relevant to the Committee, it was noted that it had addressed some of the items necessary to provide biological advice for use in such a framework (e.g. with respect to plausible stock hypotheses and uncertainty in biological parameters related to population growth) at its meeting two years ago (IWC, 1995a, pp.89-90). Since then, however, some new information had arisen, particularly with respect to stock identity (see SC/49/SM9). It was agreed that an intersessional group under Bravington (for members, see Annex P) would examine the new evidence and begin to formulate plausible stock hypotheses for North Sea harbour porpoises.

With respect to the current status of eastern North Atlantic harbour porpoises, the Committee reiterates the **advice** it provided last year (IWC, 1997j, p.170) that known bycatches in the Gulf of Maine, Kiel Bight, Celtic Shelf and southern North Sea are above 2.5% of the best abundance estimate and may therefore not be sustainable.

The Committee noted that these discussions and those of last year (IWC, 1997j, pp.169-70) had illustrated that no one algorithm is likely or indeed needs to be appropriate across the full range of circumstances in which the status of small

cetaceans may be assessed. In its consideration of North Atlantic harbour porpoises it had considered a number of approaches and all had provided some insights. Depending on the quality and nature of the data available, a variety of criteria can be used to determine whether concern needs to be expressed, including 1% of the abundance estimate or a PBR-like approach. Case-specific approaches, such as that suggested in Annex I, Appendix 3, may provide a way forward in situations where the simpler approaches have indicated general concern. However, the Committee recognised that carrying out an evaluation of the scope and complexity of that proposed in Annex I, Appendix 3 would probably require resources (e.g. time, data-coding, data validation, computer runs) outside the scope of those available to it. It **agreed** that such work could more appropriately be carried out by member governments or relevant intergovernmental bodies. It **agreed** that its role could be to provide the relevant biological information for such an exercise in the course of its normal review process.

14.2.3 Global review of Stenella coeruleoalba

The Committee reviewed existing knowledge of striped dolphins, using the review in SC/49/SM27 as a starting point for discussion. There the author noted that serious gaps remain in our knowledge of this species. The Committee focused its attention on striped dolphins in three marine regions: the Mediterranean Sea, and the Atlantic and Pacific Oceans.

14.2.3.1 DISTRIBUTION, STOCK IDENTITY AND MIGRATION

Striped dolphins are found throughout warm temperate and tropical offshore waters of the Atlantic, Pacific and Indian Oceans and in the Mediterranean Sea. SC/49/SM28 described significant differences in skeletal morphology between five populations of this species: the western Pacific Ocean; eastern Pacific Ocean; western Atlantic Ocean; eastern Atlantic Ocean; and the Mediterranean Sea. Skulls from the two Pacific populations were of significantly different size, but skulls of the two Atlantic populations were similar, suggesting that gene flow across the Atlantic is greater than across the Pacific.

MEDITERRANEAN

The species is distributed throughout the Mediterranean, although it prefers open waters beyond the continental shelf (SC/49/SM17). Osteological evidence (SC/49/SM28) supports previous research indicating that the Straits of Gibraltar effectively isolate the Mediterranean population from that of the Atlantic. The species has not been reported in the Black Sea.

ATLANTIC

As noted in SC/49/SM27, the species ranges throughout the eastern Atlantic south of the UK and along the coasts of France, Spain and Portugal and offshore to the Azores and Canary Islands. Striped dolphins have stranded on the west and south coasts of Ireland, but not on the coast with the Irish Sea (SC/49/SM40). Striped dolphins have a wide distribution south and west of Ireland, as documented from both sightings and bycatches in the albacore driftnet fishery.

Striped dolphins are found off the eastern coast of South America, throughout the Caribbean and Gulf of Mexico and north along the eastern seaboard of the USA and Canada. In the northern Gulf of Mexico sightings occur primarily off the continental shelf (SC/49/SM26). Along the eastern coast of the USA, striped dolphins are distributed along the edge of the continental shelf and along the north wall and warm core rings of the Gulf Stream (SC/49/SM26). Sightings and strandings of this species occur regularly in southeastern Canada (SC/49/SM4 and SC/49/O 6). As in other areas, striped dolphins at the northern extent of their range in the western North Atlantic are associated with deep, warm waters, often along the edge of the continental shelf.

PACIFIC

In the eastern Pacific, the species is distributed north at least to British Columbia (SC/49/SM4) and south in deep, warm waters to Peru (SC/49/SM12). The range extends across the tropical Pacific to New Zealand, Australia, Indonesia and mainland Asia. In the western North Pacific, striped dolphins are uncommon in the Sea of Japan, East China Sea and Ryuku Islands, but common off the Pacific coast of Japan, south of the 18°C isotherm (SC/49/SM29).

SC/49/SM14 examined seasonal changes in the distribution of striped dolphins in the western North Pacific documented from research cruises conducted between 1982 and 1996. Striped dolphins occurred in waters with surface temperatures between 18 and 30°C. Areas of concentration changed seasonally. In August, a concentration was found in northern offshore waters, disjunct from a smaller area of concentration in coastal waters. As the season progresses, striped dolphins in the northern offshore region appeared to move southwest into coastal waters, following the southern movement of the 18°C isotherm. It was not clear whether dolphins present in coastal waters during summer remain there during autumn and winter or move to other areas.

Two papers presented the results of genetic studies of striped dolphin stock structure in the western North Pacific. SC/49/SM38 examined geographical variation in restriction fragmental length polymorphisms (RFLPs) in the mitochondrial D-loop control region. Samples were obtained from 30 specimens from coastal waters in December and 29 specimens from the offshore region in August. There were no significant differences in haplotype frequencies between the two samples. SC/49/SM41 described geographic variation in mitochondrial DNA sequences. Thirty-four samples were obtained from the coastal region between August and November and 43 samples were taken from the offshore region in August and September. There were no significant differences in haplotype frequency in the two areas, but the majority of haplotypes were present only in the offshore sample. There was considerable discussion of these two papers. RFLP and sequence analysis of the mitochondrial genome provide low statistical power when used with pelagic delphinids and non-significant results using these techniques do not necessarily indicate a lack of stock differentiation. Analysis of microsatellites offers a more powerful alternative to these techniques and should be explored in future genetic studies of striped dolphin stock structure in the western North Pacific. Archer noted that the sample sizes in both studies were small and should be enlarged in future work, perhaps by obtaining biopsy samples from free-ranging animals. Finally, the Committee noted that, given the results on seasonal changes in distribution noted in SC/49/SM14, synoptic samples should be obtained from coastal and offshore samples in August, when the two concentrations of dolphins are disjunct.

In concluding its discussion on stock structure of striped dolphins in the western North Pacific, the Committee noted that there was still no consensus on the existence of a

separate coastal stock. It welcomed the work of Japanese scientists on stock structure and **recommends** that this work be continued and expanded in the future.

14.2.3.2 ABUNDANCE

MEDITERRANEAN

Estimates of abundance are available only from the western Mediterranean, where the striped dolphin is the most abundant cetacean (SC/49/SM17). In 1991, following the main epizootic in the Mediterranean, Forcada *et al.* (1994) estimated abundance in the western Mediterranean as 117,880 (95% CI 68,379-214,800).

ATLANTIC

In the eastern Atlantic, the abundance of striped dolphins in the area of the French driftnet fishery was estimated as 73,843 (95% CI 36,113-150,990) in 1993 (SC/49/NA9). There are no comprehensive estimates of the abundance of this species over its entire range in the eastern Atlantic. The same situation exists in the western Atlantic, where estimates are available for several portions of the range, but no estimate of total abundance exists (SC/49/SM26). The best available estimate of partial abundance is 31,669 (CV = 0.73), from a combined ship and aerial survey conducted between July and September 1995 from Virginia to the mouth of the Gulf of St Lawrence. This estimate was corrected for $g(0)$ and bias due to school size. Shipboard line transects conducted between 1991 and 1994 yielded an estimate of 4,858 (CV = 0.52) striped dolphins in the northern Gulf of Mexico, but this estimate was not corrected for $g(0)$, nor did it cover the entire range of the species in that region (SC/49/SM26).

PACIFIC

Estimates of abundance are available for three areas of the western North Pacific, from surveys conducted in August and September 1983-91 (Kato *et al.*, 1993): 497,725 (CV = 0.18) in the northern offshore area; 52,682 (CV = 0.95) in the southern offshore area; and 19,631 (CV = 0.70) in the coastal waters of Japan. As noted in SC/49/SM29 it is not clear whether striped dolphins in these areas should be considered as separate stocks.

14.2.3.3 DIRECTED TAKES

MEDITERRANEAN AND ATLANTIC

The Committee was unaware of any evidence of recent directed takes in these regions.

PACIFIC

The history of striped dolphin exploitation was reviewed in detail by Kasuya (SC/49/SM29 and references therein). The species has been taken for several centuries by hand harpoon and driving at three locations on the Japanese coast, primarily in autumn, winter and spring. The largest catches have been recorded at Taiji (33°35′N, 135°55′E) and Izu (35°00′N, 139°00′E). Maximum annual catches at Taiji exceeded 10,000 per year in 1980 before dropping to less than 1,000 after 1990. Maximum annual catches of more than 21,000 were recorded at Izu during World War II, but declined from approximately 10,000 per year in 1960 to less than 1,000 annually in the early 1980s.

The exploitation of striped dolphins in Japan is currently regulated by species- and fishery-specific quotas. Quota levels for the 1997-98 season are: 70 striped dolphins for the drive fishery in Izu, 80 for the hand harpoon fishery off Chiba, 100 for the hand harpoon fishery off Taiji and 450 for the drive fishery at Taiji (SC/49/SM29). Data on recent catches of striped dolphins in Japan are given in SC/49/ProgRep Japan.

14.2.3.4 INCIDENTAL TAKES

MEDITERRANEAN

Striped dolphins have been taken in pelagic driftnet fisheries for tuna and swordfish by vessels of three countries: Italy, Spain and Morocco (SC/49/SM17). Information on the magnitude of this bycatch is available only for the Spanish fleet, which is estimated to have taken 338 (95% CI 129-547) and 295 (95% CI 157-433) dolphins in 1993 and 1994 respectively (SC/49/O 12). Approximately half of these dolphin bycatches are believed to have been striped dolphins. The Spanish driftnet fishery was closed in 1995, but the Italian and Moroccan fisheries continue to operate. Incidental catches of striped dolphins are also believed to occur in other fisheries, but mortality estimates are not available.

ATLANTIC

Striped dolphins are taken in French and UK pelagic driftnet fisheries for albacore in eastern Atlantic waters. Annual average incidental takes by the French fleet were estimated to be 1,172 (95% CI ± 21%) striped dolphins in 1992 and 1993 (SC/49/NA9). Incidental takes by the UK fleet were estimated to be 104 (95% CI 38 - 169) in 1995 (SC/49/NA9). An Irish driftnet fishery operates in the same area as the UK fleet, but no estimates of bycatch are available. Striped (and large numbers of common) dolphins are taken in French pelagic trawl fisheries in this region. Major stranding events are often preceded by periods of westerly winds on the French Atlantic coast during periods of fishing activity. The Committee **recommends** that the magnitude of bycatches be estimated for these trawl fisheries to allow a better assessment of striped and common dolphins in the northeastern Atlantic.

In the western North Atlantic, striped dolphins are taken in US pelagic driftnet and bottom trawl fisheries (SC/49/SM26), but numbers are thought to be low both here and in eastern Canadian fisheries (SC/49/SM4). No bycatches are known to occur in US fisheries operating in the Gulf of Mexico. In the southeastern Atlantic, striped dolphins are taken in a pelagic driftnet fishery for sharks, although the magnitude of this mortality is unknown (SC/49/SM7).

PACIFIC

Small numbers of striped dolphins have been taken sporadically in the purse seine fishery for yellowfin tuna in the eastern Tropical Pacific. Striped dolphins are taken as bycatch in several Japanese fisheries (SC/49/ProgRep Japan), but the magnitude of this mortality is not known.

14.2.3.5 STATUS

MEDITERRANEAN

Assessment of the status of striped dolphins in the Mediterranean is hampered by lack of a time series of abundance estimates for small cetaceans there. Anecdotal evidence suggests that the abundance of striped dolphins has increased in the past few decades, while that of common dolphins has declined. It is unclear, however, whether this apparent shift in species composition is real. In SC/49/SM17, Aguilar noted that the status of striped dolphins in the Mediterranean has been affected by several factors: the 1990-92 epizootic, bycatches in commercial fisheries and depletion of prey species. In addition, striped

dolphins in the western Mediterranean carry very high loads of organochlorine contaminants. These levels are among the highest ever recorded for any marine mammal and above the levels expected to cause detrimental effects in mammals. As noted below, interpretation of past interactions of diet, body condition, pollutant loads and the morbillivirus epizootic is difficult and, at the present time, it is not possible to fully assess the status of striped dolphins in the Mediterranean Sea. Despite these limitations, the Committee **agreed** that the combined effects of high pollutant levels, large bycatches in commercial fisheries, prey depletion and the epizootic were cause for serious concern.

ATLANTIC

The Committee had insufficient information to assess the status of striped dolphins in the Atlantic Ocean. It noted, however, that the existence of large bycatches of this species in several driftnet fisheries was cause for concern. In the western Atlantic, striped dolphins are not considered a strategic stock in either the Atlantic or Gulf of Mexico under the US marine mammal management scheme (SC/49/SM26). There is insufficient information to assess the status of striped dolphins in the South Atlantic.

PACIFIC

The Committee was not able to assess the status of striped dolphins in the eastern Pacific, because no new information was presented for this region.

As noted during its 1992 meeting, the Committee has long expressed concern regarding the status of striped dolphins in the western Pacific due to the level of exploitation sustained by this stock (IWC, 1993b). SC/49/SM29 provided a thorough review of the history of exploitation and summarised the two primary reasons for concern: observation of density-dependent changes in life history parameters and a decline in catch levels prior to 1980 with little concomitant change in fishing effort. The author also noted that a full assessment of the status of this stock required more information on the level of bycatches in commercial fisheries and an evaluation of the survival of dolphins taken and released in coastal drive fisheries.

The Committee reviewed recommendations on the status of striped dolphin in the western North Pacific made during its last review (IWC, 1993b). The Committee welcomed progress made on several of the recommendations, particularly the institution of species-specific catch limits by the Japanese Fisheries Agency and research conducted on stock structure by Japanese scientists and presented to this meeting. It continues to be concerned, however, about the status of striped dolphins in the coastal waters of Japan, and particularly in the Izu area. If a separate, small stock of striped dolphins exists in coastal waters, current catch levels are probably unsustainable. In addition, given the reported poor survival of captive animals (SC/49/SM16 and SC/49/SM27), concern was raised that the impact of the drive fishery may be underestimated by the reported catch. The situation underscores the need to continue research on stock structure of striped dolphins in the northwestern Pacific and, in particular, to determine whether such a separate coastal stock exists.

14.2.3.6 LIFE HISTORY

MEDITERRANEAN

A considerable body of information is available on the life history of striped dolphins from the western Mediterranean and is summarised in SC/49/SM17 and references therein. Sexual maturity occurs at approximately 12 years of age and 187cm in females and 11 years of age and 190cm in males.

ATLANTIC

Observations of stranded and bycaught striped dolphins in Irish waters suggests that life history parameters for this stock are similar to those of the Mediterranean and western Pacific stocks (SC/49/SM40).

PACIFIC

Striped dolphins in the western North Pacific are one of the best-studied populations of small cetaceans. The life history of these dolphins was reviewed in detail in SC/49/SM29. Length at birth is approximately 100cm and asymptotic lengths are 236cm in males and 225cm in females. Striped dolphins in the western North Pacific are larger than in the Mediterranean. Age at onset of sexual maturation in females decreased from 9.4 years in the 1956-68 cohort to 7.5 in the 1968-70 cohort (Kasuya, 1985), in a density-dependent response to exploitation. Off Izu, the female reproductive cycle lasts for 2.5 to 3 years; there has been no statistically detectable change in that parameter with time.

An analysis of 720 samples from striped dolphins taken in the Taiji drive fishery between 1991 and 1995 was presented in SC/49/SM15. Mean length at attainment of sexual maturity was estimated as 200cm for females and 224cm for males.

14.2.3.7 ECOLOGY

MEDITERRANEAN

SC/49/SM17 characterised striped dolphins in the Mediterranean as opportunistic feeders, exploiting a wide variety of pelagic and bathypelagic schooling species. In terms of ingested mass, fish and cephalopods are equally important in the diet.

ATLANTIC

In Irish waters, striped dolphins consume epipelagic and mesopelagic fish, cephalopods and crustaceans (SC/49/SM40). There is no information on the feeding ecology of striped dolphins in the northwestern or southern Atlantic.

PACIFIC

Western North Pacific striped dolphins feed on myctophids and other mesopelagic species (Miyazaki *et al.*, 1973).

14.2.3.8 OTHER

MEDITERRANEAN

More than 1,000 carcasses of striped dolphins were recovered in the western Mediterranean during 1990 and 1991 following massive mortality associated with a morbillivirus infection. Adults and calves suffered the greatest mortality and relatively few juveniles were affected. The total number of dolphins killed in this epizootic is unknown, as many carcasses sank before reaching shore and no data are available from the eastern or southern coasts of the Mediterranean (SC/49/SM17).

Several anthropogenic factors have been implicated in the origin and extent of the Mediterranean epizootic, particularly pollutants and depletion of prey resources. Striped dolphins in the Mediterranean carry extremely high burdens of organochlorines and moderate to high levels of heavy metals (SC/49/SM17). Concentrations of organochlorines in dolphins that died during the epizootic were higher than those sampled either before or after the event, raising

concerns over the immunosuppressive effects of these contaminants (Aguilar and Borrell, 1994). In the early phases of the outbreak, many diseased individuals exhibited poor body condition, which has been interpreted by some as reflecting food limitation prior to the onset of the epizootic (Aguilar and Raga, 1993).

Three alternative hypotheses may explain the arrival of the morbillivirus epizootic in the Mediterranean striped dolphin population:

(1) morbillivirus was enzootic in the Mediterranean population of striped dolphins and some factor triggered the epizootic;
(2) morbillivirus was introduced to striped dolphins in the Mediterranean from an external source;
(3) a new strain of morbillivirus arose, either within the Mediterranean or outside it, infecting striped dolphins.

At the present time, there is insufficient information to choose between these three hypotheses.

14.3 Review of other presented information

14.3.1 Bycatch reduction measures

SC/49/SM2 described a pinger experiment in the California swordfish/shark driftnet fishery. While the analysis of these results is not complete, the Committee noted that the results appear to show that the nets fitted with pingers caught fewer dolphins than those with 'control' pingers.

SC/49/SM42 described the results of a field test of the use of pingers to reduce incidental mortality of harbour porpoises in gillnets for the spring groundfish fishery in the Gulf of Maine. A total of 11 porpoises was caught in control (silent) nets and none were caught in nets with active pingers. As in previous studies, the experiment was double-blind. To date, three independent tests have demonstrated that pingers work in reducing cetacean bycatch under experimental conditions. Work is now needed on other aspects of 'pingers', for example, the effect of habituation, effects on other species and a mechanism to allow pingers to be implemented in 'real' fishery situations.

14.3.2 ETP

Incidental mortality of dolphins in the eastern Pacific Ocean tuna fishery in 1996 was reported in SC/49/SM1. That caused by the tuna purse seine fleet in 1996 was 2,547 individuals, including spotted dolphins, spinner dolphins and common dolphins, representing a decrease of 22% in total dolphin mortality from 1995.

14.3.3 Pelagic trawl fisheries

SC/49/NA9 summarised cetacean bycatch in pelagic trawl fisheries in parts of the Northeast Atlantic over the period 1993-1995. The paper discussed the results of a recent observer programme - Chalutier Pelagique (CHAPEL). Stranding records indicate that recurring large mortalities of oceanic dolphins, believed to originate from the bycatch of pelagic trawl fisheries, exceed the bycatch estimates derived from observer data, especially on the coasts of France and England. It was noted that there is evidence of white-sided dolphin bycatch in pelagic trawl fisheries in the western part of the Celtic Sea where the density of this species is thought to be low and the Committee **requests** that steps be taken to evaluate its extent and impact.

14.3.4 White whales

SC/49/SM19 and SC/49/SM20 presented the results of aerial surveys of white whales in Cook Inlet, Alaska in 1996 and 1997, and compared them with similar surveys in 1993, 1994 and 1995. While there was no significant trend in the indexed counts, the most recent index (1997) was the lowest for the last five years. Average annual catches from this small and isolated stock have been much higher than the PBR in recent years. The Committee has **great concern** for the survival of this stock of whales unless the harvest is reduced. DeMaster commented that efforts were on-going among the Cook Inlet Marine Mammal Council, the National Marine Fisheries Service and independent native hunters to develop a co-management agreement to limit the take to a sustainable level.

14.3.5 Franciscana

The Committee received three papers relating to the abundance and bycatch of the franciscana dolphin, *Pontoporia blainvillei* (SC/49/SM18, 36, and 37). An aerial survey along the Rio Grande do Sul coast in southern Brazil (SC/49/SM18) gave an estimate of 4,507 dolphins, the first time that this approach had been used to estimate the population size of this species. The Committee **agreed** that this was a welcome start, but that the survey methodology needed refinements.

Trends in franciscana stranding rates in Rio Grande do Sul from 1979 to 1996, and estimates of fishing effort in the artisanal bottom gillnet fishery, were presented in SC/49/SM36. This fishing effort was calculated using available CPUE data from trawl fisheries combined with estimates of the annual catch from the artisanal fisheries. Strandings rates were found to decline with time in the face of a large increase in fishing effort. These stranding rates are a matter of concern, suggesting that an impact on the southern population of franciscanas has occurred. The Committee **recommends** that work should continue to accurately assess the status of the population and bycatch levels.

14.3.6 Other

Berggren reviewed information on harbour porpoises in the Baltic. Based on morphometrics and genetic information (mtDNA), harbour porpoises in the Baltic are considered to be a distinct population. A survey of the area (excluding the Polish coast) was carried out in 1995 and resulted in an estimate of 599 pods (95% CI 200-3,300). A German survey of the Kiel and Mecklenburg Bays (ICES area IIIC) in 1996 provided an estimate of 941 pods there. Very little is known about bycatch in the Baltic but, because of the low abundance estimate, there is concern about the harbour porpoise status. The Committee noted that ASCOBANS has contracted a study for the Baltic Sea to look at all the available data (on past and current abundance; bycatch estimates and methodology; and fishery types and effort) with a view to making recommendations for future research based on likely levels of precision and variance, and taking into account the need to provide advice on status.

The Committee welcomed this initiative and looks forward to receiving the results at its next meeting.

14.4 Future topics

In view of the venue and timing of the 1998 meeting, the Committee agreed that priority topics provisionally scheduled for 1998 and 1999 should be deferred. New

Table 4

Priority topics regarding small cetaceans for discussion at the 1998 meeting.

Year	Topic
1998	Small cetaceans in the Indian Ocean and Red Sea, with special reference to the Middle East.
	Further consideration of the criteria for assessing the status of harbour porpoise populations.
1999	Global review of white whale and narwhal.
	Review of bycatch mitigation measures.
2000 or later	Global review of the genus *Tursiops*.
	Review of Dall's porpoise.
	Southern Ocean odontocetes, in particular the bottlenose whale.
	Global review of the genus *Lissodelphis*.

priorities for 1998 were proposed in their place (Table 4) and two further topics were added for consideration in the year 2000 or later.

14.5 Other business

The Committee agreed that collaborative links with ICCAT (International Commission for the Conservation of Atlantic Tunas) remain helpful to its work and therefore **recommends** that they be continued.

15. WHALE SANCTUARIES

A number of papers were submitted that presented the results of research carried out in sanctuaries. These were discussed in the relevant sub-committees.

15.1 Commission advice on commonly-agreed objectives for the Southern Ocean Sanctuary

For the last two years (IWC, 1997e, p.104; IWC, 1996d, p.93) the Committee has requested 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 has as yet made no comment on this matter. The Committee **draws the attention** of the Commission to it and **requests** its advice.

16. WHALEWATCHING

Last year (IWC, 1997e, p.105) the Scientific Committee recommended that the Commission consider the following 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.

Furthermore, the Committee 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.

16.1 Commission's response

The Commission adopted the Objectives and Principles for managing whalewatching proposed by the Scientific Committee and approved the Committee's future work programme (IWC, 1997b).

16.2 Priority items identified at the 1996 meeting

Priority items (a)-(d) (IWC, 1997b, p.106) formed the basis of discussions.

16.2.1 Review of guidelines

The Committee reviewed whalewatching activities in the Canary Islands (SC/49/O 26) including regulation of the industry through a permit system, a code of conduct and the implementation of sanctions against offenders. The potential conflict between the fishing and whalewatching industries of the Canary Islands was considered. No conflict between them exists although there is common use of resources by the fishing industry and the focal species, pilot whales. The incorporation of research results into the code of conduct in the Canary Islands was noted.

IWC/49/WW1 reported on whalewatching in the UK. The industry is regulated by local guidelines rather than central regulations. This system is well-suited to the UK where there are relatively few whalewatching operations.

Thiele reported on the development of a national set of guidelines for whalewatching in Australia. Carlson reported on the updating of SC/48/O 25, a review of national and regional guidelines and regulations worldwide and offered to submit an updated version to the 1998 meeting.

16.2.2 Assessment of short term reactions to whalewatching

SC/49/O 29 reported on reactions of cetaceans to tourism activities. Findlay summarised the methods used around the world to assess short-term reactions of tourism and the parameters used to judge such reactions.

Distribution and movements of sperm whales off Dominica and implications for the development and regulation of a local whalewatching industry (SC/49/O 27) were reviewed. The report concluded that the development of a whalewatching industry was feasible based on the results of two surveys. Lawrence questioned this conclusion in light of the multiple use of this marine region.

The Committee reviewed a study of physiological measurement of stress in dolphin species in South Africa (SC/49/SM22) and commended the study. Discussion on the applicability of the technique to the assessment of reactions to whalewatching was held.

16.2.3 Comparative studies
No information on comparative studies was received although it was noted that such studies were being carried out. The Committee **agreed** that cooperation between the Working Groups on Whalewatching and the Environment on how the concept of critical habitat might relate to whalewatching was valuable.

16.2.4 Report from Monkey Mia, Western Australia
The report requested last year (IWC, 1997e, p.106) on the adverse impact of the feeding of dolphins at Monkey Mia was not available. The Committee looks forward to receiving it for review at next year's meeting.

16.3 Action arising
The Committee noted the paucity of submitted information on all the priority items identified at its 1996 meeting and **recommends** that all items be retained on the Agenda for next year.

17. COMMITTEE OBJECTIVES AND PRIORITIES

A Working Group was established under Gambell to consider SC/49/O 17 as a starting point for defining the objectives and procedures of the Scientific Committee and possibly revising the Rules of Procedure of the Committee.

The primary references involving the Scientific Committee, either implicitly or explicitly, which appear in Commission texts are:

The Convention, Articles IV, V paragraphs 1 and 2(b), VII, VIII paragraphs 1, 3 and 4;
The Schedule, paragraph 30;
The *Commission Rule of Procedure,* M, paragraphs 1, 4, 5 and 6.

Based on the discussions within the Working Group and further review by the full Committee, the amendments to the *Rules of Procedure of the Scientific Committee* shown in Annex L were approved. The Committee agreed they should be given final consideration at next year's meeting. It **recommends** that they (amended if considered appropriate) should be adopted at the 50th Annual Meeting of the Commission. This complies with the requirement for amendments to the Rules of Procedure to be notified 60 days in advance of the meeting at which the matter is to be discussed [*Commission's Rules of Procedure R.1*].

The changes proposed are of two kinds. First, that language reflecting the conclusions reached on the Committee's functions, drawn from the texts of the *Convention, Schedule* and *Rules of Procedure* of the Commission, should be inserted as a preamble to the *Rules of Procedure of the Scientific Committee.*

Second, that a number of the Rules should be revised to bring them into line with the current and evolving practice of the Committee.

The guidelines for availability of data held by the IWC which currently appear as Appendix 1 of the *Rules of Procedure of the Scientific Committee* have been incorporated into the body of the revised text. The Working Group recognised that there may be a need to develop Rules for computer programs used to give management advice in the future.

During the Committee's discussions, Joseph spoke of the need for financial assistance to be provided to developing nations to allow them to participate more fully in the work of the Scientific Committee. The Committee **draws this point to the attention** of the Commission.

The Committee paid particular attention to the question of Invited Participants, once again reiterating its strong belief that they are essential to the work of the Committee and to its ability to provide advice to the Commission. It noted that details of the procedure for selecting and providing financial support for such participants could usefully be added to the new Rules of Procedure (see Annex L).

The suggested additions would come under Rule 6.

(a) Convenors will submit suggestions for Invited Participants to the Chairman (and copied to the Secretary) **not less than four months** before the meeting in question. The Chairman may also consider offers from suitably qualified scientists to contribute to specific aspects of the work of the Committee, if they submit such an offer to the Secretariat **not less than four months** before the meeting in question, providing information on the contribution they believe that they can make. The Chairman, in consultation with the Convenors and Secretary, will then develop a list of invitees **three months** before the meeting. In exceptional circumstances, the Chairman, in consultation with the Convenors and Secretary, may waive these time restrictions.
(b) The Chairman will indicate which participants should be offered financial support (at the standard subsistence rate offered by the Commission) and the period of the meeting for which that support will be provided. Scientists not supported for the full period, may, with the agreement of the Chairman, attend the remainder of the meeting at their own expense.
(c) The Secretary will send out invitations to the selected scientists, in accordance with the Commission's Guidelines (IWC, 1997a).

In addition, the Committee agreed that the letter of invitation should include the following ideas:

Under the Committee's Rules of Procedure, Invited Participants may present and discuss papers, and participate in meetings (including those of sub-groups). They are entitled to receive all Committee documents and papers. They may participate fully in discussions pertaining to their area of expertise. However, discussions of Committee procedures and policies are in principle limited to Committee members nominated by member governments. Such issues will be identified by the Chairman of the Committee during discussions. Invited Participants are also urged to use their discretion as regards their involvement in the formulation of potentially controversial recommendations to the Commission; the Chairman may at his discretion rule them out of order.

The Committee agreed that the procedures for invited participants outlined above should come into effect immediately, although their formal adoption into the Rules of Procedure would come at the 50th Annual Meeting (see above).

17.1 1997/98 work plan and initial agenda for the 1998 meeting
Given the lack of time for consideration of this matter by the full Committee, it **agreed** that the Chairman and convenors should review the work plan for 1997/98, in particular the establishment of sub-committees, for adoption for the next meeting.

Table 5

Computing tasks identified in the Committee and sub-committee reports.
Key: A: work to be done by Allison; C: contract out; S: work to be done by other members of the Secretariat.

	Task	By	Estimated time
	Annex I (AWMP)		
1	Amend and make additions to the common control and summary results programs (see Appendix 7). Produce trajectory plots - *highest priority*.	A	2 months
2	Develop a program to implement the multi-stock trials detailed in Appendix 3, Section G.	A	2 months
3	S-Plus course. Estimated time includes two weeks to gain basic experience with package.	A	3 weeks
	Annex D (RMP)		
4	Change the existing *CLA* program to double precision and retune it (Appendix 3).	A	3-4 weeks
5	Investigate methods to calculate catch limits under the *CLA* more efficiently. The sub-committee suggested that the Secretariat consider contracting out this task.	C?	3 months
6	Amend the control program and complete the conditioning of the North Pacific minke whale trials (Annex D and IWC/48/4, Annex J, Appendix 5).	A	3 months
6	Add incidental catches off Japan and Korea to the catch data files for North Pacific minke trials.	A/S	1 week?
7	Extract data from sightings database for calculation of additional variance.	S	
8	Complete documentation of the single stock control program (carried over from last year).	A	2 weeks
	Annex G (SHH)		
9	Code any revised Soviet catch data if they become available - *highest priority*.	S	Depends on extent of data.
10	Complete validation of Southern Hemisphere Discovery marking data from 1930s - *next highest priority*.	A/S	2 months
11	Continue coding and validation of Southern Hemisphere catch records for the period 1900-1939, in particular the data from South Georgia.	S	
12	Investigate availability of original individual catch data for the *Olympic Challenger* and remove data known to be false from database. Retain/add to data where catches can be confirmed.	A/S	1 month
13	Contact Natural History Museum regarding the availability of catch data from South Georgia for the period 1910-13. Also investigate other sources of data, in particular *Mem. Queensland Mus.* 42 (1): 105-138 may reveal new sources of data.	A	
14	Enquire about availability of the original marking data from the Soviet marking scheme.	A	
	Annex E (AE)		
15	Work on the three tasks described in Annex E (Item 3.2.1) on outstanding issues from 1996 analysis of NASS-88/89 and NILS-95.	A	2 weeks?
16	Complete validation of 1996/97 Southern Hemisphere minke whale cruise data and incorporate into the sightings database.	S	5-6 months
17	Coding of 1997/98 Southern Hemisphere minke whale cruise and blue whale cruise data.	S	3-4 weeks
18	Validation of 1997/98 Southern Hemisphere minke whale cruise data and incorporation into sightings database.	S	6 months
19	Code pre and post IDCR data 1978/9-1991/92. The time estimate applies at least for the most recent data.	S	3 months/year
	Annex M (SM)		
20	Collection of statistics of small cetacean catches and compilation of table for the Scientific Committee report.	A/S	2-3 weeks
	Work related to oversight (see Item 7.1.2)		
21	Verification of North Pacific Bryde's whale abundance data	A/S	
	Carried over		
22	Collate statistics of incidental catches of great whales and incorporate into database.	A/S	
	Routine work		
23	Routine work such as compilation of catch statistics for FAO and extraction of data as requested by individuals from the Scientific Committee and general public.	A/(S)	

18. DATA PROCESSING AND COMPUTING NEEDS FOR 1997/98

The Committee identified the computing tasks (Table 5) to be carried out during the coming year. It recognised that it would not be possible for all of these to be completed in time for next year's meeting. Where the sub-committees had identified priorities, these are indicated in Table 5. The Committee agreed that of the tasks identified, it was particularly important that task 1 (AWMP) be carried out as soon as possible after the meeting to enable the developers to begin work. The Committee recognised that final decision with respect to priorities would need to be made after the Commission meeting so that it could take into account Commission deliberations. It was agreed that the Chairman, in consultation with Allison and the Chairs of those sub-committees requesting computing (Donovan, Hammond, Best and Polacheck) would develop a final list of priorities as soon as possible after the closure of the Commission meeting. It agreed that this group would also review progress during the year to decide if priorities needed to be changed in the light of experience. The Committee also noted the large amount of work which will be necessary in the future in order to satisfy the oversight of abundance estimates for use in the RMP (verification of data and validation of the computer programs used) - see Item 7.1.2. The Secretariat should consider how this work might be best achieved.

19. FUNDING REQUIREMENTS FOR 1997/98

The Committee considered that the research activities given in Table 6 should be funded in the 1997/98 financial year.

The Secretary informed the Committee that the amount of money available in the Research Budget is £165,000. In addition there remains £4,300 designated for environmental activities and £6,700 for the SOWER cruises. This brings the total available to £176,000. This leaves a potential shortfall of £20,000.

Given the importance of the items requested, the Committee **strongly requests** that the Commission funds all the designated activities. If it proves impossible for the Commission to supplement the research budget this year, the Committee agreed that the order of deletions should be as given in Table 7.

Table 6

Funding requirements for 1997/98.

	Project	Report references	Cost
	Comprehensive Assessment		
(a)	Abundance and distribution from IDCR/SOWER and JSV data	Item 10; Annex E	£4,000
(b)	Right whale workshop	Item 10.3; Annex H	£25,000
(c)	Genetic studies of parent/offspring (SC/49/RP2) - first year of two	Item 13; Annex V	£22,000
	Data analyses		
(d)	DESS - sightings database and estimation software including training	Item 10; Annex E; Annex O	£10,000
(e)	Development of spatial modelling approach	Item 7; Annex E; Annex F; Annex O	£8,000
	Environmental concerns		
(f)	Pollution project planning meeting	Item 6.1; SC/49/Rep6; Annex F	£15,000
(g)	Antarctic project, intersessional activities and planning meetings	Item 6.1; SC/49/Rep5; Annex F	£10,000
	RMS/AWMP		
(h)	Improve efficiency of program to calculate catches under the *CLA*	Item 7.2; Annex D	£3,000
(i)	Training to use S-Plus package	Item 11.1; Annex I	£1,000
	SOWER		
(j)	Blue whale cruise	Item 10.1; SC/49/Rep3; Annex H	£32,900
(k)	Antarctic cruise	Item 10.5; SC/49/Rep4; Annex H	£53,500
(l)	Development of biopsy system (SC/49/RP3)	Item 13; SC/49/Rep3; Annex V	£7,600
(m)	Antarctic cruise data analysis, 1996/97	Item 10; Annex E	£4,000
	Total funds requested		**£196,000**

Table 7

Order of deletions should the research budget for 1997/98 not be able to fund all items in Table 6.

	Project	Reason	Cost
(m)	Antarctic cruise data analysis, 1996/97.	A general review is planned in two years.	£4,000
(c)	Genetic studies of parent/offspring (SC/49/RP2) - first year of two.	Representing the non-humpback whale element, which is considered to be less important to the IWC.	£8,000
(e)	Development of spatial modelling approach.	Less urgent to the IWC's needs.	£8,000

The Committee **advises** the Commission that the funding sought for research activities under this Item is quite separate from any sums recommended for oversight procedures in Item 7.1.2.

20. PUBLICATIONS

In accordance with normal practice, the Editorial Board was constituted from Convenors and the Scientific Editor, i.e. Bannister, Martin, Reilly, Zeh and Donovan. The Board reviewed the available documents for publication in the Commission's Report.

21. ELECTION OF OFFICERS

In view of the proposed changes to the Rules of Procedure (i.e. that the Chair and Vice-Chair should normally remain in office for three years), no elections were held.

22. OTHER BUSINESS

22.1 Communications

As indicated in IWC/49/21, the Secretariat has been considering its means of communicating with the members of the Commission in order to best take advantage of developments in the appropriate technology which are now available more-or-less worldwide.

Many members of the Scientific Committee use e-mail as a regular method of communicating with one another, for transferring information and data. As the note from Australia suggests in the Addendum to IWC/49/21, a combination of e-mail (or fax for those without e-mail) plus normal post would seem to provide the best combination for ensuring that everyone receives communications as quickly and efficiently as possible from the Secretariat.

The Secretary invited views from members of the Committee on this suggestion. He noted that the large number of intersessional e-mail correspondence groups established this year (Annex P) clearly demonstrated that e-mail was the preferred means of communication for Scientific Committee members.

The Committee **recommends** that the primary means of communication between the Secretariat and Scientific Committee members be via e-mail with fax used for those without e-mail. At regular intervals (e.g. monthly) a summary of transmitted e-mails will be sent by normal post to all members. Each e-mail message should be identified as a circular communication from the Secretariat to the Committee and given a reference number (e.g. IWC/SC/CC/12345). The Secretariat will compile a list of members who wish communications to be sent as hard copy by fax or normal post. The Secretary proposed that the period until next year's meeting could be treated as a trial during which both systems could be used.

23. ADOPTION OF REPORT

The report was adopted at 1845hrs on 11 October 1997. Items 17.3, 18 and 20 were finalised by the Editorial Board.

The Committee thanked the Secretariat for their customary cheerfulness and hard work throughout the meeting, in particular in difficult conditions on the afternoon

of the last day when a major computer breakdown interrupted the flow of the report to the Committee for its final consideration.

REFERENCES

Aguilar, A. and Borrell, A. 1994. Abnormally high polychlorinated biphenyl levels in striped dolphins (*Stenella coeruleoalba*) affected by the 1990-1992 Mediterranean epizootic. *Sci. Total Environ.* 154(2-3):237-47.

Aguilar, A. and Raga, J.A. 1993. The striped dolphin epizootic in the Mediterranean Sea. *Ambio* 22(8):524-8.

Anon. 1997. Illegal trade in whale meat. CITES Document 10.40.1 presented to the Tenth Meeting of the Conference of the Parties, Harare (Zimbabwe), 9-20 June 1997. 4pp.

Baker, C.S., Perry, A., Bannister, J.L., Weinrich, M.T., Abernethy, R.B., Calambokidis, J., Lien, J., Lambertsen, R.H., Urbán, J., Vasquez, O., Clapham, P.J., Alling, A., O'Brien, S.J. and Palumbi, S.R. 1993. Abundant mitochondrial DNA variation and world-wide population structure in humpback whales. *Proc. Natl Acad. Sci. USA* 90:8239-43.

Baker, C.S., Slade, R.W., Bannister, J.L., Abernethy, R.B., Weinrich, M.T., Lien, J., Urbán, J., Corkeron, P., Calambokidis, J., Vasquez, O. and Palumbi, S.R. 1994. Hierarchical structure of mitochondrial DNA gene flow among humpback whales, *Megaptera novaeangliae*, world-wide. *Mol. Ecol.* 3:313-27.

Baker, C.S., Florez-Gonzales, L., Abernethy, R.B., Rosenbaum, H.C., Slade, R.W. and Banister, J.L. In review. Mitochondrial DNA and gene flow among humpback whales of the Southern Hemisphere.

Ballance, L.T. and Pitman, R.L. In press. Distribution and relative abundance of cetaceans in the pelagic western tropical Indian Ocean and some comparisons with two other tropical systems. *Mar. Mammal Sci.*

Bérubé, M., Aguilar, A., Dendanto, D., Larsen, F., Notarbartolo di Sciara, G., Sears, R., Sigurjónsson, J., Urbán-Ramirez, J. and Palsbøll, P.J. 1997. Population genetic structure of North Atlantic and Mediterranean Sea fin whales, *Balaenoptera physalus* (Linnaeus 1758): analysis of mitochondrial and nuclear loci, and comparison with the Sea of Cortez fin whale population. (Accepted by *Molecular Ecology*). Paper presented as SC/49/For Information Paper 8 to the IWC Scientific Committee, September 1997, Bournemouth. 53pp.

Borchers, D.L., McCracken, M., Gunnlaugsson, T. and Burt, M.L. 1997. Estimates of minke whale abundance from the 1987 and 1995 NASS aerial surveys. NAMMCO Scientific Committee Working Group Document SC/5/AE/1.

Brown, M.R., Corkeron, P.J., Hale, P.T., Schultz, K.W. and Bryden, M.M. 1994. Behavioural responses of east Australian humpback whales *Megaptera novaeangliae* to biopsy sampling. *Mar. Mammal Sci.* 10(4):391-400.

Butterworth, D.S. and Punt, A.E. 1996. An extension of the ADAPT approach put forward for the analysis of catch-at-age information for Southern Hemisphere minke whales. Paper SC/48/SH17 presented to IWC Scientific Committee, June 1996, Aberdeen (unpublished). 17pp.

Butterworth, D.S., Borchers, D.L. and Chalis, S. 1993. Updates of abundance estimates for Southern Hemisphere blue, fin, sei and humpback whales incorporating data from the second circumpolar set of IDCR cruises. *Rep. int. Whal. Commn* 43:530.

Butterworth, D.S., Punt, A.E., Geromont, H.F., Kato, H. and Miyashita, T. 1996. An ADAPT approach to the analysis of catch-at-age information for Southern Hemisphere minke whales. *Rep. int. Whal. Commn* 46:349-59.

Cooke, J. 1997. Further analyses for the estimation of $g(0)$ and effective strip width for minke whale surveys. *Rep. int. Whal. Commn* 47:513-28.

Cooke, J.G. and de la Mare, W.K. 1994. Some aspects of the estimation and modelling of baleen whale sustainable yields. *Rep. int. Whal. Commn* 44:451-7.

Dawbin, W.H. 1997. Temporal segregation of humpback whales during migration in Southern Hemisphere waters. *Mem. Queensl. Mus.* 42(1):105-38.

DeAngelis, M.L., Martin, T. and Parryman, W.L. 1997. Pod size estimates studies through thermal sensors. Contract rep. to Natl. Mar. Mammal Lab., NMFS, NOAA, 7600 Sand Pt. Way, NE, Seattle, WA 98115. 7pp.

De Lestang, J.N. 1993. Status of marine mammals in the Eastern African region. Unpublished report to UNEP; UNEP Regional Seas Reports and Studies series.

Donovan, G.P. 1991. A review of IWC stock boundaries. *Rep. int. Whal. Commn* (special issue 13):39-68.

Doroshenko, N.V. 1996. Results of investigations of blue whale pygmy (*Balaenoptera musculus brevicauda*) taken by the Soviet whaling flotillas in the Indian Ocean during 1962/63-1979/72. *Izvestiya of the Pacific Research and Fisheries Centre (TINRO-centre)* 121:150-62.

Farrell, J. 1986. A whale of a window on Santa Barbara. *Exxon* 25(2):28-31.

Fenstad, A.M., Helgeland, J., Aldrin, M. and Volden, R. 1993. High accuracy computer program for the IWC Catch Limit Algorithm. Paper SC/45/Mg3 presented to the IWC Scientific Committee, April 1993 (unpublished). 38pp.

Fiedler, P., Reilly, S., Hewitt, R.P., Demer, D., Philbrick, V.A., Smith, S., Armstrong, W., Croll, D.A., Tershy, B.R. and Mate, B.R. 1997. Blue whale habitat and prey in the Channel Islands. *Deep-Sea Res.* (California Current Special Issue). 36pp.

Forcada, J., Aguilar, A., Hammond, P.S., Pastor, X. and Aguilar, R. 1994. Distribution and numbers of striped dolphins in the western Mediterranean Sea after the 1990 epizootic outbreak. *Mar. Mammal Sci.* 10(2):137-50.

George, J.C., Suydam, R.S., Philo, L.M., Albert, T.F., Zeh, J.E. and Carroll, G.M. 1995. Report of the spring 1993 census of bowhead whales, *Balaena mysticetus*, off Point Barrow, Alaska with observations on the 1993 subsistence hunt of bowhead whales by Alaska eskimos. *Rep. int. Whal. Commn* 45:371-84.

International Whaling Commission. 1989a. Report of the Comprehensive Assessment Workshop on Catch Per Unit Effort (CPUE), Reykjavik, 16-20 March 1987. *Rep. int. Whal. Commn* (special issue 11):15-20.

International Whaling Commission. 1989b. Report of the Comprehensive Assessment Workshop on Management, Reykjavik, 23-25 March 1987. *Rep. int. Whal. Commn* (special issue 11):21-8.

International Whaling Commission. 1991. Report of the Scientific Committee, Annex D. Report of the sub-committee on management procedures. *Rep. int. Whal. Commn* 41:90-112C.

International Whaling Commission. 1992a. Report of the Comprehensive Assessment Special Meeting on North Atlantic Fin Whales, Reykjavík, 25 February - 1 March 1991. *Rep. int. Whal. Commn* 42:595-644.

International Whaling Commission. 1992b. Report of the Fourth Comprehensive Assessment Workshop on Management Procedures, Annex D. Single stock trials for finalised procedures. *Rep. int. Whal. Commn* 42:317-8.

International Whaling Commission. 1992c. Report of the Third Comprehensive Assessment Workshop on Management Procedures, Oslo, 1-8 February 1990. *Rep. int. Whal. Commn* 42:271-304.

International Whaling Commission. 1993a. Chairman's Report of the Forty-Fourth Meeting, Appendix 2. Resolution on the need for research on the environment and whale stocks in the Antarctic region. *Rep. int. Whal. Commn* 43:39-40.

International Whaling Commission. 1993b. Report of the Scientific Committee, Annex G. Report of the sub-committee on small cetaceans. *Rep. int. Whal. Commn* 43:130-45.

International Whaling Commission. 1993c. Report of the Special Meeting of the Scientific Committee on the Assessment of Gray Whales, Seattle, 23-27 April 1990. *Rep. int. Whal. Commn* 43:241-59.

International Whaling Commission. 1994a. Report of the Scientific Committee. *Rep. int. Whal. Commn* 44:41-201.

International Whaling Commission. 1994b. Report of the Scientific Committee, Annex D. Report of the sub-committee on management procedures. *Rep. int. Whal. Commn* 44:74-92.

International Whaling Commission. 1994c. Report of the Scientific Committee, Annex G. Report of the Working Group on North Pacific Minke Whale Management Trials, Appendix 2. Catch data for North Pacific minke whale simulation trials. *Rep. int. Whal. Commn* 44:126-32.

International Whaling Commission. 1994d. Report of the Scientific Committee, Annex H. The Revised Management Procedure (RMP) for Baleen Whales. *Rep. int. Whal. Commn* 44:145-52.

International Whaling Commission. 1994e. Report of the Scientific Committee, Annex I. A programme to implement the catch limit algorithm. *Rep. int. Whal. Commn* 44:153-67.

International Whaling Commission. 1994f. Report of the Scientific Committee, Annex M. Report of the Working Group on MSY rates. *Rep. int. Whal. Commn* 44:181-9.

International Whaling Commission. 1995a. Report of the Scientific Committee. *Rep. int. Whal. Commn* 45:53-103.

International Whaling Commission. 1995b. Report of the Scientific Committee, Annex D. Report of the sub-committee on management procedures. *Rep. int. Whal. Commn* 45:104-19.

International Whaling Commission. 1995c. Report of the Scientific Committee, Annex F. Report of the sub-committee on aboriginal subsistence whaling. *Rep. int. Whal. Commn* 45:142-64.
International Whaling Commission. 1995d. Report of the Scientific Committee, Annex N. Revisions to annotations to the Revised Management Procedure (RMP) for baleen whales. *Rep. int. Whal. Commn* 45:214.
International Whaling Commission. 1996a. Chairman's Report of the forty-seventh annual meeting. *Rep. int. Whal. Commn* 46:15-48.
International Whaling Commission. 1996b. Chairman's report of the forty-seventh annual meeting. Appendix 11. Resolution on the environment and whale stocks. *Rep. int. Whal. Commn* 46:47-8.
International Whaling Commission. 1996c. Chairman's report of the forty-seventh annual meeting. Appendix 9. Resolution on whaling under special permit in sanctuaries. *Rep. int. Whal. Commn* 46:46.
International Whaling Commission. 1996d. Report of the Scientific Committee. *Rep. int. Whal. Commn* 46:49-236.
International Whaling Commission. 1996e. Report of the Scientific Committee, Annex D. Report of the sub-committee on management procedures. *Rep. int. Whal. Commn* 46:107-16.
International Whaling Commission. 1996f. Report of the Scientific Committee, Annex G. Report of the sub-committee on North Pacific Bryde's Whales. *Rep. int. Whal. Commn* 46:147-59.
International Whaling Commission. 1996g. Report of the Scientific Committee, Annex S. Review of IWC Scientific Committee Procedures for assessing research proposals-report of intersessional correspondence group. *Rep. int. Whal. Commn* 46:227-8.
International Whaling Commission. 1997a. Chairman's report of the forty-eighth annual meeting. *Rep. int. Whal. Commn* 47:17-55.
International Whaling Commission. 1997b. Chairman's report of the forty-eighth annual meeting. Appendix 1. IWC Resolution 1991 -1. Resolution to resolve the distress of the Japanese small-type coastal whaling as community-based whaling. *Rep. int. Whal. Commn* 47:48.
International Whaling Commission. 1997c. Report of the Abundance Estimation Working Group. *Rep. int. Whal. Commn* 47:261-90.
International Whaling Commission. 1997d. Report of the IWC Workshop on Climate Change and Cetaceans. *Rep. int. Whal. Commn* 47:293-319.
International Whaling Commission. 1997e. Report of the Scientific Committee. *Rep. int. Whal. Commn* 47:59-257.
International Whaling Commission. 1997f. Report of the Scientific Committee. Annex E, Appendix 3. Report of the *AD-HOC* working group on the 1996/7 and 1997/8 Southern Ocean whale surveys. *Rep. int. Whal. Commn* 47:143-6.
International Whaling Commission. 1997g. Report of the Scientific Committee. Annex E. Report of the sub-committee on Southern Hemisphere baleen whales. *Rep. int. Whal. Commn* 47:128-52.
International Whaling Commission. 1997h. Report of the Scientific Committee, Annex F. Report of the sub-committee on aboriginal subsistence whaling. *Rep. int. Whal. Commn* 47:153-62.
International Whaling Commission. 1997i. Report of the Scientific Committee, Annex G. Report of the sub-committee on North Pacific Bryde's whales. *Rep. int. Whal. Commn* 47:163-8.
International Whaling Commission. 1997j. Report of the Scientific Committee, Annex H. Report of the sub-committee on small cetaceans. *Rep. int. Whal. Commn* 47:169-91.
International Whaling Commission. 1997k. Report of the Scientific Committee, Annex J. Report of the working group on North Pacific minke whale trials. *Rep. int. Whal. Commn* 47:203-26.
International Whaling Commission. 1997l. Report of the Scientific Committee, Annex K. Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme. *Rep. int. Whal. Commn* 47:227-35.
International Whaling Commission. 1997m. Report of the Scientific Committee, Annex P. Report of the working group on aboriginal whaling management procedures. *Rep. int. Whal. Commn* 47:243-9.
International Whaling Commission. 1998. Report of the Workshop on Chemical Pollution and Cetaceans. *Rep. int. Whal. Commn* (special issue):In press.
Jefferson, T.A., Curry, B.E., Leatherwood, S.E. and Powell, J.A. 1997. Dolphins and porpoises of West Africa: a review of records. *Mammalia* 61(1):87-108.
Jones, M.L. and Swartz, S.L. 1986. Demography and phenology of gray whales and evaluation of whale-watching activities in Laguna San Ignacio, Baja California Sur, Mexico: 1978-1982. Dept. Commerce N.T.I.S. Publ. PB 86-2190778. 69pp.
Kasamatsu, F. and Joyce, G.G. 1995. Current status of Odontocetes in the Antarctic. *Antarct. Sci.* 7(4):365-79.
Kasuya, T. 1985. Effect of exploitation on reproductive parameters of the spotted and striped dolphins off the Pacific coast of Japan. *Sci. Rep. Whales Res. Inst., Tokyo* 36:107-38.
Kato, H., Tanaka, E. and Sakuramoto, K. 1993. Movement of southern minke whales in the Antarctic feeding grounds from mark-recapture analyses. *Rep. int. Whal. Commn* 43:335-42.
Katona, S.K. and Beard, J.A. 1990. Population size, migrations and feeding aggregations of the humpback whale (*Megaptera novaeangliae*) in the western North Atlantic Ocean. *Rep. int. Whal. Commn* (special issue 12):295-305.
Laake, J.L., Rugh, D.J., Lerczak, J.A. and Buckland, S.T. 1994. Preliminary estimates of population size of gray whales from the 1992/93 and 1993/94 shore-based surveys. Paper SC/46/AS7 presented to the IWC Scientific Committee, May 1994 (unpublished).
Larsen, F. 1995. Abundance of minke and fin whales off West Greenland, 1993. *Rep. int. Whal. Commn* 45:365-70.
Leatherwood, S. and Reeves, R.R. 1983. *The Sierra Club Handbook of Whales and Dolphins*. Sierra Club Books, San Francisco. xvii+302pp.
Mackintosh, N.A. 1942. The southern stocks of whalebone whales. *Discovery Rep.* 22:197-300.
Maigret, J. 1994. Marine mammals and fisheries along the west African coast. *Rep. int. Whal. Commn* (special issue 15):307-16.
Mikhalev, Y.A. 1996. Pygmy blue whales of the northern-western Indian Ocean. Paper SC/48/SH30 presented to IWC Scientific Committee, June 1996, Aberdeen (unpublished). 30pp.
Mikhalev, Y.A. 1997. Report of the Scientific Committee, Annex E, Appendix 5. Additional information about the catches of Soviet whaling fleet *Sovetskaya Ukraina*. *Rep. int. Whal. Commn* 47:147-50.
Mills, J., Ishirhara, A., Sakaguchi, I., Kang, S., Parry-Jones, R. and Phipps, M. 1997. *Whale Meat Trade in East Asia; a Review of the Markets in 1997*. TRAFFIC International, Cambridge. (UK ISBN 1 85850 1253).
Miyazaki, N., Kasuya, T. and Nishiwaki, M. 1973. Food of *Stenella coeruleoalba*. *Sci. Rep. Whales Res. Inst., Tokyo* 25:265-75.
NAMMCO. 1997. Scientific Committee Report of the Fifth Meeting. Annex 3: Report of the Scientific Committee Working Group on Abundance Estimates. Sondre Tollbodgate 9, Tromso, Norway.
O'Shea, T.J. and Brownell, R.L. 1994. Organochlorine and metal contaminants in baleen whales - a review and evaluation of conservation implications. *Sci. Total Environ.* 154(2-3):179-200.
Palsbøll, P.J., Allen, J., Bérubé, M., Clapham, P.J., Feddersen, T.P., Hammond, P.S., Hudson, R.R., Jørgensen, H., Katona, S., Larsen, A.H., Larsen, F., Lien, J., Mattila, D.K., Sigurjønsson, J., Sears, R., Smith, T., Sponer, R., Stevick, P. and Øien, N. 1997a. Genetic tagging of humpback whales. *Nature, Lond.* 388:767-9.
Palsbøll, P.J., Bérubé, M., Haug, T., Heiberg, A.C., Larsen, F., Sears, R. and Sigurjønsson, J. 1997b. Preliminary analysis of population genetic data obtained from North Atlantic minke whales, *Balaenoptera acutorostrata*. Paper SC/49/NA4 presented to the IWC Scientific Committee, September 1997, Bournemouth (unpublished). 17pp.
Reeves, R.R. and Heide-Jørgensen, M.P. 1996. Recent status of bowhead whales, *Balaena mysticetus*, in the wintering grounds off West Greenland. *Polar Research* 15(2):115-25.
Reilly, S.B. 1981. Population assessment and population dynamics of the California gray whale (*Eschrichtius robustus*). Ph.D. Thesis, University of Washington. 265pp.
Robineau, D. and Vely, M. In Press. Small cetaceans in coastal waters of Mauritania (NW Africa).
Sanpera, C. and Jover, L. 1989. Density estimate of fin whales in the North Atlantic from NASS-87 Spanish cruise data. *Rep. int. Whal. Commn* 39:427-9.
Schweder, T. 1997. Report of the Scientific Committee, Annex I, Appendix 5. Minority statement on ITEM 4. Maximising utility or satisfying prespecified need? *Rep. int. Whal. Commn* 47:202.
Schweder, T., Skaug, H.J., Dimakos, X.K., Langaas, M. and Øien, N. 1997a. Abundance of northeastern Atlantic minke whales, estimates for 1989 and 1995. *Rep. int. Whal. Commn* 47:453-84.
Schweder, T., Skaug, H.J., Langaas, M. and Dimakos, X.K. 1997b. Simulated likelihood analysis of line transect data in descrete availability hazard models, illustrated on minke whales abundance estimation. (Submitted to *Biometrics*).
Simmonds, M.P. and Mayer, S.J. 1997. An evaluation of environmental and other factors in some recent marine mammal mortalities in Europe: implications for conservation and management. *Environ. Rev.* 5:89-98. Paper presented as For Information Paper No. 12 to the

IWC Scientific Committee, September 1997, Bournemouth (unpublished). 10pp.
Smith, T.D., Allen, J., Clapham, P.J., Hammond, P.S., Katona, S., Larsen, F., Lien, J., Mattila, D., Palsbøll, P., Sigurjønsson, J., Stevick, P.T. and Øien, N. In review. An ocean-basin wide study of the abundance, population structure and reproduction of the North Atlantic humpback whale (*Megaptera novaeangliae*). *Mar. Mammal Sci.*
Tanaka, S. 1990. Estimation of natural mortality coefficient of whales from the estimates of abundance and age composition data obtained from research catches. *Rep. int. Whal. Commn* 40:531-6.
Tanaka, S., Kasamatsu, F. and Fujise, Y. 1992. Likely precision of estimates of natural mortality rates from Japanese research data for Southern Hemisphere minke whales. *Rep. int. Whal. Commn* 42:413-20.
Taylor, B.L. and DeMaster, D.P. 1993. Implications of nonlinear density dependence. *Mar. Mammal Sci.* 9(4):360-71.
Wada, S. and Numachi, K. 1991. Allozyme analyses of genetic differentiation among the populations and species of the *Balaenoptera*. *Rep. int. Whal. Commn* (special issue 13):125-54.
Wade, P.R. 1996. A Bayesian stock assessment of the eastern Pacific gray whale using abundance and harvest data from 1967 to 1996. Paper SC/48/AS8 presented to IWC Scientific Committee, June 1996, Aberdeen (unpublished). 17pp [plus supplement].
Whitcher, B.J., Zeh, J.E., Rugh, D.J., Koski, W.R. and Miller, G.W. 1996. Estimation of adult bowhead whale survival rates. Paper SC/48/AS12 presented to IWC Scientific Committee, June 1996, Aberdeen (unpublished). 22pp.
Zemsky, V.A., Berzin, A.A., Mikhalev, Y.A. and Tormosov, D.D. 1995. Report of the sub-committee on Southern Hemisphere baleen whales. Appendix 3. Soviet Antarctic pelagic whaling after WWII: Review of actual catch data. *Rep. int. Whal. Commn* 45:131-5.