Report of the Scientific Committee

The Committee met at 10.15 a.m. on 6 June 1977 and following days, in the Commonwealth Scientific and Industrial Research Organisation Conference Room, Canberra, under the Chairmanship of K. R. Allen. A. G. Bollen, Chairman of the Commission welcomed participants to Canberra.

There were present:

K. R. Allen J. L. Bannister B. K. Bowen A. E. Caton G. P. Kirkwood R. H. Walker	Australia
M. C. Mercer E. M. Mitchell	Canada
F. O. Kapel	Denmark
Y. Fukuda S. Kimura Y. Masaki S. Ohsumi T. Saito K. Yamamura	Japan
P. J. H van Bree	Netherlands
A. N. Baker M. W. Cawthorn	New Zealand
I. Christensen Å. Jonsgård C. J. Rørvik	Norway
P. B. Best	South Africa
R. G. Borodin G. A. Borovkov M. V. Ivashin I. G. Tshenker G. V. Vainer	U.S.S.R.
J. R. Beddington S. G. Brown J. W. Horwood	U.K.
G. A. Bertrand J. M. Breiwick R. L. Brownell D. G. Chapman M. F. Tillman	U.S.A.
S. J. Holt	FAO
A. J. Mence	IUCN
R. Gambell	Secretary to the IWC

1. CHAIRMAN'S REMARKS

The Chairman outlined meeting times and servicing arrangements for computer access.

2. APPOINTMENT OF RAPPORTEURS

The duties were shared between Brown and Caton; Chairmen of sub-committees appointed rapporteurs for their meetings.

3. ADOPTION OF AGENDA

The Agenda adopted is shown in Annex A.

4. ARRANGEMENTS FOR MEETING

In accordance with its Rules of Procedure, the Committee established a number of *ad hoc* sub-committees which met during the meeting. Reports arising are dealt with under relevant Agenda items.

5. EXCHANGE AND REVIEW OF DOCUMENTS

Lists of documents, progress and other reports available are appended as Annexes B1, B2 and B3.

6. RULES OF PROCEDURE

6.1 Admission of observers

The Committee set up a sub-committee on Rules of Procedure to re-examine its policies on the admission of outside scientists and observers to its meeting. On the basis of the sub-committee's report, the Committee re-examined Section A 'Membership and Observers' of its Rules of Procedure which were set out in Annex C2 of the report of the 1976 meeting and noted by the Commission. It inserted new paragraphs 3 and 4 so that the Section, as amended now reads:

> *"A. Membership and Observers*
> 1. The Scientific Committee shall be composed of scientists nominated by the Commissioner of each nation which elects, at the annual meeting of the Commission, to be represented on that Committee. The Secretary of the Commission shall be an *ex-officio* non-voting member of the Scientific Committee.
> 2. The Scientific Committee recognises that while FAO and UNEP are represented at the Commission's meeting by Observers their representatives attend the Scientific Committee as scientists with the status of advisers to the Committee. The representatives of other international organisations of similar scientific standing may also be given the same status in the Scientific Committee,

subject to the agreement of the Chairman of the Committee acting according to such policy as the Commission may decide.

3. Other accredited observers to the Commission may attend the meetings of the Scientific Committee, subject to the agreement of the Chairman and Vice-Chairman of the Committee and the Secretary of the Commission, acting according to such policy as the Commission or the Scientific Committee may decide. They do not participate in discussions, present papers or documents, but shall receive the papers and documents of the Committee.

4. The Chairman of the Committee, acting according to such policy as the Commission or the Scientific Committee may decide, may invite qualified scientists not nominated by a Commissioner to participate by invitation or otherwise in committee meetings as non-voting contributors. They may present and discuss documents and papers for consideration by the Scientific Committee, participate on sub-committees, and they shall receive all Committee documents and papers."

Most members of the Committee re-affirmed rules 1 and 2 above, but the Japanese and Soviet scientists believe that rule 2 refers only to representatives of intergovernmental organisations.

The majority of the Committee decided to adopt the newly inserted rule 4 above, providing for attendance of outside scientists as contributors, but regarded rule 3 as a preliminary draft awaiting any policy guidance from the Commission, on admission of observers.

The Japanese scientists, in view of the great responsibility referred to the Scientific Committee to work out, without outside disturbance, objective and scientific bases for the Commission's decisions on regulations which would bind the member governments, objected to the inclusion of rule 3, and in regard to rule 4 want participation of qualified scientists not nominated by a Commissioner to be dependent upon a consensus of all the scientists present at the meeting who represent the contracting governments.

The committee noted that the UK had indicated an intention to raise this matter at the forthcoming Commission meeting.

At its 29th Annual Meeting the Commission adopted an amended Rule A.3 as follows:

"Any other international organisation sending an accredited observer to a meeting of the Commission may nominate a scientifically qualified observer to be present at meetings of the Scientific Committee. Any such nomination must reach the Secretary not less than 60 days before the start of the meeting in question and must specify the scientific qualifications and relevant experience of the nominee. The Chairman of the Scientific Committee shall decide upon the acceptability of any nomination but may reject it only after consultation with the Chairman and Vice-Chairman of the Commission. An observer admitted under this rule shall not participate in discussions nor present papers or other documents but the papers and documents of the Scientific Committee shall be made available at the same time as to members of the Committee. The number of places for observers admitted under this rule at any meeting and the observers to whom they are to be allocated shall be determined by the Chairman of the Scientific Committee having regard to the accommodation available but the number shall not normally be less than five."

6.2 Out of session decisions

The Committee noted that the main instance where formulation of an opinion on its behalf may arise between meetings is in the case of comment on intentions to issue scientific permits.

The Committee took this into account when considering Item 9.3.2 and found no need to set up other out-of-session procedures at the present time.

7. FAO/ACMRR WORKING PARTY ON MARINE MAMMALS

The Secretary in his capacity as IWC Observer to the FAO/ACMRR 'Mammals in the Sea' consultation at Bergen, September 1976, drew attention to the recommendations formulated by the ACMRR Working Party on Marine Mammals in response to the consultation. These progress from the general consideration of objectives and arrangements for management and conservation, through scientific advisory questions to details of information exchange, and publication and distribution of materials related to the consultation. They include consideration of possible arrangements for the funding and development of expanded internal co-operative research on marine mammals, and the continuation of the marine mammal project activity.

Holt explained that the report, recently published, had been made available to ACMRR, UNEP and the FAO Committee on fisheries but ACMRR and UNEP had yet to comment. COFI, in commenting on some of the recommendations, agreed that FAO should continue to take an interest in marine mammals, added that continued independent monitoring of scientific advice on marine mammals was desirable and specifically endorsed the recommendation which sought intergovernmental action within the UN system to formulate objectives of mankind in relation to marine mammals.

The Committee noted that the Bergen meeting, the report and the activity that it was likely to generate, represented a substantial contribution towards knowledge on marine mammals. Due to lack of time the Committee was unable to give detailed consideration to the report and the recommendations; it agreed to give serious consideration to the matter at its next annual meeting.

8. INTERNATIONAL DECADE OF CETACEAN RESEARCH – RESEARCH PROPOSALS

The Secretary provided a report on actions taken during the year and on the present position regarding funding of the four high priority projects identified last year (IWC/27, pp. 36–7). Further to this the Committee was advised that the USA was continuing work on development of the computer data base (project 1) and meeting all costs. Data from BIWS were now held by Breiwick and he was ready to proceed. Jonsgård also stated that because Norway regarded minke whale ageing (project 4) as a high priority project, the Norwegian Government will provide at least $10,000 for this project. The Committee noted that the combined Canadian and Norway contributions towards the project may be sufficient to permit commencement of project 4 on a two-year basis.

The situation in relation to project 2 (South East Indian Ocean cruise) was less encouraging as only $21,000 from Australia and perhaps $10,000 from USA seemed available. It would be necessary to raise the remaining $29,000 and re-negotiate the charter of the USSR catcher vessel for the project to become operative.

The United States Government regarded project 3 (North Pacific sperm whale ageing) as a highly important project and it was expected that $25,000 would be made available for it.

The Committee expressed deep concern that the $100,000 budget for the above projects had not been realised, reminding the Commission that the projects were selected as special priority projects representing a viable minimum from the highest priority group of the Consolidated Research Proposals for the IDCR. It urged that the Commission consider means of raising appropriate funds.

The Committee reviewed these projects together with those arising during the meeting and agreed the following research programmes should receive priority, for 1977/78, in the following order:

Item	*Reference*	*Estimated Cost* (US $)
1. Provision of computer facilities at next Scientific Committee meeting, Cambridge	This report, p. 71	9,000
2. Sperm whales, North Pacific, preparation and analysis of age data	IWC 27, p. 37, Item 3	33,000
3. Minke whales, Southern Hemisphere, marking and sightings programme (including cost of 1500 marks $11,000)	This report, p. 57 and Annex G (p. 84)	(11,100)*
4. Minke whales, North Atlantic, collection and analysis of age data from Norwegian fishery	This report, p.63 and IWC 27, p. 37 Item 4	45,000
5. Sperm and other whales, South East Indian Ocean, marking and sightings programme (including cost of marks and marking guns $4,500)	IWC 27, p. 37, Item 2	60,000
6. **Bryde's whales, South Pacific and Indian Ocean, collection of biological data, marking and sightings cruises (including cost of 300 marks and 4 guns $2,600)	This report, p. 41	115,000
7. Sei whales, North Atlantic (Iceland–Denmark Strait Stock) marking and sighting cruises (including cost of 300 marks and 2 marking guns $2,300)	This report, p. 65	120,000
8. **Bottlenose whales, North Atlantic, marking sighting and collection of biological material (including cost of 300 marks and 2 marking guns $2,300)	This report, p. 66	62,300
9. Sperm whales, North Atlantic, collection and analysis of biological material, Madeira	This report, p. 66	500
10. Fin whales, North Atlantic, analysis of Icelandic/British collections; collection and analyses of future biological data	This report, p. 65	28,000
11. Sperm whales, North Atlantic, analysis of biological material especially age data, from Iceland	This report, p. 66	25,000
12. Gray whales, North Pacific, expansion of sightings research; possible marking	This report, p. 68	15,000

*This only includes cost of marks and guns; detailed planning has not yet been carried out and total costs will not be available until that has been completed.
**Subject to discussion of the Scientific permit by the Scientific Committee.

The Committee believes that in view of the high cost of such a total programme, the Commission should give particular priority to item 1 and to assisting marking programmes by the provision of whale marks and guns included in items 3, 5, 6, 7 and 8. It therefore recommends that the Finance and Administration Committee consider the provision of a sum of $32,200 to meet such costs at least.

Item 3 is considered to be of highest priority in the Southern Hemisphere, however detailed planning should await results of the proposed special meeting on minke whales. In the meantime Japanese and Soviet fleets are encouraged to intensify marking of southern minke whales.

The Committee was informed by the Observer from IUCN of the possibilities offered under the IUCN Marine Programme (funded by the World Wildlife Fund) for inclusion of cetacean research projects in that programme. It recommends that the Secretary of the Commission be authorised to discuss with IUCN the submission of any of the above programmes for inclusion in that programme and to take the appropriate action thereafter, in conjunction with the relevant national groups.

It is recommended that overall responsibility for co-ordination of the programme should rest with the Secretary of the Commission, working with local organisers appointed for each project.

9. REPORTS AND INFORMATION

9.1 Reports of Standing Sub-committees

The Standing sub-committees, formed by the Committee at its 1976 meeting, met during the meeting. Their reports were received by the Committee and are incorporated, as modified by the Committee, in the relevant sections of its report.

The documentation available to the sub-committees is summarised below:

Sperm Whales
SC/29/Docs 4, 8, 18, 21, 26, 31, 32, 47, 50
SC/29/Prog Reps 1, 4, 5, 6, 9, 10

Northern Hemisphere Baleen Whales
SC/29/Docs 1, 5, 8, 10, 13, 21, 23, 27, 29, 30, 33, 35, 37, 39, 42, 43, 44, 46, 47, 48
SC/29/Prog Reps 2, 3, 4, 7, 10

Southern Hemisphere Baleen Whales
SC/29/Docs 2, 3, 7, 8, 11, 14, 15, 16, 20, 24, 25, 28, 31, 32, 36, 38, 40, 41, 43, 45

SC/29/Rep 1 (and background documents T12, T14, T16, T17, T18 and T20 associated with that report)

Small Cetaceans
SC/29/Docs 1, 8, 10, 12, 14, 22, 32, 49, 51
SC/29/Prog Reps 2, 3, 8, 9, 10, 11

9.2 Progress Reports

The Committee reviewed Progress Reports submitted by National Groups as listed in Annex B2.

9.3 Scientific permits

A sub-committee consisting of Saito, Ohsumi, Tillman, Bertrand, Best, Cawthorn, Ivashin and Mitchell (Chairman) was appointed to consider the indication by Japan of continuing a scientifically directed harvest of Bryde's whales, and the suggested procedure (SC/29/Doc 34) for reviewing Scientific Permits. The Committee adopted the report of the sub-committee on items 9.3.1 and 9.3.2 as follows:

9.3.1 Review of Permits for 1976–77

Indications are given in SC/29/Doc 38 (a comprehensive report on studies undertaken in connection with a 1976–77 Bryde's whale permit) of intent to issue permits by Japan next season for:

(1) 120 Bryde's whales in the South Pacific
(2) 120 Bryde's whales in the Indian Ocean.

The Committee noted that, although a broad range of biological measurements were made of the previous sample of 225 Bryde's whales (SC/29/Doc 38), 40 were completely measured for body proportions. The Committee recommends that all whales taken under Special Scientific Permit should be fully measured to collect data for discriminant function analyses of stock identity. Also the Committee recommends that an increased sightings programme be conducted and a more substantial marking programme be carried out.

Some members of the Committee however felt strongly that surveys directed towards obtaining estimates of stock size (through sightings and marking) should precede the exploitation of a new resource. Such surveys would be far less effective if attempted in conjunction with catching operations, as the time available for sighting and marking would be adversely affected. This was clear from the data in Doc 38, which showed that only 7 of the 18 catchers involved had been used as scouting boats, and only 3 whales had been marked (compared to 225 Bryde's whales caught). This situation was considered to be particularly valid for Southern Hemisphere Bryde's whales where it was possible that several local stocks existed, and where oceanographic conditions suggested that stock sizes could not be very large. They therefore felt that the proposed programme of biological sampling should be postponed until a planned sighting and marking survey had been undertaken. Such a programme should be carried out in the following manner:

1. a pilot survey searching for areas of high density
2. an intensive grid survey of one or two such areas including substantial marking, and
3. a programme of the collection of biological data in subsequent seasons and areas from 1 and 2.

Other members pointed out, however, that as explained in SC/29/Doc 38, this research plan was intended to achieve the estimate of population and stock identification as expeditiously as possible by combining the sighting, marking, density survey and collection of biological data. They thought that such a research plan, with an intensified sighting and marking programme should bring about valuable information essential for population estimate and stock identification of the Southern Hemisphere Bryde's whale which is at present classified as an initial management stock not open to commercial exploitation due to lack of population estimates.

9.3.2. Advance review of permits

Neither the Scientific Committee nor the Commission can require that proposed permits be submitted for scientific review prior to issuance. However in order to assure maximum co-ordination among nations conducting research, to allow for the possibility of collaboration among scientists, to recognize and assure validity and utility of the proposed research, and to assure that proposed permits will not adversely affect the conservation of whale stocks, the Scientific Committee recommends that governments receiving permit applications which they are considering granting, make such proposed permits available to the Commission for review and comment by the Scientific Committee before the permit is issued by the national government. The Scientific Committee believes that proposed permits should contain all necessary information on the objectives, methods and effects of the permit on whale conservation to allow scientific review and comments. The Scientific Committee will prepare a list of minimum data requirements including standard measurements,* to ensure that broadly comparable research results are obtained. Results of the research should be made available to the Scientific Committee as soon as possible but in any event a preliminary report should continue to be incorporated as part of the national progress report or as a special report for the next annual meeting.

The following procedure is suggested. If the research were not going to be carried out prior to the forthcoming annual meeting the proposed permit would be reviewed and discussed at the annual meeting of the Scientific Committee. If the research were imminent the Commission Secretariat would provide the proposed permit to members of the Scientific Committee and appropriate review and comment would be made by mail. The results would be provided to the Secretariat and forwarded by the Secretariat to the Commissioners, the national government providing the proposed permit, and to a scientist designated by the national government to receive the comments. Every effort should be made to make the proposed permit available early enough to allow consideration at the annual meeting of the Scientific Committee.

The Committee adopted a new Rule of Procedure for the Scientific Committee incorporating the above procedure and suggestions.

New Rule of Procedure

F. Review of Scientific Permits

1. When proposed Scientific Permits are sent to the Secretariat before they are issued by national governments the Scientific Committee shall review and comment on them.

*Norris, K., 1961. Standardised methods for measuring and recording data on the smaller cetaceans. *Journal of Mammalogy, 42: 471–476.*

2. The proposed permit and supporting documents should include specifics as to the objectives of the research, number, sex, size, and stock of the animals to be taken; opportunities for participation in the research by scientists of other nations, and the possible effect on conservation of the stock resulting from granting the permit.
3. The Scientific Committee shall review the scientific aspects of the proposed permits at the annual meeting and comment on such proposed permit to the Commission, the national government concerned, and any scientist designated by that government.
4. In the event that the proposed permit would be granted prior to the next annual meeting of the Scientific Committee, members shall review and comment on the scientific aspects of the proposed permit by mail.
5. The proposed permit and the preliminary results of any research resulting from the permits should be made available for the next meeting of the Scientific Committee as part of the national progress report or as a special report.

Dr Holt, adviser on behalf of FAO, asked that the following views be recorded in the report of the Committee:

"A proposal to take substantial numbers of whales under research permits should be endorsed only if satisfactory arguments are put forward, substantiated by full documentation, that

(a) such catch will not significantly affect the stock, especially one which has been previously depleted or is thought to be small, in absolute terms;
(b) a full analysis has been made of existing data and this analysis has been critically discussed by the body which is requested to endorse the proposal; and
(c) the results of the research, considered together with other current research on that stock, will with reasonable probability, provide the needed scientific basis for classification of the stock and estimation of its size and of the sustainable or replacement yield that might be taken from it."

9.4 Reports of special meetings

9.4.1. Sei whales

The committee received the report (pp. 335–343) of the meeting held in Tokyo from 20–27 April on Southern Hemisphere sei whales. The recommendations of the report are considered under item 11.1.

9.4.2. Historical data

Tillman reported progress on arrangements for an International Workshop on Historical Whaling Records.

Originating as a proposal to examine historic sperm whale data, the workshop will now include other species. $8,000 towards the cost has been provided jointly by the US Marine Mammal Commission and the US National Oceanic and Atmospheric Administration, the IWC funding the remaining $2,260. The workshop for about 30 invited participants will be held from 12–16 September at the Kendall Whaling Museum near Boston.

9.5 Progress of Whale Marking and Whale Mark Recoveries

Brown presented SC/29/Rep 6 (Annex D) which contained a summary of whale marking activities during 1976 and 1977; the Committee received the report.

The international marking scheme has for many years been co-ordinated by the Whale Research Unit of the Institute of Oceanographic Sciences, as agreed on a number of occasions by the Scientific Committee. As noted in SC/29/Prog Rep 10, the Unit has been transferred from the Institute to the premises of the British Antarctic Survey, Cambridge. The Scientific Committee hopes that it may be possible for the present arrangements to continue.

Commission's Contribution to Whale Marking

Last year the Commission contributed £2,000 towards the cost of the provision of marks for use in the international scheme.

This contribution is towards the cost of marks used in the marking carried out annually in the Antarctic with the assistance of Japanese expeditions. The Committee recommends that in order to carry out this marking and marking elsewhere, including that of minke whales in Japanese waters as requested by the Committee last year, the Commission should provide funds at this same level for the coming year. In addition to this marking, a number of other marking programmes are being suggested by the Committee and estimates of the funds required for this additional marking are given under Agenda Item 8 (International Decade of Cetacean Research – Research Proposals).

9.6 Reports of previous season's catches

Statistical data prepared at the Bureau of International Whaling Statistics under the direction of E. Vangstein were presented by Jonsgård who conveyed Vangstein's appreciation of prompt USSR monthly and season data returns and his enquiry about absence of various Japanese, Canadian, Danish and USA data. The Committee noted that the delays in submission of the Japanese data were due to an extension of the Japanese 1976 coastal season to March 1977. Nevertheless, the Committee recognised that it had asked Vangstein to prepare data for consideration at the annual meeting and had an obligation to facilitate this. It agreed with a USSR suggestion that Progress Reports should also incorporate the data as a back-up source. As a personal communication, Brownell reported that 136 fin whales were caught by Spain in 1976.

9.7 Sighting programme. Data reports from 1976/77 season and analyses of data

The Committee noted that sighting reports had been received from Australia, Iceland, Japan and USSR. It commented that some of the data were of little use in their present form because of their incompleteness, particularly in regard to effort data. It agreed that the sighting data (on the standard forms) and an analysis of them should be presented by each country in its progress report unless they are the subject of a special publication. This would ensure that the original data would first be reviewed by a scientist who could ensure that omissions would be rectified. It was agreed that the Secretary should send the form to a selected scientist in each country or to the Commissioner as requested.

9.8 Stock handbook

The Chairman and Secretary had discussed handbook preparation but had been unable to make any progress to date.

9.9 Indexed list of Scientific Committee documents

The Committee endorsed a recommendation by Chapman that the Secretariat prepare a bibliography of Scientific Committee documentation (giving particular attention to material prepared in connection with Special Meetings which had not been incorporated in published Annual Reports), and that the Secretariat be prepared to supply, at cost if necessary, copies of any such documentation held by it.

The Committee agreed that the bibliography should include all documentation since 1961 or earlier if possible; it should consist of a list of documents by meeting in time sequence, publication details (in annual report, in a journal or unpublished), an author index and a subject index. The Committee suggested that the Commission might explore the possibility of external sources of funds or assistance, e.g. FAO, in the preparation of the index.

10. CLASSIFICATION OF WHALE STOCKS

10.1. Criteria of classification

10.1.1. IUCN resolution

The Committee formed a sub-committee consisting of Mercer (Convenor), Holt, Beddington, Bertrand and Best; the Committee's comments are based on the sub-committee's report. The Committee considered and commented upon Resolution No. 8 of the 12th general assembly of IUCN, entitled "Principles replacing maximum sustainable yield as a basis for management of wildlife resources". While the IUCN Resolution calls the attention of the IWC to the results of its programme of workshops on wild living resources, such results have not been made available to the Committee as they have not been published. This report thus refers only to the Resolution.

In so far as the principles are stated in the form of value judgements pertaining to the *objectives* of resource use, such were deemed to be outside the competence of the Committee. The Committee offers the following comment on the operations of the Scientific Committee and that of the Commission as these bear upon the IUCN principles:

It is sometimes assumed that management on the basis of MSY implies that population parameters (recruitment, growth, mortality) vary only in response to population density and structure (age, distribution, sex ratio, etc.). The Committee recognises that this is unreasonable where either the physical environment has changed or where other populations interacting with the species have increased or decreased. Furthermore, other factors will tend to affect population parameters in a stochastic way and thus a fully deterministic analysis can be misleading. One important corollary of this recognised by the Committee is that maintenance of stocks at a fixed level by means of a constant quota for a long time is not feasible and becomes even less so as MSY stock level is approached. However, the theoretical MSY level and yield can provide a useful guide for management purposes.

The Committee agreed that single species models, incorporating reasonable safety factors, are the only appropriate basis for management in the absence of other information. Where data on other factors, such as inter-species effects, are available these can be used to develop more appropriate single-species models. In this regard the Committee refers to incorporation of effects of competitive phenomena in assessment of sei whales and minke whales at the 1977 meeting. However this is only one step towards the desirable objective of constructing realistic multi-species models for fisheries management.

The following comments refer on a point by point basis to the IUCN principles:

1. "The ecosystem should be maintained in such a state that both consumptive and non-consumptive values can be realised on a continuing basis, ensuring present and future options minimising the risk of irreversible change or long-term adverse effects."

The Commission does not have management options over the whole ecosystem. However it does have access to information on the system and can thus manage in this context.

While the Commission is not specifically concerned with "non-consumptive" values, it is observed that such may depend upon relatively large population sizes. The sustained consumptive use regulated by the Commission is also dependent upon relatively large population sizes and the intention to maintain exploitable stocks at MSY level implies the intention to hold the stocks between approximately 50 and 70% of their initial sizes. Hence the Commission's present policy is not necessarily incompatible with management for non-consumptive values.

The Commission's policy of prohibiting commercial exploitation of any stock which is estimated to be below 90% of MSY level reduces risk of resource depletion and is a very powerful safeguard against threats of extinction by commercial whaling activities of IWC members.

2. "Management decisions should include a safety factor to allow for limitations of knowledge and imperfections of management."

The Commission and the Committee employ certain safeguards in their operations. Without prejudging the sufficiency of these, the Committee lists them as follows:

(a) The IWC requires an estimate of initial population size before exploitation is permitted to commence. At the 1976 annual meeting zero quotas were set for Southern Hemisphere Bryde's whales and Central and Eastern Pacific minke whales as a result of this policy.
(b) Restriction of catches from initial management stocks, where only stock size has been estimated, to an annual maximum of 5% of the estimated initial stock size.
(c) Restriction of catches to 90% of MSY rather than MSY for stocks at MSY level or above.
(d) Total prohibition on commercial killing of whales by IWC members from stocks which are considered to be below 90% of MSY level.
(e) While control cannot be exercised over the whaling of non-members, their catches, in so far as these are known, are taken into account in assessments and regulation of whaling by IWC members.
(f) Annual revision of quotas and other regulations and strict enforcement of these, including an International Observer Scheme.

3. "Measures to conserve one resource should not be wasteful of another."

While national allocations are not under the purview of the Commission, its members meet in other fora to make such arrangements. This has reduced wastage of effort

through competition among members for shares of the total quotas.

The Committee notes that recent literature pertaining to the economics of fishery resources management indicates that there are advantages in maintaining stock levels above the MSY level. The Schedule of the IWC refers to the intent to bring the whale stocks to an optimum level; economic and other criteria could be considered in determining this optimum level.

4. "Survey or monitoring, analysis and assessment should precede planned use, and accompany actual use, of a resource and the results should be made available promptly for critical public review."

The Committee makes the following observations:

(a) Comment under 2(a) above also applies to this question; paragraph 6(b) of the Schedule includes the provision that "Exploitation (of a stock) should not commence until an estimate of stock size has been obtained which is satisfactory in the view of the Scientific Committee".

(b) Certain kinds of basic data are required by the Commission. Analysis and assessment are utilized by the IWC as exploitation proceeds. There is no statutory requirement for biological material and data available are not always adequate for assessment. Indications of where such data collection should be improved are given annually by the Committee. In this regard the Committee notes the importance of increased research and reporting on the catches, population dynamics and energetics of species which are major components of the ecosystems in which the whale stocks occur.

(c) The publication policy adopted by the Committee in 1976 (IWC/27, p. 60) requires that all documents of the Committee upon which management recommendations are based be made available for public distribution immediately following the meeting of the Scientific Committee making management recommendations. This is followed by rapid publication of the documents.

10.1.2. Southern Hemisphere sei whales

The Committee recognised the difficulty of applying the new management procedure in the sei whale situation where substantial population size changes had taken place in response to environmental changes. Selection of an appropriate initial population size and MSY population level as a basis for classification and catch limits cannot be made in isolation because of the influence of blue and fin whale abundance on the abundance of sei whales. This matter is considered in detail under item 11.1 in relation to sei whale assessments.

The problems associated with the development of a southern ocean fishery for krill were discussed in relation to all baleen whales, but especially the sei whales. The present state of the krill fishery and its implications to whales and whaling are discussed in SC/29/Doc 16. The Committee also had available information in SC/29/Rep 4 which made further reference to the whale/krill situation and noted the probable importance of other krill predators in the system. It outlined proposed international co-ordination of living resources research in the Southern Ocean under the BIOMASS Programme. The Committee noted that some members of the Committee were associated with organisations which would participate in the programme.

10.1.3. Relation to classification under the Convention on International Trade in Endangered Species of Wild Fauna and Flora

A sub-committee consisting of van Bree, Mercer, Walker and Bertrand (Convenor) was established to consider this matter. The Committee adopted the following report:

The Committee examined the relationship between the Convention on International Trade in Endangered Species of Wild Fauna and Flora (ESC) and the International Whaling Convention (IWC).

When the ESC was negotiated in 1973 all whale species then protected by the IWC were included in Appendix I of the ESC which prohibits commercial trade. In 1976 at the 1st Meeting of the parties to the ESC there was an attempt to add all fin and sei whale stocks recently classified as Protection Stocks by the IWC under the new management regime to the ESC Appendix I and other stocks of these species to Appendix II.

When the initial classifications were made to the ESC in 1973 only very generalised criteria were used for determining which, if any, classification was appropriate for a species or other taxon. In 1976 the 1st Meeting of the parties adopted criteria on trade and biological status for evaluating proposed listings. These general criteria do not provide the specific guidance needed to evaluate the listing of cetacean species without additional interpretation and refinement.

The Committee noted the following points regarding the relationships between the classifications employed by the two Conventions:

1. The ESC meets every two years and the IWC each year. The ESC listings will be at least a year behind IWC in incorporating changes in classification. The Committee felt that this could become a practical problem when a stock was going from the Protected to Sustained Management classification. Adoption of classification criteria suggested below would avoid this problem.
2. The IWC Protection Stock classification is too broad for direct application to either of ESC Appendices I or II. This IWC classification includes both species or stocks which range in status from those in danger of biological extinction, such as the bowhead, to those which are not endangered but are more than 10% below the MSY level.
3. The ESC does have a provision for listing by "biological stocks" which are not also taxonomic subspecies. It is thus possible to list individual stocks or, where appropriate, all stocks of a species on appropriate appendices.
4. Listing of a species or stock in Appendix II of the ESC has the connotation that the species may become threatened without regulation of trade. In the case of whales and many other species this assumption is not necessarily true, e.g. stocks of whales which are not subject to any harvest.
5. The ESC is inconsistent in listing higher taxa in cases where the identification of species or their products is difficult. Sometimes the entire genus or family is listed to allow effective enforcement, at other times however exceptions are made for individual stocks or species which cannot be differentiated. The country of origin is the only evidence of stock or species identification in these cases. From the practical standpoint it would be impossible to differentiate whale meat among the various species.

To further define the ESC criteria, with regard only to biological status, for evaluation and classification of a proposed listing, the Committee proposed the criteria given below for application to cetacean stocks.

After discussion the Committee rejected recommending specific numerical levels as part of the criteria. It was felt other factors such as the quality of data for the stock, environmental changes, and biological factors should be considered in conjunction with Annex G, 27th Report of the Scientific Committee, in determining classifications for the ESC.

Appendix I: The stock has been either greatly reduced to a small fraction of its initial size or, in the case of stocks where the initial size is very small, it has been reduced by a lesser proportion but the present population size is so small as to warrant concern over its survival. In either case exploitation could endanger the survival of the stock.

Appendix II: The stock is significantly below MSY level but continues to be exploited at levels which could prevent its recovery or the stock is small and decreasing and would thus be threatened by commercial exploitation.

The Committee has referred to questions of biological status only and feels that trade criteria would be more appropriately considered by the Commission.

The following species, presently listed in the Appendices of the ESC, are of biological status appropriate for classification in Appendix I under the ESC criteria and the criteria given above:

Eschrichtius robustus (Western Pacific stock)[1]
Balaenoptera musculus
Megaptera novaeangliae
Balaena mysticetus
Eubalaena spp.

The following currently listed species are of biological status appropriate to Appendix II of the ESC.

Balaenoptera borealis (stock in North Pacific)
Balaenoptera physalus (North Pacific and all Southern Hemisphere Areas except Area VI)

The Committee believes the following other species would be appropriately classified as regards biological criteria, in the Appendices of the ESC as follows:

Appendix I *Platanista minor*
Lipotes vexillifer
Appendix II *Phocoena sinus*

10. CLASSIFICATION OF WHALE STOCKS

10.1. Criteria of classification

10.1.4. General principles

Dr Holt, adviser on behalf of FAO, asked that the following views be recorded in the Report of the Committee.

Practically all whale stock estimates depend, ultimately, on catches per unit effort as indices of changes in abundance. While these indices have been improved by corrections for increase in tonnage or horsepower of catchers and, in the case of sperm-whaling, for employment of Asdic, it is by no means certain that all increases in catching efficiency over the years have thus been taken into account. For example, while Asdic is of more significance in sperm-whaling than in baleen whaling, it has been reported that it is of some, unmeasured, benefit in the latter, and this has not so far been taken into account. In another instance, a view that increases in sightings indicate an increase in Southern Hemisphere minke whales has been opposed on the grounds that whalers have actually become more efficient in finding them; if this is true the effect should, and could be taken into account in determining stock sizes of minke whales.

While it is undoubtedly true that catches per unit effort can, in certain instances, be caused to fall faster than a whale stock declines, as a result of transfer of whaling interest elsewhere, to other species, to the other sex or to smaller but more abundant animals, these transfers are counterbalanced by increases elsewhere, and should be taken into account as a whole if they cannot otherwise be properly treated. In general it is to be expected that efficiency will if anything increase, and that not all causes of such increase can be allowed for or even identified; thus catch-induced changes will tend to be underestimated. This means that estimates of 'initial' stock, and of the ratio of present to 'initial' stock, will be too high. Use of effort data corrected to exclude occasions on which no whales of the species in question were caught can cause a similar bias.

10.2 Recommendations on additional categories

The Committee discussed the establishment of new classification categories, decided that their formulation would be premature at present and agreed to re-examine the matter at its next meeting.

10.3 Determination of quotas

10.3.1 Effect of variability

The Committee noted that this item was on the Commission's agenda and that it would be expected to provide advice on the issues involved. It reviewed a background document (SC/29/Doc 6) on the question. This pointed out that there is a risk under a constant equilibrium catch that environmental variability may drive a stock into the Protection category. The 'return time,' which is proportional to that taken for recovery after disturbance, is used as an index of stability; the longer the time the greater the risk that the stock goes into the Protection category. The mathematical analysis showed that this time, and therefore the risk, does not vary greatly for constant catches less than about 0.8 MSY, but that it increases rapidly, and at an exponential rate, as the MSY catch is approached. It was therefore suggested that on these grounds it would be appropriate to set the quota at a level lower than 0.9 MSY, such as 0.8 MSY or possibly 0.7 MSY.

In discussion it was pointed out that the general principle that there was a direct correlation between decreasing the level of the permitted catch and reducing the risk of undesirable reduction of the stock had been recognised in all the discussions which had led to the adoption by the Commission of the new management procedure. In these discussions, emphasis had generally been placed on the risks arising from errors in the structure of the population models or in the parameter values used in them. The point now raised, concerning risks arising from environmental variability, had not been previously recognised specifically. It therefore constitutes a valuable addition to the factors which must be taken into account in developing a management strategy. However, no information is available to the Committee on the actual time scale associated with the risk

[1] Stock migrates between summer feeding grounds in the Okhotsk Sea and the winter calving grounds in the vicinity of the Korean Peninsula.

of reducing stocks into the Protection category as a result of the effect under consideration. This would depend both on the time scale of environmental variability and the rate at which a whale population can respond to environmental changes. The latter was generally considered to be low on account of the long life span, high age at maturity and low fecundity of whales. For these reasons it appeared to some members of the Committee that the risks arising from environmental variation would be of small significance at the present level of knowledge compared to those arising from uncertainties in model structure and parameter values.

It also appeared that the theory underlying the present analysis postulated that the catch level, having once been established correctly, was held constant for a number of years and not adjusted in response to changes in the population. The present procedure requires however that the status of all stocks should be kept under annual review. Thus if, as the basic theory requires, the original catch limit was able to be set correctly it should also be possible to make adjustments in response to changes in the state of the stock.

It was generally agreed that the point which had been raised was of importance and should be further examined at the next meeting of the Committee. It was however felt by the majority of the Committee that at the present stage insufficient information was available concerning the effects involved to warrant an immediate change in the level, relative to MSY, used in determining catch limits.

10.3.2. Male Sperm Whales – Initial Management Stocks

The Committee examined the Japanese proposal that the catch limit would be MSY plus 10% of the amount by which the male stock exceeds its MSY level. The quota calculated on this basis would facilitate rapid reduction of sperm whale stocks toward an estimated Sustained Management Stock level.

If the present population model, biological parameters and existing management scheme (90% of MSY) remain unchanged, three male sperm whale stocks would never be lowered to the SMS level. The figures in Allen (IWC 27, pp. 237–9) were updated and are presented in Table 1.

Any management scheme involves risks which arise from inadequate knowledge of biological parameters, estimates of stock size, and uncertainties concerning the model. The faster a stock is reduced toward the desired management level the greater is the risk of overshooting that level.

The Committee decided that in order to reduce risk the Japanese proposal could only be applied where the Committee believes that the data on stock size and biological parameters are highly reliable and where the stock in question is well above the SMS level.

In examining the specific stocks in the Southern Hemisphere the Committee noted Divisions 2 and 8 would take the longest to reach the SMS level, 17 and 28 years respectively. The stock estimates within these two areas are poor, with 1946 stock estimates for Division 2 ranging from 33,000 to 72,000 and for Division 8 from 25,000 to 70,000. In each case the lower estimate was adopted. This kind of reliability should be examined annually in light of new information.

Estimates of the biological parameters for sperm whale stocks have fluctuated within the past few years resulting in large revisions in the estimates of yields. Additional data may result in further major revisions. The question of reserve males was discussed and some members felt that there was a critical need to maintain as large a male population as possible until this question is resolved.

If the Japanese proposal were to be applied the 1977 quotas shown in Table 2 would be obtained.

The majority of the Committee recommends that the Japanese proposals should not be adopted until the Committee believes that the reliability of estimates balances the risks of error in the proposed scheme.

10.3.3. Duration of quotas

The Committee discussed a proposal that quotas in the Schedule be fixed for an extended or indefinite period, instead of the present practice of fixing quotas only for the forthcoming season. The Committee concluded that review of quotas should proceed on an annual basis as at present.

11. MAJOR EXPLOITED STOCKS, STATUS AND REGULATORY MEASURES

A summary of the stock classifications and catch limit recommendations contained in the following paragraphs is included in Annex F.

Table 1

Length of time to reach Sustained Management Stock levels under the Japanese proposal.

Division	Male % over MSYL	Female % over MSYL	Time in years to SMS: Japanese proposal $\alpha = 0.10$*	Time in years to SMS: New management procedure
2	53	24	17	∞
4	61	–25	7	12
6	42	23	9	∞
8	175	29	28	∞

* Under the Japanese proposal
Quota = MSY + α (P– P_{MSY}) if $P > 1.2P_{MSY}$

Table 2

Catch limits under the Japanese Proposal and the New Management Procedure on Southern Hemisphere Male Sperm Whale Stocks at IMS

A. JAPANESE PROPOSAL					
Division	2	4	6	8	Total
(1) 10% of the difference between present stock and MSY level	570	530	150	2140	3390
(2) MSY	898	629	307	971	
(1) + (2)	1468	1159	457	3111	6195
B. NEW MANAGEMENT PROCEDURE					
(1) 90% of MSY	808	566	296	874	2524

11.1. Sei whales, Southern Hemisphere

Southern Hemisphere sei whales – Areas II–V.
Appendix C of SC/29/Rep. 1 (p. 343) provides population estimates from CHPOP and COHORT programmes at various times in the early 1960s. These were back-calculated to 1959/60 (Table 5) but apparently some errors were made and these have now been corrected in SC/29/Doc 45. These back-calculations used the recruitment estimates obtained from CPOP and also the mortality rate M = 0.075 agreed on at the Tokyo meeting. This procedure can also be used for forward calculation and population estimates for 1976/77 so obtained are given in Table 3 of SC/29/Doc 45.

However there are other ways to forward calculate. The recruitment can be estimated indirectly from the pregnancy rate and other basic parameters. Alternatively other data, e.g. CPUE or sightings can be used. Such other data have other problems – CPUE and sightings data are not available for all seasons. Further, sightings data and CPUE usually begin at a later season than the base year for which CHPOP and COHORT estimates were obtained. Thus to apply such data to forward extrapolation it is necessary to bridge the gap between the base year and the first season for which CPUE or sightings indices are available. To bridge this gap the CHPOP procedure has been used.

The CPUE data used are those given in Tables 4–7 of Doc T.18 and identified as CPUE-II. This is regarded as the best effort to use to measure sei whale abundance and has been adjusted for weather, operation time, tonnage and whale distribution (or selection). It is not known to what extent CPUE has been affected in recent seasons by changes in operations caused by quota reductions or allocations of quotas by Areas, although it is quite probable that it has been affected. The ratio between CPUE and absolute numbers is determined by dividing the base year CHPOP population estimate by the base year CPUE. This ratio is then used to calculate later population estimates.

Sightings data were used as follows. A straight line was fitted to data in SC/29/Doc 31 Table 8 (note that all missing data in this table have been replaced by overall averages; such missing data were not used in the fitted line). The ratio of sightings in 1976/77 fitted from the line to those in the initial (underlined) season is used to estimate the 1976/77 population value. An alternative way to smooth the sightings data is to consider the average of the last 3 seasons' sightings to initial seasons. The ratios so obtained are shown in Table 3.

The results are shown in Table 4 for the two basic estimates CHPOP and COHORT. Also shown are extrapolations from SC/29/Doc 3 using the programme SEI with M = 0.07 and recent pregnancy rate = 0.46, and from Doc T.3 of the Tokyo meeting. The programme SEI of SC/29/Doc 3 and the programme SEIPOP of Doc T.3 begin with lower 1959/60 population estimates. The figures under column SEIPOP are the average of the four models of Tables 5a-d of Doc T.3.

The SEI results are clearly not compatible with those obtained by other methods as far as the ratio between present and 1959/60 are concerned. Some members doubt the validity of the ratio as a criterion of evaluating the procedure because of entirely different circumstances in whaling in those two seasons, and they believe that the SEI model seems to reflect the behaviour of CPUE except in certain Areas. The essential difference between the series

Table 3

Ratio of last three seasons' sightings to initial seasons indicated.

Area	II	III	IV	V
Ratio	0.330	0.200	0.253	0.169
Seasons	Last three to 1965/66 and 1966/67 average	Last three to 1965/66 and 1967/68 average	Last three to 1966/67 and 1967/68 average	Last three to 1966/67 and 1967/68 average

Table 4

Estimates of Exploited Sei Whale Population Sizes 1976/77 by several methods (000s).

Area II

Basic Estimate Update Procedure	CHPOP CHPOP	COHORT CHPOP	CHPOP CPUE	COHORT CPUE	CHPOP Sighting	COHORT Sighting	SEI	SEIPOP
1959/60	55.7	60.4	55.7	60.4	55.7	60.4	37.0	44.2
1963/64	38.1	42.5	38.1	42.5	38.1	42.5	30.5	
1964/65	35.4	40.1	82.4	92.0			31.4	
1965/66	23.0	28.6	42.4	47.3			17.1	
1966/67	10.2	15.9	–	–			7.2	
1967/68	6.7	41.1					8.3	
1968/69	9.6	16.1					10.6	
1969/70	7.6	12.9					16.8	
1970/71	6.5	12.1					17.9	
1971/72	6.8	13.3					19.4	
1972/73	6.1	12.1					21.1	
1973/74	6.1	12.1					23.0	
1974/75	6.0	12.0					23.5	
1975/76	5.9	11.9					23.1	
1976/77	5.4	11.2	25.0	37.2	13.1	14.6	23.5	14.6

Area III

Basic Estimate Update Procedure	CHPOP CHPOP	COHORT CHPOP	CHPOP CPUE	COHORT CPUE	CHPOP Sighting	COHORT Sighting	SEI	SEIPOP
1959/60	44.7	26.5	44.7	26.5	44.7	26.5	22.0	27.3
1963/64	29.1	15.4	29.1	15.4	29.1	15.4	18.2	
1964/65	39.6	18.8	39.6	18.8	39.6	18.8	16.1	
1965/66	27.6	12.5	27.6	12.5	27.6	12.5	15.4	
1966/67	20.8	7.8	23.6	10.7			13.3	
1967/68	13.8	0.7					7.7	
1968/69	12.0	0					7.2	
1969/70	9.4	0					9.6	
1970/71	7.8	0					9.4	
1971/72	6.5	0					9.8	
1972/73	5.2	0					9.9	
1973/74	4.7	0					10.5	
1974/75	4.3	0	2.9	1.3			11.0	
1975/76	4.1	0					11.1	
1976/77	3.9	0			0.7	0.3	11.3	7.1

Area IV

Basic Estimate Update Procedure	CHPOP CHPOP	COHORT CHPOP	CHPOP CPUE	COHORT CPUE	CHPOP Sighting	COHORT Sighting	SEI	SEIPOP
1959/60	26.1	30.2	26.1	30.2	26.1	30.2	22.2	28.2
1963/64	25.3	29.6	25.3	29.6	25.3	29.6	21.1	
1964/65	22.7	26.7	22.7	26.7	22.7	26.7	21.1	
1965/66	22.6	26.8	22.6	26.8	22.6	26.8	20.0	
1966/67	22.4	26.7	22.4	26.7	22.4	26.7	20.0	
1967/68	20.4	24.8					17.9	
1968/69	19.7	24.5					16.5	
1969/70	20.1	25.3					18.8	
1970/71	19.2	25.1					18.0	
1971/72	16.0	22.4					15.4	
1972/73	11.7	17.2					14.2	
1973/74	11.6	17.9					14.1	
1974/75	11.0	18.0					13.9	
1975/76	7.7	13.2					14.2	
1976/77	7.3	12.8	8.4	10.1	3.0	3.6	14.8	11.4

Area V

Basic Update	CHPOP CHPOP	COHORT CHPOP	CHPOP CPUE	COHORT CPUE	CHPOP Sighting	COHORT Sighting	SEI	SEIPOP
1959/60	17.8	18.8	17.8	18.8	17.8	18.8	13.0	15.0
1963/64	13.7	14.6	**13.7**	**14.6**	**13.7**	**14.6**	11.0	
1964/65	12.0	12.9					9.6	
1965/66	10.3	11.3					8.0	
1966/67	10.0	11.1					7.6	
1967/68	10.7	12.0					7.6	
1968/69	7.7	8.8					5.7	
1969/70	4.4	5.3					5.7	
1970/71	6.1	7.5					6.0	
1971/72	6.6	8.2					6.4	
1972/73	5.8	7.6					5.9	
1973/74	4.2	5.8					5.5	
1974/75	2.9	4.6					5.5	
1975/76	2.9	4.9					5.5	
1976/77	2.5	4.5	7.7	8.2	2.4	2.5	5.3	3.7

Data in bold in this table refer to season for which CPUE or sightings calculations begin. This estimate is obtained from CHPOP or COHORT and is used to convert CPUE or sightings data to absolute numbers.

lies in the method used for extrapolating from year to year – the update. These are:

CHPOP – r_{II} recruitment rates obtained from age distribution

CPUE – relative population sizes as indicated by CPUE

Sighting – relative population sizes as indicated by sightings

SEI – simulation using observed pregnancy rate and constant juvenile and adult mortality rates which balanced at unexploited level.

SEIPOP – recruitment rates calculated according to model indicated.

It should be noted that the basic estimates by COHORT depend on age data and on an estimate of F which was determined from SEIPOP.

There are two ways to proceed. One way is to take the average of six estimates in Table 4 based on CHPOP and COHORT updated by CHPOP, CPUE or sightings data. These averages are shown in Table 5, together with the 1977/78 populations calculated as in SC/29/Doc 45 using average recruitments of Table 2 of that document.

Table 5

Comparisons of Total Mature Sei Whale Populations 1959/60 – 1976/77 (000s)

Area	1959/60(a)	1976/77(b)	1977/78
II	58.0	17.8	17.5
III	28.2	2.8	2.7
IV	35.6	7.5	7.1
V	18.3	4.6	4.1

(a) Average of CHPOP and COHORT estimates from Table 4.
(b) Average of CHPOP and COHORT estimates updated by three procedures – CHPOP, CPUE, sightings from Table 4.

The 1959/60 populations are believed to have been still expanding following the reduction of blue and fin whales and are therefore below the level to which the unexploited population would expand if it remained unexploited and other conditions remained unchanged. The present populations relative to the natural unexploited level are therefore even lower than in the above table.

The ratio of 1976/77 estimates to 1959/60 population values are consistent when CHPOP, CPUE or sightings are used. However, the recruitment estimates from CHPOP seem too low. The average value of the recruitment rate in Areas II and III is less than the natural mortality rate so that in those Areas the population would have fallen in the 17 year period even in the absence of catching according to this analysis. In Areas IV and V, the estimated recruitment rates exceed the mortality rate line only by 0.003 and 0.006 respectively. Thus the age data from which these recruitment rates are calculated may be incorrect and the estimates need to be recalculated with recruitment calculated from the pregnancy rate and the mortality rate.

An alternative way to proceed is to calculate recruitment from the observed apparent pregnancy rate P′, from the immature mortality rate M′ and from the age of first parturition (t_p), as is done in programme SEI (SC/29/Doc 3). It is then possible to fit a model to the calculated recruitment taking into account blue, fin and sei whale population levels.

Recruitment R is calculated as

$$R = Ne^{-t_p m'} \qquad (N = \text{no. mature } ♀♀)$$

where $M' = 0.07$, $t_p = 10.5$ decreasing to 8.1 over the period 1946/47 to 1975/76

Finally P is calculated from the apparent rate P′ taken from the IWC statistics adjusted both for the bias in determining pregnancy in catch data and for the under-representation of lactating females in the catch since they are protected by regulations. From data of Masaki (Doc. T.14 of the Tokyo meeting) the first adjustment was to increase the apparent rate P′ by 10%. Then P′, as adjusted, was converted to P by the formula:

$$P = \frac{P'}{0.94 + 0.6P'} \text{ (from SC/29/Doc 7)}$$

with $\alpha = 0.4$ $P_{lt} = 0.1$).

The sei whale population is that for Areas II to V combined from output of SEI with M = 0.07 (from SC/29/Doc 3). The basic data so obtained are given in Table 6. Numbers of blue and fin whales are taken from an unpublished manuscript of Allen.

Table 6

Data for multiple regression of recruitment (R) on numbers of blue, fin and sei whales

Season	Percent pregnant Apparent rate (P')	Rate of recruitment R	No. blue (000s)	No. fin (000s)	No. sei (000s)
1947	.226	.105	58	307	94.2
1948	.269	.123	49	298	94.1
1949	.238	.111	43	290	93.7
1950	.396	.170	38	280	93.3
1951	.285	.131	33	270	92.2
1952	.416	.178	27	260	91.3
1953	.431	.184	23	250	90.5
1954	.415	.179	20	241	90.2
1955	.347	.157	17	230	90.0
1956	.480	.202	15	217	90.1
1957	.411	.181	13	202	90.2
1958	.424	.186	12	184	89.7
1959	.517	.217	10	168	88.4
1960	.453	.198	8	153	94.2
1961	.500	.214	8	137	90.4
1962	.484	.211	8	122	87.2
1963	.549	.233	8	105	84.5
1964	.499	.218	8	90	80.8
1965	.504	.222	8	80	78.2
1966	.477	.214	8	80	60.5
1967	.480	.217	8	80	48.0
1968	.510	.229	8	80	40.9
1969	.555	.245	8	80	40.0
1970	.599	.261	8	80	50.9
1971	.564	.252	8	80	51.3
1972	.546	.248	8	80	51.0
1973	.530	.243	8	81	51.1
1974	.517	.240	8	82	53.2
1975	.452	.218	8	83	53.9
1976	.574	.261	8	84	53.9

Two models were fitted:

$$R = a + bB + cF + dS$$

and $$R = a + bB + cF + dS^{2.39}$$

In both cases the fin whale population contributed almost nothing to the variance explained and this variable was deleted. The resulting fitted equations were

$$R = 0.29592 - 0.0020984B - 0.00079409S$$

and

$$R = 0.26691 - 0.0020247B - (9.4341).10^{-7}S^{2.39}$$

The second model gives a slightly better fit ($R^2 = 0.859$ for the first and 0.863 for the second).

To estimate the maximum population levels, it is seen that these are attained when recruitment equals natural mortality. The recruitment in Table 6 and hence in the fitted equations is male and female combined. Hence the population is a maximum when:

$$\frac{R}{2} = 0.07 \text{ (mortality rate)}.$$

For the two models these are calculated to be:

Linear model: maximum sei whale population size (with B = 8) = 175.2×10^3 which is 1.86 times the 1959/60 population level

Non-linear model: maximum sei whale population size (with B = 8) = 132.2×10^3 which is 1.40 times the 1959/60 population level

The population levels given in SC/29/Doc 3 have been updated using the procedure and parameter values of that paper. These and estimated maximum values of the sei whale population are shown in Table 7. These maxima are those expected at the present level of the blue whale population.

Table 7

Maximum Populations of Sei Whales at Present Level of Blue Whale Populations from SEI Model (000s)

a. Linear Fit

Area	II	III	IV	V
1959/60 Population	37.0	22.0	22.2	13.0
Maximum Population	68.8	40.9	41.3	24.2
1977/78 Population	23.5	11.8	15.8	5.1
Ratio of 1977/78 level to maximum	0.34	0.29	0.38	0.21

b. Non-linear Fit

Area	II	III	IV	V
1959/60 Population	37.0	22.0	22.2	13.0
Maximum Population	51.8	30.8	31.1	18.2
1977/78 Population	23.5	11.8	15.8	5.1
Ratio of 1977/78 level to maximum	0.45	0.38	0.51	0.28

Problems in determining MSY levels for sei whales

The present management procedure presents few conceptual problems when environmental constraints, including food supply, on the stock are remaining stable. If, however,

these constraints change in a way which will alter the level at which the stock becomes stable, problems arise in defining the MSY level which should be used as a basis for classification and catch limits. Quite apart from any difficulties there may be in estimating the level at which the stock would now stabilise in the absence of exploitation, careful consideration needs to be given to the question of whether this or some other level is the appropriate basis from which to calculate the MSY level.

This problem has become of immediate importance in the case of Southern Hemisphere sei whales due to evidence that reduction of other baleen whale species has brought about an increase in pregnancy rate and a decrease in age at maturity of sei whales. It is possible that some change of this nature occurred as a result of the reduction of right whales in the 18th and early 19th centuries although there is no evidence to support this belief. The existing evidence relates to the effect of the reduction in fin and blue whales in the present century and implies that the sei whales have had an increased reproduction rate and therefore a potential to increase in numbers since at least the 1930s.

Two possible levels which could be used in determining management measures could be that which prevailed about 1930 before the current expansion began, or the level at which the stock would stabilise at some future date in the absence of exploitation, on the assumption that competing species, especially blue and fin whales, remained at a constant level. Each of these represent true equilibrium levels: that in 1930 at the original level of blue and fin whales; the future level, that associated with the present level of blue and fin whales. Past recommendations of the Committee have assumed that the 1959/60 level was an equilibrium level and hence appropriate as a management basis. It might be suggested that this basis be continued as a compromise one between the two alternatives noted above. These alternatives are now examined.

Adoption of 1930 levels as a base line would mean that stocks at or above MSY levels of that time would be exploited on a continuing basis by taking yields of 90% of that MSY. This would allow the stock to expand, although more slowly than it would if unexploited, and thus make use of some of the production capacity available to it. Ultimately, however, the expansion of fin and blue whale stocks should reduce the resources available to sei whales and they would again decline and would finally restabilise at about the original MSY level. This is dependent of course upon correctness of estimate of MSY for 1930, and on constancy of other features of the environment. Since it is inappropriate to extrapolate the model far outside the time period for which we have data, we cannot calculate the estimates of the MSY level or MSY from it, but simply assume that the MSY level would be at 60% of the 1930 level and the MSY would equal 4% of the approximate MSY level. Given these assumptions such a system would provide:

first, constant catches over a long period apart from changes required to correct errors;
secondly, automatic return to the final optimum level;
and thirdly, a conservative catch level which was except at the beginning and end of the series, always below the 90% of MSY laid down by the new management procedure.

Increases of competitor species (Laws, R. M., (1977) Seals and Whales of the Southern Ocean. *Phil. Trans. R. Soc. Lond. B*) or a fishery for krill (SC/29/Doc 16) make it quite probable that these stocks will not return to their former levels.

Attempting to determine the MSY level that is associated with the maximum population level of sei whales at the present levels of blue and fin whales leads to a number of complications. In the first place this level is less accurately known than the 1930 level since estimation depends on use of a hypothetical stock-recruitment function which has not, and cannot, be tested over the critical part of its range, whereas the 1930 level can be estimated using observed data for past years. Secondly, it would produce considerable variability over time in permitted catch levels under the current formula. Initially, there would probably be a marked reduction or cessation of catching since this procedure would cause the estimated current stock sizes to be a much lower proportion of 'unexploited' level and hence must place the stocks in the protection category. At a later stage the stocks would rise to the new MSY level and catching would resume at a fixed level. Still later, however, as noted above, if blue and fin whale stocks do rebuild to their MSY levels, sei whale stocks will begin to decline towards the original level. This would imply a new and lower MSY and catches would have to be reduced. This could occur in one or more stages but ultimately, in the absence of error, the stock might be stabilised at the same stock and catch level as before.

One peculiar anomaly of this system may be noted. If the stock is stable at the MSY level, and constant catches at the correct level are being taken, the immediate effect of an environmental improvement which permits stock expansion is to cause a reduction or a cessation of catching.

The possible compromise alternative is not in accord with the new management procedure. There is not any scientific basis for determining an MSY level on the assumption that the 1959/60 sei whale population level was stable. The Commission can determine MSY levels by taking them to be 60% of the 1959/60 level and the MSY as 4% of this 60% level but neither of these can be justified scientifically. An alternative possibility as an interim measure is to calculate replacement yields, i.e. catches that could be taken and leave the stock unchanged.

Table 8a shows classification and quota recommendations:

(1) if the first set of estimates (Table 5) are accepted and using the 1930 base as an equilibrium level. The 1930 base has been calculated from the 1960 population levels of Table 5, using the ratio between 1930 and 1960 population estimates in SC/29/Doc 11.
(2) if the second set of estimates (Table 7b) are accepted
  (i) using the 1930 base;
  (ii) using the maximum sei whale population level expected with the present level of blue whales;
  (iii) using the maximum sei whale population level associated with the 1948 level of blue whales.

Also shown in Table 8b are the replacement yields, together with explanatory notes relating to their calculation.

The figures have been calculated in two ways one (A) using a smoothed pregnancy rate in the SEI model, the other (B) using the fitted recruitment function. Two sets of data are calculated in each case (1) on the assumption that age of parturition is 8 years and (2) that it is 9 years. This statistic was declining over the period. It can be readily seen that the figures are highly sensitive to this parameter as the replacement yield model assumes a knife edge recruitment.

Table 8a

	Areas			
	II	III	IV	V
Alternative 1 – Estimates using Calculated Recruitment, CPUE, Sighting				
1930 Base (000s)	56.3	27.3	30.4	16.0
MSY level (000s)	33.8	16.4	18.2	9.6
% Present/MSYL	52	16	39	43
Classification	PS	PS	PS	PS
Quota	0	0	0	0
Alternative 2 – Estimates using Estimated Recruitment and SEI Model				
1930 Base (000s)	39.0	19.7	19.4	11.8
MSY level (000s)	23.4	11.8	11.6	7.1
% Present/MSYL	100	100	136	72
Classification	SM	SM	IMS	PS
Quota	842	424	418	0
Maximum if blue whales remain at present levels (000s)	51.8	30.8	31.1	18.2
MSY level (000s)	31.1	18.5	18.7	10.9
% Present/MSYL	76	64	85	47
Classification	PS	PS	PS	PS
Quota	0	0	0	0
Maximum if blue whales recover to 1948 levels (000s)	29.1	17.3	17.4	10.2
MSY level (000s)	17.5	10.4	10.4	6.1
% Present/MSYL	135	113	153	84
Classification	IMS	SMS	IMS	PS
Quota	630	374	374	0

Table 8b

Calculated Replacement Yields

Area	II	III	IV	V
A1	837	337	1112	299
A2	480	193	638	171
B1	742	298	986	265
B2	352	142	467	126

Southern Hemisphere sei whales – Areas I and VI

Analyses of data and estimation of populations from Areas I and VI have been more difficult because of the lower levels of catch and the more erratic series of operations in these Areas. In past years no direct analysis has been possible but estimates were made by comparison with estimates from Areas II to V. This year the direct or comparative estimates shown in Table 9 can be calculated from the data provided or are available in the documents presented to the Committee.

The estimates for Area VI are reasonably consistent even between the SEI method which uses recruitment from pregnancy rates and the others which use recruitment estimated from age data or from an assumed *a priori* model. If the ratios of 1977/78 to 1959/60 population estimates are averaged, the result is 0.48. This indicates that this stock should presently be classified as a Protection Stock.

The estimates for Area I are by contrast quite variable. This is not surprising in view of the relatively limited data from the erratic catches in this Area. For example, there

Table 9

Method of estimation	Area	
	I	VI
1959/60 Estimates (000s)		
CHPOP	–	9.2
Doc T.3 (Tokyo meeting)	9.8	9.5
SEI (SC/29/Doc 3) (M = 0.07)	18.6	8.7
Current Estimates (000s)		
CHPOP (SC/29/Doc 45)	–	4.0
Doc T.3 updated by Allen recruitment model	3.6	4.1
SEI (SC/29/Doc 3) (M = 0.07)	19.0	5.0

has been an increase in the CPUE II index in recent years over that in the early 1960s. On the other hand the sightings index has decreased but there are many missing years in the index, so that it is difficult to regard it as reliable. By coincidence the average of the two quite different current estimates in Table 9 is quite close to the estimate given for Area I of 11,800 in IWC 27. It seems therefore that in the absence of new information of a satisfactory nature that the classification of the sei whale stock in Area I and the catch limit should be the same as last year (SMS – catch limit 353). The Committee notes that substantial catches of 'sei' whales are reported by South American land stations in Area I. Allowance has been made for these in the estimates as far as possible, but it is not known with accuracy what proportion are actually Bryde's whales. Limited data from Peruvian catches do not indicate any decline in the stock.

Table 10 shows the population sizes calculated for the 1976 meeting of the Committee and is included for comparison with the assessments provided in Table 8(a).

Table 10

Calculations of Southern Hemisphere sei whale population sizes (000s) at the beginning of March, seasons 1973–77, as made by the Scientific Committee at its meeting in London, June 1976 (taken from IWC 27, p. 40)

	Area					
Year	I	II	III*	IV	V	VI
1973/74	13.4	24.90	11.1	18.0	16.4	17.0
1974/75	12.5	26.14	12.1	17.8	16.2	16.1
1975/76	11.7	26.36	12.1	17.1	17.2	15.1
1976/77	11.3	26.15	13.2	18.8	17.1	16.1

* Catches include those at South Africa and in South Atlantic.

The preceding paragraphs contain the material prepared by the sub-committee during its consideration of the sei whale assessment problem and subsequently adopted by the Committee. In reviewing the material, the Committee recognised that two main issues were involved. The first, relating to selection of the most appropriate assessment method for each of the Antarctic Areas II–V, was basically a scientific issue for the Committee. The second, relating to the application of the new management procedures in a situation where MSY for a single species was changing as a result of changes in stock size of other exploited species, was an issue which would require comment by the Commission.

Selection of Assessment Method for Areas II–V

For Area V, the Committee accepted the conclusion outlined in Table 8(a) that using either of the alternative assessment methods, the stock should be classified as a Protection Stock.

When considering Areas II, III and IV, the Committee had before it a table of correlations of CPUE with population estimates from the SEI model; results are shown in Table 11. It was agreed that the SEI model is in accord with CPUE in Area IV but there is serious disagreement for Area III. The situation in Areas II and V is less conclusive. For Area IV, on the basis of reasonable correlation between CPUE data and the SEI model, the Committee accepted the Alternative 2 assessment method indicated in Table 8(a). It recognised that recommendation of classification and catch limit would be conditioned by the Commission's decision in relation to the desirable MSY level.

The strong negative correlation for Area III and the lack of conclusive correlation for Area II led most members of the Committee to adopt the Alternative I assessment method indicated in Table 8(a) for these areas, resulting in a recommendation that these stocks be classified in the Protection Stock category. In suggesting this approach, those members took account of strong supporting evidence. In Area III, all indices of abundance suggested low population density; in particular, sightings and tagging evidence from the Durban region had indicated a catastrophic stock decline. Similarly, in Area II, catches from the Brazilian land station had shown a similar decline which was also evident in other CPUE trends.

The Japanese scientists were not satisfied that the Alternative I approach was appropriate for Areas II and III. In their opinion:

'The Japanese scientists, referring to the procedures underlying Alternative I, stated that those procedures originally intend to possibly best fit to the CPUE behaviours and therefore their outputs must be tested by some other factors than CPUE. In this respect, they failed to provide any reasonable recruitment rates especially for the early 1960s. As shown in Table 12, the outputs indicate that in three Areas except Area IV the natural mortality annually exceeds the recruitment considerably and the populations in Areas II, III and V would have been decreasing even in the absence of exploitation. This is completely against the general agreement during the sei whale Special Meeting in Tokyo that the sei whale populations, responding to changes of external conditions, were increasing at least during the period late 1950s through mid-1960s.
Therefore, the procedures underlying Alternative I and their output estimates are scientifically unacceptable in this case. The SEI model, as commented in the above, may be still unsatisfactory in some respects, it is true, but all the more evidently there are no grounds to go back to the procedures underlying Alternative I and their doubtful estimates, especially for the Areas II, III and IV.'

Table 11

Correlation Analysis of CPUE with Population Estimates of SEI and CHPOP
Models with M = 0.07
(Number of data points in parenthesis)

	SEI Model (Recruitment using pregnancy rate)				CHPOP Model (Recruitment using CHPOP)		
	Area				Area		
Index	II	III	IV	V	II	III	IV
CPUE II	+ 0.14(4)	– 0.28(9)	+ 0.564(11)	+ 0.57(8)	+ 0.92(3)	+ 0.92(9)	+ 0.35(11)
CPUE Series D	– 0.34(7)	– 0.52(9)	+ 0.391(11)	– 0.0007(8)	+ 0.72(7)	+ 0.92(9)	– 0.025(11)
CPUE Land Station	– 0.91(10) (Brazil)	– 0.12(10) (S. Africa)			+ 0.65(10) (Brazil)	+ 0.92(10) (S. Africa)	

(Note. The Committee initially carried out a correlation analysis for the SEI model and this is the basis for the main text. Re-examination to check the correlation of the CHPOP model was carried out in connection with the request by the Japanese Commissioner as outlined in Annex J.

Table 11 now incorporates this additional CHPOP correlation analysis for comparison. As noted in Annex J, the positive correlation with CPUE data for Areas II and III is consistent with the decision by the majority of the Committee that it was more prudent to use Alternative I from the two choices available for Areas II and III.

As also indicated in Annex I, Japanese scientists considered that other evidence suggested that the Alternative I approach was inappropriate for Areas II and III).

Table 12

Average annual recruitments and natural mortalities (1959–63) (000s)

		Area II	Area III	Area IV	Area V
CHPOP	Recruitment	1.5	0.3	2.2	0.9
	Natural Mortality	3.5	2.7	1.9	1.2
COHORT	Recruitment	1.7	0.2	2.5	0.9
	Natural Mortality	3.9	1.6	2.2	1.3

Problems in relation to the New Management Procedure

It is difficult to establish an initial population size for sei whales and an associated MSY stock level to which new management procedures can be related. Some management strategy must be adopted which recognises the influence that decreased blue and fin whale population densities have had. It must also recognise the implications which are inherent in the new management procedure's objective of restoring blue and fin whales to much larger population levels. The considerations in the previous section (Problems in determining MSY levels for sei whales) have discussed various possibilities and Table 8(a) suggests catching strategies (albeit temporary in the absence of firm indications of likely environmental responses) that relate to them. The bases used relate to blue and fin densities in 1930, 1948, and currently, and estimate corresponding equilibrium population sizes of sei stocks. In effect, the Commission is faced with a choice of options of desired ultimate (in an unexploited situation) sei whale stock sizes.

The Committee recognised that it faced a basic difficulty in establishing the current situation of the sei stocks both in relation to replacement yields and to other whale stocks and competitor species in a dynamic situation. Setting catch limits with respect to an MSY on the basis of the stocks' assumed capacity to increase within the blue/fin whale 'gap' may result in wastage of sei whales which become displaced by recovering blue and fin whale stocks. However, there is no guarantee that such a recovery of blue and fin whales is assured. Indeed there are no firm data on population trends for blue whale stocks in the Southern Hemisphere. Furthermore, other competitor species have shown increases in density. Accordingly there is considerable reason to doubt that the operation of this strategy will result in blue, fin and sei whale populations moving to near 1930 densities. All these problems will necessarily be exacerbated by an expansion of the krill fishery.

Given this situation, most members of the Committee considered that a conservative approach was necessary, since it is important to make allowance for failure of the environment to respond as anticipated. A quota determined on a 1930 base (which infers a smaller absolute sei whale stock and a relatively high current stock level in comparison) may generate a catch limit which, on the basis of the current catch curve, could lead to a steady stock decline if the Commission and the Committee are unable to monitor stock decline.

Japanese scientists did not accept that such conservatism was necessary but suggested that:

'As a management strategy at this stage, it would be best to maintain stocks at around the present sizes. Neither insisting on further increase nor on hasty reduction of them; in this regard, harvest based on replacement yield would seem appropriate.'

11.2 Minke whales, Southern Hemisphere

The Committee reviewed pertinent data and stock estimates from SC/29/Doc 31, SC/29/Doc 36, and last year's sub-Committee report (IWC 27, pp. 67–8).

The assessment given in SC/29/Doc 36 applied a modified DeLury method to data from Area IV, assuming equilibrium prior to the start of exploitation. Evidence was presented indicating that such an assumption was in doubt. A crude analysis of the sightings data (total all Areas) from Table 14 of SC/29/Doc 31 showed a 3.7% per annum increase in numbers sighted during 1965/66 – 1972/73. If the data for later years are included, the apparent rate is higher, but this might be because crews of scouting vessels were getting more experienced at sighting minke whales, especially since commercial exploitation began. In this case the CPUE would have to be adjusted accordingly, with significant effect on the best estimates of initial and current stocks.

Additionally, the maximum rate of increase of sei whales as a consequence of reduced competition from blue and fin whales appears to have been about 5% annually (Agenda Item 11.1). The diet and distribution of minke whales are such that one might expect this species to be more competitive with blue whales than is the sei whale (Kawamura, Doc T.12; Laws, R. M., *Phil. Trans. R. Soc. Lond, B. 1977*). Analogous to the sei whale, minke whales may have undergone an increase in population size prior to the onset of exploitation.

Trends in CPUE data given in SC/29/Doc 31 and SC/29/Doc 36 were also discussed. The slight, statistically insignificant, downward trend in Area IV, which has been the most exploited of the six stock Areas, and the lack of trends in other Areas tended to confirm the suspicion that the minke whale was increasing prior to exploitation; i.e., that increased recruitment offset catches leading to either small or no changes in stock sizes.

Consequently, it was hypothesized on the basis of this evidence that the minke whale had been increasing at a constant rate prior to the onset of exploitation. It was decided to undertake a new assessment of the Area IV data incorporating this idea.

Mitchell stated his reservations regarding the use of sightings and CPUE data in making the above inferences and as a basis for assessing the stocks. These appear in Annex G which was considered under Agenda Item 8.

The appropriate value of M, instantaneous rate of natural mortality, to be used in the new assessment was discussed by the Committee. The mean value for both sexes of 0.125 reported by Ohsumi and Masaki (1975)* and used in previous assessments was obtained from an analysis of the age distribution of catches in the initial two seasons of exploitation. If the minke whale population was increasing as hypothesized, the catch curves utilized in the above analysis would yield estimates of M which were biased upwards by population growth.

Several factors were subsequently discussed in deciding upon a more appropriate rate:

1. From the natural mortality estimates for sei whales (0.07 or 0.075) and fin whales (0.04) it was suggested that the trend of increasing natural mortality with decreasing body size might be extrapolated. Linear extrapolation of M against length gave M for minke whales in the range 0.08–0.09 (back extrapolation gave a corresponding estimate for blue whales of 0.02). Linear extrapolation on the basis of weight rather than length gives a value of 0.075–0.080 for minke whales and a negative value for blue whales. M values for odontocetes tend to be lower than and not comparable with those for baleen whales.

*Ohsumi, S. and Masaki, Y. 1975. Biological Parameters of the Antarctic Minke Whale At Initial Population Level. *J. Fish Res. Bd. Can. 32(7): 995–1001.*

2. An average annual rate of increase of 3.7% on the basis of sightings would imply M = 0.088; this is an underestimate of M if crews of scouting vessels are getting more efficient at sighting minke whales.

3. Values of M = 0.07 and 0.09 both appear to give annual population estimates more consistent with the series of catches per unit effort than are the estimates assuming M = 0.125. Further analysis might favour one or other value, and even lead to a best estimate for M but that analysis is not practicable at the present time.

4. There is a possibility that due to segregation and thus selection in catches the true pregancy rate in the total population may be less than the pregnancy rate observed from pelagic catches, and that this would lead to a lower estimate of M. Further examination of this effect should be undertaken.

In the light of the above considerations the Committee decided to proceed on the basis of M = 0.09 in providing advice for 1977/78.

The DeLury model was modified to account for recruitment proportional to an increasing stock size with a seven-year time lag. Stock sizes prior to N_o were approximated by $N_o\ (1 + r-M)^{-t}$ where t is the number of years prior to the start of exploitation. Since the apparent rate of natural mortality obtained by Ohsumi and Masaki (1975)† would be biased upwards by an amount equivalent to the net rate of population increase, $M^1 = M + (r-M)$, the gross rate of population increase, r, was taken as equivalent to the mean value of M^1 for sexes combined, 0.125.

These assumptions were incorporated into the usual DeLury model (SC/SP 74/Doc 30) resulting in a multiple regression model of catch per unit effort against adjusted cumulative recruitment and adjusted cumulative catch. The model was applied to Area IV data and gave an estimate of stock size at the onset of exploitation (1971/72) of 32.6×10^3. This estimate was then extrapolated to the 1977/78 level and prorated to the other stock Areas by the average of the indices of abundance for 1975/76–1976/77 found in Table 4 of SC/29/Doc 36. These current, 1977/78, stock sizes were then back-calculated to their levels prior to exploitation by an iterative procedure, assuming that the stocks were increasing prior to exploitation and utilizing the recursive equation:

$$N_{i-1} = (N_i - R_{i-7})/e^{-M} + C_{i-1}$$

where $R_{i-7} = r\, N_{i-7}$.

The results obtained are shown in Table 13.

Given the hypothesis that stocks were increasing prior to exploitation, the Committee found it difficult to interpret these results, and, hence, to classify the stocks according to the new management procedure. Despite an inability to classify the stocks, the Committee agreed that indices of abundance tended to show that past catches had not substantially affected stock sizes and that this had come about as a result of an excess of recruitment over natural mortality which may have balanced catches. This suggested that exploitation could proceed on a conservative basis for an interim, one-year period.

There was disagreement in the Committee, however, as to the interim measure to be applied in calculating catch limits. Some members believed that the best use of available data would be made if replacement yields were utilized as the interim measure. In this case catch limits would be determined as no more than the net rate of population increase (r–M = 0.035) times the current stock size. These catch limits should be regarded as the maximum possible given the trend in recent years of an increasingly disproportionate catch of females; this imbalance may have depressed recent recruitment rates, particularly in those stock areas subject to lengthy periods of exploitation; e.g. Areas II and III.

Table 13

Estimates of initial and current minke whale stock sizes (000s)

Area	I	II	III	IV	V	VI
Index of Abundance relative to Area IV	0.745	1.226	1.957	1.000	1.005	0.713
Start of Exploitation	73/73	65/66	68/69	71/72	74/75	75/76
Size at Start of Exploitation	20.95	28.7	46.4	32.6	25.5	17.5
Current Size 1977/78	18.2	29.8*	47.5	25.0	24.1	17.8

*Includes proposed catch of 1,000 by Brazilian land station during 1977.

The Committee agreed that the replacement rates should be calculated on the basis of the true parent stock size, but most members felt that because of the uncertainty in the back-calculation of populations needed to estimate the parent stock sizes, it was preferable to base the calculations on the current stock size. The catch limits equivalent to replacement yields are shown in Table 14.

The Japanese scientists could not agree with the replacement rate calculation using 3.5% and requested that the following statement be included in the report:

'First of all, the net rate of population increase of 3.5% is no more than a speculation, because there seems to be some conceptual confusion in its derivation as to Type I

† Ohsumi, S. and Masaki, Y. 1975. *ibid.*

and Type II recruitments. If we accept as assumptions M = 0.09, and r (Type I recruitment rate) = 0.125, then the net rate of population increase would be no more than 2.2% by the formula given in SC/29/Doc 15. If we assume, together with M = 0.09, that the net rate of population increase is 3.5%, then the Type I recruitment rate would be increased to 0.149. Either case Type II recruitment rate will be variable depending on the parent and current stock sizes, while Type I recruitment is determined by the biological structure alone of the population. Unfortunately there may be yet no reliable estimates on mortality rate and the rate of possible population increase in the minke whales. Therefore, any set of these values is at present hypothetical indeed, but it is the Japanese scientists' view that if we agree to take a set of values, M and r, as appropriate, to calculate the stock sizes at the start of exploitation and at present, we should follow on the same procedures in calculating the replacement yield in the coming season, using the ordinary recursive equation:

$$N_{i+1} = (N_i - C_i)e^{-M} + R_{i+1},$$

where $R_{i+1} = rN_{i-6}$. The results with M = 0.09 and r = 0.125 are shown in Table 15.

limits very similar to those applied last season and to the average catches over the several seasons of exploitation in each stock. Since the past catches did not measurably affect stock sizes, except slightly in Area IV, it is likely that applying catch limits calculated by the 5% rule would leave the stocks unchanged during the interim.

The catch limits obtained in this manner as well as the average catches from past seasons and last season's catch limits are given in Table 16.

The majority of the Committee considered that it would be prudent to adopt the first replacement yield recommendations given in Table 14.

The Committee also agreed that utilisation of either of the above catch limits was only an interim measure pending the holding of a Special Meeting next Spring to examine all existing data for minke whales. It was further agreed that catch limits would be recommended next year only if a stock assessment satisfactory to the Committee were produced as a result of the Special Meeting, especially since animals born during the early years of exploitation will soon be entering the recruited stock, and hence drops in recruitment might be expected. Attainment of a satisfactory assessment would require submission of the following detailed analyses:

Table 14

Estimated Replacement Yields of Minke Whales (3.5% x current stock size)

Area	I	II	III	IV	V	VI	Total
Replacement Yield	640	1,045	1,660	875	845	625	5,690

Table 15

Replacement Yields in 1977/78 by Japanese Approach

Area	I	II	III	IV	V	VI	Total
Population Size ($\times 10^3$)	18.2	29.8	47.5	25.0	24.1	17.8	162.4
Recruitment	2,450	3,710	6,010	4,080	2,880	1,910	21,040
Replacement Yield	967	1,253	2,103	2,110	882	414	7,729

In view of the still insufficient knowledge on biological parameters and that the recent catches did not appreciably affect the population sizes, the Japanese scientists believed that the Southern Hemisphere minke whales are still at an early stage of exploitation and should be classified as Initial Management Stock and the catch limit should be determined by the 5% rule.'

Most members of the Committee felt the Japanese replacement yield estimate involved an unwarranted number of assumptions regarding the back calculation of parent stock sizes.

Other members of the Committee believed the weight of evidence indicated that past catches had not affected stock levels and suggested calculating interim catch limits as had been done for past seasons, i.e. taking 5% of stock sizes at the start of exploitation. Given the estimates of abundance for the onset of exploitation, this procedure provides catch

1. Examination of age distributions in succeeding seasons to identify bias in previous estimates of M;
2. Separate assessments for each sex to account for the disproportionate catch of females in recent seasons, additionally examining the assumption of recruitment proportional to female numbers;
3. Comprehensive diet studies of minke whales and comparison with other species to assess the degree of interspecific competition.
4. Examination of recent biological samples to re-estimate age at sexual maturity and pregnancy rate and to determine if temporal changes have occurred in either prior to exploitation;
5. Consideration of the effects of changes in whaling equipment, techniques, and strategy, and of seeking behaviour in minke whales upon measures of effort currently employed in the fishery.

Table 16

Catch Limits by 5% Rule and Average Catches of Minke Whales

Area	I	II	III	IV	V	VI	Total
Catch limits (5.0% rule)	1,050	1,435	2,320	1,630	1,275	875	8,585
Average catch	1,279	1,558*	1,727*	2,750	944	107	8,365
Catch limits in 1976/77	965	1,855	2,730	1,600	1,385	365	8,900

*Includes land station catches

6. All information pertinent to stock identification should be analysed, in particular variation in baleen and flipper coloration, morphometrics and biochemical characteristics, and including a detailed analysis of density distribution from year to year on the feeding grounds.

The Committee referred the IDCR proposals to the IDCR sub-committee for review to consider the possibility of establishing a comprehensive sighting and marking programme as a means of obtaining stock estimates independent of whaling operations. The suggested scope of such a programme is discussed in Annex H. The IDCR consideration is referred to under Item 8 above.

Best expressed his reservations about some conclusions reached by the Committee. These were as follows:

1. Undue emphasis was placed on an apparent increase of 3.7% in sightings from 1965/66 to 1972/73 which was not statistically significant. The statement that later year's abundance is higher is due to the fact that area coverage was greater in 1973/74 and subsequent seasons.
2. It is quite possible that deficiencies in effort determination could mask the decline that might have taken place in any one Area, and the lack of observation of a trend does not necessarily confirm the possibility of increased recruitment leading to small or no changes in stock size. Alternatively initial stocks might have been much larger than calculated.
3. It is accepted that values of natural mortality rate calculated from catch curves can be biased upwards by an increasing recruitment rate. However the fitting of a trend line to the two observed M values (for fin and sei whales) can tell us little about the true value for minke whales as assumptions have to be made about the relationship with body size. If the observed value for Bryde's whales (0.085 – see SC/29/Doc 46) is plotted against size at sexual maturity in the female, a trend line could equally well be drawn through the observed M of 0.125 for minke whales as through the value of 0.09 extrapolated from two data points. Thus there is no good reason to accept M = 0.09 over M = 0.125.
4. As no statistically significant trends of CPUE against time were observed, it is not valid to fit a DeLury estimate. Hence the population estimates that were obtained through use of this method are not valid.
5. The hypothesis from analogy with sei whales that an increase in population size may have occurred prior to the exploitation is accepted as such, but it is considered to be unsupported by any observational data to date, and it is certainly considered to be premature to adopt a current rate of increase of 3.5%.

Area II Minke whale quotas

At the last meeting of the Commission Brazil requested Scientific Committee advice on the allocation of quotas in Area II (IWC 27, p. 24). There is no compelling scientific reason why quotas should be apportioned in any particular way and the Commission should apportion quotas as it sees fit.

Minke whale size limits, all oceans

In response to questions (Annex H) from the Infractions sub-committee of the Technical Committee in relation to the need for minke whale size limits and any associated implication with respect to lactating whales, the Committee indicated that it was unable to comment without detailed consideration which it would undertake at the 1978 annual meeting.

11.3 Sperm whales

Biological parameters. The Committee decided to review the key parameters as used in the sperm whale model for the Southern Hemisphere at the last meeting, and to comment on whether these were applicable to the North Pacific as well, or whether there were data to suggest different parameters. These are listed in Table 6 of last year's Report (IWC 27, p. 42).

There was considerable discussion of the values adopted for pregnancy rate, harem size and harem reserve, and how these might change with changes in the density of the population. Although there had been some suggestion that pregnancy rates were intrinsically higher in North Pacific stocks than in the Southern Hemisphere, re-examination of more recent data, (SC/28/Doc 21) indicated that current pregnancy rates were low (0.15–0.20).

As it did not seem logical to propose that southern and northern stocks of sperm whales should have different reproductive rates, and that these rates changed differently with respect to stock size, it was assumed that the pregnancy rates adopted for Southern Hemisphere sperm whales at La Jolla in 1976 should be applied to North Pacific stocks as well. Late in its deliberations the Committee received a paper* raising objections to the assumption that pregnancy rate increased under exploitation. The Committee noted that in the La Jolla model changes in pregnancy rate have a major effect only on the yield of females; the effect on the yield of males is very much less, and only occurs when the higher values of the density dependence exponent are used (see IWC 27, pp. 245–6). The levels providing MSY are little affected by changes in pregnancy rate.

*J. P. Fortom-Gouin: Changes in the pregnancy rate of the female cachalot in relation with changes in population density or exploitation rate.

The term 'harem size' was considered to be misleading, and it was suggested that it should be replaced by the term 'number of mature females available to a school master*'. An average of 15 mature females is found in a mixed school, and as on average, 1.5 socially mature males are present during the breeding season, the mean number of mature females available to a school master is 10. This may not change with changes in the overall density of the population because it is felt that there are social factors regulating the effective size of a mixed school and that these are not likely to change with population density. The minimum proportion of reserve males (= harem reserve in Table 6, IWC 27, p. 42) needed to maintain adequate efficiency of fertilisation is not known. At the 28th meeting it was set at 0.3 in order to produce about 2 mature males per mixed school (15 mature females) instead of 1.5. Evidence given in SC/29/Doc 50 for polygynous pinnipeds indicated that reductions of 82 to 84% in the proportion of reserve males were possible without adversely affecting the recruitment rate. By analogy this would infer that the proportion of reserve male sperm whales might be reduced to 0.62–0.70 with some degree of confidence. It was pointed out however that some of the observed changes in pinniped active:idle bull ratios were accompanied by major changes in the mean age of males attending harems, so that the actual decline in the proportion of reserve males in the mature male population as a whole was greater than that observed in the actual breeding area.

The Committee therefore felt that at this time it was difficult to provide an alternative figure for the minimum proportion of reserve males required and decided to use 0.3 in current assessments.

Some discussion occurred on the logic of assuming a reduction in the mean age at sexual maturity in female sperm whales with density while no such change was proposed in the mean age at social maturity of males. The assumption of a density-dependent growth response in females had been made by analogy with mysticete whales and pinnipeds. It was felt that an odontocete analogy might be more appropriate. The comparison between two populations of *Stenella* in the Pacific, one heavily affected by kills incidental to purse seine tuna fishing and the other lightly exploited, suggested that changes in growth rate were not conspicuous in either sex, but that there was a shorter calving interval (and hence a higher pregnancy rate) and a reduction in duration of lactation in the exploited population (Perrin *et al*, 1976. *Fish. Bull.*, 74(2): 229–270).

Consequently the Committee believes it would be more appropriate, as well as conservative, not to allow for a decrease in age at sexual maturity in either sex without additional evidence for such a change. Such evidence can only be obtained from heavily exploited stocks, e.g. in Southern Hemisphere Division 9.

It was pointed out that the social organisation of the sperm whale was different and more complex than that of the *Stenella* species concerned. No other odontocete analogies are available.

The Committee reiterated the statement in its last year's Report (IWC 27, Section 11.1.2, p. 42) that the La Jolla model assumes that all sexes and all age groups are equally available to the fishery, whereas the seasonal segregation of large males and limited distribution of females means that the age and sex groups available to the fishery depend on the type and location of operations. Revisions of the model should take this into account. The one parameter that could clearly differ between Southern Hemisphere and North Pacific stocks is the age at recruitment. Inspection of age data available at the meeting from the Japanese age length key (IWC 27, p. 300) and Japanese land station and pelagic catches combined gave a probable mean age at recruitment of 9 years for both sexes in the North Pacific. More detailed analyses of this parameter for land station and pelagic operations separately, as well as by stock area, are needed.

In view of the rather low pregnancy rate observed in Western Australian data for 1976 (SC/29/Prog Rep 1), it was agreed that Soviet and Japanese Indian Ocean data should be analysed in the forthcoming year to provide evidence from larger samples of any changes in the pregnancy rate values.

Questions by the Commissioner from Panama. In response to a request by the Commissioner from Panama, the Committee provided answers (Annex J) to 9 questions relating to sperm whales population assessment parameters.

11.3.1 Southern Hemisphere sperm whales

Stock identity. It was agreed that there was no reason to alter the 9 Divisions adopted previously. The geographical limits of a possible independent breeding stock in the eastern equatorial Pacific (SC/29/Doc 8) do not conflict with the present limits of Division 9.

Assessments. Catch per unit effort figures for the 1975/76 and 1976/77 seasons are shown in Tables 17 and 18. These complement the tables for 1946/47–1974/75 given by Gambell (IWC 27, pp. 280–6). Data coverage south of 40°S is too limited to discern trends. North of 40°S only the Soviet data are sufficiently comprehensive for comparisons to be made. Those suggest an upward trend in male abundance in the last two seasons in Divisions 1 and 4, essentially no trend in Divisions 2 and 3, and a downward trend in Divisions 5 and 7. The data for females indicate recent increases in CPUE in all Divisions.

SPVAP analyses (IWC 27, p. 263) were employed to give estimates of MSY level (MSYL) and MSY per 10,000 mature females, using the same parameter values as listed in Table 6, IWC 27, p. 42, except that age at maturity in females is held at 10 years. The Committee noted that both in last year's and this year's analyses a density dependence factor of 1.4 was used.

The SPVAP results were then applied to the estimates of initial (1946) stock size obtained last year (IWC 27, p. 57, Annex F), together with estimates of 1977 stock size obtained by updating the 1975 figures to allow for subsequent catches. The relative change in male stock size for each Division between 1975 and 1977 is shown in Table 19.

Table 20 tabulates the results by Division, and includes recommended catch limits and classifications.

The Committee noted that as a result of the quotas set under the new management procedure the total Southern Hemisphere catch limits for both males and females show some increase over last year's figures, and that classifications are altered in two Divisions (1, 7) for males and three Divisions (1, 2, 6) for females.

In further updating 1975 estimates to provide the estimates of current stock size by Division, the Committee noted the importance of using all available data, in particular, catch per unit effort data. A correlation analysis was undertaken to compare trends in the last five years CPUE

*Equivalent to 'harem master' in previous reports.

Table 17

Antarctic pelagic catches of sperm whales outside the baleen whale season, net catcher days worked, and catch per net catcher day (in parentheses)*

Season	Division 1	2	3	4	5	6	7	8	9	Total
					Males					
					USSR					
1975/76	–	–	34/45 (0.778)	18/39 (0.462)	–	–	31/18 (1.722)	120/108 (1.111)	–	204/210 (0.971)
1976/77	–	–	–	47/52 (0.904)	–	–	–	58/65 (0.892)	–	105/117 (0.897)
					Japan					
1975/76	–	–	–	–	–	–	10/10 (1.000)	1/6 (0.167)	–	11/16 (0.688)
1976/77	–	–	–	–	–	19/48 (0.396)	–	–	–	19/48 (0.396)
					Females					
					USSR					
1975/76	–	–	10/45 (0.222)	11/39 (0.282)	–	–	6/18 (0.333)	0/108 (0)	–	27/210 (0.129)
1976/77	–	–	–	0/52 (0)	–	–	–	0/65 (0)	–	0/117 (0)
					Japan					
1975/76	–	–	–	–	–	–	10/10 (1.000)	0/6 (0)	–	10/16 (0.625)
1976/77	–	–	–	–	–	0/48 (0)	–	–	–	0/48 (0)

* Including only those 10° squares where sperm whales only were caught.

Table 18

Pelagic catches of sperm whales north of 40°S in the Southern Hemisphere, net catcher days, and catch per net catcher day (in parentheses)

Season	Division 1	2	3	4	5	6	7	8	9	Total
					Males					
					USSR					
1975/76	703/510 (1.378)	258/435 (0.593)	10/30 (0.333)	140/151 (0.927)	57/132 (0.432)	–	52/126 (0.413)	111/288 (0.385)	–	1,331/1,672 (0.796)
1976/77	121/96 (1.260)	720/444 (1.622)	224/216 (1.037)	288/234 (1.231)	41/65 (0.631)	–	0/39 (0)	0/78 (0)	–	1,394/1,172 (1.189)
					Japan					
1975/76	–	23/30 (0.767)	79/24 (3.292)	16/18 (0.889)	64/45 (1.778)	–	36/33 (1.090)	11/30 (0.367)	–	229/180 (1.272)
1976/77	–	–	36/77 (0.468)	–	–	–	–	12/32 (0.375)	–	48/109 (0.440)
					Females					
					USSR					
1975/76	754/510 (1.478)	409/435 (0.940)	0/30 (0)	287/151 (1.901)	21/132 (0.159)	–	192/126 (1.524)	777/288 (2.698)	–	2,440/1,672 (1.459)
1976/77	51/96 (0.531)	194/444 (0.437)	151/216 (0.699)	0/234 (0)	0/65 (0)	–	94/39 (2.410)	61/78 (0.782)	–	551/990 (0.557)
					Japan					
1975/76	–	15/30 (0.500)	0/24 (0)	45/18 (2.500)	52/45 (1.156)	–	51/33 (1.545)	54/30 (1.800)	–	217/180 (1.206)
1976/77	–	–	32/77 (0.416)	–	–	–	–	25/32 (0.781)	–	57/109 (0.523)

Table 19

Relative change in male stock size between 1975 and 1977

Division	1	2	3	4	5	6	7	8	9
1977/1975	0.86	1.04	1.13	1.01	1.00	1.10	1.17	0.97	1.11

Table 20

Southern Hemisphere sperm whales – estimated stock sizes (000's) and MSYs, and recommended catch limits by divisions

		Division									
		1	2	3	4	5	6	7	8	9	Total
1946 Stock	(♂)	12.4	33.0	38.4	23.1	21.9	11.3	15.9	37.7	36.2	229.9
1946 Stock	(♀)	20.3	54.1	63.0	37.9	35.9	18.5	26.1	58.5	46.4	360.7
1977 Stock	(♂)	4.6	16.4	13.7	12.1	7.4	5.1	4.9	33.6	12.8	111.3
1977 Stock	(♀)	17.8	50.8	52.6	21.6	34.1	17.3	21.0	57.4	25.7	299.4
% 1977/1946	(♂)	37.1	49.7	35.7	55.4	33.8	45.1	30.8	89.1	35.4	48.4
% 1977/1946	(♀)	87.7	93.9	83.5	59.9	95.0	93.5	80.5	98.1	55.4	83.0
MSY	(♂)	337	898	1,046	629	596	307	433	971	877	6,094
MSY	(♀)	112	298	347	208	197	102	144	322	251	1,981
MSY Level	(♂)	4.0	10.7	12.4	7.5	7.1	3.6	5.1	12.2	14.8	
MSY Level	(♀)	15.4	41.1	47.9	28.8	27.3	14.1	19.8	44.5	35.3	
% 1977/MSYL	(♂)	115	153	110	161	104	142	96	275	86	
% 1977/MSYL	(♀)	116	124	110	75	125	123	106	129	73	
Catch limit	(♂)	303(S)	808(I)	941(S)	566(I)	536(S)	276(I)	234(S)	874(I)	0(P)	4,538
Catch limit	(♀)	101(S)	268(I)	312(S)	0(P)	177(I)	92(I)	130(S)	290(I)	0(P)	1,370

Table 21

1976/77 Pelagic sperm whale catch; 1976/77 and 1977 quotas

	Male				Female			
Division	Catch	Land station quota	Catch limit	+10% allowance	Catch	Land station quota	Catch limit	+10% allowance
1	296	14	287	316	62	11	66	73
2	785	–	764	840	194	–	176	194
3	632	–	712	783	183	–	204	224
4	590	–	536	590	0	–	0	0
5	47	508	508	559	23	116	116	128
6	213	–	261	287	3	–	60	66
7	0	–	0	0	94	–	85	94
8	745	–	826	909	208	–	190	209
9	0	–	0	0	0	–	0	0
Total	3,308		3,894		767		897	

data by Division with corresponding predicted values from the model. The inherent variability in the sperm whale CPUE data, the relatively erratic pattern of operations within and between Divisions during this time and the relatively small changes in population size predicted by the model provided an inadequate series of data points for a comprehensive analysis. The results did not indicate a contradiction between the observed data and the model predictions.

Allowances. The Committee reviewed the 1976/77 Southern Hemisphere pelagic catch figures (Table 21) and considered the questions of allowances by Division and by sex.

1. *Allowance by Division.* Since recommended catch limits are set at 90% of MSY level, an allowance of 10% means that 99% of MSY may be taken in certain Divisions. The Committee draws attention to the fact that when likely shore station catches are taken into account more than the recommended catch limit would be taken in four Divisions for males and four Divisions for females, and that the full allowance would be exceeded in one instance (Division 5 females).

2. *Allowance by sex.* The Committee believes that in general there should be no allowances between sexes, but recognises the special problems presented when the male stock is protected and the female stock is open to exploitation in the same Division. In this case the Committee believes that, under the present management procedure, a 10% allowance of the female catch limit could be taken as males less than 38 feet. Once this allowance has been taken, whaling in that Division should cease, irrespective of female catch to that time. The combined male and female catch should not exceed the female catch limit for that Division.

Because of the differences in size and distribution which allow males to be selected, there should be no allowance by sex for male stocks exploited in a Division where females are protected.

11.3.2 North Pacific sperm whales

Acting on the recommendation in the 1976 Report, the Committee considered application of the La Jolla sperm whale population model to North Pacific sperm whales by stocks.

Stock identity. Having reviewed the data on female catch distribution in SC/28/Docs 21 and 25, the Committee considered there is sufficient evidence to designate at least two stocks with a boundary delineated as follows:

'From the ice edge south along the 180°W meridian of longitude to 180°W, 50°N, then east along the 50°N parallel of latitude to 170°W, 50°N, then south along the 170°W meridian of longitude to 170°W, 40°N, then east along the 40°N parallel of latitude to 160°W, 40°N, then south along the 160°W meridian of longitude to the equator.'

This boundary should be reviewed as further information on distribution is made available.

However because mark returns show a high degree of mixing of males in northern latitudes of the Pacific Ocean (see IWC 27, p. 171, Fig. 4) it is not possible to distinguish between males from these stocks for assessment purposes, particularly for the early years of the fishery.

Assessments. Because of the above reasons the assessments could therefore only be undertaken for the total North Pacific. Parameter values adopted were as for the Southern Hemisphere apart from the mean age at recruitment. From age-length data, using a Japanese age-length key (IWC 27, p. 300), this was estimated at 9 years for each sex. The La Jolla CHPOP and SPVAP analyses were used (IWC 27, pp. 258, 263).

As last year, the more conservative value of the density dependence exponent i.e. 1.4, was used in obtaining the estimates.

The effort data used were 1954–72 Japanese pelagic effort data. These were corrected for changes in tonnage over the period (IWC 27, p. 184) and a CHPOP analysis gave the population size estimates shown in Table 22, extrapolating back to initial population size and forward to 1977 using actual coastal and pelagic catches.

Table 22

Estimated Population Sizes (000's), Using Tonnage Corrected Pelagic Effort Data

Year	1947	1972	1976
Exploitable males	211	129	127

However, it was pointed out that the effort data had not included a correction for the introduction of Asdic over the period and the Committee agreed that such a correction was essential. The analyses were therefore repeated using the same correction as in the Southern Hemisphere (IWC 27, p. 272) giving the results shown in Table 23.

Table 23

Population Estimates Using Tonnage and Asdic Corrected Effort Data

	Exploitable males	Mature females
Initial Population	170,000	160,000
Population in 1972	71,000	134,000
Population in 1977	69,000	127,000
Population in 1978 (January)	71,000	125,000
Current Population as % of Initial	41	79
MSY Level as % of Initial	46	78
MSY	3,800	848
Classification	PS	SMS
Recommended Catch Limit	0	763

With a catch of 763 females per year and no catch of males in 1978 the male population on the present model and parameter values can be expected to increase so as to become a Sustained Management Stock by 1979.

The Japanese scientists stated that they could not agree with the above result in the light of considerable changes resulting from minor modifications until a more detailed examination of the data available is completed.

It was pointed out that from about 1966 onwards a significant number of females was taken by the Japanese pelagic fishery which was the basis of the CPUE data used in the analysis. The effect of this would be to reduce the amount of effort effectively applied to catching males, and therefore the CPUE for those years would be underestimated. This would lead in turn to some underestimate of the absolute and relative stock size on which the above recommendations are based. The extent and significance of this effect is very difficult to determine and impossible to estimate at this meeting, although the Committee has discussed some possible approaches. Although the effect on estimated stock sizes is probably slight, it would have a major effect on stock classifications and quotas. This question, as well as other possible sources of uncertainty should be examined as soon as possible.

One other possible bias which operates in the other direction is that the change in minimum size limits effective in 1973 means that the catches used for the extrapolation are not strictly comparable with those used for determination of 1948 and 1972 stock sizes. Use of catches corrected to exclude whales of length between the old and new size limits leads to a very slightly higher stock estimate for 1977 than that given in Table 23 but, on the other hand, the observed catches per unit effort of the same size groups in recent years have declined sharply. This might be however, in part, a result of transfer of attention by whalers from larger to smaller whales, but again the extent of this effect cannot be estimated at this time.

The Soviet scientists requested that the following statement be recorded:

'The North Pacific assessment situation for sperm whales was quite complex and had been subject to a number of modifications during the course of the meeting. While these modifications had involved relatively negligible changes in estimates of the size of the stock, they had significant implications in relation to classifications and quotas. Such a consequence seemed premature on the basis of the uncertainty surrounding the assessment. Resolution of the matter had been further hampered by the progress of the meeting whereby the serious issues had been discussed at night sessions or delayed until beyond the scheduled completion date of the meeting, giving no time to examine the nature and implications of the successive modifications. Adequate time to consider these proposals and any amendments to them that may be appropriate should be allowed before the Committee moves to recommendations that have such significance.

It is difficult to forecast the Commissioners' attitude to the reliability of the Committee's classification and catch limit recommendations when these have encompassed a change from Initial Management Stock category through Sustained Management Stock category to Protection Stock category in two consecutive meetings. Despite this, catch per unit effort has remained at the same level.

Taking the foregoing matters into account, it would seem to be more appropriate for the approach adopted at the last meeting to be retained pending a more thorough review of the modifications that have arisen at this meeting. In the haste of the meeting it is possible that some of the modifications were applied in an unscientific manner. The models and parameters used are conservative to make

allowance for their inadequacies, yet they are changed hastily, with significant consequences, in a situation where due consideration may well indicate that such changes are inappropriate.'

The Committee recommends that, in order that any changes in the classifications and quotas recommended in this report which result from further study of the above effects and uncertainties may be considered by the Commission in setting quotas for the 1978 season, a special meeting to review North Pacific sperm whales should be held as soon as possible.

12. OTHER NON-PROTECTED STOCKS, STATUS AND REGULATORY MEASURES

12.1 Minke whales

12.1.1 North Pacific minke whales

No new assessment data were available to the Committee except that SC/29/Doc 35 reported separate landing statistics from all whaling grounds around Japan between 1965 and 1975 as requested by the Committee last year. CPUE (SC/29/Doc 35) has gradually increased since the 1950s, and since 1970 it has increased rapidly. Catches from the Republic of Korea were also available for the period 1965 to 1975. Last year two stocks were recognized in the western North Pacific:

1. Sea of Japan, Yellow Sea, and East China Sea.
2. The Pacific side of the Japanese coast and the Okhotsk Sea.

The former stock is exploited by Japan, the Republic of Korea, and probably by the People's Republic of China and the Democratic People's Republic of Korea.

The Secretary provided the Committee with some data on the catch of this species by the Republic of Korea. The fishing grounds are in two areas:

> the Yellow Sea between 36°N–37°N and 124°E–126°30′E;
> and the Korean Sea (Sea of Japan) between 36°N–37°30′N and 129°30′E–132°E.

It was also reported that 'the decline of total catches from 1974 is attributable to the decreased whaling efforts due to financial difficulties faced by the (Korean) whaling industry.'

SC/29/Doc 39 provided information on minke whales found by Japanese scouting boats between 1966 and 1976. A special scientific permit was issued for not more than 100 minke whales to be taken on the pelagic whaling grounds. One whale was sighted from a scouting boat and another one was caught at 32°24′N, 172°33′E on 12 July. Minke whales were scarce on the pelagic whaling grounds during the 1976 whaling season.

The Committee recognised two stocks in the Western North Pacific:

Okhotsk Sea/West Pacific stock

This stock is at present exclusively fished by Japan. The catches taken from the Okhotsk Sea and the Pacific side of Japan between 1965 and 1976 totalled 3,857 with a mean annual catch of 321. The highest recorded catch was 521 in 1973. Again, only limited data on this stock were available. The Committee noted that the CPUE on this stock is increasing, possibly reflecting an increase in efficiency which is not allowed for in the calculation. In view of these factors the Committee recommends that the stock be classified as a Sustained Management Stock and that the quota be 400 whales for 1978, which represents the mean annual catch for the period 1965–1976 with an allowance for the variation apparently inherent in this fishery.

Sea of Japan stock

The catch taken from the Sea of Japan stock between 1965 and 1976 for Japan and 1965 and 1975 for Korea was 5,995 with a mean annual catch of 545. The Committee noted that the greater part of this catch is taken by the non-member nations and that catch data by the People's Republic of China and the Democratic People's Republic of Korea have not been available.

The Committee welcomed the information supplied by Japan in response to the request at the last meeting and the plans to increase the available information from these minke whaling activities. It similarly welcomed the new (albeit limited) catch data from the Republic of Korea.

In the absence of any further information the Committee was not in a position to make a more comprehensive assessment of the stock. Until this information is available the Committee recommends that the stock be classified as a Sustained Management Stock and that the Commission request that the Japanese catching effort on this stock should not be increased. It further recommends that the Commission urge non-member whaling nations currently exploiting this stock to apply similar restraint, and also to provide CPUE and biological data from their whaling activities.

The other stocks in the North Pacific should be classified as Initial Management Stocks with zero quota pending satisfactory estimates of stock size.

12.1.2 North Atlantic minke whales

Greenland season

The Committee referred this matter to the sub-committee on Northern Hemisphere Baleen Whales. Relevant sections of the report as adopted by the Committee form the basis for the Committee's comments below.

The Committee noted that Commission Agenda Item 13 refers to a proposal included at the request of Denmark to replace the words 'eight months' by 'nine months' in the last sentence of Schedule Section II, paragraph 2(e). The effect of this would be to extend the present continuous open season for minke whale hunting in Greenland by one month, i.e., from April to November, to April to December each year. In explanation of their request the Danish Authorities state that 'According to the existing provision the open season in Greenland for the taking of minke whales is the eight-month period from April to November each year. The climatic conditions during December however occasionally permit a catch of minke whales which would, especially at that time of the year, contribute a desirable supplement to the nutrition of the local population and for this reason Denmark proposes an extension of the open season by one month which would, from a Danish point of view, cause no concern, taking into account the overall limitation on catch instituted by the quota regulation.'

The Committee believes that one additional month of hunting in December should not adversely affect the state of the West Greenland Stock of minke whales, since a catch

limit is in force for this stock. However, extension of the season may lead to a change in the sex ratio of the catch and the situation should therefore be kept under review.

Status and regulatory measures. No new information was available on the distribution of the different stocks of minke whales in the North Atlantic. The Committee prepared charts and text to define the geographical boundaries of the four stock units recognized last year and these appear in Annex C, together with proposed boundaries for fin and sei whale stocks in the North Atlantic.

A. *Canadian East Coast Stock.* No new information was available. The Committee recommends no change to the present classification as a Sustained Management Stock with a catch limit of 48 whales, but points out that this limit is based on the average catch over five years ending in 1972 and relates only to the catch by an average of two or three vessels in Trinity Bay, Newfoundland.

B. *West Greenland Stock.* The Committee last year was not able to arrive at a definite conclusion on the status of this stock. Two opinions were expressed on the annual catch limits which might apply:

1. 227–250 whales which represents the average Greenlandic landings 1966–75.
2. 406–429 whales which includes catches by the Norwegians.

At the last meeting Kapel noted that a drop in the Greenlandic catch in the last few years may reflect the expansion of exploitation of this stock since 1969. He has re-examined the data (SC/29/Doc 23) on the use of average catch per Greenlandic fishing vessel, and the catch per season for particular vessels as a measure of the availability of minke whales off West Greenland. He concludes that it is not possible from the available data to show any definite trend in CPUE, nor to state whether or not Norwegian whaling in the Davis Strait has adversely affected this stock. He points out that the intensity of fishing has been approximately the same during the eight years 1969–76 for the Norwegian fishery and for the Greenlandic fishery since 1965. The small decline in the Greenlandic catches may be explained by factors such as defective reporting, competition between whaling and fishery activities, and the development of collective catching, as explained in SC/29/Doc 23, and may not be the result of a decline in the numbers of whales available. The Committee recommends that in this situation it is appropriate to classify this stock provisionally as Sustained Management Stock and to use the average catch over a period of years to arrive at a catch limit for the 1978 season. The average catch for the Norwegian fishery for 1969–1976 is 180 whales, and for the Greenlandic fishery for 1967–1976 is 217 whales, a total of 397 whales.

C. *East Greenland – Iceland – Jan Mayen Stock.* No new sightings data are available. Recorded catches averaged 298 whales per year in 1961–1975. The Icelandic catch was 171 in 1975 and 197 in 1976. The Norwegian catch from this stock was 97 whales in 1976 (SC/29/Doc 48, Table 2). This reduced catch compared with previous seasons is a result of the quota introduced for the 1976 season on catches of minke whales from the stocks east of Kap Farvel. As a result, Norwegian whaling ceased on 15 August instead of 1 September as in previous years. The Committee recommends no change in the present classification as a Sustained Management Stock with a catch limit for this stock of 320 whales in 1978.

D. *Svalbard – Norway – British Isles Stock.* (East Atlantic Stock). During a four-week Norwegian marking cruise in July–August 1976 in the Bear Island–Svalbard region only 15 minke whales were marked because of extremely bad weather; 150–200 minke whales were sighted (SC/29/Prog Rep 7). Christensen and Rørvik (SC/29/Doc 13) give an estimate from marking/recovery data of nearly 50,000 whales for this stock (95% confidence interval from 20,000 to 130,000). This estimate is of the same order of size as previous estimates (20,000–40,000 in IWC 27, p. 373). The Norwegian 1976 catch of 1,860 whales from this stock was limited by the cessation of whaling on 15 August because of the quota limit of 2,000 whales introduced in that season for stocks east of Kap Farvel.

The Committee recommends that the stock remain classified as a Sustained Management Stock, with the same catch limit as for 1977 (1,790 whales). Rørvik pointed out, with reference to SC/29/Doc 48, that new, more detailed catch report forms had been introduced for Norwegian minke whaling in the 1976 season and that the CPUE derived from these was not comparable with earlier measurements of CPUE.

Bertrand drew attention to a change in the sex ratio of catches from this stock over the years with an increasing proportion of females (shown in SC/29/Doc 48, Annex D, Table 1). Jonsgård explained that this arose from the marked segregation of the sexes in different areas and at different times of the year, and the effect of changing whaling grounds mainly resulting from Norwegian national regulations of minke whaling.

The Committee stresses the importance of reducing the high percentage of females in the Norwegian minke whale catches, and understands that this might be possible by altering the Norwegian national regulations.

The Norwegian scientists unanimously reiterated their concern over the appropriateness of catch quota regulation for this fishery in view of the impossibility of introducing an effective control system as explained in IWC 27, pp. 400–1.

The Committee confirmed the high priority given last year to the collection and analysis of minke whale age data from the Norwegian fishery. It is understood that Canadian $5,000 has been provided as partial funding for this research proposal by the Canadian Government. Jonsgård stated that the Norwegian Government will provide at least US $10,000 for the project and Bertrand indicated that the USA will also seek funds for the project. In view of this support, the Committee strongly recommends that this project be undertaken during the 1978 season.

Kapel will this season investigate the problem of obtaining biological material, including ear plugs, from minke whales caught in West Greenland. SC/29/Prog Rep 7 records biological observations made on the stocks in the Norwegian fishery in 1976 and these are continuing this season. A programme of research is in progress on the species in Icelandic waters (SC/29/Prog Reps 4 and 7). SC/29/Doc 29 gives preliminary results of staining techniques devised for the examination of minke whale ear plugs, and SC/29/Doc 42 details studies on the blood of this species.

12.2 Bryde's whales

12.2.1 Southern Hemisphere

The Committee had available SC/29/Doc 38 which reported research work undertaken by Japan under a Scientific Permit. The studies included sightings, marking, biological examinations and population analysis but were still inadequate to provide satisfactory estimates of stock sizes. The Committee recommends continued classification of Bryde's whales in the Southern Hemisphere as an Initial Management Stock at present; it recommends once again that additional exploitation of this species in the whole Southern Hemisphere should not be undertaken until satisfactory estimates of stock sizes have been obtained and therefore the northern limit for pelagic operations on this species in the Southern Ocean should not be extended for the present. In accordance with this principle catches from land stations should not be increased.

The Committee drew attention to the importance for stock assessment purposes of obtaining prompt information from Peru on Bryde's whale (and other whales) catches from land stations. It recommended that in addition to representations to government sources, the Secretary should direct enquiries to industry sources to see if a more timely supply of information could be arranged.

12.2.2 North Pacific

At its 1976 meeting the Committee classified the North Pacific Bryde's whale stock in the Initial Management Stock category. The recommended catch limit was set at 1,000 whales (5%) of the estimated (IWC 27, p. 63) initial population size of 20,000 whales.

The Committee had available information in SC/29/Docs 37, 43, 46 and 47. Although the possible existence of three stocks (SC/29/Doc 43) was recognised of which the eastern stock was essentially unexploited, the Committee had insufficient data available to manage them separately.

Two indications of the condition of the stock were available. The first (SC/29/Doc 43) using Japanese coastal and pelagic CPUE and sightings data concluded that, although data were inadequate to provide reliable estimates of population size, there were no indications of a decreasing trend in stock density. This would imply that a similar management regime to that adopted last year would be appropriate. From SC/29/Doc 46 which used USSR pelagic CPUE data the initial population was estimated as 24,278 whales and the current population as 17,840. That paper indicated that a statistically significant trend of decline in stock size was apparent. Making an analogy with sei whales and taking MSY as 0.04 of MSY population level (i.e. 0.6 of initial population) provided an estimate of current population level as 122% of MSY population level.

The Committee agreed that the evidence above supported continued classification as an Initial Management Stock. It considered two options for catch limits, namely retention of the practice recommended last year representing 5% of estimated initial population size (1,214 whales) or a limit of 90% of estimated MSY. The Committee notes the lack of guidance from the Commission with regard to the transfer of stocks from the 5% of initial stock management rule to the 90% of MSY rule and seeks guidance on this general question. There is no unequivocal scientific evidence to support either of these options, but since the stock is approaching the Sustained Management category, it might be appropriate to set the quota for the coming year midway between the two values.

Some members of the Committee considered that as data available were inadequate to provide reliable estimates of MSY, the Committee should adopt the first approach in keeping with its past procedure in relation to currently exploited Initial Management Stocks for which firm estimates of MSY were unavailable.

Particularly in view of the statistically significant decline observed in the USSR pelagic CPUE (SC/29/Doc 46), the majority of the Committee agreed that sufficient justification existed to adopt the MSY (583 whales) estimated from SC/29/Doc 46 and to recommend a catch limit of 90%, namely 524 whales.

On the basis of the MSY estimate, continued reduction of current stock at 5% of initial population size would quickly place it in the Sustained Management Stock category. The Committee notes that if the sei whale analogy model is correct, and taking into account the lags in the system, a catch of 870 would not reduce the population to the Sustained Management classification within the next year.

The Soviet scientists requested that the following statement be inserted in the report.

> 'The Soviet scientists note that the CPUE data used in SC/29/Doc 46 for the fishery for Bryde's whale in the North Pacific do not take the following into consideration. In view of the decline in the fin and sei whale catches followed by the cessation of the fisheries, the Soviet fleet moved to more southern areas. At the same time raw material processing methods aboard factory ships were modified; in addition to oil reduction, meat and oil are now processed. In association with this, quality requirements for the raw material have become higher and the processing takes more time, involving a gradual decline in catches. This has resulted in lower CPUE data. This is the reason why the CPUE data shown in SC/29/Doc 46 do not represent actual CPUE values. Thus the assessments obtained are not sufficiently reliable and cannot be taken as a basis for the formulation of recommendations for Bryde's whale catch limits.'

12.3 Fin Whales, North Atlantic

No new information was available on the distribution of fin whale stocks in the North Atlantic. Geographical boundaries to the seven stocks recognized last year are given in Annex C. The Scientific Committee agreed to re-examine the identity of the West Greenland stock at the next meeting.

Status and regulatory measures

A. *Nova Scotia Stock.* No new information was available on this stock which it is recommended should continue to be classified as a Protection Stock.

B. *Newfoundland–Labrador Stock.* In the absence of new information, this stock should continue to be classified as an Initial Management Stock with a catch limit of 90 whales.

C. *West Greenland Stock.* Five whales were caught by Greenlanders in 1976. This was the only new information available and the Committee was not able to classify this stock. In response to a request made in last year's Committee report, Kapel has initiated enquiries into the availability of logbook records, containing sightings data, from the whaling carried out by one Danish catcher boat in the periods 1924–39 and 1946–57.

In response to a request from the Technical Committee, the Committee further examined this stock. Despite statistics showing small catches (1–5 whales) in recent years incidental to minke whaling, the Committee noted (IWC 27, p. 425, Table 18 and p. 426 Table 21) that a consistant fishery had operated on this stock for two periods from 1922–39 and from 1946–50; accordingly, it agreed that classification in the Initial Management Stock category was inappropriate. The Committee recommended that the stock be classified in the Sustained Management Stock category and, taking account of the magnitude of catches during the last five years, that the annual quota be limited to 4 whales.

D. *East Greenland – Iceland Stock.* In the absence of any new data apart from the catch statistics, this stock should continue to be classified as a Sustained Management Stock with the existing catch limits. Brown outlined the present position of the Icelandic-British studies on the animals taken by the Icelandic whaling company. Biological collections are being made by a British biologist for part of the 1977 season, and trials with the experimental visual streamer mark on blue whales may continue. It is understood that an Icelandic biologist is being trained in Norway and that he will undertake studies on the Iceland whale catch in future. The Committee urges that the Icelandic/British collections and data be completely worked up and fully reported. They also strongly recommend that the Commission impress upon the Icelandic authorities the importance of studies on this last major exploited fin whale stock. In order to get more firm evidence of the state of the stock the Committee recommends:

(a) That more of the logbooks of the past and present catcher operations be examined to obtain a better CPUE measurement than catch per boat per season or day, e.g., catch per hour on the whaling grounds.
(b) That the Icelandic authorities be requested to arrange for full biological collections to be made by a permanently appointed technician during the current season and in future seasons. The Committee points out that the presence at the whaling station this year of a biologist and an experienced Canadian observer would be of assistance to this technician.

E. *North Norway Stock.* This stock was not classified by the Scientific Committee last year. SC/29/Doc 21 presents an analysis of the available catch data for fin and sperm whales for the period 1960–71, after which whaling ceased. This shows the inverse relationship between the catches of the two species. Fin whale catch per day spent hunting fin whales indicates great variation but no overall decrease. The Committee recommends that the stock be provisionally classified as a Sustained Management Stock. Should whaling recommence, catches should not exceed the average catch over the period 1948–71 of 61 whales annually.

F. *West Norway and Faroe Island Stock.* In the absence of any new data on this stock the Committee recommends that it should continue to be classified as a Protection Stock.

G. *Spain, Portugal and British Isles Stock.* This stock was not classified by the Committee last year. The only new information is the catch for Spain in 1976 which Brownell stated was 136 'fin' whales. No figures are available for 1975; the average catch for the 5 years 1970–74 is 92 whales, and for the 6 years 1970–74, 1976 it is 99 whales. The Committee recommends that there be no increase in present catch levels.

In the absence of clear evidence of the status of this stock, the Committee recommends that the Commission request the Secretary to obtain further information from the Spanish authorities on the species composition of the catch of whales taken at the Spanish whaling station.

12.4 Sei whales, North Atlantic

The occurrence of this species on the whaling grounds of the north east Atlantic appears to be erratic. Off Nova Scotia its occurrence is apparently much more regular. Identification of possible stocks is very difficult. For the purposes of management, the Committee recommends the adoption of the stock boundaries given in Annex C.

Status and regulatory measures

A. *Nova Scotia Stock.* No new analyses of data were presented to the Scientific Committee. The Committee recommends that the classification as a Protection Stock should remain.

B. *Iceland – Denmark Strait Stock.* SC/29/Doc 27 analyses age at maturity, ovulation rate, and estimates mortality rates. No reliable estimate of the state of the stock was available. The erratic availability of sei whales on the Icelandic whaling grounds renders CPUE insensitive as an index of changes in stock size. The average catch in 1972–76 was 84 whales with an annual catch ranging from 3 to 139 whales, and over the period 1967–76, 83 with a range of 3 to 240 animals.

As in the case of the fin whale stock in the same region, the Committee strongly recommends that biological sampling of the catch be intensified (Paragraph in item 12.3 above). Mitchell called attention to the possibility that sei whales in the Labrador Sea might also represent this stock (SC/SP 74/40). In order to obtain better information on the size of the stock, it is necessary for marking and sighting cruises to be carried out and the Committee urges that these be undertaken.

Until sighting and marking cruises are initiated, the Committee recommends that the catch should be held at no more than the average catch over the last five years 1972–76 of 84 whales.

In response to a request by the Technical Committee for a consideration of the appropriateness of a block quota over several years, the Committee further examined the matter. The information available on catches (IWC 27, p. 426, Table 20) for the last 50 years indicated high variability (in contrast to the relatively stable pattern of fin catches) and an increasing trend recently. Some members suggested that the extreme annual fluctuations represented changes of accessibility associated with a tendency for sei whales to remain out of reach of the land station in some years; the occasional low catch years were not an indication of stock decline. The Committee agreed that it would be appropriate for the stocks to be classified in the Sustained Management Stock category, however it was not prepared at this stage to recommend a block quota. Instead it decided that it would be prudent to recommend that the stock catch limit for the 1978 season should be set at the average (84 whales) of the last 5 seasons' catches and that the matter should be reviewed next year, hopefully with the benefit of data from the sighting and marking studies recommended.

12.5 Sperm whales, North Atlantic

The documents before the Committee contained no additional information on stock identity, size or the biological parameters of the North Atlantic sperm whale population, and the Committee is therefore unable to make any new recommendations.

The Committee notes that catch data are incomplete for the Azores, Madeira and Spain from 1974. It recommends that the Commission again seeks to obtain such data, as resolved at ICES in 1976 (IWC/29/16(c)). One hundred and eleven sperm whales were caught by Iceland in 1976 but it is not known whether the total catch from the stock will exceed that suggested (685) for 1977.

In the absence of further information the Committee recommends that the North Atlantic sperm whale stock remain classified as a Sustained Management Stock and that the catch should remain stabilised at current levels, i.e., an average of 685 animals per year. It reminds the Commission that the greater part of the catch is taken by non-member nations.

The Committee requests that Iceland be asked to obtain and analyse biological specimens and data from its sperm whale catch, in particular age material, and that existing Icelandic/British collections be fully reported.

The Committee reaffirmed its 1976 recommendation that the Commission should encourage non-member whaling nations to undertake research on North Atlantic sperm whales. It expressed the hope that new information on stock condition may be forthcoming as a result of the Workshop on Historical Whaling Data.

The Committee also recommends that funds from the IWC Special Research Fund be allocated to obtain and work up specimens collected by an independent research worker at the Madeira station, and to supply equipment to undertake marking experiments.

12.6 Bottlenose whales, North Atlantic

The Committee has no new information beyond that reported in IWC 27, p. 49.

Rørvik emphasised the view that because of changes in catcher efficiency and length of season the view expressed at last year's meeting, indicating a decline in stock after 1913, did not hold. He also emphasised that the operation was not a multi-species but basically a single species fishery, on the basis that after 1946 3% of the fleet took more than 80% of the bottlenose catch, killer and pilot whales are mainly taken outside the bottlenose season (April–June) and whalers very seldom take bottlenose and minke on the same trip. Jonsgård pointed out that if on the basis of a decrease in catch, the stock was believed to have declined from 1972, the same conclusion should apply to killer and pilot whales, and that this seemed unlikely.

Mitchell drew attention to the recommendations of the North Atlantic Group (IWC 27, p. 375) particularly items (1) and (3) seeking economic data and analysis of the transition period for bottlenose to modern minke whaling. He requested that full economic data be supplied for study and publication for the period 1880–1976, including minke and bottlenose meat and oil production and prices; and also that basic catch and vessel statistics such as presented at last year's meeting be published.

However the Committee doubted whether such full economic data would be readily available.

The Committee noted that since it is not in a position to assess the condition of the stock the greatest need is for information on stock size and biology; it therefore strongly recommends that research be undertaken urgently, to obtain an estimate of stock sizes by sighting and marking and age data by means of a research catch. The Norwegian scientists stated that they were prepared to co-operate in preparing a research programme and that two Norwegian vessels may be available to carry it out. They also suggested that a foreign observer with knowledge of the species take part in the programme and van Bree agreed to try to obtain the services of such an observer. Until further information is available the stock should be classified as a Protection Stock.

13. PROTECTION STOCKS, REVIEW OF STATUS

The Committee agreed that at the next meeting it would undertake stock assessments on Protection Stocks approaching the Sustained Management Stock category. It reviewed available evidence on all stocks as follows:

13.1 Bowhead whales

At its 28th meeting the Committee indicated an urgent need, because of its concern about the safety of this species, to limit the increasing effort in the Alaskan bowhead fishery and to gather information to permit an evaluation of stock conditions. The Committee reviewed the new evidence available, noting that marking studies had not been undertaken and reiterating the urgent need for them. It explained that its intention in this regard was to suggest serial numbering of shoulder gun bombs to provide some indication of the 'struck and lost' survival rate and possible reference to faulty batches of bombs.

The Committee considered the species on the basis of five stocks as follows:

SPITZBERGEN STOCK

The Committee had a review (SC/29/Doc 33) of the history of exploitation indicating an initial stock in 1679 of approximately 25,000 bowheads. The absence of sightings from other whaling vessels indicates that the stock is now at a very low level.

DAVIS STRAIT STOCK

SC/29/Doc 33 indicates an initial stock of approximately 6,000, and a present stock of approximately 10% of initial.

HUDSON BAY STOCK

This stock was proposed (SC/29/Doc 33) to be newly recognised. Initial size may have been approximately 700; present size is approximately 15% of initial.

BERING SEA STOCK

The Committee had available reports of studies of bowhead whales in Alaska to 1976 (SC/29/Docs 10 and 30), and an historical summary and evaluation of the stock (SC/29/Doc 33). A previous estimate of stock size of 4,000–5,000 by Rice (1974 *in* Schevill, *The Whale Problem,* Harvard Univ. Press) was derived from data on whaling in the period 1868–84. SC/29/Doc 33 identified an earlier peak catch period, provided vessel extrapolations, summarized data on loss rates, and concluded

that initial stock size in 1850 was a minimum of 11,700 (10 year peak catch plus adjustment of losses), and probably approximately 18,000 (adjustment for residual stock). The best available scientific evidence indicates that the present stock size may be as high as 2,000 and low as 600, 6–10% of an estimated initial stock. Available evidence shows no increase in loss rates from 1920–75 (SC/29/Doc 33), but recent catches are increasing.

SC/29/Docs 10 and 30 indicated that 1976 was a record season, recent catches representing a threefold increase in the last seven years. Table 24 summarises data for the last four years from SC/29/Doc 30 and includes preliminary data for the spring 1977 season presented by Tillman.

Table 24

Number of bowheads taken, known killed but lost, and known struck but lost, in Alaskan Eskimo fishery 1973–77

	Number Landed	Number Killed but Lost	Number Struck and Lost
1973	37	0	10
1974	20	3	28
1975	15	2	26
1976	48	8	35
1977*	26	2	77

* Incomplete; data for 1977 autumn season to be added.

The increase in catch was associated with caribou take restrictions and an increased availability of cash for whaling activities arising from petroleum exploration employment and settlement of compensation claims relating to land rights.

Losses of struck or killed animals increased in 1976 associated with a progressive change from using the darting gun to use of the shoulder gun. Bombs from the latter frequently fail to detonate and do not incorporate a fixing line as a standby. Bertrand advised that proposed USA declaration as a depleted species would allow USA quota establishment and whaling control, but not before 1978 and only if complex aboriginal rights issues can be overcome. The Committee felt that use of the shoulder gun should be prohibited.

Ivashin explained that the USSR had overcome high loss rates in their aboriginal fishery by providing a special catcher 10 years ago which replaced aboriginal methods of hunting; this applied mainly in the gray whale fisheries. In recent years only one or two bowheads had been taken in occasional seasons and these by traditional methods.

OKHOTSK SEA STOCK

Few useful statistics were available for this stock. SC/29/Doc 33 provided a vessel extrapolation, and an estimated intial stock size of approximately 6,500 bowheads. The present population size is unknown exactly, but few survive.

The Committee expressed its appreciation of the very useful compilation of information presented in SC/29/Doc 33.

Taking into account its apprehension last year about the safety of the species, the Committee viewed with real concern the continued increase reported above and the continued high loss rate. It noted that at a time when there has been considerable pressure for a moratorium on commercial whaling on stocks in a sound condition, the species most endangered is one which has been subject to such a moratorium for about 40 years. The stock assessment details above suggest that current population size for the Bering Sea stock is from 6–10% of estimated initial population size and for the species as a whole is between 2–3% of initial population size, clearly placing the stock in the Protection Stock category. Despite this, the kill rate in the Bering Sea stock continues at about at least 5% of current populations and shows an increasing trend. In contrast, the Scientific Committee has only endorsed an exploitation rate as high as 5% for those stocks in the Initial Management Stock category.

The Committee noted with concern that 3 bowheads have been recorded as killed from the Hudson Bay population during the past 6 years and that further unsuccessful hunts have been recorded during 1975 and 1976 (IWC 27, p. 75; SC/29/Prog Rep 2).

The Committee believes that on biological grounds exploitation of this species must cease and recommends to the Commission that the words 'or right' in paragraph 7 of the Schedule be deleted. In making this recommendation, the Committee has taken into account the potential pollution hazard associated with petroleum development in the North American Arctic and its possible critical consequences for stocks at low levels of abundance. A particularly serious consequence of this high rate of exploitation of a small stock is the attendant instability of the system in the face of environmental perturbations. Such problems, examined in detail in SC/29/Doc 6, are exacerbated when a stock is at a low level relative to its initial size; the Committee agrees that the bowhead whale stocks are in such a state.

The Committee believes that any taking of bowhead whales could adversely affect the stock and contribute to preventing its eventual recovery, if in fact such recovery is still possible. No bowhead whale stocks have shown any discernable increase since protection began 40 years ago.

The Committee decided to review in more detail at its next meeting the question of aboriginal whaling on all species listed in the Schedule, giving particular attention to the possibility of suggesting safe quota limits within which national control could operate.

In response to a request by the Commissioner for the USA, the Committee provided further comment as follows.

The reduction of the bowhead whale to a small fraction of its initial population level poses two inter-related questions about the chances of survival of the species. In the absence of exploitation, environmental fluctuations will be expected over time to reduce the population below a critical level where extinction is likely. The smaller the population the higher the risk and the shorter the time to extinction. However, where the population is subjected to exploitation this problem is considerably exacerbated; if a quota is set and at any time some natural disaster reduces the population to any degree, continued application of the quota will result in severe depletion and a correspondingly shorter time to extinction. This risk is only slightly reduced if an effort regulation is used. Accordingly there is a clear scientific case to be made for a moratorium on this species in the hope that it will recover to a somewhat safer level.

13.2. Right whales

North Pacific

The Committee reviewed sightings data given in SC/29/Doc 47 and noted that three whales were sighted compared with two last year.

North Atlantic

SC/29/Doc 44 summarises much of the available information in the right whale (*Eubalaena glacialis*) in the Western North Atlantic. It includes information from the shore whaling period through 1937, sighting and stranding records for the period of protection since 1937, a discussion of past and present evidence for seasonal north-south migrations, and a consideration of factors other than whaling which may continue to retard the recovery of the stock.

Sightings data suggest a minimum population of 70–75 animals, based on the largest number sighted in one day. The problem of repeated sightings of the same individuals renders the use of sightings data to estimate population size difficult until distinctively recognizable individuals or visually tagged animals can be used in a systematic census. The increase in the numbers of sightings and strandings during the last ten years may indicate some recovery of the stock but it may also reflect increased observer effort. The paper lists a number of possible reasons for the apparent failure of the stock to recover more quickly, including depletion below some 'critical population size,' natural predation, competition with other species for food, and increasing pollution.

The Committee endorses the recommendations made in the paper for the continued opportunistic recording of strandings and sightings and the photo-documentation of bonnet patterns and anomalous colouration in areas where regular sightings are made. It is noted that no recommendation is made for marking this species at present because of the possible effects of disturbance on the animals.

Brown reported that no right whales had been recorded on the Icelandic whaling grounds during the whaling season (June to September) since 1969. Jonsgård stated that no sightings of this species had been reported by Norwegian whalers in the Eastern North Atlantic. A recent record of the species in the area is the animal captured at Madeira in 1959 (IWS XLV, p. 26). Rørvik stated that an additional individual was killed there more recently, but it is not recorded in the International Whaling Statistics. In view of the lack of sightings of this species in the Eastern North Atlantic suggesting that the population may be extremely small, the Committee recommend that the Commission draw the attention of the Portuguese authorities to these catches at Madeira, and request that no additional animals be killed.

Southern Hemisphere

SC/29/Prog Rep 8 reported a total of 148 whales (including 23 calves) sighted during the annual survey off South Africa. The number of calves sighted was lower than counts in 1972, 1974 or 1975, but the total was the highest since surveys started in 1969. Regression coefficients between 1969 and 1976 were significant at the 5% level for both calves and adults and indicated that the population had been increasing since 1969.

SC/29/Prog Rep 9 reported a total of 45 individuals from Soviet sighting data in Areas I, II and VI in the Antarctic. SC/29/Doc 31 reported 29 whales from Japanese sightings south of 30°S and extrapolation of these data suggested an average sighting abundance of 3,700 whales for that region.

SC/29/Prog Rep 6 reported 14 whales at Campbell Island and two off the New Zealand coast in 1976; these counts were 52 lower than in 1975, partly a result of poor sighting conditions at Campbell Island; indications were that this population was fairly stable at about 200 animals.

SC/29/Prog Rep 1 reported a low incidence of this species off the south coast of Australia in the months of August and October 1976.

The Committee noted that no data were forthcoming on the stocks of right whales off Argentina, and urged that data on numbers and trends be obtained from USA scientists concerned.

13.3 Gray whales

The Committee considered whether the Californian stock is above MSY stock level and should be reclassified according to the new management procedure.

However doubt about adequacy of the initial population size estimate, together with reasonable indications that the species may be subject to habitat reduction and harassment on the calving grounds suggested that reclassification may be premature.

The Committee decided to recommend that the species remain in the Protection Stock category pending a detailed review of the condition of the stocks at the 1978 meeting. In this regard it noted its 1976 meeting recommendations for expanded research efforts and stressed the need for such information to support its assessments:

> 'Because of the problems outlined in SC/28/Doc 33 [IWC 27, pp. 209–11], the Scientific Committee recommends that the Commission request IWC North Pacific countries to continue current research (shore counts from Monterey) and to expand research efforts to investigate the following·
>
> (1) possible changes of the migratory route off Southern California;
> (2) the mortality of calves in the lagoons;
> (3) changes in distribution of whales related to human activities;
> (4) application of whale marking (using the Discovery mark), external tagging, and radio tagging with a view to the possibility of the marked whales being recovered in the Soviet fishery on behalf of the Siberian aborigines.
>
> The Scientific Committee recommends that the Commission request that the US and Mexican Governments establish regulations to reduce harassment of whales in all the breeding areas. The Committee notes with concern the possible effects on the gray whale of petroleum development on the continental shelves of the United States including the Gulf of Alaska and the Bering Sea.'

In relation to items (2) and (3) the Committee noted that USA and Mexican co-operation on research projects would be required and requested the Commission to encourage such co-operation.

In response to advice from Tillman that future USA counts of migrating gray whales may be made biennially instead of annually, the Committee urged that USA annual counts be maintained because of the greater time span

needed to detect trends from biennial data and the possible deterioration of census skills. It stressed that the annual counts should be maintained at least until the Committee had carried out satisfactory stock assessments.

In supporting postponement of reclassification till 1978, Ivashin advised that this would provide an opportunity for the USSR to prepare biological data on the species for presentation to Scientific Committee. He explained that the former aboriginal hunting for gray whales was changed 10 years ago in order to reduce the number of animals lost. Local people now apply to hire a special whaling boat which is allocated for that use. A local conservation body examines their application and sets a local catch quota which is then caught by this whale boat, which carries a whaling inspector during the whole season. In the 1976 season 163 gray whales were taken. The Committee requested that full details of USSR biological collections be presented at the next meeting and if necessary attempts be made to expand the collections (to ensure ear plug data are available) to permit comparisons with data presented by Rice and Wolman (*Amer. Soc. Mammal.* Sp. Pub. no. 3. 1971).

It also requested that the USA provides full documentation on sightings, that Mexico provides full details of the research being carried out on the breeding grounds and that Canada provides details of sightings and unpublished carcase examination data.

The Committee noted advice that Henderson in the USA was re-examining historical logbook data to include, in his estimates derived on an oil yield basis, a factor to allow for losses of animals struck but not captured. This work and that of Nesheim on primary publication sources would be valuable when available. The Committee requested that information about sightings on feeding migrations and about studies on the implications of industrial development in the breeding lagoons be sought for the 1978 meeting.

13.4 Blue whales

North Pacific

Some evidence of a possibly isolated population of blue whales off the Californian coast was given in SC/29/Doc 8. In one day 71 whales were observed in small groups and between 19 and 23 June, a total of 106 whales was recorded. Sightings of 20 pygmy blue whales in the area 8°55′–9°07′N and 93°34′–93°55′W in March 1975 which were likely to represent a separate stock were recorded for the first time in SC/29/Prog Rep 9. Reports of two whales were received from Soviet catcher boats (SC/29/Prog Rep 9) and none were reported from Japanese catcher boats (SC/29/Prog Rep 5). The reason for the lack of sightings was a concentration of whaling activities in lower latitudes.

North Atlantic

Three blue whales were trapped by ice on the southwest coast of Newfoundland in February 1977; two escaped but one stranded and died (SC/29/Prog Rep 2). Similar incidents were recorded in the same area in March 1976. Mitchell expressed concern that this and similar known entrapments in the late winter–early spring of 1974–76, while representing few animals, might represent substantial mortality in the apparently small Gulf of St. Lawrence population.

Brown reported that there were 134 sightings of 288 animals on the Icelandic whaling grounds during the 1976 whaling season. The numbers, which do not allow for probable multiple sightings of the same animals, are of the same order as those in recent seasons.

Southern Hemisphere

Two groups with a total of 20 whales were reported from the eastern equatorial Pacific (SC/29/Doc 8). No indication was noted of a trend in abundance in the region south of 30°S in recent years and last year a total of 88 sightings was recorded (SC/29/Doc 31). A total of 124 sightings was reported in 1976/77 compared with 34 in 1975/76 (SC/29/Prog Rep 9). SC/29/Prog Rep 6 reported a 27.4 m blue whale stranded in northern New Zealand in the summer of 1975/76.

SC/29/Prog Rep 1 reported aircraft sightings of up to 13 animals off Albany in any one year since 1972; the index of abundance has shown little variation from 1972 to 1976.

In February 1975 in the Ross Sea, one blue whale was sighted (SC/29/Doc 32).

13.5 Humpback whales

North Pacific

SC/29/Prog Rep 11 reported censuses conducted around the Hawaiian Islands during the winter and in the inside waters of south eastern Alaska during the summer. Results were 412 whales around Hawaii, and 60 whales in south eastern Alaska. The index of abundance of whales based on whale sighting from Japanese scouting boats was lower in the 1976 season compared with the previous four years (SC/29/Doc 47). Once again this related to a concentration of whaling in lower latitudes.

North Atlantic

In the eastern North Atlantic 20–40 humpback whales were sighted during a four week cruise in Bear Island – Svalbard waters in July–August 1976, (SC/29/Prog Rep 7); no trends in abundance are yet evident. Christensen drew attention to data on catches in the Barents Sea quoted in Benjaminsen, T. *et al. Fisk. Hav., 76(2), pp. 9–23.* 1084 whales were caught off Finmark from 1881 to 1905 when whaling ceased. In addition 25 humpback whales were reported caught off Murmansk during 1885–7, and 40 off Svalbard in 1903–10 (IWC 27, p. 424, Tables 16, 17). Off the west coast of Norway 13 were caught in the years 1918–39. Since the earlier catches reduced the stock to very small numbers, with very few animals caught in later years, the authors suggest that the initial stock in this region was small.

Brown reported 41 sightings of 67 whales on the Icelandic whaling grounds in the 1976 season. These numbers are much lower than in recent seasons but this may be a result of changes in the hunting area for other species. Sightings records will be maintained this year to check any further apparent decline in numbers.

In the western North Atlantic, Kapel reported that 5 humpback whales were caught in Greenland in 1976 and that length and sex data were available for some of them. This number is near the average catch in recent years.

Two animals were reported trapped in fishing nets on the Newfoundland coast in June–July 1976. Both animals were marked with visual tags and one was studied alive for some time before being released bearing a radio transmitter (SC/29/Prog Rep 2). SC/29/Doc 5 reports preliminary

results of a long-term humpback whale study using the research vessel *Regina Maris*. Sightings off Newfoundland and Labrador and strip censuses in the Caribbean area support estimates by Mitchell, Winn and others suggesting that the population of humpback whales in the western North Atlantic is around 1,000 to 1,500 animals. Photographic studies of identifying features of individuals (e.g. dorsal fin shape, colour pattern of flukes and flippers) are being undertaken. One animal photographed off Newfoundland (51°N, 55°W) in August 1976 was recognised at Silver Bank (21°N, 70°W) in March 1977. This is apparently the first direct evidence of a feeding/breeding grounds migration link in the western North Atlantic humpback whales.

The Committee recommends that personnel of research vessels, particularly those operating in the Newfoundland and Caribbean areas, be encouraged to record photographically the fluke patterns of any humpback whales they may encounter with a view to possible further identification of recognisable individuals.

The Committee recognised the need to examine at its next meeting all sources of mortality in the western North Atlantic humpback stock, (e.g. the Caribbean fishery, strandings, and drownings in fish traps) in addition to the catch by Greenlanders. In view of the small size of this stock, the Committee requests the Commission to review at its next meeting the appropriateness of the present exemption (Schedule paragraph 7) allowing the catch of 10 humpback whales per year in Greenland waters.

Southern Hemisphere

Forty-seven humpbacks were sighted by land based observers in the New Zealand region in 1976. The previous highest number of sightings since 1971 was 15 in that year. A small subsistence fishery in Tonga was reported to account for less than 5 juveniles per year (SC/29/Prog Rep 6).

SC/29/Doc 31 reported a total of 32 whales from south of 30°S. Extrapolation of Japanese sightings gave an average abundance of 3,510 individuals. No change in abundance was indicated. A total of 344 sightings was reported from Soviet catchers, an increase of 29 from last year, with a decreased sighting effort.

An aircraft sightings programme off Carnarvon, Australia was begun during July 1976, but the amount of effort was too low to compare with results obtained during the last year of commercial whaling, in 1963 (SC/29/Prog Rep 1). There had been an increase in numbers of this species sighted from the aircraft operations off Albany in 1976, when 20 individuals were reported.

The sightings of two humpback whales are reported in the area in the North Ross Sea in February 1975 (SC/29/Doc 32).

13.6 Fin whales

North Pacific

SC/29/Prog Rep 9 reported 12 whales sighted from Soviet catcher boats and 14 were sighted from Japanese scouting boats (SC/29/Doc 47) during 1976. A few whales were also observed in the eastern tropical Pacific (SC/29/Doc 8). The Committee recommends that the stock remain classified as a Protection Stock.

Southern Hemisphere

A total of 275 whales was sighted from Japanese scouting boats in the Antarctic during the 1976/77 season (SC/28/Doc 31). A total of 638 whales were sighted from Soviet catcher boats in the Southern Hemisphere during the 1976/77 season (SC/28/Prog Rep 9). The Committee recommends that fin whales in all Areas of the Southern Hemisphere remain classified as Protection Stocks.

13.7 Sei whales

North Pacific

Seven sei whales were sighted from Soviet vessels, and 2 were marked (SC/29/Prog Rep 9). 15 whales, of which 9 were marked (SC/29/Prog Rep 5), were sighted from Japanese vessels.

14. SPERM WHALES: NEED FOR CLOSED SEASON

The Committee considered proposals in SC/29/Doc 18 for extending and expanding the current closed season protection for males, and possibly extending the closed season to females and calves.

The Committee recommends that the current four month closed season for Southern Hemisphere harem bulls north of 40°S be retained on the basis of evidence presented in SC/29/Doc 18. Data from western South America were not included in reaching this conclusion in view of the fact that zero quotas are already operating in Division 9.

The Committee also considered that a closed season applying similarly to North Pacific males is desirable. SC/29/Doc 18 indicates a peak in mating in April–May, implying a four-month closed season from March to June inclusive. Many Committee members believe that a closed season for bulls greater than 45 feet south of 40°N should be imposed for a four-month season from March through June inclusive, subject to modification of the boundary of 40°N in light of any new distribution data and new biological data from the pelagic fishery which may be provided in the future.

15. AMENDMENTS TO THE SCHEDULE

15.1 Opening and closing dates for Antarctic baleen season

The Committee discussed the value of setting precise dates for the opening and closing of the whaling season south of 40°S latitude for baleen whales. It noted that the duration of the seasons for sperm and minke whales throughout the world is limited to eight and six months respectively in any period of twelve months. There appear to be no biological reasons for restricting the Antarctic baleen whaling season by precise dates now that there are catch limits set by Areas based upon the Commission's management policy, and in view of the present arrangements with regard to national quotas.

The Committee therefore recommends to the Commission that a four-month season for baleen whales should be declared by Contracting Governments, and suggests the following amendment to the Schedule paragraph 2(a) to read:

> 'Each Contracting Government shall declare for all factory ships and whale catchers attached thereto under its jurisdiction one continuous open season not to exceed four months out of any period of twelve months during which the taking or killing of baleen whales

except minke whales by the whale catchers may be permitted.'

15.2 Amendments to Paragraph 1 of the Schedule

The Committee recognised the need to update both the scientific and common names in the interpretation of the Schedule (Part I, paragraph 1). Members of the Committee were requested to communicate suggestions for changes to the Secretary during the forthcoming year, and the Secretary was instructed to present a compilation of these suggestions to the next meeting of the Scientific Committee.

In accordance with its decision last year, the Committee has further examined definitions for whales and, under item 17.2.2, relevant additions to the Schedule.

16. SMALL CETACEANS (OTHER THAN BOTTLENOSE WHALES)

16.1 Status of stocks

16.2 Recommendations for management and conservation

The report of the Standing sub-committee on Small Cetaceans, consisting of Baker, van Bree, Cawthorn, Christensen, Jonsgård, Kapel, Mercer and Rørvik and chaired by Brownell was received by the Committee and adopted as modified (Annex E).

17. DATA COLLECTION

17.1 Review of the arrangements for exchange of data and for collection and storage by a central agency

A sub-committee consisting of Beddington, Breiwick, Gambell, Horwood and Kirkwood (Convenor) considered the question of provision of computing facilities at annual meetings. Its modified report was adopted by the Committee.

This year computing facilities were available for the first time at an annual meeting of the Committee. Access to a large computer was gained via a remote terminal finally situated in the building in which the Committee met. Considerable use was made of these facilities, and it is anticipated that there will be an increasing demand for computing. It was considered essential that suitable access to a computer be available at all future annual meetings, if the current trend towards the analysis of sophisticated population models continues.

Computing demands at this meeting fell into two categories: running of existing stock assessment and population estimation programs, both with new data and revised parameter estimates; and the use of various statistical packages. Experience gained at the present meeting indicates that in the future:

(a) all programs for which a demand is anticipated should be implemented and tested on the actual system to be used prior to the annual meeting;
(b) data required for these programs should be available in computer-compatible form prior to the meeting;
(c) access to the computer should be within the building in which the meeting is held. It should be possible to use the computer at nights and weekends as well as during normal working hours, and for jobs to be given high priority on the computer system used;
(d) major computing jobs should be commenced early in the meeting. This may imply that the sub-committees requiring computations meet early and specify these requirements;
(e) if possible, persons familiar with the detailed operation of the various programs used should be present at the annual meetings, particularly if results are required urgently.

Analysis of present population models requires access to a large computer, whilst the simpler *ad hoc* statistical calculations could be carried out more easily on a mini-computer. The above recommendations could be satisfied at the next annual meeting in Cambridge by gaining access to one of the many computer networks in the U.K. It may also be possible to lease a mini-computer for the duration of the meeting. It is recommended that Gambell, in consultation with Horwood, investigate the most practical computing arrangements that could be set up. On the basis of the cost of facilities provided at the recent Special Meeting on Southern Hemisphere Sei Whales in Tokyo, the cost of a large computer, including the services of an operator/programmer for the duration of the Committee meeting, would not be less than £5,000.

In view of recommendations (b) and (d) above, it is also recommended that as much as possible of the Bureau of International Whaling Statistics data be available in computer compatible form. In this connection, the work being carried out by Breiwick with BIWS data should be strongly encouraged. Further, it is desirable that other biological data at present held in differing forms at various national laboratories be collected and consolidated into a common computer compatible form. The current collection of sperm whale age and maturity data is an example of such consolidation, and should be given full support.

17.2.1 On large whales

Recommendations concerning large whales are made under the appropriate species headings.

The Committee noted that at the 26th meeting (1974) and the 28th meeting (1976), the Commission amended the current paragraph 23 (b and c) of the Schedule to require collection of the following information:

(b) For each catcher ship attached to a factory ship or land station
  (i) the dates on which each is commissioned and ceases whaling for the season;
  (ii) the number of days on which each is at sea on the whaling grounds each season;
  (iii) where possible the total number of hours spent each day searching for, chasing and catching whales, but not including time spent picking up or towing;
  (iv) the gross tonnage, horsepower and length of each and the list of those equipped with Asdic; vessels used only as tow boats should be specified;
  (v) any modifications of the above measures or data from other suitable indicators of fishing effort for 'small-type whaling' operations.
(c) A list of the land stations which were in operation during the period concerned, and the number of miles searched per day by aircraft, if any.

The Committee is concerned that these data have not been reflected in the statistics available to it. They are of particular importance for the improvement of CPUE estimates which are vital to stock assessments. The Committee urges the Commission to consider ways of ensuring that the

required data are provided for all large whales, as well as minke whales taken in pelagic factory ship or land station operations.

The Committee noted that Item 17 of the Commission Agenda refers to requirement for collection of biological data. The Committee recognised the desirability of collection of gonads (or parts of them), ear plugs or teeth as appropriate from each whale taken as a precaution in relation to unforeseen future data requirements for stock assessment. The Committee agreed to consider the matter again next year and in the interim recommended that the Schedule should be amended by insertion of a new paragraph as followed within the Information Required section to require the collection, where possible, of these materials from each whale taken:

(a) Where possible all factory ships and land stations shall collect from each whale taken:
  (1) the combined weight of both testes, and tissue samples from one testis; or both ovaries.
  (2) at least one ear plug, or one tooth (preferably first mandibular).
(b) Where possible similar collections to those described in sub-paragraph (a) of this paragraph shall be undertaken by small-type whaling operations conducted from shore or by pelagic fleets.
(c) all specimens collected under sub-paragraphs (a) and (b) shall be properly labelled with the platform or other identification number of the whale and be appropriately preserved.

17.2.2 On small cetaceans

As noted under Agenda item 15.2 above, the Committee has examined definitions for small whales in connection with the Commission's Agenda item 12. This is concerned with the collection and reporting of data on small cetaceans taken in the following ways:

(1) 'small-type whaling',
(2) direct fisheries for small cetaceans,
(3) possibly fisheries involving incidental take of small cetaceans.

The Committee adopted a recommendation from its Standing sub-committee on Small Cetaceans, that the following revision of the definition of 'small-type whaling' be added to Section I, Interpretation, of the Schedule.

(1) 'Small-type whaling' – means catching operations using powered vessels with mounted harpoon guns hunting exclusively for minke, bottlenose, beaked, pilot or killer whales.

'Bottlenose whales' – means any whale known by the name Baird's beaked whale (*Berardius bairdii*), Arnoux's whale (*Berardius arnuxii*), Southern bottlenose whale (*Hyperoodon planifrons*), or Northern bottlenose whale (*Hyperoodon ampullatus*).

'Beaked whale' – means any whale belonging to the genus *Mesoplodon* or any whale known by the name of Cuvier's beaked whale (*Ziphius cavirostris*), or Shepherd's beaked whale (*Tasmacetus shepherdi*).

'Pilot whale' – means any whale known by the name of long-finned pilot whale (*Globicephala melaena*) or short-finned pilot whale (*Globicephala macrorhynchus*).

'Killer whale' – means any whale known by the name of killer whale or orca (*Orcinus orca*).

Kapel expressed the view in considering the definition of 'small-type whaling', and especially its implications in relation to paragraphs 21–23 of Section VI, Information Required, of the Schedule, that the Greenlanders' take of whales should not be considered as 'small-type whaling'. This and similar fisheries should be referred to as 'occasional (direct or incidental) capture of whales'. This type of fishing is carried out occasionally as a secondary activity during other fishing operations. The distinction between 'small-type whaling' and 'occasional capture of whales' is important in relation to the kinds of information which are relevant and which can be collected from these two types of fisheries.

The Committee recommend that direct fisheries for small cetaceans be defined as 'Deliberate, direct capture of small cetaceans' and that the following definitions be incorporated in Section I, Interpretation, of the Schedule.

(2) 'Deliberate, direct capture of small cetaceans' means catching small cetaceans by any method in which the small cetaceans are the desired catch.
'Small cetaceans' means any toothed whale other than the sperm whale.

The Committee recommend that in Section VI, Information Required, of the Schedule paragraph 21, the following sub-paragraphs be added,

(e) A record similar to that described in sub-paragraph (b) of this paragraph shall be maintained for the 'deliberate, direct capture of small cetaceans', and all of this information mentioned in the said sub-paragraph shall be entered therein as soon as available.

The Committee recommend that fisheries involving incidental take of small cetaceans be defined as 'Incidental capture of small cetaceans in fisheries' and that the definition be incorporated in Section I, Interpretation, of the Schedule, as follows:

(3) 'Incidental capture of small cetaceans in fisheries' means catching of small cetaceans in any fisheries where small cetaceans are not the desired catch such as:
  (1) inadvertent, in gill-net, trawl, purse seine, set net, and longline fisheries, and
  (2) deliberate, in purse seines.

The Committee recommend that in Section VI, Information Required, of the Schedule paragraph 21, the following sub-paragraph be added:

(f) A permanent record shall be maintained with the following information as soon as it becomes available:
  a. species name and local vernacular name where available;
  b. numbers caught;
  c. location of catch;
  d. wherever possible biological data should be collected;
  e. an appropriate indication of the intensity of catching effort and of the primary species sought.

While the majority of the Committee recommends that reporting of data on small cetaceans should be undertaken for fisheries as outlined above, Japanese scientists considered that it was inappropriate to include fisheries of the type outlined in items 2 and 3 above.

18. EFFECTS OF POLLUTION ON WHALE STOCKS, INCLUDING SMALL CETACEANS

The Committee received no information for large cetacea. Van Bree summarised his publication 'On former and recent strandings of cetaceans on the coast of the Netherlands' (*Z. Säugetierkunde*, 42 (1977): 101–7) which suggested recent strandings were associated with high levels of pollutants, importantly chlorinated hydrocarbons, polychlorinated biphenyls and heavy metals. Pollutants possibly assume importance when non-feeding individuals draw on body reserves.

Kapel advised of an ICES resolution (C. RES 1976/4: 25) that all specimens of harbour porpoises found dead should be sampled for pollutants; the Committee endorsed the ICES resolution and recommended that it should be extended to all species of cetaceans.

19. HUMANE KILLING OF WHALES

The Committee had before it documentation (SC/29/Rep 5a, b, c, d) incorporating a report by the Secretary on requests to member countries for information on potential methods of humane killing of whales, a circular communication submitting comments from Professor Rowsell (Canada), a copy of correspondence from a UK student carrying out a review and a summary of information from Japan on research on humane killing. It noted with regret the poor response to the Secretary's enquiries and urged that any outstanding information available to member countries be communicated promptly. It recognised that the poor response was associated with a lack of promising alternatives at present to the explosive harpoon.

The Secretary advised that little further research had been undertaken on humane killing methods since the particularly comprehensive study by an IWC Special Committee in 1960–61. The potential utilization of electrical harpoons and CO_2 was limited due to practical difficulties (SC/29/Rep 5d and a Japanese statement that darts iced up and grenades were unsuccessful). Use of high velocity projectiles or killing by drugs such as M99 still appeared to present the most promising avenues (if health standards will permit the use of the latter) for future research. The Committee noted in this regard that South Africa hoped to euthanise a stranded dolphin with M99 and subsequently carry out toxicological studies on tissue samples.

Mitchell asked Committee members for references to published and unpublished work on humane killing experiments and practices, for inclusion in an annotated, indexed bibliography being prepared by him in Montreal in collaboration with J. Seiler. The sponsor, the Canadian Federation of Humane Societies has requested that the final document be submitted to the IWC Scientific Committee for its use next year.

The Committee noted that a proposal to make it statutory to report the number of harpoons used to kill each whale was before the Commission. They considered this to be an unsatisfactory measure of humaneness because it might encourage gunners to use less harpoons and finish off the animal by other means (e.g. compressed air), so being counter-productive. The Committee felt that attention should rather be directed towards monitoring the use of cold grenades.

20. EDITORIAL POLICY RELATIVE TO PUBLICATION OF THE SCIENTIFIC COMMITTEE'S REPORTS AND ASSOCIATED DOCUMENTS

The Committee referred to the policy in relation to publication of documents that it adopted at its last meeting (IWC 27, p. 56). The Committee noted that papers will be subject to outside review before acceptance and that the Secretary shall be the Editor; it agreed that this arrangement was satisfactory. The Committee requested that the Secretary should provide a set of instructions to authors for their guidance, particularly when he was seeking contributions of documents prior to the annual meeting.

The Committee received advice from the Secretary that the final version of some of the background documents from the December, 1974, sei whale meeting had still not been provided by the authors concerned, despite repeated requests by him. The Committee was particularly disturbed at the delay to publication which this lack of co-operation caused; it requested that the Secretary should set a final deadline and proceed with publication of the report of the meeting without the documents if they were not received.

The Committee agreed that the following reports used during the meeting should be published in the Report of the Commission:

SC/29/Reps 5, 6 and 7.

It left to the Secretary the decision with respect to SC/29/Reps 2 and 4. It agreed that SC/29/Rep 1, the report of the special meeting on Southern Hemisphere sei whales, should be published separately, together with the following background documents from that meeting: T3, T4, T5, T6, T7, T8*, T9*, T10, T11, T12, T14, T15, T16, T17, T18, T19, T20, T21† and T22.

* – only if referenced in the text
† – the Committee agrees that the authors may expand this document.

The Committee agreed that all Progress Reports should be published unless the authors requested otherwise; it requested that the Secretary again forward details of the standard format of the reports prior to the next meeting.

The Committee identified the following 'decision documents' considered at the 29th Annual Meeting and recommended that they be published in the Report of the Commission:

SC/29/Docs 1, 2, 3, (5?), 6, 7‡, 8, 11, 13, (14?), 15, 16, 17§, 18, 19, 20, 21, 22, 23, (24?), 25, 26, 27, 28, 31, 32, 34, 35, 36, 37, 38, 39, 40, 41, 43, 44, 45, 46, 47 and 48.

The Committee noted that documents SC/29/Doc 10, 12, 24, 30, 33 and 50 would probably be published elsewhere.

‡ – perhaps alternatively as a background document in the report of the special sei meeting.
§ – to be condensed.

21. FUTURE MEETINGS AND NEED FOR SPECIAL STUDIES

The Committee agreed that Tillman should convene a special meeting early in April 1978 to examine all existing data for minke whales (see p. 72). The Committee urged

that activity to assemble the information necessary for the meeting should be commenced as soon as possible.

The Committee noted that it had also indicated an intention (see p. 36) to examine further the question of risks under a constant equilibrium catch as a result of environmental variability. It agreed that during the inter-session period, Horwood should encourage document preparation and co-ordinate its distribution by post well in advance of the next annual meeting.

Brownell advised that the meeting sponsored jointly by the USA Marine Mammal Commission and the National Marine Fisheries Service to attempt to resolve problems of age determination of as wide a range of toothed whales as possible was scheduled for early 1978 in La Jolla. The Committee suggested that it may be possible for the meeting to be held at a time (perhaps late March) convenient with respect to the proposed special meeting on minke whales.

The Committee discussed its recommendation (see p. 90), arising from problems with North Pacific sperm whale assessment, that a special meeting should be held as soon as possible to examine the uncertainties surrounding stock separation, effort data and age at recruitment. It recommended strongly that the venue for the meeting should be Cronulla and that it should be a 6-day meeting late in November. Bannister was appointed Convenor and the Committee agreed that he should urge the assembling of data and the preparation of necessary analyses and should co-ordinate distribution of the material.

22. ELECTION OF OFFICERS AND COMMITTEES

K. R. Allen and J. L. Bannister were elected Chairman and Vice-Chairman for the coming year.

Two Standing sub-committees were formed (see Rules of Procedure, IWC 27, pp. 55, 56):

Sperm whales – Bannister (Convenor), Ohsumi, Ivashin, Best, Beddington, Kirkwood

– The sub-committee was given the specific task of compiling a bank of data in a readily accessible form.

Small Cetaceans – Brownell (Convenor)

– membership and activities to be arranged by the Convenor.

23. INITIAL AGENDA FOR 1978 MEETING

In view of the difficulties of dealing adequately with *ad hoc* questions in Committee during the week of the Plenary Session meeting, the Committee agreed to consider at its next meeting the inclusion of a new rule of procedure specifying that, during the week of the Plenary Session, the Committee would consider *ad hoc* questions only if they were referred to it by the Chairman of the Technical Committee.

The following matters, referenced to appropriate sections of the report, were specified during the course of the meeting as items to be discussed at the next annual meeting:

7. Review of the report of the FAO/ACMRR Working Party on Marine Mammals.
9.3.2 Preparation of a list of minimum morphometric data requirements to be obtained from material collected under scientific permits.
9.8 Preparation of Stock Handbook.
10.2 Establishment of new classification categories.
10.3.1 Effect of environmental variability on management risks.
11.2 Size limits for minke whales.
12.1.2 Effect of change in season on sex ratio in West Greenland minke whale catches.
12.3 Re-examination of the identity of the West Greenland fin whale stock.
12.4 Review the Iceland–Denmark Strait sei whale stock.
13. Undertake stock assessments of Protection stocks now approaching the Sustained Management stock category.
13.1 Review aboriginal whaling on all species listed in the Schedule.
13.3 Review the status of gray whales.
13.5 Review sources of mortality in the western North Atlantic humpback stock.
15.2 Review the Scientific and Common Names in Paragraph 1 of the Schedule.
17.2 Review Requirement of Collection of Biological Material from each Whale Captured.
23. New Rule of Procedure requiring *ad hoc* questions to come through Technical Committee.
Annex H Questions from the Infractions sub-Committee on size limits for minke whales.

The following matters were referred by the Technical Committee to the Scientific Committee for consideration at the 1978 meeting:

(1) Safeguards in present management criteria.
(2) Establishment of new classification categories.
(3) Use of a block quota system for Icelandic sei whale catches.
(4) Sources of mortality in humpback whales.
(5) Proposals for a specific programme of research on humane killing after review of the bibliography being prepared by Mitchell.
(6) Sperm whales – Consideration from a biological point of view step procedures in implementing quota decisions (this is to be discussed at the Special Meeting).
– Continued examination of the question of appropriate quotas for initial management stocks of males.
(7) Gray whales – Consideration of classification, and review of data from Canada, USSR, USA and Mexico.

Rules of Procedure

Changes in Rules of Procedure affecting the Scientific Committee relating to:

(1) Attendance of Observers at Scientific Committee meetings.
(2) A requirement that the preliminary report of the Scientific Committee should be available to all Commissioners by the opening date of the Commission meeting (Rule XVII).