Report of the Scientific Committee

The Committee met at 09.00 on 10 June 1990 and following days at the Leeuwenhorst Congres Center, Noordwijkerhout, the Netherlands, under the Chairmanship of R.L. Brownell, Jr. A list of participants is given in Annex A.

1. CHAIRMAN'S WELCOME AND OPENING REMARKS

The Chairman welcomed participants to the Congres Center. For the first time for many years, Doug Chapman (USA) was not present as he was still recovering from a road accident. It was agreed to send a message for a speedy recovery signed by the members of the Committee. The Committee was also informed of the serious illness of John Gulland, a member of the Committee of Four Scientists established by the Commission in the 1960s and FAO representative on the Scientific Committee for several years. A message signed by those who know him was sent on behalf of the Committee.

2. ADOPTION OF AGENDA

The adopted Agenda is given in Annex B. Statements concerning the Agenda are given in Annex S. They refer to Items 7.1 and 7.2 and Item 11.

3. ARRANGEMENTS FOR MEETING

3.1 Appointment of Rapporteurs

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

3.2 Meeting procedures and time schedule

The Committee agreed to a work schedule similar to that in previous years. This took into account comments, suggestions and procedures agreed to at earlier meetings (*Rep. int. Whal. Commn* 33:36; 38:59).

3.3 Establishment of sub-committees

The Chairman stressed that the main business at this year's meeting was to be the discussion of management procedures (a 3-day workshop had preceded this meeting) and the in-depth assessments of Southern Hemisphere and North Atlantic minke whales. Three sub-committees were established to examine these matters and their reports are given in Annexes D-F respectively. The standing sub-committee on small cetaceans also met and its report is given as Annex G. A series of *ad-hoc* sub–committees was established to examine specific questions: aboriginal subsistence whaling; research proposals; the effects of biopsy sampling on cetaceans; planning for future assessments; and the IDCR minke whale assessment cruise. Their reports are given as Annexes or incorporated under relevant Items.

3.4 Computing arrangements

Allison outlined the arrangements for access to the University of Cambridge computer system. A digital link had been installed from the Congres Center to the international packet switching system (IPSS) providing up to five communication channels connected to personal computers. In addition four personal computers running MS-DOS were available for use by Committee members, both for running programs and word processing.

4. REVIEW OF AVAILABLE DATA, DOCUMENTS AND REPORTS

4.1 Documents submitted

A list of documents is given in Annex C.

4.2 National progress reports on research

National progress reports received this year had been prepared according to the revised guidelines developed by the Committee (*Rep. int. Whal. Commn* 39:130). The Committee reaffirmed its view of the importance of progress reports to its work and again **recommends** that the Commission urges member nations to provide them following the approved guidelines.

4.3 Data collection, storage and manipulation

4.3.1 Catches and other statistical material from the previous season(s)

Individual catch data for the 1989/90 season had been received from Iceland and Japan, and encoded by the Secretariat. A summary of the past season's catches was circulated.

During the past year the Secretariat had received computer discs or tapes containing the following data for use during the current meeting:

Iceland	Individual minke whale catch records 1973–85 1986 aerial survey data NASS 1987 and 1989 sightings survey data
Norway	NASS 1987 and 1989 sightings survey data 1988 sightings survey data Results of 1989 parallel ship experiment
Faroes	NASS 1987 sightings survey data
Denmark	Summary of minke whale catches off Greenland since 1948 and individual records for some recent catches
Japan	An update to the Southern Hemisphere biological master tape

4.3.2 Progress on data coding projects
Allison reported that good progress continued to be made with the data coding projects. The IWC data base now includes all available catch data since 1945. Coding of pre-war data has begun.

4.3.3 Progress on computing projects
Allison reported that the control program for use in screening trials of management procedures had been written and used successfully by procedure developers. Screening trials for the NMP based management procedure had been carried out and results presented to the Management Workshop in Oslo (SC/42/Rep2). New screening trials had been specified at that Workshop and major additions were made to the control program to incorporate these. The new version of the control program was used by procedure developers in results presented to the Workshop immediately preceding this meeting.

Data files of Antarctic baleen whale catches by species, month and 1° square had been prepared as recommended by the Committee last year.

Haw reported that data validation, routine abundance estimation and analyses of experiments from the 1988/89 Southern Hemisphere minke whale assessment cruise had been completed.

4.4 Whale marking

No new 'Discovery' marks were placed in the 1989 or 1989/90 seasons. Three marks were recovered from fin whales off Iceland (SC/42/ProgRep Iceland). Information on natural marking research is given in a number of progress reports: SC/42/ProgRep Australia, Denmark, Iceland, Japan, New Zealand, Sweden, UK and USA.

5. COOPERATION WITH OTHER ORGANISATIONS

5.1 Observers' reports

5.1.1 ICES
The report of the IWC observer at the 77th meeting of ICES held in Den Hague, Netherlands, October 1989, was available as IWC/42/10A. The IWC observer attended the meetings of the Marine Mammals Committee (MMC) and a list of the papers submitted to the MMC is appended to the observer's report. The meeting thanked Bjørge for attending the ICES meetings on its behalf.

5.1.2 CMS
Johnson directed the Committee's attention to SC/42/O 12, which provided background information on CMS, the Convention on Migratory Species of Wild Animals. In particular she reported that the Scientific Council was undertaking a global review of the conservation status of small cetaceans, and to this end had established a Working Group on small cetaceans. The Working Group met for the two days prior to this IWC Scientific Committee meeting.

5.1.3 CCAMLR
Last year the Committee informed CCAMLR that the proposed joint IWC/CCAMLR Workshop on the Feeding Ecology of Southern Baleen whales would have to be deferred. In its discussion of Southern Hemisphere minke whales, the Committee had noted that in developing an ecosystem approach to the management of whales it could be important to take account of the abundance and distribution of other krill predators, and the quality of the data available on these. Recognising the need for more information on these predators and the fact that the evaluation of such information should properly involve the scientific committees of both the IWC and CCAMLR, the Committee **recommends** that the terms of reference and participants for the joint workshop on the Feeding Ecology of Southern Baleen Whales should be expanded to cover studies of other major predators of krill, especially those pertinent to estimates of abundance and trends in abundance. The Committee agreed that planning for this meeting should continue in cooperation with CCAMLR, with the aim of holding the meeting in 1992. Harwood reported that he was unable to continue on the Steering Committee. The Committee agreed that Reilly should be its representative in future.

5.1.4 IATTC
No observer was present from IATTC at this year's meeting. A paper on dolphin mortality prepared by scientists from IATTC was discussed under Item 11 (Annex G).

5.2 UNEP

5.2.1 Global Plan of Action for the Conservation, Management and Utilisation of Marine Mammals
The UNEP observer noted that the Global Plan of Action for the Conservation, Management and Utilisation of Marine Mammals adopted by UNEP in 1984 was subsequently endorsed by the Food and Agriculture Organisation (FAO), the World Conservation Union (IUCN) as was its cetacean component by the IWC at its 34th meeting. She drew attention to the following high priority activities that have been or are to be implemented with the assistance of UNEP funding:

(1) preparation of identification sheets by FAO (in FAO standard format), of those marine mammal species most frequently fished or taken as incidental catch in fisheries, in order to improve catch statistics of these species;
(2) a review of the existing databases on marine mammals to be prepared by WCMC (World Conservation Monitoring Centre), who will subsequently establish a global database network on marine mammals;
(3) a directory of threatened (as defined by IUCN) marine mammal species covered by the Global Plan may be prepared by IUCN;
(4) continued support of the production of public awareness material and the Marine Mammal Technical Reports series.

The Scientific Committee was informed that UNEP is developing the procedures necessary to advance the Marine Mammal Action Plan through the establishment of a Planning and Coordinating Committee and a Scientific Advisory Committee. However, last year the IWC decided that it will not sign the Memorandum of Understanding designed to formalise these arrangements, but it will note such cooperation that may occur on a scientific level and which has no financial implications to the Commission.

The Scientific Committee reiterates the view it expressed last year that the IWC should continue to be involved in the Action Plan to the fullest extent possible. Members of the Scientific Committee are ready to assist in the work of the proposed Scientific Advisory Committee as requested. The Committee believes that the IWC should continue to be represented by an observer in any future meetings.

5.3 Gillnets and Cetaceans

5.3.1 Symposium and Workshop

Perrin reported that the conference entitled 'Mortality of cetaceans in passive fishing nets and traps' will take place from 20–25 October 1990 in La Jolla, California. The first two days will be an open symposium and the final four days will comprise a workshop of experts. The Workshop will cover three major areas: a review of relevant fisheries; a review of methods to reduce cetacean mortality; and a review of the impact of such fisheries on cetacean populations.

5.3.2 UN General Assembly

In December 1989 the United Nations General Assembly adopted a Resolution (44/225) on 'large-scale pelagic drift net fishing and its impact on the marine living resources of the world's oceans and seas'. The Commission has been invited to submit its views on the subject before July 1990 so that they may be taken into account in a report by the UN Secretary General to the 45th session of the General Assembly (IWC/42/22).

Last year the Committee noted new information on the incidental kill of large and small cetaceans in gillnets and other fishing gear (*Rep. int. Whal. Commn* 40:177). SC/42/O 1 reported a North Pacific right whale that stranded in October 1989 on Cape Lopatka off southern Kamchatka with a 20m section of salmon driftnet wrapped around its caudal peduncle. The western North Pacific right whale population probably numbers between 100 and 200 animals and the eastern North Pacific population possibly only a few individuals (*Rep. int. Whal. Commn* (special issue 10):1-13); gillnets may represent a significant source of mortality to this population in particular and to other large cetaceans as well. The Committee noted that an April 1990 FAO meeting in Rome identified serious gaps in our knowledge on the effects of driftnets on cetacean populations. Recent information on substantial by-catches of non-target species, particularly catches of small cetaceans, in high seas gillnet fisheries was cause for great concern. Morimoto stated that the Secretary General of the United Nations is awaiting information from the IWC on the driftnet fishery's impact on living marine resources including cetaceans. However, in his view, discussion at this Scientific Committee meeting is not appropriate due to a lack of sufficient knowledge on this subject. He believed, therefore, that further comment should await the forthcoming October Workshop.

The Committee **recommends** that the Secretariat inform the UN Secretary General that its concern regarding the effects of gillnets on cetaceans was such that it had conceived and planned the October 1990 Symposium and Workshop described under Item 5.3.1. It further **recommends** that the report from this meeting should be forwarded to the UN Secretary General for consideration in his report to the 45th session of the General Assembly.

6. COMPREHENSIVE ASSESSMENT – PRIORITY STOCKS

6.1 Management procedures – commercial whaling (see also Annex D)

6.1.1 Report of Workshop on Management Procedures

The Third Comprehensive Assessment Workshop on Management Procedures (SC/42/Rep2) was held in Oslo, Norway in February 1990. Its aims were to review results of the first phase of second stage screening of potential revised management procedures, to specify the second phase trials, and to develop quantitative methods for comparisons of performance of procedures.

The Workshop considered results of screening trials specified at the 1989 Annual Meeting for four of the five revised management procedures under development. The 160 sets of simulations had been carried out for each procedure using a common control program developed by Allison. Similar results were considered for a procedure based on the 'New Management Procedure' (NMP). A partial set of results was available for the fifth revised management procedure, but these were not considered.

The screening trials involved investigation of a number of different factors, both individually and in combination. The Workshop found that in cases where there was no uncertainty in stock identity, the revised management procedures had some encouragingly robust properties. The NMP-based procedure was far less robust, and caused the simulated stock to be extinguished in some cases. The Workshop concluded that very substantial progress had been made towards designing management procedures which would be more effective than the NMP. Further testing of an NMP-based procedure was abandoned.

In contrast to the robust properties shown when stock identity was known, trials based on a possible land station whaling situation in which two real stocks were managed as a single stock caused all management procedures to fail. Two possible reactions to this were considered: further efforts could be made to make the management procedures more robust to uncertain stock identity, or this lack of robustness of procedures could be accepted and efforts be devoted to reducing the level of uncertainty. The Workshop agreed to take the former approach, on the grounds that the latter is unlikely to yield a satisfactory general situation in the near future. It was considered that better performance may be obtained if the absolute and relative abundance data were available in the trials on a spatially disaggregated basis, as they normally are in practice. New trials to examine this were specified, for completion by the 1990 Annual Meeting.

Given the large number of trials and performance statistics, the Workshop had considerable difficulty in summarising and contrasting the performance of the procedures. This emphasised the potential value of using some decision-making techniques when comparing procedures. Two possible methods were discussed by the Workshop. The Workshop noted that there had been considerable convergence in the approaches to management used in the procedures over the period of development. This led to the suggestion that it may be possible to integrate some or all of the current procedures, thus making easier the task of selecting a 'best' procedure in 1991. Developers were encouraged to consider this.

In addition to re-specifying the trials dealing with uncertain stock identity, the Workshop specified a number of second phase, second stage screening trials to be completed by the 1990 Annual Meeting. It also identified a subset of these and earlier screening trials that should be repeated if further changes are made to procedures.

6.1.2 Further development of management procedures

6.1.2.1 *Results of screening trials*

Since the Oslo Workshop, further modifications have been made to all but one of the five revised management procedures under development. Three of them now rely

either primarily or solely on absolute abundance estimates. The other two rely on both absolute abundance estimates and catch–related relative abundance indices, such as CPUE data.

By now, a considerable number of screening trials have been specified. Trials specified before the Oslo Workshop made up the first stage of screening and the first phase of the second stage of screening. A review of the results of these trials led the Oslo Workshop to identify a subset that allowed discrimination between the performance of procedures. This subset of trials was to be repeated each time a procedure was modified. Results for the modified procedures on this subset of earlier trials, and on the second phase trials of second stage screening specified at the Oslo Workshop (SC/42/Rep2), were presented in SC/J90/Mg 2, 6, 7, 11, 13, 14. These were discussed initially at a 3-day workshop held immediately before the Committee meeting and subsequently by the sub-committee on management procedures.

Trial by trial comparisons of the performance of the procedures are given in Items 7.2 and 7.3 of Annex D. The Committee agreed that, for all but the trials involving uncertain stock identity, the five procedures have continued to show encouragingly robust properties.

However, uncertain stock identity remains a major problem. As noted above, results for an earlier version of the 'coastal whaling' trials tabled at the Oslo Workshop indicated very poor performance, with frequent stock extinction. In those trials, the absolute and relative abundance data were assumed available for the whole area only. Results tabled at this meeting for a revised trial in which the abundance data were available on a spatially disaggregated basis indicated that in certain circumstances it is now possible to prevent the two stocks from being extinguished. However, this was only achieved by taking very low catches, thus substantially under-exploiting the resource when there was only one true stock. The Committee agreed that some aspects of the revised specification of this trial remained unrealistic and further revision was necessary. However, while some improvement in performance has been achieved, the stock identity problem has not yet been solved.

6.1.2.2 *Specification of additional screening trials*

Not all the second phase trials for second stage screening previously identified by the Committee had been specified at the Oslo Workshop. The outstanding trials are listed in Annex N of SC/42/Rep2. The Committee developed the detailed specifications in Appendix 4 of Annex D.

For the 'coastal whaling' stock identity trials, a further revised specification was made. The Committee also considered the draft specification of a 'pelagic whaling' stock identity trial (Annex K, SC/42/Rep2), which was loosely modelled on Antarctic minke whaling. Alternative hypotheses on stock identity provided by the Southern Hemisphere minke whale committee (see Annex E) in response to questions posed by the management procedures sub-committee (see 6.1.2.4 below) were quite similar to the draft specifications. The Committee therefore revised the specifications to take specific account of these alternative minke whale hypotheses.

The response to a similar question posed to the North Atlantic minke whale sub-committee on stock identity in that region was received too late in the meeting for a draft specification to be made for an additional trial. The Committee **recommends** that this be developed by correspondence and finalised at or before the proposed inter-sessional meeting.

6.1.2.3 *Comparison of performance of procedures*

The relative merits of management procedures must be judged primarily on their ability to meet the Commission's three management objectives (*Rep. int. Whal. Commn* 38:36). The Committee noted the response by the Commission to the request for advice on the operational definitions of these objectives and the quantitative weightings that it assigns to them. No consensus had been reached at the 1989 Commission Meeting, but most delegations had stated that the highest priority should be given to the objective that there be an acceptable risk that a stock not be depleted below some chosen level. No advice was given as to what might constitute an acceptable risk, but several delegations spoke in favour of the incorporation of a protection level.

The Committee noted that because no clear advice has been given by the Commission, the five procedures remain tuned to different balances among the three management objectives. Also, the concept of protection levels is treated differently in the procedures. It is essential that these differences be accounted for when comparing procedures. The Committee **recommends** that additional trials be conducted to assist in this process (see Appendix 4 of Annex D).

With respect to the relative weightings of the management objectives, the Committee agreed that the Commission would require, for an informed judgment, at least quantification of the trade-offs between the different objectives. An example of such information for the Punt-Butterworth procedure is in the figures in Appendix 3 of Annex D, which show for the four base case screening trials the levels of total catch, final population size, lowest depletion and catch variability that result from varying the tuning parameters of the procedure over a range from emphasising high yields to emphasising the avoidance of depletion.

Similar views were expressed by members when considering the question of protection levels. A specified protection level is an integral part of the current management procedure (NMP); it is one of the elements of the NMP designed to ensure that stocks are not depleted to levels much below the MSY level. However, in at least some of the alternative management procedures being developed, the approaches taken do not require imposition of a formal and relatively high protection level to insure against excessive stock depletion. The Committee agreed that it would be necessary to present clear evidence of the performance of procedures in this respect, whatever concept of protection level has been employed, before seeking future clarification on protection levels.

The principal problem in comparing the performance of the revised management procedures is that comparisons must be made over a very large number of trials and a large number of performance statistics for each trial. The difficulty of comparisons would be reduced if a smaller number of procedures were to be compared. At the Oslo Workshop, the possibility of synthesising or combining procedures had been raised, given the extent of convergence in approaches. The Committee encouraged procedure developers to consider merging of their procedures in the coming year. Three different techniques

for making performance comparisons of the type facing the Committee were reviewed and the Committee agreed that it would attempt to draw on all three in future meetings.

6.1.2.4 *Requirements for implementation of a management procedure to actual stocks/areas.*

The Committee agreed that it was by no means straightforward to apply a management procedure to a particular stock or region. The first step is to determine the extent of knowledge of stock identity and to check the extent to which the properties of the catch data, absolute abundance estimates and relative abundance indices fall within the bounds examined by the screening trials. Should they not do so, additional trials may be necessary to ensure that the management procedure is still robust and reliable.

These issues were examined briefly for the priority stocks considered at this meeting. A series of questions was posed to the two minke whale sub-committees (see Item 10.1 of Annex D). The responses with respect to hypotheses on stock identity were taken into account when specifying additional stock identity trials (see 6.1.2.2 above). The Committee noted the responses to the other questions and **recommends** that these be borne in mind should an adopted management procedure be considered for use with these stocks. The Committee agreed that there were other potential uncertainties that must be resolved before a procedure could be applied to an actual stock. In particular, it is important to identify exactly what segments of the population are referred to in the catch data, absolute abundance data and relative abundance data. This should be examined in further trials.

The Committee considered new information in SC/42/O 10 that bore on the estimation of MSY rates. This matter had been discussed at length by the Committee last year. The new information confirmed the views of some members that a 1% MSY rate was most unlikely and that a realistic upper bound was higher than 4%. Others stated their view that the inferences required to reach this conclusion remained invalid. No consensus could be reached on likely ranges of MSY rates. The Committee did agree, however, that as part of the screening process for management procedures a trial with an MSY rate of 7% should be carried out.

6.1.2.5 *Work plan for 1990/91*

The Committee reviewed the timetable for development and recommendation of a management procedure it agreed at its last meeting (*Rep. int. Whal. Commn* 40:51). Based on the progress achieved since its last meeting, it confirmed that it was still working towards recommending a 'best' management procedure to the Commission at its 1991 Annual Meeting.

The Committee agreed that selection of a satisfactory revised management procedure by that time could be accomplished for cases where stock identity is known. However, it noted that it has not yet been demonstrated that the revised procedures can perform satisfactorily in the face of uncertain stock identity. The new stock identity trials are intended to provide a more realistic test of that performance.

The 1989 timetable envisaged that Allison would validate all screening trials on finalised procedures. The Committee agreed that since a common control program developed by Allison is being used by all developers, the need for this extensive validation was largely negated at this stage. It **recommends**, however, that Allison repeat the base case trials with current versions of each procedure.

The Committee **recommends** that all the screening trials and revised summary statistics specified in Appendix 4 of Annex D be implemented within the common control program by Allison as soon as possible after the meeting and that the revised program be circulated to all developers. Using this program, the developers should carry out all the trials on their procedure.

The Committee agreed that the 1991 deadline can only be met by holding another inter-sessional workshop. It **strongly recommends** that an 8-day Workshop be held in early December 1990. The terms of reference of the Workshop would be to review the results of the screening trials nominated above, including specification of a North Atlantic minke whale stock identity trial if not already completed; to specify and carry out further test applications of procedure comparison techniques; to specify any other general trials that would enhance the ability to apply a management procedure to particular stocks/areas in a timely manner; and to plan work to be completed before the 1991 Annual Meeting.

Arrangements should be made to ensure the attendance of Allison and up to six invited participants (the Convener, four procedure developers and an expert in multi-criteria decision making). Morimoto advised that Japan would be pleased to host the Workshop in Tokyo. Budgetary implications of the Workshop and the computing costs that will be incurred by developers of procedures and the Secretariat during 1990/91 are discussed under Item 13.2.

The Committee **recommends** that the full set of raw output data from the trials should be submitted to the Secretariat two weeks before the date of the Workshop, if possible. It also **recommends** that computer programs implementing the comparison techniques for procedures be lodged with Allison sufficiently in advance of the Workshop to enable her to prepare for their implementation.

To facilitate communications throughout the year, the Committee **recommends** that activities continue to be coordinated by a steering committee convened by Kirkwood. Given the critical need to ensure continuity in developing an appropriate management procedure by 1991, the Committee strongly urges that Kirkwood should continue to chair future Comprehensive Assessment management meetings and attend the 1991 Annual Meetings.

6.1.3 Progress report for Commission

Last year, the Committee agreed that as part of its report to the Commission for the 1990 Comprehensive Assessment, a progress report on development of revised management procedures should be presented. A draft progress report prepared by Kirkwood was revised and updated during this meeting, taking account of members' comments. It appears as Annex R. The Committee agreed that this document should form the primary basis for its progress report.

The Commission had also requested a simple and pictorial presentation of the Comprehensive Assessment, management objectives and management procedures. In Kirkwood's unavoidable absence, it agreed that this should be made by Brownell.

6.2 Management procedures – aboriginal subsistence whaling

The Commission's Agenda notes that catch limits for aboriginal subsistence whaling to satisfy aboriginal subsistence need have been established in accordance with principles identified in Schedule paragraph 13(a) and that, according to sub-paragraph (3)

> These provisions will be kept under review, based upon the best scientific advice, and by 1990 at the latest the Commission will undertake a comprehensive assessment of the effects of these provisions on whale stocks and consider modification.

A brief summary of the background to the scheme and the Committee's subsequent advice on aboriginal subsistence whaling is given in Annex H. It is clear that the Committee has not been able to determine minimum stock levels for each stock and has had great difficulty in establishing rates of increase for all but the gray whale and, in recent years, the bowhead whale. The Committee noted the similarity of the scheme to the provisions of Schedule Para. 10(a)-(c), the New Management Procedure (NMP), with estimation of maximum sustainable yield (MSY), MSY level and MSY rate being necessary; the main difference between them is in the protection level. The difficulties associated with the NMP have been well documented in the Committee's reports and have led to the extensive effort currently underway as part of the Comprehensive Assessment to develop alternative management procedures. The Committee has given priority to this work under its Comprehensive Assessment rather than to the aboriginal whaling scheme. This was based on the assumption that any revised commercial whaling procedure would, as at present, be generally compatible with that for aboriginal subsistence whaling. The Committee agreed that a full discussion of any new management scheme for aboriginal whaling could only usefully take place after an alternative management procedure for commercial whaling had been established.

The Committee noted that the difficulties it had found in implementing the procedure specified in paragraph 13(a) precluded it from answering the question concerning the effects of the scheme on stocks. However, it believed that the procedures it had followed, in providing to the Commission where possible its best information on current stock size, levels of depletion, recent trends in population size and yield, or explaining why this could not be done, were satisfactory. It recognised that the Commission itself had set catch limits largely based on aboriginal subsistence need as reflected in discussions of the Technical Committee's sub-committee on aboriginal subsistence whaling.

The Committee noted the importance of defined objectives to the development of alternative management procedures. It agreed that further discussion on any new management scheme for aboriginal subsistence whaling would need to examine the question of objectives for such a scheme. A Technical Committee working group met in 1981 to examine the question of management principles and guidelines. Its report, accepted by the Commission, agreed on three broad objectives (*Rep. int. Whal. Commn* (special issue 4):84):

> To ensure that the risks of extinction to individual stocks are not seriously increased by subsistence whaling;
>
> To enable aboriginal people to harvest whales in perpetuity at levels appropriate to their cultural and nutritional requirements, subject to the other objectives;
>
> To maintain the status of whale stocks at or above the level giving the highest net recruitment and to ensure that stocks below that level are moved towards it, so far as the environment permits.

The Committee noted that if the Commission confirmed these objectives, they could be eventually used in the development of a new aboriginal subsistence whaling scheme.

6.3 Review of Genetics Workshop Report

The Committee received SC/42/Rep1 which was the report of the Workshop on the Genetic Analysis of Cetacean Populations held at the Southwest Fisheries Center, La Jolla, USA in September 1989. The workshop had originally been planned to consider the genetic and biochemical analysis of tissue samples collected by biopsy sampling and other means. However, its terms of reference had been widened at the 1989 Scientific Committee meeting to address the questions 'What quantitative information can molecular genetic techniques provide on past and present interchange between IWC stocks?' and 'What sample sizes are needed for this?'

The workshop had concluded that a variety of genetic techniques was now available to answer a wide range of questions about population structure, including the way sub-populations are divided in space and time. However, a range of techniques may be required to answer a particular question, and the answer is likely to be more complete if information on behaviour and demography is also collected. Specific conclusions were: the genetic distance between some whale stocks recognised by the IWC is as great as the distance between recognised baleen whale species; and that sample sizes in the range 20–50 should be sufficient to detect fixed genetic differences between populations, provided the samples were taken throughout the populations' ranges.

The workshop noted that the absence of a detectable difference in a particular genetic system between two putative populations did not necessarily indicate that they could be treated as a single unit for management. In such circumstances it would also be necessary to consider morphological, behavioural, geographic and demographic differences.

The Committee took note of the Report of the Working Group on the Effect of Biopsy Sampling (Annex M). It concluded that while there was clearly variation between individuals, most cetaceans from which samples had been taken showed no or only a mild short-term response to the impact of biopsy sampling.

The Committee noted that cetaceans are more likely to repeatedly encounter greater physical injury from natural causes than from biopsy sampling and could thus tolerate any minor wound caused by a biopsy dart.

The Committee stressed that biopsy sampling techniques are an important tool in obtaining information valuable to the management and conservation of cetaceans and agreed that, when responsibly carried out, biopsy sampling is not likely to have any long-term or even it was desirable to take ecosystem considerations into account in developing management advice on Southern Hemisphere minke whales, because of the major changes in the abundance of krill predators which had occurred this century. It noted that CCAMLR had developed an ecosystem monitoring programme using populations of land-based krill predators, notably at South Georgia, Seal

Island and Prydz Bay. This was primarily directed towards detecting any ecosystem effects caused by commercial krill harvesting.

Aspects of this topic as it relates to the proposed joint workshop with CCAMLR on the Feeding Ecology of Southern Baleen Whales are discussed under Item 5.1.3.

In more general discussion, Sigurjónsson commented that studies on the modelling of interspecific reactions are now beginning for various ocean areas around the world. He welcomed this development, noting its importance for the future management of marine resources including whales and proposed that the item be kept on the Agenda. Holt commented that, while work on multi-species modelling is a useful part of the search for an understanding of ecosystem dynamics, he believed that the application of such models for management was unlikely to occur for many years, if it ever became possible. Specific comments on the development of a multi-species model for the Barents Sea are discussed under Item 9.

The Committee agreed to keep this item on its Agenda, repeating its view that only discussion of specific matters should occur, where these were supported by documentation.

6.5 Data inventories and coding

Donovan reported that all data inventories submitted had been coded. Last year the Committee had recommended that the Commission urge three countries, Chile, Peru and New Zealand, to submit data inventories as soon as possible. No inventories have yet been received. The Committee again **recommends** that these countries be urged to submit these inventories.

7. COMPREHENSIVE ASSESSMENT – PRIORITY STOCKS

7.1 Southern Hemisphere minke whales

7.1.1 Assessment

Stock identification, migration and distribution

The Committee recognised the existence of two morphological forms of southern minke whales: the larger *bonaerensis* form, which was the basis of the past commercial catch; and a smaller so-called diminutive or dwarf form (Best, 1985, *Sci. Rep. Whales Res. Inst., Tokyo* 36: 1–33; Arnold *et al.*, 1987, *Sci. Rep. Whales Res. Inst., Tokyo* 38: 1–46). Wada and Numachi (SC/S89/Gen22) have suggested that the genetic difference between the recognised subspecies of minke whales is sufficient for them to be classified as full species, and the Committee agreed that the two forms in the Southern Hemisphere should definitely be considered separately for management purposes. Due to a lack of information on the biology or status of the diminutive form the rest of the Committee's report only concerns the *bonaerensis* form, except possibly for sightings North of 60°S in summer.

The Committee considered SC/42/SHMi8, a review of published information on the stock identity of Southern Hemisphere minke whales and new information submitted to the meeting.

Genetic analysis using isozyme variation, mitochondrial DNA, and hypervariable minisatellite regions had demonstrated no unambiguous differences between whales in the currently accepted management Areas. However, there were significant differences between North Atlantic, North Pacific and Antarctic minke whales. The Committee **recommends** that further work on the mitochondrial DNA genome of minke whales from stock Areas other than IV and V should be conducted to examine stock identity, if suitable samples are available.

The Committee therefore concluded that while Antarctic minke whale stocks were certainly separate from those in the Northern Hemisphere, there must be sufficient interchange between the currently recognised stocks in the Southern Hemisphere to counteract the effects of genetic drift (which builds up genetic differences between populations through the random loss of variation). However, this could be achieved by the movement of one reproductively successful individual per generation between neighbouring stocks.

SC/42/SHMi8 reviewed information on the recovery of 94 Discovery marks from minke whales in the Southern Hemisphere. Two marks had been recovered from whales on the winter breeding grounds off Brazil (Area II). These whales had been marked at locations 54° of longitude apart in the Antarctic. The other 92 recoveries indicated that 90% of marked whales were recovered within ±20° of longitude of their marking position from two years after marking onwards, with no significant increase in this range with time from marking.

The Committee noted that movements indicated by mark recoveries will be influenced by the distribution of marking and catching effort. This, and the relatively small number of recoveries, made it difficult to interpret the implications of such movements for stock identity.

A study of the incidence of a warm-water ectoparasitic barnacle (*Xenobalanus*) and of freshly-healed white scars, probably caused by bites of a small pelagic shark (*Isistius*) in low latitudes, suggested that whales in each of Antarctic Areas I, III and IV come from different wintering grounds (Bushuev, *Rep.int.Whal.Commn* 40:317–24).

The Committee **recommends** that Soviet data on the distribution of ecological markers should be analysed in more detail to provide some measure of the reliability of these conclusions.

SC/42/SHMi20 analysed sightings of minke whales collected by Japanese scouting boats and research vessels operating in the Southern Hemisphere since 1976. Areas of higher density, which were believed to be breeding grounds, were found: north of 35°S in October-November between 100° and 120°W, and 130° and 180°W in the South Pacific; and between 40° and 50°E and 90° and 110°E in the Indian Ocean. Observations of whales between 35–50°S suggested that the major proportion of animals from the breeding grounds migrated south from October onwards to feeding areas in the Antarctic to arrive by January. It was suggested that animals from the western Pacific migrate to waters between 130–140°E and 120–130°W, and those from the eastern Pacific to Antarctic waters between 120–130°W and 60–70°W. Animals from the eastern Indian Ocean may migrate to an area between 60–80°E and 130–140°E, whereas those from the western breeding grounds may migrate to an area west of 60–80°E. These proposed breeding grounds and feeding areas are shown in Fig. 1. of Annex E.

In SC/42/O 15 data from the IWC/IDCR Southern Hemisphere minke whale cruises made since 1978/79 were summarised. These indicated the density of minke whale sightings in the Antarctic Ocean. There were noteworthy regions of high and low density, but some of these appeared to have shifted in the interval between the surveys. However, there were consistent high concentrations in the South Atlantic sector between 30°W

and 30°E, and in the Indian Ocean sector between 70–100°E. There were consistent discontinuities at 30–70°E and around 100°E.

The Committee welcomed these useful summaries and noted that the Southern Hemisphere minke whale sub-committee had used them as the basis for hypothesis on stock structure which it developed in response to a request from the sub-committee on management (see Item 6.6 of Annex E).

Catch history

Extensive catching of Southern Hemisphere minke whales began in the 1972/73 pelagic season. Catches are documented in detail in SC/42/SHMi7.

Population estimates

SIGHTING SURVEY

The most detailed information on minke whale abundance south of 60°S came from the series of sightings surveys conducted since 1978/79 on the IWC/IDCR Southern Hemisphere cruises. Data had been collected in two survey modes: Closing Mode (CM), where the survey vessel closed on a school immediately it was sighted to confirm species identity and estimate school size; and Passing Mode (PM), where the vessel did not deviate from the trackline. Until 1983/84 surveys had only been conducted in CM; after this, surveys had been carried out in both modes.

At previous meetings the Committee had concluded that abundance estimates from PM surveys were likely to be less biassed than those from CM. This was because in the latter mode a lot of time is spent closing on schools in high density areas. The secondary sightings made during these periods are not used for estimation. One possible result is that sightings made in high density areas may be under represented, leading to a downward bias (Kishino and Kasamatsu, 1987, *Rep. int. Whal. Commn* 37:253–8). However, comparison of density estimates in CM and PM made in the same Area had revealed larger differences than expected (*Rep. int. Whal. Commn* 40:133). The Scientific Committee had therefore **recommended** further analysis to evaluate the importance of a number of operational factors which could have contributed to this difference.

The Committee concluded that analyses described in SC/42/SHMi5 explained much of the difference between density estimates in the two modes. It decided that a comparable series of PM and CM abundance estimates could be produced by dividing the CM estimates by 0.751 (the mean of the CM/PM density estimates in SC/42/SHMi5) and adjusting the variance accordingly to provide a 'pseudo-passing' mode estimate. Where both CM and PM estimates were available the PM and 'pseudo-passing' mode estimates could be pooled using inverse variance weighting to provide a single value.

The Committee had considered many times in the past the problem of estimating the probability that a school on the trackline was seen (g(0)). Despite recommending a number of different experiments to try to estimate the value of this parameter, the Committee had always chosen to use a value of 1.0 in its estimation of abundance.

The results of experiments aimed at estimating g(0) were reviewed in Appendix 4 of Annex E. The Committee noted that estimates of this parameter should be applied to estimates of density derived from sightings from the barrel only. If available estimates of g(0) were used in this way, the calculated estimates of density were not substantially different from those made using g(0) = 1 and all sightings. The Committee agreed to continue to use a value of 1.0 for g(0) in its calculations.

The Committee welcomed the new approach to the problem of estimating g(0) described in SC/42/SHMi27. It noted that the use of a double trackline survey method offered considerable opportunity for the further investigation of some of the problems identified above. It suggested that those responsible for designing future surveys using this method might usefully discuss the possibilities with other experts in this field.

IDCR RESULTS

The results of the 1988/89 IWC/IDCR cruise in Area IV had been analysed in SC/42/SHMi3 using the 'standard methodology' adopted by the Scientific Committee in 1988 (*Rep. int. Whal. Commn* 39: 71–4). As in previous analyses, it had been necessary to pool data from some strata to obtain satisfactory fits to the hazard-rate model. It was possible to estimate total population size in each Area south of 60°S based on the results of the IWC/IDCR cruises, and to make corrections for the differences between PM and CM surveys in the way described above. These estimates are shown in Table 1.

The Committee noted that where two abundance estimates are available for particular Areas these values are not strictly comparable because of differences in the northerly extent of the surveys in the two years. The cumulative catch in each Area is also included in this Table.

The Committee identified three sources of downward bias in these estimates: (i) animals north of 60°S; (ii) animals within the pack ice; (iii) problems in the estimation of g(0).

The results of SC/42/SHMi18 and 26 indicated that there were substantial numbers of whales north of 60°S in the austral summer, although the abundance in these latitudes in January and February was less than further south. However, the Committee noted that if these animals remained north of 60°S throughout the austral summer they would not be vulnerable to commercial exploitation with the operating pattern of recent Antarctic whaling.

Concerning the question of whales within the pack ice, Kato indicated that a Japanese scientist, who was a member of the South Pole expedition, made independent sighting surveys from an ice-breaker while the IDCR cruise was undertaken in Area III in 1979/80. He found numbers of minke whales within the pack ice and in open leads in the fast ice area south of the area covered by the IDCR vessels (Naito, 1982, *Rep. int. Whal. Commn* 32: 929–33). The Committee noted that satellite imagery of the extent of the pack ice in each Area was available throughout the period of the IDCR cruises. It **recommends** that these images should be analysed to determine the extent of the pack ice, by concentration, in each Area when the surveys were conducted.

Thus the magnitude of the bias caused by (i) and (ii) could not be quantified because it was not known how many of the animals north of 60°S were likely to be vulnerable to exploitation, and there was no information on the number of animals within the pack ice. Problems in estimated g(0) could only lead to a downward bias, because the sub-committee had assumed g(0) = 1. The analysis in Appendix 4 of Annex E indicated that the magnitude of the bias caused by this assumption was likely to be small. However, the Committee noted that this did not take

Table 1

Best estimates of Southern Hemisphere minke whale population sizes. Bold numbers show those values used in assessments (see text). 'Pseudo-passing' population estimates are CM population divided by the closing mode/passing mode calibration factor 0.751 (CV 0.152) taken from SC/42/SHMi5). * = The IVW (70°-100°E) survey in 1984/5 has been omitted because PM in that survey did not include the IO, and therefore is not comparable to subsequent PM results. Notes: (i) P is an inverse variance weighted average of PM population estimate and 'pseudo-passing' population estimate; (ii) No adjustment has been made for the differing northerly extents of surveys of the Areas in different years.

		Total population size								Total catch to 1990		
Area	Year	CM	CV	PM	CV	Pseudo	CV	P	CV	Male	Female	?
I	**1982/83**	55,050	0.203	-	-	**73,302**	0.254	-	-	6,499	5,606	3
II	1981/82	37,306	0.213	-	-	49,675	0.262	-	-	6,435	13,286	18
	1986/87	92,114	0.206	121,549	0.285	122,655	0.256	**122,156**	0.190			
III	1979/80	61,272	0.188	-	-	81,587	0.242	-	-	9,016	18,512	13
	1987/88	51,820	0.521	102,984	0.309	69,001	0.543	**88,735**	0.273			
IV*	1978/79	72,867	0.156	-	-	97,027	0.218	-	-	14,774	19,805	7
	1988/89	64,403	0.343	68,570	0.349	85,756	0.375	**74,692**	0.257			
V	1980/81	133,382	0.216	-	-	177,606	0.264	-	-	5,009	10,156	
	1985/86	211,150	0.174	303,284	0.172	281,158	0.231	**294,610**	0.138			
VI	1983/84	80,283	0.232	-	-	**106,901**	0.277	-	-	2,848	2,150	1

account of heterogeneities caused by weather conditions which could provide an additional downward bias. Some upward bias might be caused by the method used to estimate school size in the analysis of PM surveys (see SC/42/SHMi29). Judgment on the likely magnitude of this bias may be made from consideration of the discussion of this issue in Annex E.

The results of SC/42/SHMi18 indicated that there were probably also substantial numbers of whales in the region between the northern strata of some IDCR cruises and 60°S. Rather than attempt to correct the abundance estimates from these surveys for the whales in this region, the Committee chose to use only the results of later surveys, most of which came within 1–2° of 60°S, for its further assessments. These values are shown in bold type in Table 1.

USE OF CATCH AND EFFORT DATA

The interpretation of catch and effort data from the Antarctic was discussed at length by the Comprehensive Assessment Workshop on Catch Per Unit Effort (*Rep. int. Whal. Commn* (special issue 11): 15–20) which identified the problems with existing series of data.

The Committee had discussed CPUE series from the Antarctic and from the Brazilian land station at considerable length in the past. The most recent discussions for the Antarctic data were in 1985, when it was concluded that there were no significant trends in the data when account was taken of a variety of weather and operational factors (*Rep. int. Whal. Commn* 36: 70). The Brazilian data were last examined in 1988, when the Committee agreed that the existence, or otherwise, of a trend in CPUE for this fishery could not be determined (*Rep. int. Whal. Commn* 39: 75).

The Committee concluded that existing CPUE series could not be used as an index of abundance for any of the stocks under consideration.

MARK-RECOVERY ESTIMATES

The most recent reanalysis of the results from Discovery marking experiments with Southern Hemisphere minke whales had been carried out as part of the Comprehensive Assessment (Buckland and Duff, 1989, *Rep. int. Whal. Commn* (special issue 11): 121–44) and reviewed at the 1988 meeting of the Committee (*Rep. int. Whal. Commn* 39: 75). Discussion had concentrated on problems of heterogeneity in the probability of marking and recapture, and the potential biases caused by short-term mark shedding and marking-related mortality. The estimation of abundance from mark-recovery data requires a large number of assumptions to be made. Many of these are likely to be violated by the Discovery marking experiments. Although corrections can allow for this it is not possible to estimate each correction reliably (see Table 17 of Buckland and Duff, 1989 for a complete documentation of assumptions and corrections).

The Committee noted that there had been an insufficient number of Discovery mark recoveries to yield meaningful estimates of abundance in Areas I, II and VI (Buckland and Duff, 1989) but estimates were obtained for the remaining three Areas both separately and combined. The authors had cautioned about the number of assumptions that had been made in calculating these estimates but noted that the estimates of total stock size for Areas III, IV and V were in the region of 300–350,000. Pooled estimates from the sightings surveys were 458,000 (all whales, the sum of the bold type values from Table 1) and 301,000 (takable only, the value for 'all whales' multiplied by the 'percent takable' correction of 0.658). Mark-recovery data by their nature only allow estimation of takable whale numbers. Since whales smaller than the size specified as 'takable' were often taken, mark-recovery estimates might be expected to fall between the sightings estimates given above.

The Committee concluded that it was not sensible to take these analyses any further without additional data. Should such data ever become available there would still be problems of analysis because of the large number of assumptions, some of which are untestable, which are involved.

Biological parameters

AGE AT RECRUITMENT

No new documents on age at recruitment (t_r) were available. However, it was noted that the values of t_r used by the Committee in its most recent calculations (e.g. *Rep.*

int. Whal. Commn 39:76) had been developed at the 1981 Special Meeting on Southern Hemisphere minke whales using the CPOP computer program and catch at age data for each management Area. The resulting values for t_r had been very variable, and the Committee noted that it was now possible to calculate t_r directly for Area IV by comparing the age structure of the catch with that of the Japanese research take. Age-specific selectivities based on these data indicated full recruitment at age 11. The Committee agreed on values of 7 years for t_r and 10 years for age at 95% recruitment.

AGE AT MATURITY

SC/42/SHMi11 provided a review of data on age at sexual maturation (t_m) in Antarctic minke whales. t_m for an individual whale has been estimated by subtracting the number of corpora in the ovaries from its age, or by determine the position of the transition phase in the earplug. Mean age at maturation has been estimated from the average of individual estimates, from the proportion of the catch ovulating for the first time at a particular age, from the plots between sexual maturity rates and ages, and from a regression of mean number of corpora on age. The estimation t_m for fully recruited year-classes in the current catch from corpora examination is relatively uncontroversial. Trends in t_m with time can be examined by comparison of estimates made in this way over the course of commercial whaling. However, for Southern Hemisphere minke whales this provides a rather short time series.

A much larger time series and larger sample size can be obtained if estimates of t_m from the transition phase are used. However, the interpretation of such time series has been controversial. The problems were discussed at considerable length at a Workshop in 1983 (*Rep. int. Whal. Commn* 34:676–81). This identified a number of problems which could generate an apparent change in t_m estimated from the transition phase with time. These were: problems in recognition of the transition phase; variations in readability with the total number of growth layers; improvements and learning effects if the same readers examined earplugs over a number of years; methods of plotting the data; and truncation effects (caused primarily by under-representation of animals with large t_m values in the most recently sampled cohorts). The authors of SC/42/SHMi11 have attempted to overcome some of these problems by plotting t_m against age-at-capture for cohort groups using only earplug data from older animals, and by plotting t_m against cohort for samples collected in different periods. They concluded that t_m for Southern Hemisphere minke whales had declined from 12–13 years in the mid-1940s to 10 years in 1955, and that there may have been a further decline to 7–8 years in the early 1970s. They interpreted this as a result of an increase in the carrying capacity of the Antarctic for minke whales following the major depletion in large baleen whale numbers during the first half of the twentieth century. The Committee could not reach a unanimous view on the conclusions of this review.

Some members agreed completely with the conclusions of the authors of SC/42/SHMi11. Others believed that the carrying capacity for minke whales may have changed following the depletion of large whales, but this was not a necessary consequence of that depletion. They considered that because of the unresolved methodological problems involved in interpreting time series of estimates of t_m from the transition phase, the data in SC/42/SHMi11 could not be interpreted as evidence of a decline in t_m. Yet others considered that the demonstration of the existence or otherwise of an historic change in t_m was of importance for management. They considered that the results presented in SC/42/SHMi11, although suggestive of such a change, were not yet conclusive. They argued that the problems of interpreting the data were a consequence of the shortness of the time series, and would be resolved by the provision of future data.

SEX RATIO

Details of the segregation of animals by sex south of 60°S derived from the Japanese research take were provided in SC/42/SHMi1, 10 and 25. The authors found that mature females tended to be found close to the ice edge. They concluded that this would account for the fact that the Japanese commercial catch, which was primarily taken along the ice edge, was strongly biased towards females.

PREGNANCY RATES

SC/42/SHMi10 provides information on the pregnancy rate of mature females taken in Areas IV and V as part of the Japanese research catch. Observed values of 0.946 and 0.906 were obtained. These were substantially higher than the value of 0.78 which had been used in the past (e.g. *Rep. int. Whal. Commn* 37:69). This value was based on the proportion of non-lactating animals amongst a sample of mature females examined at the South African land station (Best, 1982, *Rep. int. Whal. Commn* 32:779).

NATURAL MORTALITY RATE

In the past (e.g. *Rep. int. Whal. Commn* 33:93, 34:78, 39:77) the Committee had used a value of 0.086 for natural mortality (M). This was based on an inter-species comparison of estimates of M carried out by Chapman (1983, *Rep. int. Whal. Commn* 33:311–314). However, the Committee had agreed in 1984 that mortality rates estimated from an interspecific relationship with maximum lengths could not be used (*Rep. int. Whal. Commn* 35:76). The choice of an appropriate value of M for use with the HITTER/FITTER model is discussed below.

Assessment

USE OF HITTER/FITTER MODEL

The HITTER/FITTER program provides a procedure for estimating the effect of a history of catches on a stock provided there is an estimate of absolute abundance, a series of relative abundance data, or both, estimates of a number of demographic parameters, and MSYL. It can fit a population model to the absolute and/or relative abundance data to provide estimates of current and past abundance as well as estimating MSY rate (MSYR). If no series of relative abundance data are available it is only possible to use the HITTER part of the program which gives a population trajectory that passes through a point estimate of absolute abundance. In these circumstances values of MSYR have to be specified. No suitable series of relative abundance data was available for Southern Hemisphere minke whales.

Some members of the Committee considered that appropriate information for the use of HITTER/FITTER was not available for Southern Hemisphere minke whales

and concluded that the use of the program was not worthwhile, for the following main reasons:

(1) there are no estimates of MSYR for the southern minke whale and no agreement on a likely range;
(2) there is no agreement on the validity of applying increase rates from species such as gray and right whales to minke whales;
(3) there is no agreement on whether or not there was a trend in abundance before exploitation began in the 1970s and whether or not any related trends in carrying capacity continued during the period of exploitation.

These matters are fully documented in *Rep. int. Whal. Commn* 40: 119–26. Furthermore, they believed it was impractical to undertake any runs other than by the area breakdown of the old six 'management areas' and perhaps by some combinations of these. Such a process implicitly assumes each contains a breeding population with little or slow mixing with others.

Thus they considered that the only such run that would be indicative of the effects of whaling on this group of stocks would be one for the entire Southern Hemisphere, with MSYR=0%. But, given the insensitivity of the runs to the value of M, the same indication is given simply by comparing the 'current' stock estimate with the total cumulative catch.

Other members believed that use of HITTER with an appropriate range of MSY rate values would provide information which would allow an assessment of the status of the stocks. First, they were of the opinion that attempts to estimate upper bounds for the extent to which stocks might have been reduced by exploitation was of value in this respect. They noted that the IDCR sighting survey abundance estimates were negatively biased measures of the 1+ population sizes which they suggested be used for the HITTER calculations. Further, in the light of the large reduction of the populations of other Southern Hemisphere baleen whales they judged that only some increase (but not a decrease) in the carrying capacity for minke whales was a likely possibility. They therefore reasoned that HITTER runs with MSYR=0% would provide estimates of upper bounds on the extent to which minke stocks had been reduced below their initial levels, and further that such estimates would be positively biased.

In addition, they considered that focussing upon MSY rates approaching 4% for these stocks was perfectly appropriate. They drew attention to the 3.2% increase rate for the Californian gray whale as estimated from censuses during a period of annual catches of about 1%, noting that this population is agreed to be sufficiently large to warrant either an SMS or an IMS classification (IWC/42/4A). They further commented that the method advanced by Butterworth and Best (1990, *Rep. int. Whal. Commn* 40:433–47), taken together with tabulated increase rates for depleted populations (*Rep. int. Whal. Commn* 40:129), provided estimated lower bounds for baleen whale MSY rates in the range 2.4% to 6.9%.

CHOICE OF PARAMETER VALUES

Values of age at recruitment (t_r) suitable for use with HITTER are described in the section on Biological Parameters. They are 7 years for age at 50% recruitment and 10 years for 95% recruitment.

Estimates of mean t_m and the age at which 95% of the population reached maturity are also required for the runs of the HITTER routine. These were estimated as 7.5 years and 14 years, respectively, for the current Antarctic population, from histograms of percent mature at age in Kato (1987, *Sci. Rep. Whales Res. Inst., Tokyo* 38:47–73).

A value for M is also required. The Committee chose to use a value of 0.10 derived from the mark-recovery analysis of Buckland and Duff (1990, *Rep. int. Whal. Commn* (special issue 11):132). The Committee noted its earlier caution (*Rep. int. Whal. Commn* 39:75) that this estimate had been calculated on the assumption that mortality was exactly balanced by recruitment and was therefore subject to the same problem of confounding between trends in recruitment and in mortality which makes the analysis of catch-at-age data so difficult. However, it was assured that the HITTER routine was relatively insensitive to the value chosen for M.

MSYR values of 1, 2, 3 and 4% were used to cover the range being used by the management sub-committee in its modelling exercises. In addition, a value of 0% was used to set a lower bound on the response of the model population to exploitation.

MSYL was generally set at 60% to coincide with the value used most recently in applications of the New Management Procedure. However, runs were carried out for Areas II and IV using an MSYL of 80% to indicate the sensitivity of the results to this parameter.

In order to investigate the implications of an increase in carrying capacity (K) before the start of serious exploitation in 1972, a run was carried out for Area IV with K increasing to three times the value in 1929/30 (the season before the catch of blue whales in the Antarctic was at its maximum, leading to a massive reduction in these stocks) by 1972.

The target populations for the modelling exercises for each Area were those shown in bold in Table 1.

STATUS OF STOCKS

The full set of outputs from the runs of HITTER can be found in Annex E Appendix 6. Those members of the Committee who thought these runs had been worthwhile agreed that the most useful summary value for assessing the status of the stocks was the ratio of the exploitable female stock in 1990 to that at the start of exploitation, because of the predominance of females in the catch. These values for the 'best' population estimates and their lower 95% confidence limits (CLs) are shown in Table 2.

Those members who thought the runs worthwhile noted that the effect of an increasing K up to 1972 was to reduce the extent to which the stocks had been reduced compared

Table 2

HITTER results using the inputs shown in IWC/42/4 Annex E, Table 2. Results are given as exploitable female stock/female stock in 1972.

MSYR	I	II	III	IV	V	VI	I+II+III+ IV+V+VI
'Best estimate'							
0%	0.85	0.80	0.67	0.62	0.93	0.96	0.94
4%	0.92	0.87	0.74	0.70	0.95	0.97	0.95
Lower 95% CL							
0%	0.73	0.71	0.46	0.43	0.90	0.91	0.90
4%	0.83	0.79	0.51	0.48	0.93	0.94	0.93

to the case with a constant K. Increasing MSYL also resulted in smaller reductions but also smaller MSYs. Pooling Areas produced an effect which was almost exactly the average of that seen in the individual Areas.

In terms of the overall status of the stock, these members concluded that, if the carrying capacity had been constant before 1972, for most of the stocks the exploited female component of the stock was at the high end of the range 50–100% of K. They also noted that, had abundance estimates from earlier IDCR cruises over Areas III and IV also been taken into account, values for the corresponding lower 95% CL's in Table 2 would have been substantially higher.

Those members who considered that the only useful indication of the status of the stocks came from a comparison of the 'current' stock estimate with the total cumulative catch (as shown in Table 1), concluded that Areas V and VI (i.e. the major part of the Pacific sector) have been subject to relatively light exploitation. Thus the abundance of minke whales in this region has been little changed by those catches. Area I (the eastern sector of the Pacific) and Area II (in the South Atlantic) have had only moderate levels of exploitation. The abundance in these regions will not have been affected to the extent which would raise questions as to whether the historic rates of exploitation have been too high. Areas III and IV (covering the South Atlantic and Indian Ocean sectors) have experienced catches high both in relation to other Areas and to the abundance estimates. This raises the question whether lower rates of exploitation would have been desirable. They added that there had been a tendency for catching to concentrate on the Area III/Area IV boundary. Such catches could have led to greater reduction in the boundary region if it did not in fact divide two stocks which mix fully and rapidly within the greater areas of the putative stock divisions.

CLASSIFICATION OF STOCKS

Some members of the Committee concluded that it was not appropriate to classify the stocks of Southern Hemisphere minke whales. Others members concluded that it was possible to classify these stocks using the results of the HITTER runs shown in Table 2, subject to the assumptions on which the runs had been based, on the basis of the definitions given in paras. 10(a)-(c) of the Schedule. If the carrying capacity (K) was constant at the start of exploitation in 1972, the following classifications were obtained for an MSYL of 60%, an MSYR of 0% and the 'best estimates': I – IMS, II – IMS, III – SMS, IV – SMS, V – IMS, VI – IMS.

The runs made with the lower 95% confidence limits of the target population estimates indicated that there was only a small probability that any new abundance estimates could lead to the above classifications being changed. If K had been increasing before exploitation then the extent to which the stocks had been reduced by exploitation would be less.

7.1.2 Management advice

Effect of zero catches for commercial whaling

The Committee noted that its ability to provide advice on the effects of the zero catch limit for Southern Hemisphere minke whales, which came into effect in the 1985/1986 pelagic season, was influenced by: the length of time for which the decision of 1982 had been in effect; the general population biology of large whales; the precision and frequency of abundance surveys; and the reliability of the population models used for prediction.

It noted that the slow growth rate of whale populations meant that there was no possibility that there had been a substantial change in minke whale numbers since the 1985/1986 whaling season. In addition, attempts to compare the results of IDCR sighting cruises in the same management Area had indicated that only major changes in abundance could be detected because of the size of the coefficient of variation associated with the individual estimates.

Other management advice

SC/42/SHMi15 argued that, on the basis of estimates of current population size, observed changes in CPUE and age at sexual maturation and indirect evidence on the relationship between krill as prey (the main food of minke whales) and its predators in the Antarctic, there was no longer any reason to protect the Southern Hemisphere stocks of minke whales from exploitation. The author believed a catch limit of 1% of the exploitable population in sub-areas of the six management Areas was appropriate, as an interim management measure, even in the most conservative case.

It had been noted during earlier discussions in the Committee that, in the absence of an agreed revised management procedure, it would not be out of order to attempt to formulate advice on catch limits in accordance with the provisions of the Schedule paragraphs 10(a)-(c). Some members considered that such catch limits could be calculated from the results of the HITTER runs and the classifications described above, if an appropriate value of MSYR could be chosen. Some of these members believed that a value of 2% for MSYR would provide a conservative estimate for interim catch limits. Others considered that there was no objective basis for such a choice but agreed that a value of 2% could be used in such calculations for illustrative purposes. The calculated catch limits based on the 'best estimates' with a 60% MSYL, 2% MSYR and taking 90% of the MSY values from Table 1 of Appendix 6 of Annex E, with no allowance for the sex ratio of the catch, are: Area I: 456; Area II: 792; Area III: 650; Area IV: 583; Area V: 1,746; Area VI: 626.

Those members who considered 2% as a conservative interim measure were of the opinion that until such a time as the Schedule was revised, management advice still was based on the existing paragraphs 10(a)-(c) of the Schedule. Further, regardless of uncertainties about the dynamics of minke whale 'stocks', a catch limit at an MSYR of 2% would not result in appreciable reduction in stock abundance in the short term (5 years) no matter what assumptions are made, nor would it affect the development of revised management procedures.

Other members stated that it is now generally recognised that the management procedure incorporated in paragraphs 10(a)-(c) of the Schedule is inadequate. Accordingly they believed that offering advice on catch limits under this procedure was no longer appropriate. For the specific case of minke whales in the Southern Hemisphere they drew attention to the reasons they gave earlier for believing that the application of the HITTER routine to these stocks was inappropriate and pointed out that there is great uncertainty about stock identity and boundaries, most importantly for the more heavily exploited Indian Ocean sector (present Areas III and IV).

Thus the problems which made impossible the application of paragraphs 10(a)-(c) remain unresolved. They believed that the Committee does not at this time have instructions from the Commission, or any other basis, for providing advice on catch limits. They anticipated that the revised management procedures now being developed would be able to avoid the problems described above. However, they noted that SC/42/Rep2 had indicated that the success of these procedures was likely to depend largely on their ability to cope with uncertainty about stock identity.

Harwood considered that, in the light of the estimates of abundance and associated variance given in Table 1, and the catches which these stocks had experienced, it should, in principle, be possible to give advice on catches which would not have an adverse effect on the stocks. The use of the HITTER routine, with a suitably wide range of input parameters, was a crude but useful method for evaluating the effect of past catches. The application of Schedule paragraphs 10(a)-(c) to these results, as described above, gave a broad indication of the magnitude of catches which might be sustained. He noted that, in essence, this methodology forms the basis of many of the revised management procedures being considered. However, he cautioned that such a procedure was, as yet, insufficiently developed, and that calculations using uncertain point estimates were not an appropriate basis for interim management. Reilly, Stokes and Zeh associated themselves with this view.

Holt and Cooke expressed the view that in offering management advice on classifications and catch limits a consistent approach should be adopted in the sense that either 'best estimates' should be used in both cases or 'conservative' ones.

Ohsumi believed that the 'best estimates' were conservative, because they were based on negatively biased population estimates, as detailed earlier in the report. He considered that using results for MSYR = 0% for classification purposes was also conservative.

7.2 North Atlantic minke whales

7.2.1 Assessment

7.2.1.1 *Stock identity*

SC/42/NHMi35 presented preliminary results of restriction fragment length analysis of mtDNA in minke whales from Davis Strait, Northeast Atlantic and Central Atlantic areas. Two basic haplotypes were distinguished, both occurring in roughly equal proportions. The data were consistent with either of two hypotheses: two distinct breeding populations that mix together on the feeding grounds, or two maternal lineages which within recent evolutionary time have merged into one population. SC/42/NHMi2, a preliminary report of restriction enzyme analysis of mtDNA from northeast Atlantic minke whales gave similar results, with at least two main haplotypes being detected, independent of geographical distribution.

DNA 'fingerprinting' undertaken on samples from West Greenland, Iceland and the Barents Sea showed that West Greenland samples were far more variable than those from the other regions (SC/42/NHMi23). The author concluded that the results support the present stock divisions. Electrophoretic isozyme analysis of samples from West Greenland, Iceland and the Barents Sea, reported in SC/42/NHMi24, gave no significant deviations from expected Hardy-Weinberg genotypic frequencies, but there were significant differences in allele frequencies for the three areas. In the authors' opinion, these results support the existence of different stocks or populations.

The Committee's attention was drawn to the presence of a rare allele in the Icelandic samples not found in the others. The Committee proposed further analyses of existing samples from Norwegian waters to make the sample size comparable with those from West Greenland and Iceland. Tissue specificity tests should also be conducted to clarify whether the results from testis and ovary (as in the Icelandic samples) can be compared with those from liver and kidney (as from West Greenland and Norwegian material).

The Committee noted that a rare allele at a different locus was found in the Norwegian sample but not in the much larger sample of material from Iceland. The samples were from different tissues but in this case tissue specificity tests had shown that the enzyme system was the same in both tissues.

There was considerable discussion of the extent to which the results could be used to determine stock identity in this species in the North Atlantic.

Most members agreed that the differences between the samples used in the electrophoretic analysis were likely to represent separate breeding populations. However, they believed the results could not be used to confirm the current stock divisions; it was possible, for example, that the same variability could occur within the currently recognised stock boundaries as well as between them and the only conclusion to be drawn was that whatever the stocks are, they are represented in different proportions in each sample. The striking difference between these results and those reported for the Southern Hemisphere, where there was much greater homogeneity throughout the area, was remarked upon.

Many members of the Committee believed that the genetic evidence was sufficiently strong to indicate that there were at least three breeding stocks. However, some others believed that although it appeared likely that there were at least three breeding stocks, there was insufficient evidence to reject the hypothesis that there are two breeding stocks to the east and west which mix together on the feeding grounds around Iceland, and that this possibility could not be ruled out.

The Committee examined data from marking experiments conducted on minke whales in the North Atlantic. Published data from marking experiments were examined in SC/42/NHMi21. The author noted the lack of compatibility of the results with the hypothesis of complete and rapid mixing of marked animals. Marking data indicated that mixing between the Barents Sea and the area south of 70°N was limited. These data also showed that within the Barents Sea there was less mixing than expected among the various parts such as west Spitbergen, Bear Island, the coast of Finnmark and the southeastern Barents Sea.

Annex F, Appendix 3 gives details of whale marking undertaken in the eastern North Atlantic during the period 1964–1985.

The Committee noted the lack of tag returns of animals marked in the northeastern Atlantic, in Iceland or elsewhere in the Central stock area, and, conversely, the lack of returns in the Northeastern stock area of animals marked in the Central stock area.

The marking data were analysed to determine the likely degree of mixing between the Barents Sea and the coast of Iceland (Annex F, Appendix 4). Three different approaches were used to estimate the amount of mixing consistent with the results of mark-recapture studies. Attention was focussed on two levels of mixing: (1) within the traditional management areas and (2) between them. All the approaches suggested that the lack of returns off Iceland from whales marked in the Bear Island area of the Barents Sea is only likely if mixing rates are small, although lack of returns outside the Barents Sea, but still within the Northeast area, could be consistent with either a high or low mixing rate. It was also noted that these results would be sensitive to tag loss. Allowing for tag loss would increase the maximum annual mixing rate that would be consistent with zero returns. Given the concentration of catches on whaling grounds within the stock divisions, the analyses gave little information on where stock boundaries would have to be placed.

Annex F, Appendix 5 shows a compilation of available information on minke whale sightings. It was noted that significant new information on minke whale distribution has resulted from the two international sightings surveys in the North Atlantic (NASS-87 and NASS-89).

There was considerable discussion of the various possibilities for stock division in the North Atlantic, related to the needs of the Comprehensive Assessment. Views expressed ranged from retaining the existing management divisions (at least West Greenland, Central, Northeastern) to the possibility of two breeding stocks, one on either side of the ocean, with mixing between the animals from them on the Central area feeding grounds. The possibility of a central ocean breeding ground was also raised. Some support for possible oceanic breeding populations was provided by the lack of coastal observations of minke whales in large numbers in winter (Annex F, Appendix 5).

The Committee agreed that the evidence points towards there being more than one breeding population in the North Atlantic but with uncertain boundaries. Many members further believed that the available evidence demonstrated that there were at least three breeding populations. The picture on the feeding grounds is complicated further by the animals' known segregation, likely fidelity to feeding area and migration route, and their possible attraction to certain oceanographic or bathymetric features associated with high productivity.

For the purpose of this meeting, most members of the Committee believed that it was appropriate to assess minke whales in the North Atlantic on the basis of three stocks that mix little, if at all, on the feeding grounds. Each such stock would be centred, for assessment purposes, on the feeding grounds in the whaling areas of West Greenland, Iceland and north and west Norway but the position of the boundaries was uncertain. Such assessments would not preclude the possibility of fewer or more breeding stocks in the North Atlantic or, in due course, of those areas themselves being subdivided in some way for assessment purposes.

7.2.1.2 *Estimates of abundance and trends*

SIGHTING SURVEY METHODOLOGY

Sightings surveys to estimate abundance of minke whales and other species have been conducted extensively in the North Atlantic in recent years. In particular, major international surveys were undertaken in 1987 (NASS-87, 8 survey vessels and 2 aircraft) and 1989 (NASS-89, 15 survey vessels and 2 aircraft).

The Committee reviewed the methodology of, and comparability between, the ship surveys conducted by Norway in 1987, 1988 and 1989 (SC/42/NHMi18; SC/42/NHMi19) and the surveys conducted by Iceland and the Faroe Islands (Gunnlaugsson and Sigurjónsson, 1990, *Rep. int. Whal. Commn* 40:571–80; SC/42/NHMi1; SC/42/O 21).

Analyses of data collected on ship surveys conducted by Iceland and the Faroes (NASS-87) and Iceland (NASS-89) were presented in Gunnlaugsson and Sigurjónsson (1990) and SC/42/NHMi30, respectively. There were major differences in methodology compared to that used in SC/42/NHMi18,19 for the Norwegian data and to that generally used within the Committee. The Committee discussed whether or not the same analytical method should be used for all North Atlantic ship survey data and agreed that this would be desirable for comparative purposes but was not essential at this meeting.

Members agreed that the correction for diving whales proposed for Icelandic and Faroese surveys should not be used. The Committee agreed that it could accept estimates produced by this methodology with the exception of the correction for diving whales.

Concern was expressed that the errors in estimated radial distances indicated in SC/42/NHMi15 could cause serious overestimation of abundance in the Norwegian surveys. Annex F, Appendix 7 describes the results of calculations undertaken to investigate the effect of these errors on the estimates of effective strip width presented in SC/42/NHMi18.

A critical factor to consider when applying line transect methodology to whale populations is estimation of the proportion of whales which are detected on the transect line, g(0). During the last 10 years the Committee has discussed this problem at length and proposed several analytical and experimental ways of approaching it, mainly in the context of the IWC/IDCR Southern Hemisphere Minke Whale Assessment Cruises. Schweder (1990, *Rep. int. Whal. Commn* 40:349–55) provided a review of these and proposed a new method for estimating g(0). As part of NASS-89, a parallel ship experiment was conducted to collect data so that an estimate of g(0) could be calculated for northeast Atlantic minke whales using this new methodology. The experiment is described in SC/42/NHMi15 which also presents a new point estimate of g(0) of 0.43 with SE of 0.03. A 95% confidence interval of 0.32–0.54 was calculated, which took account of the uncertainty in assigning duplicate sightings.

Concern was expressed about the effects of whale reaction to the survey vessel on the estimates of g(0) presented in SC/42/NHMi15. In particular, if whales change their behaviour as the survey vessel approaches, this could induce a positive or a negative bias into estimates of g(0) depending upon whether whales surfaced less often or more often close to the ship. The cue-counting method of abundance estimation is sensitive to this as is the method used in SC/42/NHMi15 to estimate g(0).

The Committee shared Schweder's concern that the errors in distance estimation, apparent in Fig. 14 of SC/42/NHMi15, could result in a bias to the estimates of g(0), as well as in effective strip width. Annex F, Appendix 7 describes the results of calculations undertaken to investigate the sensitivity of uncorrected population

estimates to errors in distance estimation and to address concerns that, although the model used to fit the hazard rate probabilities appeared to provide an adequate fit to the duplicate sighting data, the model did not provide a good fit to the observed distribution of perpendicular and trackline distances for primary sightings.

Annex F, Appendix 7 showed that both the estimate of effective strip width and the estimate of g(0) using the method in SC/42/NHMi15 were sensitive to errors in radial distance estimation and to a lesser extent to model misspecification. This latter bias would be positive, causing an underestimation of stock abundance. The effect of a positive systematic bias in radial distance estimates would cause negative bias in estimates of both effective strip width and g(0), causing a positive bias in estimated abundance. In addition, the 'true' distances used to calculate errors in the observed distances were themselves subject to error and a positive bias may occur at small distances because they were calculated using triangulation from the bearings recorded on the second vessel.

The Committee agreed that the method of SC/42/NHMi15 was a valuable step forward in trying to solve the problems of applying line transect sampling to whale populations. It also agreed that g(0) was substantially less than one. However, differing opinions were expressed on whether the method could be used to estimate a value of g(0) appropriate for use in calculating an acceptable estimate of abundance. Concerns were expressed about the degree to which the experimental conditions (sea state, area, vessel configuration) and the diving behaviour of the two radio-tagged whales were comparable to those encountered in the survey.

Some members believed that the uncertainties revealed by the calculations presented in Annex F, Appendix 7, in addition to other concerns discussed above, meant that there were unresolved problems with the method in SC/42/NHMi15 so that it could not be used to calculate a reliable estimate of g(0). Some of these members believed that if an estimate were to be used, it should be corrected by the results reported in Annex F, Appendix 7, as should the effective strip width.

Other members believed that although the method was sensitive to errors in distance estimation, a crude correction factor was inappropriate because of the way it had been calculated and because of alternative explanations to the apparent errors in distance estimation. They believed that the method to estimate g(0) should be that presented in SC/42/NHMi15.

The cue-counting methodology used to collect and analyse data from aerial surveys was described in Hiby, Lovell, and Ward (1989, *Rep. int. Whal. Commn* 39:447–55). The Committee had no comments on this methodology and agreed that it should be used as a basis for estimating abundance in West Greenland and Icelandic coastal waters.

USE OF CATCH AND EFFORT DATA

In response to recommendations at earlier meetings, SC/42/NHMi4 presented a reanalysis of the Vestfjord catch and effort data. The authors recognised that there were difficulties associated with using net catcher day (NCD) as the measure of effort. The new CPUE series showed great variability but no statistically significant trend. The Committee agreed with the authors that this was not surprising given that the analysis was largely restricted to boats which tend to catch only a single whale each trip. Under these circumstances, catch per NCD is not a useful index of abundance. Interpretation of the data is critically dependent upon operational details. These are not available and the Committee agreed that without such information, nothing could be inferred from the lack of trend in this relative abundance series.

SC/42/NHMi21 considered some aspects of the problem of determining trends in stock sizes from CPUE data in various areas of the North Atlantic. Most work had concentrated on calibrating whaling effort, taking into account changes in vessel length, tonnage and engine power. Since 1984, corrections for vessel efficiency had been made using only vessel length. However, although average boat length did not change from 1962 to 1983, engine power almost tripled in that period, with a 30% increase from 1976.

A new analysis of the catch and effort data for the northeastern Atlantic minke whale over the period 1952–83 was presented in SC/42/NHMi14. The number of acceptable catcher days (ACD) in a sequence of consecutive days (D) without catch for the years prior to 1976 was extrapolated backwards using calibration curves based on ACD versus D for the years 1976–83, for which ACD was actually observed. The ACD method was used for the Barents Sea data. The NCD method was also used for this area. The two methods gave approximately the same results. For the whole northeastern Atlantic area, a comprehensive method based on ACD in the Barents Sea and NCD to the south was used. All the models fitted in SC/42/NHMi14 allowed for smooth variability in area specific abundance according to variation in the ecological covariates, and they were based on an oceanographically defined season. Finally, change in the catchability coefficient was accounted for by estimating the effect of boat length (5 groups). To avoid confounding a possible trend in the stock with the upward trend in boat length, the true effect of boat length was estimated from the 65 boats which had operated in the Barents Sea for at least 10 years. The resulting relative abundance series for the Barents Sea separately and for the entire Northeast Atlantic showed no declining trend, but a cyclic component of cycle length 20 years was observed.

Some members expressed concern that if the post-1976 relationship between NCD and ACD was not stable, extrapolation back before this date should not be done. The stability of the relationship between NCD and ACD had not been investigated and some members believed that without this it was difficult to interpret the results.

SC/42/NHMi14 extended earlier attempts to relate changes in catch rate to changes in distribution of prey, specifically herring. Factors relating to capelin and krill availability had not been included in the model because there were no data to estimate indices of abundance for the whole period under study. The point was made that the changes in distribution of the catches were partly a result of administrative decisions which were unrelated to how whale distribution was influenced by prey availability.

Questions were raised concerning the stratification of the data in two seasons, defined by oceanographic data, rather than by month. Schweder agreed that variability might be introduced by his method of defining season but he believed that using month instead of season was more likely to introduce a bias.

Some members felt that consideration of the frequency distributions of the number of days between catches were necessary before the ACD method could be fully evaluated.

In 1984, the Committee had requested that the northeastern Atlantic minke whale catch and effort data be analysed to investigate separate area-month trends (*Rep. int. Whal. Commn* 35:90). An analysis of these data held by the Secretariat is presented in Annex F, Appendix 8. Barents Sea data were stratified by area and month using NCD-1 as the measure of effort. There were slight differences in the areas used compared to SC/42/NHMi14. In addition, engine power was included in the analysis. The results showed negative trends averaging about 2% per year over the period 1951–83 for almost all combinations of area and month. The authors of Annex F, Appendix 8 cautioned against placing too much weight on the apparent precision of the estimated trends. However a non-parametric sign test using all estimates of trend did show that the overall decline was significant (see Annex F, Appendix 8). The coefficients for engine power were significant in all except one area. Schweder stated that he had serious doubts about the methods used in Annex F, Appendix 8.

Annex F, Appendix 9, an addendum to SC/42/NHMi14, presented an extension to the analysis in that paper, stratifying by area and including engine power as a coefficient. The results showed a slight negative trend in all areas. Schweder considered the original analysis in SC/42/NHMi14 to be the more appropriate, but believed that the analysis in Annex F, Appendix 9 was better founded than that in Annex F, Appendix 8.

The Committee noted the similarity in the results from Annex F, Appendices 8 and 9, which were different from those presented in SC/42/NHMi14. Schweder explained that this may have been caused by the term for a 20 year cyclical effect, which was significant in the SC/42/NHMi14 analysis, but was not included in the analyses of Annex F, Appendix 8 or 9.

The Committee noted these and other more general concerns about the interpretation of CPUE data but came to no agreement about whether these series should be used for assessment purposes.

MARK-RECAPTURE

No review of mark-recapture methods or estimates had been received at this meeting, although some members considered that a Comprehensive Assessment should have included such a review because previous recent assessments of the Northeastern Stock had all used such estimates (*Rep. int. Whal. Commn* 34:102–4; *Rep. int. Whal. Commn* 35:98; *Rep. int. Whal. Commn* 37:90). The Committee recalled that estimates of 44,000 and 60,000 had been used for assessment purposes in 1984 and 1986, but did not discuss the methodology used to calculate them nor whether or not they should be used at this meeting.

Walløe noted that the lower mark-recapture estimate contained a downward correction for tag loss. In his opinion the correction for tag loss was questionable and none of the estimates should be used at this meeting.

ABUNDANCE ESTIMATES FOR THE NORTHEASTERN STOCK

The Committee had failed to agree on the use of the method to calculate g(0) presented in SC/42/NHMi15. As a result, a single estimate of g(0) and, therefore, stock size could not be presented. Some members were not convinced that Annex F, Appendix 7 demonstrated that the method was subject to significant bias and they believed that the estimate of 81,500 (95% CI 55,000 – 125,000) presented in SC/42/NHMi15 was the best available. Other members restated their view that, under the Comprehensive Assessment, it was not necessary to put forward an estimate but that if this were done, the estimate of 54,900 as corrected in accordance with the calculations in Annex F, Appendix 7 was the best available. Approximate 95% confidence limits (37,000–84,200) were obtained for this estimate by assuming the same CV as for the estimate above. Some members of the Working Group which undertook the calculations presented in Annex F, Appendix 7 stressed that the calculations had been designed to explore the sensitivity of the estimates, but not to calculate correction factors. It was proposed that Bayesian methods could be used to produce a combined 95% confidence interval using the two estimates and their sampling distributions. Annex F, Appendix 10 presents the results of these calculations.

The Committee agreed that the method proposed in Appendix 10 should be used to give a combined 95% confidence interval of 43,500–114,000.

ABUNDANCE ESTIMATES FOR THE CENTRAL STOCK

The Committee accepted as the best estimate of the number of minke whales in the Central stock area the estimate of 28,000, with approximate 95% confidence interval of 21,600 – 31,400 as calculated in Annex F.

ABUNDANCE ESTIMATES FOR THE WEST GREENLAND STOCK

The Committee agreed to accept the estimate calculated at last year's meeting (*Rep. int. Whal. Commn* 40:43) from aerial surveys in 1987 and 1988 of 3,266 (approximate 95% confidence interval 1,790–5,950) animals.

The Committee agreed to present estimates for several areas other than existing stock areas in preparation for alternative assessments to be attempted. These are:

(1) Central plus West Greenland stock areas – 31,200 (95% confidence interval 24,450 – 37,950);
(2) central stock area excluding the area around Jan Mayen – 22,400 (no confidence interval could be calculated);
(3) northeastern stock area excluding the southern part – 95% confidence interval of 30,200–79,200 (no point estimate was agreed);
(4) in the absence of an estimate for the Eastern Canadian stock area, an estimate for the entire North Atlantic could not be calculated. In lieu of a total for the entire North Atlantic, a sum was calculated using the estimates for the Northeastern, Central and West Greenland stock areas resulting in a range of 74,700 to 145,200.

7.2.1.3 *Biological parameters*

The Committee had no new information on vital rates in the North Atlantic apart from the Central stock area, where SC/42/NHMi27 gave a summary of a complete analysis of all available biological information obtained from the Icelandic catch in the period 1977–85.

A compilation of parameter values from the available literature is given in Annex F, Appendix 11. The Committee stressed that it had not itself reviewed or reassessed any of the values listed. The compilation was intended to illustrate the range of values derived in the

past, and as a guide to the literature. The presence of an estimate in the table cannot be taken as endorsement of that value by the Committee.

Listed separately in Annex F, Appendix 11 are values of parameters used in recent assessments, with references to the Committee's previous discussions leading to their adoption for use.

7.2.1.4 *Status of stocks*

The Committee agreed to the use of the HITTER/FITTER model for assessment, given the requirement to provide information under the New Management Procedure, in particular with respect to Norway's intention to request that the Commission reclassify the Northeastern Stock, and additionally to address the question posed by the Icelandic government in respect of possible takes from the Central Stock area.

Values of model parameters selected for runs of the HITTER/FITTER model are detailed in Annex F.

NORTHEASTERN STOCK

The Committee discussed the results of the runs of the HITTER/FITTER model presented in Annex F, Appendix 12. It noted that computational problems arose in trying to use an MSY level of 90%. Some aspects of the runs using an MSY level of 80% were not substantially different from those using 60%.

Some members expressed a lack of confidence in the results from runs using the CPUE series from SC/42/NHMi14 and Annex F, Appendix 8 which had both been criticised. Others believed that the series should be used because they contained information which would allow the MSY rate to be estimated.

Several opinions were expressed on interpretation of the results, which can be summarised as follows.

Some members believed that the best estimate of population size was 81,500 for the entire Northeastern stock which when combined with reasonable MSY rates (more than 2%) indicated that the stock was currently at more than half of its 1937 level. Other members noted that the use of the CPUE series from Annex F, Appendix 8 was consistent with the lower range of the interval for population abundance (43,500) with MSY rates of up to 2%. These results showed that the Northeastern Stock is currently reduced to about one third of its 1937 level.

These and other members noted that if the lower bound of the interval for population abundance was considered, there was strong evidence that the stock was substantially reduced below its pre-exploitation level.

CENTRAL STOCK

The Committee considered the results of the runs of the HITTER model for the Central stock area, and for the Central stock area excluding the area around Jan Mayen, given in Annex F, Appendix 13. A number of points were made. The predicted number of exploitable females in 1990 as a proportion of the number in 1940 was little affected by the population estimate used. For an MSY rate of 2% for example, this proportion ranged from 0.79, when the lower 95% confidence limit was used, to 0.86 when the upper limit was used. Exclusion of the area around Jan Mayen made only a slight difference to the results. Some members expressed the view that the results of the HITTER run were of limited value for assessment in the circumstances where there is no reliable time series of relative abundance data.

The Committee noted that, in the past, CPUE series calculated from both Icelandic and Norwegian data had been used in assessments (e.g. *Rep. int. Whal. Commn* 37:44). At this meeting, members had agreed that they had no confidence in these CPUE series and had not used them for assessment.

CENTRAL AND WEST GREENLAND STOCKS COMBINED

The results for the HITTER runs on the Central and West Greenland stock areas combined are given in Annex F, Appendix 14. Some members noted that they did not result in anomalies as had the results from the run of the model undertaken in 1988 (*Rep. int. Whal. Commn* 39:52) on the West Greenland stock area alone. These members noted that this was consistent with the view that the Committee had taken at that time that the stock boundary at Kap Farvel was not a true one.

Other members drew attention to the new results from genetic analyses presented above which they believed precluded the possibility that minke whales off Iceland and West Greenland were from the same stock. These members did not find the results of the HITTER runs useful.

7.2.2 Management advice

7.2.2.1 *Effect of zero catch limits for commercial whaling*

The Committee noted that its ability to provide advice on the effects of the zero catch limit for North Atlantic minke whales, which came into effect in the 1986 season, was influenced by: the length of time for which the 1982 decision had been in effect; the population biology of large whales; the precision and frequency of surveys to estimate abundance; and the reliability of the population models used for prediction.

It noted that the slow growth rate of whale populations meant that there was no possibility that a substantial change in minke whale numbers had occurred since 1986. Furthermore the coefficient of variation associated with individual estimates of abundance implied that only major changes in numbers could possibly be detected.

The Committee concluded that it could offer no advice at this time concerning the effect of the 1982 decision on North Atlantic minke whales.

7.2.2.2 *Classification of stocks*

NORTHEASTERN STOCK

After considerable discussion, the Committee was unable to reach consensus on classification of this stock. The range of views concerning classification of this stock are given below.

(1) The analysis of catch and effort series reported in SC/42/NHMi14 and SC/42/NHMi4 showed no significant decline over the period 1952 to 1983. A further CPUE analysis (Annex F, Appendix 9) using the method of SC/42/NHMi14, and by subarea as recommended by the Committee in 1984, showed a decline but not of more than 7% over the 32 year period. This, combined with the fact that the annual catches have varied around an average of 2,000, indicated to some members that the stock has sustained the catch and must therefore be above the MSY level. The argument is that the catches taken prior to 1952 took the stock down to a level at which it sustained the catches taken later.

The method advanced by Butterworth and Best (1990, *Rep. int. Whal. Commn* 40:433–47) taken together with tabulated increase rates for depleted populations of large baleen whales (*Rep. int. Whal. Commn* 40:129–30) with an average around 8%, indicates a MSY rate larger than 4%. Also the high pregnancy rate for minke whales near or above 90% strongly indicates a high MSY rate for this stock. The HITTER run based on the stock abundance estimate of 81,500 given in SC/42/NHMi15 and an MSY rate of 6% appears to give an appropriate description of the changes in stock abundance. The result of this HITTER run does roughly concur with the CPUE series from 1952. For this HITTER run the depletion rate is comfortably above 54%. So both with and without the CPUE series being taken into account, they concluded that the Northeastern Atlantic management stock of minke whales should be classified as a Sustained Management Stock.

(2) Some members commented that the depletion of the mature female population was the most relevant factor for the management of this stock. They also recalled the consensus of the sub-committee (Annex F, Item 9.2) that there was little evidence to support the inclusion of the British Isles/North Sea/Faroe/West Norway sectors in an assessment centred on the Barents Sea/northwest Norway whaling grounds. They noted the differing opinions in the Committee as to whether the original point estimate of 81,500 for the population size in 1989 presented in SC/42/NHMi15 was the most appropriate to use for assessment purposes, or whether it would be preferable to use the estimate of 54,900 given in Annex F, Appendix 7. They pointed out that whichever of the two estimates was used, the results of the HITTER stock simulations indicated a Protection Stock classification on the above basis for the entire range of MSY rates considered. Even if the southerly sectors are included in the assessments, the results indicate a Protection Stock classification for the range of MSY rates (up to 4%) normally considered by the Scientific Committee for minke whale assessments, whichever of the two point estimates of population are applied. An alternative classification could be indicated only by adopting all the following assumptions: (i) discarding the bias correction to the population estimate; (ii) assuming a high value of the MSY rate at the top end of or outside the conventional range; (iii) including the southerly sectors in the assessment; and (iv) discounting the evidence of decline suggested by the CPUE data. If the results of the runs based on the alternative MSY level of 80% are considered, then even these circumstances would not support any classification other than Protection Stock.

Some of these members agreed that the evidence presented at the meeting tended to confirm the present Protection Stock classification. This confirmation emerges from consideration of all available data and factors which the Committee had recommended at its 1984, 1986, and 1987 meetings should be examined. These include analyses of CPUE by subarea and month with appropriate corrections for changes in vessel efficiency. The basic data have in the meantime become available to the Committee, and the resulting analyses are documented in Annex F, Appendix 8. Notwithstanding the general erosion of confidence in recent years in CPUE data, which are suspected to conceal rather than reveal declines in abundance, and taking into account the recommendations of the Comprehensive Assessment Workshop on CPUE the evidence from corrected CPUE data for this stock should not be ignored, since they provide, with new survey estimates, the only fully documented and reviewed information on abundance and trends in abundance, especially in the absence of independent estimates of MSY rate and its likely range. These members noted that the bias-corrected point estimate of abundance was in the region of 55,000. This was broadly compatible with the marking estimates of 60,000 and 44,000 which had been used previously. All the HITTER/FITTER runs using the CPUE data as analysed in the manner recommended by the Committee in 1984 imply a depletion of the stock significantly below the Protection Stock level. They are consistent with the lower part of the range of population estimates for MSY rates up to 3–4% depending on which population estimate and assessment are used.

(3) Some members considered that the various analyses presented to the Committee (Annex F, Appendix 12) did not lead to an unambiguous classification of the stock. If the null hypothesis of the current classification (i.e. that the stock is a Protection Stock) is adopted then there is insufficient evidence to reject this null hypothesis. That is, the stock should remain classified as a Protection Stock. It should be noted, however, that the advice which led to the present classification was based on an analysis of trends in CPUE data, about which there are many uncertainties. Furthermore, new analyses of CPUE data at this meeting were not considered to have resolved the uncertainties. If, therefore, no prior hypothesis is adopted, there is insufficient evidence to classify the stock. Should further analyses prove able to diminish the problems of interpreting the different CPUE trends and estimates of population abundance, the matter of classification might be reexamined on a sounder basis, at a future meeting.

Because of this uncertainty concerning the catch and effort data, some of these members thought that the basis for the present classification was not valid since it was based on the use of these data. They noted the long history of apparently sustained catches and the high abundance estimate. However, in view of the widely differing results from the HITTER/FITTER runs, depending on the value of the abundance estimate and the value of the MSY rate used, which put the stock either in the SMS or the PS category, they felt that there was too much uncertainty for the stock to be properly classified.

CENTRAL STOCK

The Committee agreed that, if the results of the runs of the HITTER model for the Central stock as at present defined are used as a basis for assessment, the Central stock of minke whales in the North Atlantic should be classified as an Initial Management Stock.

7.2.2.3 *Effect of an annual take of 200, 300 or 400 minke whales from the Central North Atlantic stock area in the five year period 1991–1995*

The Committee discussed how it could best answer this question from the Icelandic Commissioner. Some members expressed concern that the Committee had been requested to consider such a question while attempting a Comprehensive Assessment.

The Committee noted the results of the HITTER runs for the Central stock area, presented in Annex F, Appendix 15 for three estimates of population abundance representing the best estimate and upper and lower 95%

confidence limits. These results included projections up to 1995 assuming an annual catch of 200, 300 or 400 from 1991 to 1995 and with historic levels of sex ratio from 1972. The number of exploitable females in 1995 as a proportion of the pre-exploitation level is presented to compare with that in 1990. Values of MSY and of replacement yield (RY) averaged over the five years 1991–95 are also presented.

Some members drew attention to the view of the sub-committee on Southern Hemisphere minke whales in 1988 (*Rep. int. Whal. Commn* 39:76) that in the case where a stock was still very close to its initial level, estimates of RY were inappropriate for assessing the potential effect of catches on the stock. These members believed that the figures for MSY given in Annex F, Appendix 15 were more useful for this purpose.

Other members believed that the stock in this case is likely to be reduced to a level below the case referred to above, and therefore estimates of RY (Annex F, Appendix 15) could be a useful guide to the effects of the catches on the stock over the next five years.

The Committee noted that the calculated values of MSY in Annex F, Appendix 15 were sensitive to the values of age at recruitment in those tables.

In discussion of what advice could be given concerning the Icelandic Commissioner's question, different views were expressed.

Some members believed that, from the results in Annex F, Appendix 15, it could be concluded that an annual take of 200 whales over a 5 year period would have a negligible effect on the size of the stock. Even taking an extremely cautious approach, using the lower confidence limit for population abundance and assuming an MSY rate of only 2%, the stock size remained virtually unchanged at 78–79% of its initial level.

Other members believed that whether or not an answer could be given to the Icelandic Commissioner's question depended upon whether the whales in the Central stock area comprise the whole of a single population. Holt considered furthermore that no evaluation was possible in the absence of specifications of the locations from which the postulated catches would be taken.

Some members commented that a question of this type, outside the context of a management framework, was not a useful way to approach the management of whale stocks.

7.3 Gray whales

7.3.1 Report of Special Meeting

The report of the Special Meeting held in Seattle, 23–27 April 1990 to assess the Eastern North Pacific stock is given in IWC/42/4A. The Committee noted that in Table 1 of the Report, the figures for 'Total Kill' represent the average annual take for each set of years listed.

7.3.2 Management advice

The Committee's conclusions on current population status are given in Item 11.1. Its advice on Management is contained in Item 11.5.

7.4 St Vincent and The Grenadines humpback whales

The Committee noted that the catch limit for humpback whales taken by St Vincent and The Grenadines, currently 3 whales per year, is to be reviewed by the Commission at this year's meeting.

The last humpback catch in the fishery was a single animal taken in 1987/88. The Committee noted the mark-recapture estimate obtained for the western North Atlantic from photo-identification studies of 5,505 ±2,617 for the years 1979–86 (Katona and Beard, *Rep. int. Whal. Commn* (special issue 12): 295–305). The estimated annual rate of increase was 9.4% but with extremely wide confidence intervals.

Although the relationship between animals from the Bequia-St. Vincent breeding area and other humpback whales is unknown, the Committee agreed that a catch of up to three animals was unlikely to harm the stock. It **recommends** that if whales are taken, every attempt should be made to collect as much information as possible from them. In particular photographs should be taken of the ventral surface of the flukes to allow comparison with the North Atlantic humpback whale catalogue, and samples should be collected for genetic analysis. Collection of photographs, with scale, of ovaries and foetus, if present, or testes would be valuable for documentation of sexual maturity.

7.5 Progress reports on other priority stock groups

7.5.1 North Atlantic fin whales

Sigurjónsson introduced SC/42/O 20, which provided a report on Icelandic preparations for work on an in-depth assessment of North Atlantic fin whales. The paper summarised progress on stock identity (marking data, genetic data and morphological data), biological parameters, stock size (sightings and marking data) and catch and effort data.

The Committee agreed that the question of data availability from other areas of the North Atlantic (Spain, Canada, Greenland) and from sighting surveys (especially NASS-87 and NASS-89) should be addressed by an *ad-hoc* working group established to plan for the assessment. Its report is given as Annex I.

7.5.2 North Pacific minke whales

Kasuya introduced SC/42/O 17 which provided a progress report on Japanese preparations for an in-depth assessment of North Pacific minke whales. The paper summarised work on stock identity, catch history, stock size, and biological parameters. It identified problems with respect to stock boundaries and catch history. In the case of the latter it noted that there are problems in determining whether traditional net whaling took minke whales and in determining levels of incidental takes in trap nets and gillnet fisheries. It noted that an extended sightings survey would be carried out in 1990 in the Okhotsk Sea as a follow up to the shorter survey undertaken in 1989 (SC/42/ProgRep Japan).

The Committee agreed that the question of data availability needed for the assessment of North Pacific minke whales should be addressed by an *ad-hoc* working group established to plan for the assessment. Its report is given as Annex J.

7.5.3 Western North Pacific Bryde's whales

Kasuya introduced SC/42/O 17 which documented Japanese work towards an in-depth assessment of Bryde's whales. The paper reported on progress on stock identity, distribution and migration, catch history, stock size (sightings and mark-recapture data) and biological parameters.

The Committee agreed that given the uncertainties with respect to stock identity, any in-depth assessment should consider the whole North Pacific.

7.5.4 Bowhead whales
SC/42/PS2 documented US work towards an in-depth assessment of bowhead whales. It reported on data availability, stock identity, migration and distribution, catch history, stock size, rate of increase and biological parameters. An *ad-hoc* group was established to plan for the assessment (Annex K).

7.5.5 Other
SC/42/O 20 provided information on Icelandic work towards preparation for an in-depth assessment of North Atlantic sei and sperm whales. North Atlantic sei whales are discussed further under Item 8.1.

8. COMPREHENSIVE ASSESSMENT – FUTURE WORK

8.1 Priority studies
After discussion of the information given under Item 7, the Committee agreed that the priority studies for the period up to and including the 1991 Annual Meeting were

(i) Management
(ii) North Atlantic fin whales
(iii) North Pacific minke whales
(iv) Bowhead whales.

In view of the discussions in both Annexes E and F, it was also agreed that the question of the estimation of g(0), the probability of sighting whales on the trackline, should be addressed. The report of an *ad-hoc* Working Group to plan for this is given in Annex L.

There was some discussion of priority studies for the post 1991 Annual Meeting period. The Committee agreed that North Pacific Bryde's whales and North Atlantic sei whales should be the subject of an in-depth assessment before or at the 1992 meeting.

Smith drew the attention of the Committee to document SC/42/O 25, a proposal for discussion for a 2 year study involving six nations using photo-identification and biopsy sampling methods to estimate regional and total abundance, and to determine genetic structure. This latter information would aid in understanding of cetacean 'stock' structure, a recurring problem for in-depth assessments of most species. This study fits under the third priority of studies outlined for the Comprehensive Assessment (*Rep. int. Whal. Commn* 40:60). The proposal will draw on a substantial fluke photograph database held in Bar Harbor, Maine (College of the Atlantic) that has been used, as noted earlier in this meeting, to provide an estimate of population increase of 9–10%. This database would be drawn upon and expanded in a way that would increase our knowledge about humpback whales in the North Atlantic, and would provide essential information for any future Comprehensive Assessment of this species. The Committee endorsed the proposed research; agreeing that it would contribute significantly to the Comprehensive Assessment.

8.2 Intersessional Working Groups and meetings
8.2.1 Plans for Special Meeting on North Atlantic Fin Whales
This is discussed under Item 7.5.1 and Annex I. The Committee agreed to the proposals outlined in this. Most members of the Committee agreed that this meeting should be considered a full meeting of the Scientific Committee, as had been the gray whale meeting (IWC/42/4A) and that an item 'management advice' should be included on the Agenda. They noted that this was the most efficient way to ensure progress under the Comprehensive Assessment. If discussion of North Atlantic fin whales also occurred at the Annual Meeting it would reduce the time available to address the priorities agreed under Item 8.3 for that meeting.

Holt disagreed with this view. He believed that the meeting should have the status of a sub-committee meeting, with its report discussed at the Annual Meeting. He felt that fewer members would attend a intersessional Special Meeting and that this would lead to the erosion of the role of the full regular Annual Meetings. He reiterated his view expressed at this meeting (Annex S) that addressing the question of management advice before an alternative management procedure had been agreed was detrimental to the work of the Committee and the Comprehensive Assessment. Donoghue and de la Mare agreed with this view.

8.2.2 Other
The following proposed meetings were identified by the Committee.

(i) Workshop on Alternative Management Procedures (Item 6.1.2.5).
(ii) Symposium and workshop entitled 'Mortality of cetaceans in passive fishing nets and traps' (Item 5.3.1).

8.3 Work plan for 1990/91
The Committee agreed that the intersessional work noted under Item 8.2 should be carried out. It agreed that the following items should be given highest priority at the 1991 Annual Meeting:

(i) management procedures
(ii) bowhead whales
(iii) North Pacific minke whales.

An initial Agenda for the meeting is discussed under Item 14.

9. SCIENTIFIC PERMITS

The question of associating names with viewpoints during the discussion of reports was raised. Tillman noted that the past practice of the Committee during their review of Scientific Permits was to allow members to associate themselves with various views. The Chairman ruled that this practice would be followed as in past years (*Rep. int. Whal. Commn* 39:159–66).

Sigurjónsson and Ohsumi noted that they felt that association of names of Committee members to views expressed by other members had no precedence in any scientific forum and was in essence voting on scientific subjects. They believed the report should reflect the Committee's deliberations and stated that they would associate their names with views appearing in the report only if they had participated in the debate on that point.

Best felt that, as a non-voting contributor (invited participant) to the meeting, he could not associate himself with any position on these issues, as he believed the process of listing individual names in this manner constituted a *de facto* voting procedure.

9.1 Review of research results based on existing Scientific Permits

9.1.1 Norway

The Norwegian Government issued a special permit to take 20 minke whales in 1989. A total of 17 animals was taken, 2 males and 15 females, bringing the total permit catch (1988 and 1989) to 46; 23 males and 23 females. The progress of the overall Norwegian research programme (including these aspects not directly related to the research catch) is detailed in SC/42/ProgRep Norway and 27 papers presented to the Committee. The studies directly related to the catch can be grouped under the following headings:

Age determination (SC/42/NHMi3)
Feeding (SC/42/NHMi9, 10, 11, 12)
Stock identity (SC/42/NHMi2)
Energetics (SC/42/NHMi5, 6)

Comment and discussion

Comment here is confined to discussion of specific aspects of the research carried out in 1989. A more general discussion centring around the multi-species modelling aspect of the programme is given under Item 9.2.1. The work on stock identity and age determination is discussed under Item 7.2 and in Annex F.

Smith noted the importance of simultaneous sampling of fish resources with sampling of minke whales, if examination of stomach contents was to provide information on food selectivity. He also noted that, to obtain an accurate picture, sampling would have to be carried out over several months and in different localities.

Blix concurred with this view noting that simultaneous sampling of fish resources had been attempted in 1989 and would continue in 1990. He emphasised that the present work was aimed at developing methodology and agreed that a broader sampling programme was necessary to obtain a clearer overall picture of food selectivity and consumption of minke whales.

Holt commented that he thought that some specific aspects of the methodology were questionable. He, Cooke, Lankester, Lyrholm, de la Mare, Perrin and Stokes believed that the most serious problems concerned the multi-species model for which the programme was intended to provide data. This is discussed under Item 9.2.1.

Kato and Albert commended the scientific value of the energetics and feeding studies. Kato noted that such studies would be of value in addressing questions of changes in carrying capacity.

9.1.2 Japan

The Committee reviewed the reports of information obtained from catches taken under Special Permits issued by the Government of Japan since 1987. SC/42/SHMi28 provided a summary of the purpose of and results from these catches. SC/42/O 16 described the design of a device for collecting biopsy samples from whales in the Antarctic. SC/42/SHMi25 gave a preliminary report on the cruise undertaken in Area IV between longitudes 70°E and 130°E and south of 55°S during 1989/90 as part of this research programme. A total of 767 primary sightings of minke whale schools and 478 secondary sightings had been made during a total searching of 17,094n.mile. A total of 330 individuals (184 males and 142 females) had been taken, including three diminutive form whales. The length composition of the whales taken was different from that of the commercial catch, with a higher proportion of small animals. Mature males dominated the catch throughout the research area. Pregnant females were concentrated along the ice edge and in Prydz Bay. Immature animals tended to be solitary and distributed in offshore areas. The following papers, which are discussed in Annex E, also made use of data collected as part of the Japanese research programme: SC/42/SHMi1, 2, 10, 11, 12, 13, 14, 22, 24, 27.

Discussion of the results of the programme in the context of the review of the proposal for 1990/91 are given under 9.2.2.

9.1.3 Iceland

Sigurjónsson reported on the results of the 1989 permit catch of 68 fin whales, the final year of the four–year programme and on the progress to date on the analyses of the 1986–1989 data (SC/42/O 6).

The Committee noted that final analyses were not yet complete and agreed that review of the results could be better achieved when in-depth assessments of the two species involved, fin and sei whales, are carried out (see Items 7 and 8).

9.2 Review of new or revised Scientific Permit proposals

9.2.1. Norway

Walløe reported that the proposed 1990 catch of five animals was planned mainly to complete studies on digestion and studies on the energy expenditure of free-swimming whales. The proposal is detailed in SC/42/NHMi20 and should be viewed in conjunction with the broader programme described in SC/40/Mi7.

The Committee noted that the 1990 proposal was an extension of the programme it had discussed in detail last year (*Rep. int. Whal. Commn* 40:69–71). It refers the Commission to that discussion and agreed this year to confine its discussion to new points.

Much of the discussion centred on the value of multi-species models to management. Ulltang introduced SC/42/O 7 which discussed the need for modelling species interactions in the Barents Sea. The Barents Sea ecosystem is characterised by a few key fish species. He believed multi-species modelling was necessary to address questions concerning fluctuations in stock size, mortality, growth and distribution of key predator (including minke whales) and prey species, and to try to predict short-term and long-term effects of various management strategies. He stressed that this was a formidable task and was of necessity an iterative procedure involving a combination of modelling and field investigations. SC/42/O 4 presented an outline of MULTSPEC, which described the development of a multi-species model project for the Barents Sea. The authors noted that the documentation was in its initial stages and somewhat sketchy. Ulltang noted that this model was not ready for use in management at present but that it should eventually lead to an improvement over single species management.

There was considerable discussion over the value of this project and multi-species models. In particular, several members commented that any such model should concentrate on the lower trophic levels, particularly krill and the predation of large fish on small fish which are likely to be the major interactions driving the system. The question of other top predators such as seabirds was also raised.

Walløe responded that the MULTSPEC project involved input from a wide range of institutions throughout Norway. Work was underway on many species including krill, *Calanus finnmarchicus*, fish (especially cod and capelin) and other predators. This work was being co-ordinated by the Norwegian Fisheries Research Council.

Several members (Smith, Holt, Polacheck, de la Mare, Harwood, Breiwick, Koch, Cooke, Lyrholm, Lankester, Perrin, Swartz, Barlow, Stokes and Anderson) commented that sensitivity analyses were required to assess both the importance of minke whales to the MULTSPEC model and the importance of factors such as the relative digestibility of prey items to an energetic model of the minke whale (SC/42/NHMi12). They questioned whether further work on digestibility was necessary.

Ulltang responded that work on sensitivity analysis had progressed more slowly than expected but that it was hoped to present some results of such work at forthcoming ICES meetings. Blix observed that the work on digestibility had thus far been aimed at developing a suitable methodology. Now that this was completed the preliminary results needed to be verified.

Holt, de la Mare and Swartz commented that they believed the correct approach should be first to develop a model and test the relative importance of the input parameters by simulation studies before starting a field programme. When priorities had been identified it might then be reasonable to try to obtain a suitable number of samples to obtain parameter values to the necessary precision. Holt and de la Mare recognised that the aim of the proposal was to develop methodological procedures but were concerned that unwarranted attempts had been made (e.g. in SC/42/NHMi8) to use the data obtained from the methodological studies to reach general conclusions on, for example, the total consumption of prey species by minke whales.

Sigurjónsson and Ohsumi noted that the sub-committee on Southern Hemisphere minke whales had noted the value of an ecosystems approach (Annex E, Item 10), and they welcomed the Norwegian work.

Tillman noted that the simultaneous fisheries resources surveys attempted last year and planned for this year represented a welcome change to the original proposal which would facilitate an ecosystems approach.

9.2.2. Japan

Proposals for research in 1990/91 were contained in SC/42/SHMi9. The paper noted that it was intended to take 300 whales ±10% in Area V and stated that this would not have any adverse effects on the conservation of the stocks. The expedition would consist of one factory ship (acting as a research base), three sighting and sampling vessels, and two additional sightings vessels. The sampling scheme would be similar to that used in 1989/90. An appendix to the proposal described the account which had been taken of comments made by the Scientific Committee in 1989 (*Rep. int. Whal. Commn* 40: 64–6). Foreign scientists were welcome to participate in the cruise.

The Committee agreed that before discussing the details of the new proposal, a general discussion on the results of SC/42/SHMi23 and SC/J90/Mg16 was useful. Butterworth introduced SC/42/SHMi23 which described an 'integrated analysis' method that could be applied to a combination of absolute abundance estimates from surveys and catch-at-age data. The method had been tested using the same slight amendment of the draft protocol of *Rep. int. Whal. Commn* 39:136–8 which had been applied by Butterworth and Punt (1990, *Rep. int. Whal. Commn* 40:301–16). The paper investigated true possible changes in the historic recruitment trend of 4% and 0% and concluded that estimates of such a trend and the mean net recruitment rate with standard errors less than 1% could be achieved within a 20 year period, but that these standard errors increased markedly in the absence of future catch-at-age data. Butterworth commented that these results indicated that techniques which will make use of future catch–at-age data would be able to discriminate between values of population dynamics parameters which are within the ranges that are realistic for whale populations.

Cooke disputed this conclusion. He suspected that the precision reported for the method may have been a consequence of the amendment made by the authors of SC/42/SHMi23 to the original draft protocol, and questioned why they had felt it necessary to make this change. (Essentially, this amendment involved the underlying true recruitment trend changing at a point in time, rather than remaining constant).

Butterworth disagreed, considering that allowing for a possible change in trend made estimation precision more difficult to achieve as additional parameters had to be estimated. Further, he drew attention to results in SC/42/SHMi23 for a scenario where the recruitment trend did not change with time, for which similar levels of estimation precision had been obtained. Responding to questions, Butterworth explained that he considered that the incorporation of a possible change in recruitment trend reflected an essential component of the problem, as to whether Southern Hemisphere minke whales had increased prior to exploitation. He believed that the previous report of the Scientific Committee (*Rep. int. Whal. Commn* 40:65) was ambiguous in regard to whether the Committee had intended methods of this nature to be tested using the original draft proposal of *Rep. int. Whal. Commn* 39:136–38, or the slightly amended version of Butterworth and Punt (*Rep. int. Whal. Commn* 40:301–16). Cooke commented that the report of last year's meeting (*Rep. int. Whal. Commn* 40:65) stated that the original protocol was to be used as it stood. Holt commented that if protocols are not adhered to the resolution of controversy will be impossible. Butterworth commented that no objection had been raised to these slight amendments when SC/41/SHMi17 had been discussed last year, or SC/42/SHMi23 discussed this year (Annex E). It was clear from SC/41/SHMi17 that his question last year about possible revisions to the draft protocol (as recommended in that document, but considered inessential by the Committee) referred to additional amendments. He regretted the ambiguous wording of the report.

Barlow considered that the protocol did not adequately reflect other sources of possible error (such as ageing error), which would be present in a real situation. SC/42/SHMi23 had also drawn attention to this aspect. Zeh convened an *ad-hoc* sub-group to consider revisions of the protocol.

Barlow introduced SC/J90/Mg16. Using a demographic model approach he found that even with sample sizes as large as 16,000 and ignoring many sources of variability other than sampling error, the variance in estimates of population growth rate obtained from age data would render them of little use in management.

Tanaka responded that his approach was entirely different to that examined in SC/J90/Mg16 in which a stable age distribution is assumed. By contrast his approach makes use of sampling over many years in conjunction with estimates of absolute abundance.

The Committee then addressed the proposal (SC/42/SHMi9) directly. It noted that it had commented extensively on previous proposals relating to this programme (*Rep. int. Whal. Commn* 38:56–57; 39:76) and draws the Commission's attention to those comments. It further noted that the population estimate for Area V, where the research was to be carried out, was 294,610 (CV 0.138).

Some additional comments by members are given below.

Hester drew attention to the Appendix of SC/42/SHMi9 which summarised changes made to the proposal in view of comments made at last year's Committee meeting. Holt noted that while he recognised that a serious attempt had been made to respond to criticism by members of the Committee he believed that it was essentially unchanged and that criticisms made in earlier reports of the Committee remained valid. Lyrholm and de la Mare concurred with this view.

Tillman stated that the changes made to the Japanese research proposal were only cosmetic in that they did not seriously address major issues raised by some members of the Scientific Committee. For example, there is still lacking an analysis of the sources of error inherent in the proposed methodology which would allow one to assess the accuracy and precision of results likely to arise from the proposed sample size. Swartz agreed with this.

Tillman also observed that no estimates of age-specific natural mortality rates were submitted for use in the in-depth assessment of Southern Hemisphere minke whales at this meeting and that estimating this parameter had been the primary objective of the programme. Given this situation, he concluded that the research programme had failed to achieve its goal of contributing to the Comprehensive Assessment and that, since it had not been revised in any meaningful way, it would continue to fail in this regard. Holt, de la Mare, Lankester and Donaghue agreed with this view.

Ohsumi noted that the discussion in Annex E revealed that data obtained from the programme had been used in the assessment. Zeh, Hester, Kasamatsu, Kato, Koya, Morimoto and Sakuramoto concurred with this statement. Ohsumi reiterated that the Japanese response to the comments raised in the past and repeated during these discussions are fully covered in the Appendix to SC/42/SHMi9. Tanaka added that the estimation of age-specific mortality rates was a long term programme. Research to obtain information on biological parameters would be useful for improving the efficiency of management and answering such questions as changes in carrying capacity, and is likely to require a long time series of data.

Gunnlaugsson and Tanaka disagreed with Tillman, they believed that although the research had not led to major revision of the parameters and methods used for assessment at this meeting, this did not imply that the research has not produced useful results.

Gunnlaugsson welcomed in particular the attempt to discover new methods of estimating relevant parameters. Walløe also believed that the research provided useful results. He also noted its value to the development of an ecosystem approach to management.

Sigurjónsson considered that the programme did contribute to the Comprehensive Assessment. He referred to discussion last year in the Committee on the value of information on biological parameters (*Rep. int. Whal. Commn* 40:52). He also noted that SC/J90/Mg3 had investigated how the Punt-Butterworth procedure's performance was affected if it was extended to make use of an independent estimate of MSY rate. The paper concluded that substantial improvement in performance was achieved, even if the MSY rate estimate had a 95% confidence interval as wide as ±4%. Schweder and Zeh concurred with this latter comment concerning the value of biological parameters.

Smith, Barlow and Polacheck offered a series of comments.

(1) They noted that the proposed Japanese research plan for 1990/91 must be considered in terms of the likely precision of the estimates of biological parameters (Objective 1 of the proposal). The precision of estimates of different parameters depends on the methods of analysis to be used, and the various inputs to these methods from both lethal sampling and the simultaneous sighting surveys. While the precision of such estimates is often difficult to forecast at the outset of a field programme, the two years of feasibility study and last year's first year of the experiment has provided sufficient information to allow such forecasts to be made. These analyses of precision are required for an adequate evaluation of this proposal.

(2) Particular attention should be given to the likely precision of average and age-specific mortality rate estimates as they depend on (i) the number of animals to be lethally sampled; (ii) miles of sighting survey to be conducted during sighting/catching field work; (iii) number of years sampled in each geographic area. This evaluation of the precision needs to be considered within the context of how the actual data are collected, taking into account covariance among the estimates of the parameters to be used in the estimation procedure.

(3) In addition, the specific estimation methods and the assumptions underlying them need to be clearly identified. The proposal should evaluate whether these assumptions are likely to be met based on the research data, and on other concerns, for example possible changes in the age distributions over the apparently long time period over which the research may be conducted. Finally, the sensitivity of the results if these assumptions are not met should also be displayed.

(4) It would also be useful to show explicitly how improved estimates of average or age-specific mortality would improve estimates of MSY rate or other parameters that are of direct relevance to revised (or potential) management procedures. This evaluation should also address the three aspects of the proposed sampling program outlined above.

Swartz, Tillman and Zeh concurred with this view.

Tanaka responded that some work on the effect of sample size on the variability of estimates was given in his paper from last year (1990, *Rep. int. Whal. Commn* 40:531–6). He noted that for average values of natural mortality rate the variability in the absolute abundance data is more important than sample size and 300 would be sufficient for estimating average values. However for estimation of age-dependent mortality, sample size is important.

Nevertheless he believed a sample size of 300 would provide a good probability of detecting age-dependency if it is large, as one might expect, but may not be sufficient if it is small. He would continue his work on the examination of precision and bias in the estimates. Smith and Zeh welcomed the fact that this work would continue, particularly with respect to sample size.

Reilly and Stokes shared Tillman's reservations about the failure of the Japanese Research Programme to contribute towards the Comprehensive Assessment. They also associated themselves with the above comments of Smith, Barlow and Polacheck.

However they wished to make a distinction between the lack of contributions of the Japanese Research Permit work, towards the estimation of biological parameters required for the stock management (Objective 1) and the general scientific value and contributions of papers presented as part of that work. They commended the Japanese scientists for the very high quality and quantity of research presented, noting that many contributions were made to individual disciplines. Anderson, Harwood and Perrin concurred with this view.

9.2.3 USSR

The Scientific Committee reviewed the proposal outlined in document SC/42/O 29 only with respect to the proposed lethal taking of fin and minke whales from the Okhotsk Sea. The Committee noted that the proposal reported that catching was due to take place from June to August in 1990 and 1991. It expressed serious concern that catching may already have started before the proposal was received by the Scientific Committee and thus before the Committee's comments could be transmitted to the Commission. It was pointed out that the Committee suggested at the 1985 meeting that information on proposed scientific permits should be provided to the Secretary at least 60 days in advance of an Annual Meeting of the Scientific Committee so that the proposal and supporting documentation may be sent out at the same time as the provisional Agenda (*Rep. int. Whal. Commn* 37:20). In the absence of any Soviet scientists at the meeting, and because of the rather brief and inadequate description included in the document of the work and methods proposed, it was possible to make only the following comments.

(A) The Proposal

The relevant guideline is as follows:

'A statement as to whether the permit proposal adequately specifies the four sets of information required under paragraph 30 of the Schedule.' (*Rep. int. Whal. Commn* 36:133)

1. 'Objectives of the research;' (Sched. Para. 30)
2. 'Number, sex, size and stock of the animals to be taken;' (Sched. Para. 30)

The objectives of the catch are stated to be to obtain stomach contents to examine the role of whales in the food web, to obtain biological samples for determining age, sexual and physical maturity and reproductive condition; tissue and organ samples for electrophoretic studies; internal and external parasites; and contamination by pollutants.

The proposal envisages a catch of 60–70 minke whales and 25–30 fin whales in each of the years 1990 and 1991 from the Okhotsk Sea, and, under certain conditions, probably in 1992. No information on the size or sex of animals to be taken was presented. According to the boundaries given in the Schedule, the minke whales in this area are from the Okhotsk Sea – West Pacific Stock while the fin whales are part of the North Pacific Stock.

(B) Objectives

The relevant guidelines are as follows:

1. 'Comments on the objectives of the research to be carried out under the proposed scientific permit, including in particular how they might relate to research needs identified by the Scientific Committee;' (*Rep. int. Whal. Commn* 36:133)
2. 'The proposed research is intended, and structured accordingly to contribute information essential for rational management of the stock;' (*Rep. int. Whal. Commn* 37:25)
3. 'The research addresses a question or questions that should be answered in order to conduct the comprehensive assessment or to meet other critically important research needs;' (*Rep. int. Whal. Commn* 38:27–8)
4. 'The number, age and sex of whales to be taken are necessary to complete the research and will facilitate the conduct of the comprehensive assessment'; (*Rep. int. Whal. Commn* 37:25)
5. 'Whales will be killed in a manner consistent with the provisions of Section III of the Schedule, due regard being had to whether there are compelling scientific reasons to the contrary;' (*Rep. int. Whal. Commn* 37:25)

[The Commission agreed that it has been intended by this for the Committee to report if cold grenade harpoons were used in special permit catches. (*Rep. int. Whal. Commn* 38:13)]

6. 'The research is likely to yield results leading to reliable answers to the question or questions being addressed;' (*Rep. int. Whal. Commn* 38:27–28)

North Pacific fin whales were last assessed in 1976 (Allen, 1977, *Rep. int. Whal. Commn.* 27:221). They were classified as a Protection Stock and no particular research needs were then identified. Since they do not meet the criteria for priority stocks established by the Committee (*Rep. int. Whal. Commn* 40:60), they have not yet been considered in the programme of the Comprehensive Assessment of whale stocks. Okhotsk Sea – West Pacific minke whales were last assessed in 1987 (*Rep. int. Whal. Commn* 38:47,96–97). At that meeting the Committee identified difficulties in interpreting CPUE series, a general problem of stock identity in the North Pacific, and **recommends** appropriate analyses of sightings data. North Pacific minke whales have been identified as a priority stock for the Comprehensive Assessment in 1991 (see Items 7.5.2 and 8).

The proposed investigations on the whales to be caught do not appear to be structured either to provide information essential for rational management of these stocks, or to contribute to the Comprehensive Assessment or other critically important research needs. There is insufficient information given regarding aims and methodology to be able to comment on sample size. No reasons are given in the proposal justifying chosen sizes. There is no statement of the method of killing to be employed. However the proposal notes that the catcher *Zvezdny* will be used.This is the same vessel as used in the aboriginal subsistence gray whale fishery off Chukotka.

(C) Methodology

The relevant guidelines are as follows:

1. 'Comments on the methodology of the proposed research and an evaluation of the likelihood that the methodology will lead to achievement of the scientific objectives. These comments may also include evaluation of the methodology in terms of current scientific knowledge;' (*Rep. int. Whal. Commn* 36:133)
2. 'The objectives of the research are not practically and scientifically feasible through non-lethal research techniques;' (*Rep. int. Whal. Commn* 37:25)

3. 'The research addresses a question or questions that cannot be answered by analysis of existing data and/or use of non-lethal research techniques;' (*Rep. int. Whal. Commn* 38:27–28)

It is not stated to what extent catches made during the commercial whaling operations on these species stocks were sampled. Some pollution studies and genetic analyses could be carried out by non-lethal biopsy sampling. In general, both the objectives and the methodology are inadequately described to allow an evaluation of the likelihood of success of the proposed research. The results from the internal sampling could not be achieved by non-lethal techniques. However, it is unclear from the research proposal what proportion of the whales taken will be sampled for stomach contents and whether fishery resource surveys will be undertaken simultaneously with the proposed research catches.

(D) Effect of catches on the 'stock'

The relevant guidelines are:

1. 'A review of the most recent information on the stock or stocks concerned, including information on any exploitation, stock analysis and recommendations by the Scientific Committee to date (including, where appropriate, alternative analysis and conclusions and points of controversy).' (*Rep. int. Whal. Commn* 36:133)
2. 'An evaluation of the specification in the permit proposal of possible effect on conservation of the stock. As appropriate the Scientific Committee may carry out its own analyses of the possible effects.' (*Rep. int. Whal. Commn* 36:133)
3. 'The research can be conducted without adversely affecting the overall status and trends of the stock in question or the success of comprehensive assessment of such stocks;' (*Rep. int. Whal. Commn* 38:27–28)

The Soviet research proposal does not provide an adequate review of information on the status of these stocks. If it did the following facts should have been noted.

The last catches of fin whales permitted to be taken in the North Pacific were made in 1975, and the fin whales for the total North Pacific have been classified as a Protection Stock since 1976. In 1975 the USSR took only 33 of the 166 fin whales allocated to them. During the final ten years of exploitation the USSR took 4,666 fin whales in the North Pacific. It is not known how many were taken in the Okhotsk Sea. The Scientific Committee has not reviewed their status since that time. The assessment at that time was based on an updating of estimates obtained from CPUE analyses carried out in 1974. It is therefore not possible to evaluate the effect of the proposed catches on the stock.

Minke whales in the Okhotsk Sea-West Pacific stock have been reviewed in some detail in recent years. Because of uncertainties, particularly with CPUE analyses, the stock is at present unclassified and has been identified as a priority stock in the programme of Comprehensive Assessment at next year's Annual Meeting. The effect of the proposed catches can be determined only after the in-depth assessment for North Pacific minke whales has been completed.

(E) Research co-operation

The relevant guideline is:

1. 'Comment on the adequacy and implications of specified arrangements for participation by scientists of other nations'. (*Rep. int. Whal. Commn* 36:133)

The proposal stated that participation of foreign specialists is welcomed, subject to availability of accommodation on board.

10. SECOND INTERNATIONAL DECADE OF CETACEAN RESEARCH

10.1 Review results from 1989/90

(a) IWC/IDCR Southern Hemisphere minke whale cruise 1989/90

The report of this cruise is given in SC/42/SHMi6.

(b) Computer assisted matching for right and blue whales

SC/42/PS5 reported on the pilot study part funded by the IWC. The Committee welcomed the report and noted that the authors would continue to develop the procedure. Interested members were invited to contact the authors for details of the software.

10.2 Review proposals for 1990/91

All proposals recommended for support here will be subject to the Committee's guidelines on data availability agreed in 1988 (*Rep. int. Whal. Commn* 39:61).

(a) IWC/IDCR Southern Hemisphere minke whale cruise 1990/91

The Committee **recommends** that this cruise, to survey Area VI (120°W-170°W), be funded as a contribution to the Comprehensive Assessment. Details are given in Annex N. The Committee noted with appreciation that the Government of Japan has allocated £805,000 to provide vessels, labour and other logistics required for this cruise.

(b) Unsolicited research proposals

Three research proposals were submitted to the Committee this year and were reviewed by an *ad-hoc* working group (Annex O). In the light of that review, the Committee **recommends** as summarised below. Details are given in Annex O.

(i) *'Genetic variability and stock identity of humpback whales, worldwide'* (SC/42/RP1)

The project has high potential to provide information on stock identity of this species, important for the Comprehensive Assessment. The Committee **recommends** it be funded in full, but notes that for the project to be completed in its proposed time-frame, funds will need to be made available in early July 1990.

(ii) *'A proposal to study humpbacks off Western Australia in the austral winter of 1990'* (SC/42/RP2)

Based on referee's comments the proponents had considerably reduced their multi-faceted proposal to limit it to photo-identification analysis, involving processing of tail fluke photographs. The Committee **recommends** that the reduced programme be funded as proposed.

(iii) *'Effects of whaling on sperm whale populations: comparison between Galapagos and Peru'* (SC/42/RP3)

While the proposal is relevant to the Commission's work, the Committee believes it should be conducted as a pilot project, and that the proponents should be asked to recast it accordingly, at lower cost, for resubmission next year.

11. SMALL CETACEANS

11.1 Phocoenids

The Committee conducted a review of the biology and exploitation of the porpoises. The results indicate that

many populations badly need assessment and protection against either direct or incidental takes. Species accounts follow, with discussion organised by region.

11.1.1 Harbour porpoise

Eastern North Atlantic

Several populations of harbour porpoises probably inhabit the North Atlantic and Baltic Sea, but the stock structure is unclear and complicated by seasonal migrations. Evidence from morphology and genetics is strong for at least separate Dutch and more northerly North Sea populations (SC/42/SM50), and there is preliminary evidence for several North Sea/Baltic sub-populations (SC/42/SM35).

The harbour porpoise has been considered to be strictly a coastal species, but some recent surveys have shown that it also occurs in deep offshore waters, albeit in lesser densities (SC/42/SM3).

The only available abundance estimate is for the North and Barents Seas, from line-transect vessel surveys for minke whales in 1988 and 1989 (SC/42/SM3). Abundance in the Lofoten-Barents Sea area was estimated at approximately 11,000 (CV 0.239) and in the North Sea at approximately 82,600 (CV 0.217). These may be negatively biased as g(0) was assumed to be 1.

It is clear that harbour porpoises are highly seasonal in their appearance in many parts of this region, but the migration patterns remain poorly understood. The large-scale migrations in and out of the Baltic that were reported in earlier decades no longer occur.

The information available for estimation of current life-history parameters is as yet inadequate for anything beyond confirming that reproduction is seasonal, with most births occurring in the spring; a summary is given in Annex G. The Committee wishes to underscore the importance of collecting such data and samples using standard methods and of pooling them for analysis.

It has been suggested that porpoises feed primarily on herring schools, but a study of stomach contents of incidentally caught porpoises in the UK found a predominance of other fishes, including relatively deep-living forms (SC/42/SM53).

A number of studies submitted to the meeting reported contaminant loads (summary in Annex G). PCB concentrations are high enough to warrant concern about their possible effects on the immune systems and reproductive potential (see *Recommendations*).

Nearly all of the present take of harbour porpoises in this region is incidental to fishing operations, mainly demersal gillnetting. The information on this take is fragmentary, but it may be quite large in some fisheries in the North and Baltic seas. For example, a catch of 47 porpoises was recorded for a single vessel in Denmark during 1989 (SC/42/SM51). Documented partial catches of various sizes have also been reported from Sweden, Norway, Germany, Poland and the UK (details in Annex G), however there are no reliable estimates of total catches for any fishery in the region.

All the available evidence suggests that harbour porpoises are less common in many areas of the northeast Atlantic than they were in the past, although there are very few adequate long-term time series of data that will allow this to be quantified. In some regions, e.g., the Baltic Sea, the Irish Sea, the Dutch coast and the English Channel in general, the apparent decline is drastic. There is a great need for delineation and assessment of the populations, for monitoring and reducing incidental kills and for determining habitat needs of the porpoise, so that measures can be taken to conserve the habitats.

Western North Atlantic

The situation in this region is similar to that in the eastern North Atlantic, with incidental takes in many fisheries.

Four sub-populations are believed to exist: West Greenland, Newfoundland and Labrador, Gulf of St Lawrence, and Bay of Fundy – Gulf of Maine. However, although some preliminary results of a study of isozymes supports a West Greenland/ Gulf of St Lawrence dichotomy (SC/42/SM21), these divisions have not yet been confirmed by genetic analyses.

The only available estimates for the western Atlantic are for the Bay of Fundy and Gulf of Maine (SC/42/SM21). Minimum and maximum estimates are 7,956 ±1,327 (95% CI) and 15,300 ±2,552. These may be underestimates, as the entire range of the species in the region was not surveyed.

Patterns of seasonal abundance suggest a north-south migration, with the winter range including the US mid-Atlantic coast (SC/42/SM39).

Life-history information is limited, but it suggests an annual reproductive cycle, with births in the spring or summer, depending on latitude.

There are directed takes in West Greenland. There are no statistics available for 1989, but earlier catches have been in the range 600–1,000 per year (e.g. see SC/40/ProgRep Denmark). There are also incidental takes in several fisheries throughout the region, but there are few estimates of catches, and the ones that exist are too crude to be reliable. Current estimates of incidental mortality in the Bay of Fundy/Gulf of Maine range from 280 to 800, but these figures need to be refined (SC/42/SM21 and 39).

The Committee believes that the incidental takes in the Bay of Fundy and Gulf of Maine pose a serious threat to the harbour porpoise population there.

Eastern North Pacific

The harbour porpoises along the cool-temperate west coast of North America are probably divided into several populations. Evidence from contaminant loads suggest the existence of at least two populations along the west coast of the USA (excluding Alaska), one in central and northern California and the second off Oregon and Washington (SC/42/SM6). There may be two sub-populations in California waters.

Abundance off central California has been estimated at about 3,300.

Analyses of life-history data and samples suggest that the average calving interval off California may be more than one year (SC/42/SM47), as opposed to the situation in the Bay of Fundy, where most females calve each year.

Incidental takes in gillnets off California is estimated at 200–300 annually during the period 1983/84 to 1986/86. An incidental take of unknown size also occurs in British Colombia.

If the animals off central California represent a separate stock, the takes in the mid-1980s amounted to as much as 10% of the population each year. Recent takes have been lower, because of area closures, but methods should be developed to adequately monitor trends in porpoise abundance.

Black Sea

The Committee has in the past reviewed the Turkish fishery for small cetaceans in the Black Sea and expressed concern about the status of the cetacean populations (*Rep. int. Whal. Commn* 33:60). The fishery has been under a moratorium for several years pending assessment of the porpoise and dolphin stocks. The Committee this year had available to it new estimates of population sizes (Annex G) and a description of conditions of the Turkish finfish fisheries in the Sea (SC/42/SM40).

The species composition of the sightings in the recent surveys was 52.7% harbour porpoise, 32.5% common dolphin and 14.8% bottlenose dolphin. Several major questions have arisen about the methodology of collection and analysis of the survey data (detailed in Annex G). These questions throw the reliability of the total estimate of about 454,000 into serious doubt. For example, densities in a narrow strip along the Turkish coast were extrapolated to the entire Black Sea. Another problem is that the animals may migrate in and out of the survey area. Because of recent adverse conditions in Turkish fisheries and a perception of competition between fishermen and small cetaceans, there is now great pressure to begin a cull, the size of the cull to be based on the population estimates and estimates of reproductive rates. The Committee believes strongly that the estimates should not be used as a basis for such management action (see *Recommendations*).

11.1.2 Dall's porpoise

There are believed to be at least six stocks of Dall's porpoise, all in the North Pacific. These divisions are based on the distribution of calving grounds (Fig. 1 in Annex G), colour pattern (*dalli*-type vs *truei*-type), body size, and geographical variation in parasite loads (SC/42/SM16). The six calving grounds are

(1) the central Bering Sea (*dalli*-type),
(2) south of the Kamchatka Peninsula (*dalli*-type),
(3) south of the Aleutian Islands (*dalli*-type),
(4) central Gulf of Alaska (*dalli*-type),
(5) northern Okhotsk Sea (*dalli*-type),
(6) central Okhotsk Sea (*truei*-type).

A seventh calving ground probably exists off the US Northwest and Canada. More studies of parasite loads are planned.

Preliminary estimates of abundance were available for the western Pacific (SC/42/SM10) based on sightings made in the Japanese mothership drift-net salmon fishery, but they cover parts of the ranges of two of the hypothesised stocks and suffer from other, more methodological problems (detailed in Annex G) that render them unreliable. Estimates of the populations involved in the Japanese hand harpoon fishery (discussed below) were presented to the Committee last year (*Rep. int. Whal. Commn* 40:152); they were based on surveys in 1986 and totalled 105,000+ (the portions of the range of the Sea of Japan/Okhotsk Sea stock in Soviet waters was not surveyed). The Committee wishes to emphasise the need for new abundance estimates, for both the populations affected by incidental kill in high-seas driftnet fisheries and those involved in the Japanese directed harpoon fishery (see *Recommendations*).

The populations undergo seasonal migrations (SC/42/SM31). For example, *truei*-type porpoises that are on the central Okhotsk Sea calving grounds in the spring are thought to spend the winter off the Pacific coast of Japan.

Differences in age structure exist between samples from the driftnet kills in different areas, but the samples from the driftnet fisheries may not be representative of the populations because of age and sex segregation by area and because the nets may entangle disproportionate numbers of immature animals.

Estimated incidental takes in the mothership salmon fishery in the EEZ of the USA ranged from 741 in 1987 to 4,187 in 1982 (SC/42/SM12). The fishery no longer operates in USA waters but continues elsewhere. Dall's porpoise are also taken in a Japanese land-based salmon driftnet fishery. Attempts to modify nets to reduce the kill in driftnets had equivocal results. Members of the Committee expressed concern that the take rates may have been underestimated because of unseen 'drop-outs' when the nets were retrieved. Estimates of takes in the land-based fishery may be overestimates, because they were based on take rates in the mothership fishery.

Directed takes in the Japanese hand harpoon fishery have increased sharply in recent years (>40,000 in 1988 and >29,000 in 1989). The Committee concluded last year that the 1988 take was clearly unsustainable and urged that the catch be reduced 'at least to the levels of previous years (which themselves may have been too high)' (*Rep. int. Whal. Commn* 40:76). The Committee **recommends** that assessments of the status of the stocks be carried out and that catch statistics be reported on a stock-by-stock basis. The latter recommendation has been followed (SC/42/ProgRep Japan).

Morimoto gave a brief summary of the recent history of the Japanese hand harpoon fishery and current plans for its management, as follows. The total catch increased from 25,600 in 1987 to 40,367 in 1988. In response to this increase the Japanese government introduced regulations for the hand-harpoon fisheries early in 1989 which reduced the catch to 29,048. This represents a 28% decrease from the 1988 catch. The Japanese government believes that this catch is still not at an appropriate level for these stocks and intends to take measures to gradually reduce the catch toward the average level of previous years (approximately 10,000 animals), reducing the catch in 1990 by 15% from the 1989 level. Morimoto noted that the abundance estimate of 105,000+ for these stocks from the 1986 surveys does not include the population(s) in the Okhotsk Sea and western Sea of Japan. He proposed that results of recent surveys of these populations, including comprehensive Japanese sighting surveys initiated in 1988, as well as sightings surveys in the Okhotsk Sea initiated in 1989, will provide more precise estimates of abundance of these stocks in the future, and that the regulatory measures taken for the fisheries will be reviewed accordingly.

Members of the Committee expressed concern about the accuracy of the reported catch figures, because of the recent revision of the figures for 1986 (from 10,378 to 16,515) and 1987 (from 13,406 to 25,600) (SC/42/ProgRep Japan), the landings of some catches as meat, and the lack of adjustment for struck-but–lost animals. They also noted that the populations affected by the harpoon fishery may also be subjected to incidental kill in the land-based driftnet salmon fishery.

In view of the lack of current estimates of abundance for the Dall's porpoise stocks, the uncertainty about estimates of rates of increase (see *Maximum net productivity in the*

porpoises below), and the exploitation of the stocks subject to the harpoon fishery at rates that almost certainly exceed their recruitment rates, the Committee again wishes to express its extreme concern about the continued takes and to urge some specific actions (see *Recommendations*).

11.1.3 Burmeister's porpoise

Burmeister's porpoise occurs in the coastal waters of South America from about 5°S in Peru to southern Chile and from southern Argentina to Uruguay. There are gaps in the known distribution that may relate to lack of observer effort or may be actual gaps in distribution. Porpoises from Peru differ in average body size from those in Uruguay, perhaps reflecting the existence of more than one stock.

Data from porpoises taken in gillnets in Peru indicate that the reproductive rate is relatively high; there is some evidence of annual calving.

Burmeister's porpoise are taken as by-catch in demersal gillnets in Peru (SC/42/SM5). The nets are set on the bottom primarily for small sharks, rays and sciaenids and at the surface for blue sharks and dusky dolphins, *Lagenorhynchus obscurus*, but the porpoises are retained and marketed. The catch of porpoises in 1988 is thought to have been 1,500–2,500. Catch rates in unmonitored fisheries in northern Peru may be higher, causing this to be an underestimate. Burmeister's porpoises are also taken incidentally in Chile, Argentina, Uruguay and Brazil.

Nothing is known about the abundance or status of this porpoise.

11.1.4 Vaquita

The vaquita has the most limited distribution of any marine cetacean. It is found only in the northern Gulf of California, Mexico. No reliable abundance estimates are available; several extensive aircraft and vessel surveys between 1986 and 1989 located only 110 vaquitas. Considering the scarcity of sightings relative to sighting effort, the few individuals per sighting, and the limited geographic range of the vaquita, there can be no doubt that the population of this species is very small, perhaps only in the low hundreds.

Virtually nothing is known of the life history or ecology of the species. It has been seen mostly in water depths of from 13.5 to 37m.

Vaquitas are killed incidentally in gillnets, especially those of large mesh (15–30.5cm) set for the endangered large sciaenid, the totoaba, and for sharks. The totoaba fishery is illegal. Some nets have been seized by the Mexican government in recent months, but the fishery continues. There is also incidental take in an experimental fishery for totoaba. Records are available for 85 vaquitas taken since 1985, but this is undoubtedly a small proportion of the actual kill; available information suggests an annual kill of 30–40.

Concerning all of the negative environmental and economic factors operating, the Committee believes that the vaquita is in immediate danger of extinction and strongly urges immediate action to save the species (see *Recommendations*).

11.1.5 Finless porpoise

The only new information available for this species is that four were taken incidentally in Japan (SC/42/ProgRep Japan).

11.1.6 Spectacled porpoise

Five sightings of this species were made during the IDCR cruises, most far from land (SC/42/O 15), which supports current thinking that this is an offshore porpoise. Small incidental takes occur in local fisheries in Argentina. Biological knowledge of the species is summarised in Annex G.

11.1.7 Maximum net productivity in the porpoises

Because of the existence of very many fisheries that take porpoises in large numbers, either directly or incidentally, the sub-committee on small cetaceans reviewed the available information on reproduction and survival in the various populations of the six species in an attempt to bracket the theoretical upper end of the range of net productivity (r_{max}) in the group. Usable information was available only for the harbour porpoise and Dall's porpoise. The available estimates of age at sexual maturation, pregnancy rates and longevity are listed in Table 2 of Annex G.

Age at sexual maturation is about three years in both species. Pregnancy rates ranged from 0.44 to 0.89 in the harbour porpoise and from 0.89 to 0.97 in Dall's porpoise. Many of the estimates were based on very small sample sizes and cannot be considered reliable. Possible biasing factors include mortality *in utero* and segregation by age and sex in samples from driftnet fisheries. It was also noted that pregnancy rates may vary from year to year, and the highest rate measurable in any year may not be sustainable over years.

Longevity (defined as the age reached at the 99th percentile) was estimated in five studies at 10–12 years, but this may be an underestimate due to problems in accurately scoring teeth from older animals. It was agreed that there is no reliable information available on the shape of the survivorship curve, because of the various potential sources of bias in the samples and in age determinations. The Committee concluded that there is not enough information available to produce a sufficiently accurate estimate of maximum net reproductivity. Two meeting documents (SC/42/SM6 and 33) and two previously available papers (see Annex G) were reviewed which presented attempts through empirical analysis or analogy with other species to put an upper limit on the feasible range of r_{max}. These values ranged from 0.02 to 0.094. The Committee concluded that it had no firm basis for equating any of the values with r_{max} for any phocoenid population.

In view of the uncertainty about existing estimates of reproductive rates and survivorship for phocoenid populations and in view of the finding presented in SC/J90/Mg16 that demographic models necessarily require very large sample sizes to provide reliable estimates of population growth rates, the Committee believed that any estimate for acceptable harvest and incidental take rates should be conservative. Allowable harvest and incidental take rates should be lower than half of the estimated value for r_{max}. None of the estimates of r_{max} to date have been larger than 0.10 but many present kill rates appear to be much larger than half of this rate and therefore should be reduced (see *Recommendations*). The Committee also urges that work go forward to obtain direct estimates of age-specific reproduction, longevity and especially the survivorship of juvenile age classes. This can perhaps be accomplished through longitudinal studies of individually recognisable porpoises in a relatively unexploited population.

11.1.8 Recommendations

Highest priority

The Committee believes that the following recommendations are critical because they relate to major and immediate crises in conservation of porpoise populations and wish to emphasise them, in order of priority.

(1) *Vaquita.* The vaquita is the most endangered marine cetacean. It is extremely vulnerable to further depletion because it has the most limited distribution of any marine cetacean, its abundance is very low, and it is very strongly impacted by gillnets. Because of the precarious status of the single population of the species, the Committee **recommends** that further action be taken to stop the major cause of entanglement by fully enforcing the closure of the totoaba fishery and reconsidering the issuance of permits for experimental totoaba fishing, that immediate action be taken to stop the illegal shipment of totoaba (also an endangered species) across the US border, and that a management plan for the long-term protection of this species and its habitat be developed and implemented. The plan should include: (1) an evaluation of other fisheries that take or may take vaquitas; (2) investigation and implementation of alternative methods of fishing or other economically viable activities to prevent further incidental mortality; (3) education of the local fishermen and general public to increase awareness of the vaquita's dangerous situation; (4) monitoring of the status of the population of vaquitas; and (5) studies of the population biology of the species.

The vaquita is clearly in immediate danger of extinction. The Committee **recommends** that the World Conservation Union (IUCN) change the classification of the species from Vulnerable to Endangered.

(2) *Dall's porpoise in Japan.* The take of Dall's porpoise in the Japanese hand harpoon fishery is still far above levels that could possibly be sustained by the populations (as estimated in surveys in 1986). Even the takes in earlier years (before 1986) were higher than would be supported by any existing estimate of maximum reproductive rates for porpoise species (see *11.7* above). The planned rate of reduction of the catches in 1990 by 15% of the 1989 catch is inadequate to prevent population decline if the population estimates are even roughly correct. The Committee urgently underlines the need for the takes to be reduced as soon as possible at least to the earlier levels (those before 1986) and that even further reductions be considered if necessary, based on the new stock assessments. The existing population estimates (which do not include animals in Soviet waters of the Okhotsk Sea and Sea of Japan) are for 1986, which was before the recent very large removals. The Committee **recommends** that the planned sightings surveys be carried out and new estimates developed. It is also **recommended** that a plan for monitoring trends in the populations be developed.

(3) *Black Sea.* Because of perceived competition for fish resources between fishermen and small cetaceans in the Black Sea, there is pressure for a cull of dolphins and porpoises in Turkish waters. The current estimates of abundance are of uncertain reliability because of questions concerning the methodology of collection and analysis of the sightings data. The Committee **strongly recommends** that the estimates not be used as a basis for management action and that they receive rigorous independent review.

(4) *Harbour porpoise.* The single most important action that must be accomplished to conserve the harbour porpoise throughout its range is to reduce incidental kill in gillnets, and the Committee **recommends** most strongly that this be done. This is especially important for the southern North Sea and Danish waters, the Bay of Fundy/Gulf of Maine, and the central coast of California.

Additional recommendations

Harbour porpoise

The importance of determining stock structure was identified for all areas where populations are affected by incidental mortality or other factors such as habitat degradation. The Committee **recommends** that such studies be undertaken through an integrated approach that includes a combination of analyses of pollutant levels, calving areas, non-metric variation, DNA, isozymes and other types of research that may contribute to stock discrimination. The Committee also **recommends** that for the eastern North Atlantic the information on potential stocks, distribution and other relevant data be synthesised in an attempt to produce a clearer picture of the stock structure in that region.

Abundance estimates are available for few populations of harbour porpoises, including those with significant, or possibly significant, levels of incidental mortality. The Committee therefore **recommends** that abundance be estimated for populations for which good abundance estimates do not exist or for which there is or may be a large incidental kill. These populations include those in the northeast and northwest Atlantic. The Committee also **recommends** that such studies consider that apparent declines in abundance may result from geographic shifts in distribution. Trends in abundance should be monitored on the basis of systematic surveys. For the northeast Atlantic, the Committee **recommends** dedicated sightings surveys of harbour porpoises be undertaken in the North and Baltic Seas. For the northwest Atlantic, the Committee **recommends** a joint US–Canada comprehensive sighting survey in the Bay of Fundy, Gulf of Maine and adjacent waters.

Because of the great need for additional abundance surveys of the dolphin and harbour porpoise populations in the Black Sea, especially in non-Turkish waters, the Committee endorses the recommendation in SC/42/SM40 that such such surveys be conducted as an international effort involving at least the four nations bordering the Sea.

Many past sightings surveys have assumed that the probability of detecting a target on the trackline is 1. It is **recommended** that in future surveys to estimate absolute abundance of harbour porpoises attention be given to estimating g(0).

In order to allow investigation of the relative selective effects of incidental and directed takes on the sex, age and reproductive-condition structures of samples, the Committee **recommends** that biological data and samples be collected from harbour porpoises taken incidentally in salmon nets in the waters of West Greenland and that the results of biological studies of these samples be compared to those from samples collected from the directed take in the same region.

Because of the perception of fishermen in Turkey that dolphins and porpoises are competing with them for fish resources in the Black Sea, the Committee **recommends** that studies of feeding ecology of the small cetaceans be carried out.

The harbour porpoise is known to be primarily a coastal species and occurs in areas where habitat degradation may have already had an impact on local populations, particularly in the North Sea, Irish Sea, Baltic Sea and along the west coast of North America. Habitat degradation in this regard includes pollution, risk of entanglement, depletion of food resources and other anthropogenic disturbances. Legal protection alone is not enough to ensure future existence of the populations. The species needs to be protected together with its natural habitat, including food resources. The Committee therefore **recommends** behavioural studies of free-ranging porpoises to gain knowledge of habitat requirements in order to provide a framework for establishing management plans for the species and its habitat.

The Committee **recommends** the collection and analysis of tissues of stranded and incidentally killed harbour porpoises in order to monitor their contaminant levels. It also **recommends** that monitoring of pollutants be integrated with research on reproductive biology and other population parameters to increase the understanding of the possible effects of contaminant loads on the condition of the populations. These studies should be conducted on a regional basis, with the cooperation of investigators in the region, to ensure adequate coverage of each possible stock and over a period long enough to obtain large and representative samples. This is particularly important for the northeastern Atlantic region.

Because of apparent reduction of abundance in many regions and because of the as yet poor understanding of stock boundaries, the Committee **recommends** that a high priority be given throughout the range of the species to monitoring as well as reducing levels of incidental mortality in all fisheries. This is particularly important for the Bay of Fundy/Gulf of Maine, Northeast Atlantic and the coast of central California, where available information gives great reason for concern. Possible ways to reduce the incidental kills include gear modifications, gear conversions, area or season closures and other restrictions on the fisheries. Knowledge of abundance in the waters of Newfoundland and Labrador, a region with very extensive coastal fisheries using gillnets and other fishing gear that kills small cetaceans, is very limited. Estimates of incidental catch between 1980 and 1990, however, indicate that the incidental catch may be substantial. The sub-committee **recommends** that studies of the incidental catch and abundance of harbour porpoises be given a high priority in Newfoundland and Labrador.

Because of large takes in the past, the Committee **recommends** that the level of incidental mortality of harbour porpoises in salmon drift nets in coastal waters of West Greenland be determined.

Because many estimates of incidental takes have been based on reports from fishermen without evaluations of reliability of the data, the Committee **recommends** that when questionnaires and interview methodology is used, studies of reliability and scaling of reported take estimates be included.

Dall's porpoise

Given the apparent success of the use of relative parasite loads in differentiating three stocks of Dall's porpoises, the Committee **recommends** that analyses of parasite loads in the eastern North Pacific and other areas be compared to those presented in SC/42/SM9 to help identify other possible stocks. It is also **recommended** that studies be continued or undertaken to differentiate stocks using a combination of techniques, such as differences in life-history parameters (e.g., asymptotic length), parasite and contaminant loads, reproductive seasonality, DNA and isozymes.

The Committee **recommends** that information on struck-and-lost rates be collected and analysed for each gear type in the Japanese hand harpoon fishery, to allow more accurate estimation of total mortality.

The Committee **recommends** clarification of the basis for revision of the 1986 and 1987 catch statistics.

Burmeister's porpoise

Given the high levels of mortality of Burmeister's porpoise in Peruvian fisheries, the Committee **recommends** that (1) estimates of abundance be obtained for this population, (2) better estimates of the number of porpoises killed be obtained, (3) catch statistics collected by the Ministerio de Pesqueria in Peru be recorded by species and in numbers of animals rather than by tonnage. The Committee also **recommends** that a history of exploitation be compiled, including consideration of the size of the fleet, the range of the fishery and estimated historical catch levels.

11.2 New information on other stocks

11.2.1 Baird's beaked whale

New estimates of abundance of populations off Japan total 5,780. The estimate for the Pacific coast of 3,950 (CV 0.28) is not significantly different from the previous estimate of 4,220.

Fifty-four whales were taken in 1989, from a quota of 60. A decrease of yet undetermined size in the quota is planned for 1990. The 49 taken off the Pacific coast amounted to about 1.2% of the population estimate. Because there is agreement that there is insufficient information to allow judgment of whether takes of this size are sustainable, the Committee **recommends** as in the past (*Rep. int. Whal. Commn* 39:122) that research to develop an understanding of the life history, behaviour and social system that will allow estimation of growth rate potential be continued. This should include continued collection and analysis of data and samples from the catch.

11.2.2 Northern bottlenose whale

The Committee notes with concern that a further two bottlenose whales were taken in the Faroese drive fishery in 1989 in addition to the three taken in 1988 (SC/42/ProgRep Denmark). These takes are from a Protected Stock.

11.2.3 Dolphins associated with tuna in the eastern Pacific

Time did not allow a substantive review of this issue. The Committee notes that the estimated total kill of dolphins in the fishery in 1989 rose to 96,979/101,284 (estimates by two methods), up 22.9/19.3% from 1988. The major conclusions of other submitted documents relating to the issue are given in Annex G.

11.2.4 Other species

Meeting documents containing information on other species are listed in Annex G.

11.2.5 Takes of small cetaceans in 1989

Reported takes are summarised in Annex G Appendix 2. As in past years, the data in the IWS and national Progress Reports are incomplete (examples of deficiencies are given

in Annex G), and the Committee again **recommends** that the member nations be requested to submit complete statistics for both direct and incidental catches to the IWC.

11.2.6 1991 meeting

Members of the Committee noted that numerous studies of the population biology and history of exploitation of white whale and narwhal have been completed in the last two or three years. The Scientific Committee has not reviewed these important species substantively in the last ten years, therefore it directed the sub-committee on small cetaceans to conduct such a review at the 1991 meeting, providing there is sufficient new information made available for such a review. Alternative possible topics are given in Annex G.

12. DATA PROCESSING AND COMPUTING NEEDS FOR 1990/91

Progress on data processing and computing projects in the past year is discussed under Items 4.3.2 and 4.3.3. For data coding work by the Secretariat in 1990–91, the Committee **recommends** that priority be given to data required for the stocks to be assessed in 1991. This includes the encoding of:

(1) pre-1940 North Atlantic fin whale catch data;
(2) any summary forms available for the North Atlantic detailing catches by catcher boat and month;
(3) all North Atlantic fin whale marking data;
(4) 1949–76 North Pacific minke whale catch data, to be submitted by Japan;
(5) 1977–87 North Pacific minke whale catch time budget data, to be submitted by Japan.

In addition the Committee **recommends** that the following tasks be carried out by the Secretariat in the following year:

(1) amend the common control program used in screening tests of management procedures to incorporate the new trials detailed in Annex F, Appendix 4;
(2) repeat the base case management screening trials for each management procedure;
(3) validation of both new versions of the HITTER/FITTER program that allow estimation of confidence limits, provided that full documentation is also made available by the authors;
(4) carry out data validation, routine abundance estimation and analyses of experiments from the 1989/90 Southern Hemisphere minke whale assessment cruise;
(5) validation of the NASS-1989 Spanish sightings data after it has been encoded by Spain and submitted to the Secretariat;
(6) validation of NASS and IDCR data extraction programs;
(7) development and validation of a program to implement the variable coverage probability analysis.

13. FUNDING REQUIREMENTS FOR 1990/91

13.1 Protocol for awarding of contracts

The Committee had not identified any contract studies this year and this Item was not discussed.

13.2 Comprehensive Assessment

The funding implications of the work identified under Items 6, 7 and 8 are given in Table 3. A total of £99,250 is required for these projects.

Table 3

Proposed 1990/91 research budget

Comprehensive Assessment	
Revised Management Procedures	
Allow 6 projects to be funded	
@ 1989/90 (£2,000 each) + 7.5%	£12,900
Invited Participants	
Allow 1989/90 (£18,000) + 7.5%	£19,350
Data coding	
(1 x staff + equipment)	£17,000
13th IDCR cruise	£33,300
Management Procedures Workshop	
Allow 1989 (£15,000) + 7.5%	£16,125
Special Meeting on North Atlantic fin whales	£15,000
Other	
Research proposals (Item 10.2)	£10,750
S.E. Pacific sperm whales	
Carry forward	£1,640
	£126,065
Less unexpended balances b/fwd	(£16,000)
Thus new funding requirement	£110,000

13.3 Other research items

A total of £10,750 is required to fund the two projects recommended under Item 10.2.

13.4 Priorities

A total of £110,000 is required for the items identified above. The Committee stressed that in Items 13.2 and 13.3 it had only included those projects of the highest priority. It **strongly recommends** that all of these projects are funded. The Committee believes that it is important to draw the Commission's attention to the importance of the above activities, especially those relating to the Comprehensive Assessment. The role of invited participants at the 1991 Annual Meeting was seen to be especially important in this context.

14. INITIAL AGENDA FOR 1991 MEETING

The Committee proposed that at its 1991 Annual Meeting it attempt assessments of North Pacific minke whales and bowhead whales as part of the Comprehensive Assessment (Item 8.3), and that reports on progress towards a Comprehensive Assessment be presented for other stocks or stock groups (Item 7.5.5). The report of the workshop on Alternative Management Procedure (Item 6.1.2.5) will also need to be considered as a major part of the Comprehensive Assessment. The Committee again proposed that a considerable amount of work must be carried out before and at the Annual Meeting on the further development of alternative management procedures (Item 6.1.2.5).

Two other items were identified for the next Annual Meeting: the estimation of g(0) (Item 8.1) and revised estimates of the abundance of Southern Hemisphere baleen whales (see *Rep. int. Whal. Commn* 40:47). Both of these will be handled by *ad-hoc* working groups.

The Committee also recognised that it may be required to review research results based on existing scientific permits and to review new or revised scientific proposals.

Table 4

Suggested time-table for the 1991 Annual Meeting

May	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Management			Plenary, North Pacific minke whales, management and small cetaceans							Plenary			
	Bowhead													

As last year it was agreed that results from scientific permit catches should only be discussed in so far as they are relevant to the Comprehensive Assessment of the priority stocks identified. Discussion of continuing permits should be confined as far as practicable to major changes in objectives or methodology. New scientific permit proposals should, of course, be subjected to the normal scrutiny required by the Commission.

The proposed schedule for the Annual Meeting was discussed (see Item 8.3 and Table 4). The Committee agreed that the time allocated to sub-committees would be taken up with two groups conducting assessments of bowhead whales and North Pacific minke whales, the standing sub-committee on small cetaceans and the sub-committee on alternative management procedures.

The Committee appointed conveners for the various groups to coordinate all inter-sessional work, as follows:

North Atlantic fin whales – Hammond
North Pacific minke whales – Reilly
Bowhead whales – Braham
Alternative management procedures – Kirkwood
Small cetaceans – Bjørge.

15. PUBLICATIONS

The Committee agreed, in accordance with the procedures outlined in *Rep. int. Whal. Commn* 32:63, that the Editorial Board should comprise Donovan, Brownell, Harwood, Perrin, Hammond, Kirkwood and Perrin.

16. ELECTION OF OFFICERS

Brownell and Hammond were re-elected Chairman and Vice-Chairman, respectively.

17. OTHER BUSINESS

The Committee considered Annex Q concerning IWC cooperation in the production of a book on the effects of pollutants on marine mammals. The Committee endorsed the proposal noting that it had no financial implications for the Commission. It noted however, that the final decision to go ahead should be taken by the Commission.

18. ADOPTION OF REPORT

The report was adopted by the Committee. Before adopting the report, the Committee expressed its thanks to the Secretariat for their hard work and cheerful service during the meeting.

Annex A
List of Participants

AUSTRALIA
G.R.V. Anderson
W.K. de la Mare

BRAZIL
P. Sandoval Jr

DENMARK
C.C. Kinze
F. Larsen
P. Palsbøll
T.B. Sørensen

FRANCE
J.-L. Durand

FEDERAL REPUBLIC OF GERMANY
P. Deimer
K.-H. Kock

ICELAND
A. Arnason
T. Gunnlaugsson
K.G. Magnusson
J. Sigurjónsson
G. Vikingsson

JAPAN
Y. Fujise
N. Inagaki (I)
F. Kasamatsu
T. Kasuya
H. Kato
T. Koya
S. Misaki (I)
T. Miyashita
M. Morimoto
Y. Nagata
T. Nakamura
T. Nakamura (I)
S. Ohsumi
K. Sakuramoto
Y. Taga
E. Tanaka
S. Tanaka
K. Yamamura
M. Yoshioka

NETHERLANDS
K. Lankester
P.J.H. Reijnders

NEW ZEALAND
M.F. Donoghue

NORWAY
A. Bjørge
A.S. Blix
I. Christensen
N. Øien
T. Schweder
Ø. Ulltang
L. Walløe

ST VINCENT AND THE GRENADINES
F. Hester

SEYCHELLES
S.J. Holt

SPAIN
S. Lens
H. Quiroga

SWEDEN
T. Arnbom
P. Berggren
T. Lyrholm

UK
M.J. Ford
P.S. Hammond
J. Harwood
M. Klinowska
A.R. Martin
K. Stokes

USA
T.F. Albert
J. Barlow
J.M. Breiwick
R.L. Brownell Jr
C. Clark
C.W. Fowler
M. Fraker
L.L. Jones
W.F. Perrin
T. Polacheck
A. Raftery
S.B. Reilly
T.D. Smith
S.L. Swartz
M.F. Tillman
J.E. Zeh

INVITED PARTICIPANTS
A. Aguilar
L. Andersen
J.L. Bannister
H. Benke
P.B. Best
S.T. Buckland
D.S. Butterworth
M.S. Celikkale
B. Clausen
A. Hiby
A. Hohn
C. Joiris
G.G. Joyce
G.P. Kirkwood
B.H. Larsen
J. Lien
S. Northridge
A.E. Punt
A.J. Read
J.C. Reyes
C. Smeenk
G.B. Stenson
K. Van Waerebeek
O. Vidal

OBSERVERS
International organisations
W.K. de la Mare (CCAMLR)
J.C. Johnson (CMS)
J.G. Cooke (IUCN)
J.C. Johnson (UNEP)

Non-governmental
C. Carlsson (IWC)

IWC
C. Allison
G.P. Donovan
R. Gambell
M.D. Haw

(I) = Interpreter

Annex B
Agenda

1. Chairman's welcome and opening remarks

2. Adoption of Agenda

3. Arrangements for meeting
   - 3.1 Appointment of rapporteurs
   - 3.2 Meeting procedures and time schedule
   - 3.3 Establishment of sub-committees
   - 3.4 Computing arrangements

4. Review of available data, documents and reports
   - 4.1 Documents submitted
   - 4.2 National Progress Reports on research
   - 4.3 Data collection, storage and manipulation
     - 4.3.1 Catches and other statistical material from the previous season
     - 4.3.2 Progress on data coding projects
     - 4.3.3 Progress on computing projects
   - 4.4 Whale marking

5. Cooperation with other organisations
   - 5.1 Observers' reports
     - 5.1.1 ICES
     - 5.1.2 CMS
     - 5.1.3 CCAMLR
     - 5.1.4 IATTC
   - 5.2 UNEP
   - 5.3 Gillnets and Cetaceans
     - 5.3.1 Symposium and Workshop
     - 5.3.2 UN General Assembly

6. Comprehensive Assessment – methodology
   - 6.1 Management procedures – commercial whaling
     - 6.1.1 Report of Workshop on management procedures
     - 6.1.2 Further development of management procedures
     - 6.1.3 Progress Report for Commission
   - 6.2 Management procedures – aboriginal subsistence whaling
   - 6.3 Review of Genetics Workshop Report
   - 6.4 Implications for whale management of interspecific interactions
   - 6.5 Data inventories and coding

7. Comprehensive Assessment – priority stocks
   - 7.1 Southern Hemisphere minke whales
     - 7.1.1 Assessment
     - 7.1.2 Management advice
   - 7.2 North Atlantic minke whales
     - 7.2.1 Assessment
     - 7.2.2 Management advice
   - 7.3 Gray whales
     - 7.3.1 Report of Special Meeting
     - 7.3.2 Management advice
   - 7.4 St Vincent and The Grenadines humpback whales
   - 7.5 Progress reports on other priority stock groups
     - 7.5.1 North Atlantic fin whales
     - 7.5.2 North Pacific minke whales
     - 7.5.3 Western North Pacific Bryde's whales
     - 7.5.4 Bowhead whales
     - 7.5.5 Other

8. Comprehensive Assessment – future work
   - 8.1 Priority studies
   - 8.2 Intersessional Working Groups and meetings
     - 8.2.1 Plans for Special Meeting on North Atlantic Fin Whales
     - 8.2.2 Other
   - 8.3 Work plan for 1990/91

9. Scientific Permits
   - 9.1 Review of research results based on existing Scientific Permits
     - 9.1.1 Norway
     - 9.1.2 Japan
     - 9.1.3 Iceland
   - 9.2 Review of new or revised Scientific Permit proposals
     - 9.2.1 Norway
     - 9.2.2 Japan
     - 9.2.3 USSR

10. Second International Decade of Cetacean Research
    - 10.1 Review results from 1989/90
    - 10.2 Review proposals for 1990/91

11. Small cetaceans
    - 11.1 Phocoenids
    - 11.2 Information on other stocks

12. Data processing and computing needs for 1990/91

13. Funding requirements for 1990/91
    - 13.1 Protocol for awarding of contracts
    - 13.2 Comprehensive Assessment
    - 13.3 Other research items
    - 13.4 Priorities

14. Initial Agenda for 1991 meeting

15. Publications

16. Election of officers

17. Other business

18. Adoption of Report

Annex C
List of Scientific Committee Documents

* published in this volume

SPERM

SC/42/Sp

1 CLARKE, R. and PALIZA, O. The dorsal fin callus of sperm whales.
2 WHITEHEAD, H. and WEILGART, L. Click rates from sperm whales.
3 WHITEHEAD, H. and WATERS, S. Population structure of female sperm whales off the Galápagos Islands.
4 WHITEHEAD, H. and HOPE, P.L. Sperm whalers off the Galápagos Islands and in the western North Pacific, 1830–1850: Ideal free whalers?
5 HOPE, P.L. and WHITEHEAD, H. Sperm whales off the Galápagos Islands: 1830-1850 and 1985–1989.*
6 WHITEHEAD, H. and HOPE, P.L. Estimates of catch levels and abundance of sperm whales off the Galápagos Islands, 1830–1850.*
7 GORDON, J. and STEINER, L. Sperm whale respiration patterns.
8 [No Paper]
9 BEST, P.B. A note on proportional body measurements in sperm whales.

SOUTHERN HEMISPHERE MINKE

SC/42/SHMi

1 KATO, H., FUJISE, Y. and KISHINO, H. Preliminary analyses on age and reproductive data of southern minke whales obtained from the Japanese research take in 1988/89.*
2 KASAMATSU, F., KISHINO, H. and TAGA, H. Estimations of southern minke whale abundance and school size composition based on the 1988/89 Japanese feasibility study data.*
3 HAW, M.D. Estimation of minke whale abundance from the 1988/89 IWC/IDCR Antarctic assessment cruise in Area IV.
4 BUSHUEV, S.G. Distribution and feeding of minke whales on the feeding grounds in Antarctic Area I.*
5 HAW, M.D. An investigation into the differences in minke whale school density estimates from passing mode and closing mode survey in IDCR Antarctic assessment cruises.*
6 JOYCE, G., ENSOR, P., HARA, T., KIRA, M., MERMOZ, J., NISHIWAKI, S., SANPERA, C. and TSUTSUMI, H. 1989–90 IWC/IDCR Southern Hemisphere minke whale assessment cruise, Area I.
7 ALLISON, C. and SKINNER, J. Summary of Southern Hemisphere catch data.
8 BEST, P.B. A review of information on stock identity in Southern Hemisphere minke whales.
9 GOVERNMENT OF JAPAN. The 1990/91 research plan of whale resources in the Antarctic.
10 FUJISE, Y., KATO, H. and KISHINO, H. Reproductive segregation of the minke whale population in high latitudinal waters with some estimations of pregnancy and sexual maturity rates, data from Japanese research takes in 1987/88 and 1988/89.
11 KATO, H. and SAKURAMOTO, K. Age at sexual maturity of southern minke whales: a review and some additional analyses.*
12 KATO, H., ZENITANI, R. and NAKAMURA, T. Inter-reader calibration in age readings of earplug from Southern minke whale, with some notes of age readability.*
13 YOSHIOKA, M., FUJISE, Y., KATO, H. and AIDA, K. Serum progesterone levels in southern minke whales by reproductive status.
14 ICHII, T. and KATO, H. Food of southern minke whales from Japanese research take in 1987/88.
15 OHSUMI, S. Some proposals related to management advice for the Antarctic minke whale.
16 SAKURAMOTO, K. and NAKAMURA, T. A review of cohort analysis of historical catch-at-age data and research takes data of the Southern Hemisphere minke whale populations.
17 NAKAMURA, T. A new look at the Bayesian cohort model for time-series data obtained from research takes of whales.*
18 BORCHERS, D.L., BUTTERWORTH, D.S. and KASAMATSU, F. Southern Hemisphere whale abundance estimates south of 30°S derived from IWC/IDCR survey and Japanese scouting vessel data.
19 MIKHALEV, Yu.A. Problems of determining age at maturity in baleen whales using earplugs, with special reference to the minke whale.
20 KASAMATSU, F. and NISHIWAKI, S. Breeding grounds and southbound migration of southern minke whales with special reference to stock boundaries.
21 NISHIWAKI, S., JOYCE, G., ENSOR, P., MERMOZ, J., SANPERA, C. and KASAMATSU, F. Report on the biopsy dart sampling feasibility study during the 12th IWC/IDCR Southern Hemisphere minke whale assessment cruise, 1989/90.
22 NISHIWAKI, S., TSUTSUMI, H. and KASAMATSU, F. Preliminary report of the minke whale sighting surveys in the low and middle latitudinal waters in Areas I, IV and V of the Southern Hemisphere in 1989/90.
23 BERGH, M.O., BUTTERWORTH, D.S. and PUNT, A.E. Further examination of the potential information content of age-structure data from Antarctic minke whale research catches.*
24 KATO, H. and MIYASHITA, T. Migration strategy of southern minke whales in relation to reproductive cycles estimated from foetus length.*

25 FUJISE, Y., YAMAMURA, K., ZENITANI, R., ISHIKAWA, H., YAMAMOTO, Y., KIMURA, K. and KOMABA, M. Cruise report of the research on Southern minke whales in 1989/90 under the Japanese proposal to the scientific permit.
26 KASAMATSU, F. Notes on abundance estimates of Southern minke whales in waters between 40°S and 60°S in the Southern Hemisphere.
27 TAGA, Y., KISHINO, H. and KASAMATSU, F. Detection probabilities and search half-widths of paired vessels.
28 INSTITUTE OF CETACEAN RESEARCH. Progress Report; Japanese research program on Southern Hemisphere minke whale and preliminary research on the marine ecosystem in the Antarctic and program on its feasibility studies.
29 HIBY, L. and LOVELL, P. Passing versus closing mode survey – the pod identity question.

NORTHERN HEMISPHERE MINKE

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1 GUNNLAUGSSON, Th. Reanalysis of a minke whale sightings experiment onboard *Hvalur 9* in Faxafloi, southwest Iceland, July-August 1988.*
2 BAKKE, I. and EL-GEWELY, R. Preliminary report. Restriction enzyme analysis of mitochondrial DNA of minke whale (*Balaenoptera acutorostrata*) in the northeast Atlantic.
3 CHRISTENSEN, I., KREKLING, T. and SALBU, B. Growth layers in tympanic bullae from minke whales (*Balaenoptera acutorostrata*), determined by light and electron microscopy.
4 CHRISTENSEN, I., STENSHOLT, B., VOLDEN, R. and ULLTANG, Ø. Review of catch and effort in the Norwegian coastal minke whaling in Vestfjord area, 1946–1983.*
5 FOLKOW, L.P. and BLIX, A.S. Estimation of minimum metabolic rates of minke whales (*Balaenoptera acutorostrata*) in cold water based on total body heat loss.
6 FOLKOW, L.P. and BLIX, A.S. Energy expenditure of free swimming minke whales (*Balaenoptera acutorostrata*) evaluated by use of indirect estimation of oxygen consumption.
7 SCHWEDER, T. and HOST, G. On the optimal speed for North Atlantic minke whaling and shipboard surveying.*
8 MARKUSSEN, N.H., RYG, M. and LYDERSEN, C. Estimates of food requirements in a minke whale population by use of a simulation model.
9 MATHIESEN, S.D., AAGNES, T. and SØRMO, W. Microbial symbiotic digestion in minke whales (*Balaenoptera acutorostrata*).
10 MATHIESEN, S.D. and NORDØY, E. Gastrointestinal anatomy of minke whales (*Balaenoptera acutorostrata*).
11 NORDØY, E.S. and BLIX, A.S. Preliminary data on the diet composition of minke whales in north-eastern Atlantic waters.
12 NORDØY, E.S., SØRMO, W. and BLIX, A.S. *In vitro* digestion in minke whales for the estimation of digestibility of different prey species.
13 SCHWEDER, T., HØST, G. and ØIEN, N. A measure of the bias in estimates of g(0) for northeastern Atlantic minke whales based on the number of duplicate sightings by two independent observers on the same vessel; a first simulation study.*
14 SCHWEDER, T., ULLTANG, Ø. and VOLDEN, R. A review of the Norwegian catch and effort in the north east Atlantic minke whaling from 1952 to 1983.*
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16 ØEN, E.O. Trials of chemical immobilisation of minke whales with etorphine hydrochloride in 1989.
17 ØEN, E.O. A new VHF-dart radiotransmitter for minke whales.
18 ØIEN, N. Abundance of the northeastern Atlantic stock of minke whales based on shipboard surveys conducted in July 1989.*
19 ØIEN, N. A summary of the 1987–89 shipboard survey results for northeastern Atlantic minke whales.
20 NORWAY. Norwegian proposal for a scientific permit to take 5 minke whales (*Balaenoptera acutorostrata*) of the northeast Atlantic stock in 1990.
21 HOLT, S.J. Contribution to Comprehensive Assessment of minke whales in the North Atlantic.
22 KASAMATSU, F. and TANAKA, S. Yearly change of prey species found in the stomachs of minke whales caught in the northwest Pacific off northern Japan during the period 1972–1987.
23 ARNASON, A. and SPILLIAERT, R.A. A study of variability in minke whales (*Balaenoptera acutorostrata*) in the North Atlantic using a human hypervariable region probe, alpha-globin 3'HVR.*
24 DANIELSDOTTIR, A.K., DUKE, E.J. and ARNASON, A. Genetic variation at enzyme loci in North Atlantic minke whales (*Balaenoptera acutorostrata*).
25 GUNNLAUGSSON, Th. Effect of Beaufort on minke whale sightings rate in Icelandic whale observation surveys 1982–1986.*
26 PALSSON, J. and SIGURJONSSON, J. Parasitic nematodes from stomach of minke whales (*Balaenoptera acutorostrata*) off Iceland.
27 SIGURJONSSON, J., HALLDORSSON, S.D. and KONRADSSON, A. New information on age and reproduction in minke whales (*Balaenoptera acutorostrata*) in Icelandic waters. [Plus Addendum].
28 SIGURJONSSON, J. and GALAN, A. Some information on stomach contents of minke whales (*Balaenoptera acutorostrata*) in Icelandic waters.
29 VIKINGSSON, G.A. A note on strandings and net entanglements of minke whales in Iceland.
30 GUNNLAUGSSON, Th. and SIGURJONSSON, J. Minke whale sightings during NASS-89 Icelandic surveys with respect to abundance estimation.*
31 POLACHECK, T. and SMITH, T. Simulation results on the effects of dive time and movements on line transect estimates.
32 PAYNE, P.M., HEINEMANN, D.W. and SMITH, T.D. Seasonal distribution of minke whales in the shelf and shelf-edge waters of the Northeastern US.
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