International Commission on Whaling

(Constituted under the International Whaling Convention signed at Washington on 2nd December, 1946)

TWENTY-FIRST REPORT OF THE COMMISSION

(covering the twenty-first fiscal year 1969–1970)

(As approved by the Commission at its Twenty-second Meeting in London, June, 1970, and authorized to be printed)

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CONTENTS

	Page
List of Members of the Commission	5
Report	7
Appendix I List of those attending the Twenty-first Meeting	12
Appendix II Agenda for the Twenty-first Meeting	14
Appendix III Chairman's Report of the Twenty-first Meeting, including the Amendments to the Schedule of the International Whaling Convention, 1946, made at that meeting	17
Appendix IV Report of the Scientific Committee, as circulated at the Twenty-second Meeting, 1970	24
Annex A Scientific Committee Agenda	32
Annex B Scientific Committee Documents	33
Annex C Report of the Special Meeting on Antarctic Fin Whale Stock Assessment, Honolulu, Hawaii, 13th–25th March 1970	34
Annex D Report of the Special Meeting on Sperm Whale Biology and Stock Assessments, Honolulu, Hawaii, 13th–24th March 1970	40
Annex E (Revised) Whale Marking—Progress Report, 1970	51
Annex F Central Storage and Processing of Catch/Effort and Length Statistics	56
Annex G Notes on the Assessment of Antarctic Fin Whale Stocks *K. Radway Allen*	58
Annex H A Preliminary Assessment of Fin Whale Stocks off the Canadian Atlantic Coast *K. Radway Allen*	64
Annex I Analysis of 1969/70 Catch and Effort Data for Antarctic Baleen Whale Stocks *D. G. Chapman*	67
Annex J The Seventh Memorandum on the results of Japanese Stock Assessment of Whales in the North Pacific *S. Ohsumi, Y. Shimadzu and T. Doi*	76
Annex K Status of stocks of Baleen Whales in the Antarctic, 1970/71 *T. Doi, S. Ohsumi, and Y. Shimadzu*	90
Annex L Consideration of the present technique of Whale Marking and Future Marking Programmes *S. G. Brown*	100
Annex M The Possibility of Injuring Small Whales with the Standard *Discovery* Whale Mark *Robert Clarke*	106
Appendix V Income and Expenditure Account for the Twenty-first Fiscal Year (1st June 1969 to 31st May 1970)	109
Appendix VI Infractions reported in respect of the 1969/70 Season (Antarctic) and the 1969 Season (Outside the Antarctic)	111
Appendix VII Table Showing Oil Production, etc., 1959/60–1969/70	112
Appendix VIII Map of the world showing Antarctic areas and the regions closed to factory ships for the purpose of taking and treating baleen whales	113
Appendix IX List of Reports received by the Commission during the Twenty-first Year, ended 31st May 1970	114

LIST OF MEMBERS OF THE COMMISSION

Argentina	Mr. S. N. Martinez
Australia	Mr. C. G. Setter
Canada	Dr. W. M. Sprules
Denmark	Mr. J. Norgaard
France	Mr. R. A. Lagarde
Iceland	His Excellency Mr. G. I. Gudmundsson
Japan	Mr. I. Fujita (*Chairman*)
Mexico	Mr. R. Millan Morales
The Netherlands	Mr. T. J. Tienstra
Norway	Mr. I. Rindal
Panama	Mr. A. T. Boyd
South Africa	Dr. B. van Dyk de Jager
U.S.S.R.	Mr. M. N. Sukhoruchenko
U.K.	Mr. J. Graham
U.S.A.	Dr. J. L. McHugh (*Vice-Chairman*)

R. Stacey
Secretary

Office of the Commission,
Great Westminster House,
Horseferry Road,
London, S.W.1.

June 1970

International Whaling Commission

REPORT 1969-70

1. *Meetings*

This report relates to the Twenty-first Meeting of the Commission held in London from 23rd June to 27th June 1969 under the Chairmanship of Mr. I. Fujita (Japan), to subsequent developments during the year, and to the meeting of the Scientific Committee held in London from 15th to 22nd June 1970 under the Chairmanship of Dr. D. G. Chapman (U.S.A.). Reports of these meetings are contained in Appendices III and IV respectively.

2. *Antarctic Catch Limitation*

At its Twenty-first Meeting, the Commission agreed to a catch limit for baleen whales in the Antarctic for the 1969/70 season of 2,700 blue whale units; this was 500 units less than the catch limit for the 1968/69 season. The Schedule was amended accordingly at that meeting. The season opened on 12th December 1969 and closed on 7th April 1970 and the total catch in the season was 2,477 units.

3. *The 1969/70 Antarctic Catch*

Seven expeditions were operated in the Antarctic. This compared with six expeditions in 1968/69:

	1968/69	*1969/70*	
Japan	3	3	
Norway	—	1	(factory/catcher)
U.S.S.R.	3	3	
	6	7	

The number of catcher boats operating in the 1969/70 season was 85 compared with 84 in 1968/69. These were distributed as follows:

	1968/69	*1969/70*
Japan	38	38
Norway	—	1
U.S.S.R.	46	46
	84	85

The total baleen whale catch in 1969/70 was as follows:

	Blue	*Fin*	*Humpback*	*Sei*	*Units*
Japan	— (—)	1,821 (1,821)	— (—)	3,495 (3,495)	1,493 (1,493)
Norway	— (—)	4 (—)	— (—)	22 (—)	6 (—)
U.S.S.R.	— (—)	1,176 (1,199)	— (—)	2,339 (2,281)	978 (979)

The comparative catch in the 1968/69 season is shown in brackets. It will be seen that the total Antarctic pelagic baleen catch was 5 units more in 1969/70.

The distribution by geographical areas (see Appendix VIII) of the catch in blue whale units, with comparative figures for 1968/69 was as follows:

	Area I (120°–60°W)	*Area II (60°W 0°–)*	*Area III (0°–70°E)*	*Area IV (70°–130°E)*	*Area V (130°E–170°W)*	*Area VI (170°–120°W)*
1969/70	—	232	1,108	853	242	42
1968/69	77	47	571	986	565	223
Decrease	77	—	—	133	323	181
Increase	—	185	537	—	—	—

The number of sperm whales caught by the Antarctic pelagic expeditions south of 40° south latitude totalled 3,090 compared with 2,682 in 1968/69.

The total oil output for the 1969/70 Antarctic pelagic season, including sperm oil, was 461,285 barrels. Total oil production in 1968/69 amounted to 423,880 barrels. The average catch per catcher's day's work by pelagic expeditions was 0·31 blue whale units compared with 0·30 in the previous season. There has been little variation in this average over the last five seasons.

The average fin whale size was 66·4 feet compared with 66·6 feet in 1968/69 and the average size of sei whales was 47·9 feet compared with 48·0 feet. The average sperm whale size was 44·98 feet compared with 46·4 feet in the preceding season.

No whaling operations were carried out by member governments from land stations in the Antarctic during the 1969/70 season.

4. *Outside the Antarctic*

A total of 29,942 whales was caught outside the Antarctic. Of these 28,080 whales were caught by the 6 factory ships and 17 land stations which operated in 1969; and 1,862 sperm whales were caught by the Antarctic pelagic expeditions north of 40° south latitude. Total oil production amounted to 817,732 barrels. The comparable figures for 1968 were 31,565 whales, of which 1,120 were sperm whales caught by Antarctic pelagic expeditions north of 40° south latitude, and 824,954 barrels of oil.

5. *North Pacific Whale Stocks*

The Group of Commissioners for the North Pacific reached agreement to continue the restriction of the catch of whales in that area. It agreed that the pelagic catch limit for fin whales should be 1,332 whales for 1970 (excluding the catch for the East China Sea), and for sei whales 4,924. This represented, in each case, a 10% reduction on the 1969 limit. For sperm whales, the limit was fixed at 11,273 whales, a reduction of 10% on the 1968 catch. The catches of the land stations were not to exceed the levels established for 1969.

6. *Amendments to the Schedule to the Convention*

At the Twenty-first Meeting of the Commission it was agreed (i) to amend paragraph 4(1)(a) to provide for the extension of the ban on the killing of blue whales in the North Atlantic Ocean, and (ii) to extend the provisions of paragraph 6(1) forbidding the killing or attempting to kill humpback whales in the North Atlantic Ocean, in each case for a further period of three years. Paragraph 8(a) was amended to limit the total Antarctic pelagic catch for the 1969/70 season to 2,700 blue whale units.

7. *Scientific Investigation of the Whale Stocks*

For a number of years the Food and Agriculture Organization of the United Nations has provided a report on the effect of pelagic operations on the Antarctic whale stocks and the status of the stocks. These reports have been considered by the Scientific Committee in conjunction with analyses and assessments made by scientists from member countries. At the Twenty-first Meeting the observer from F.A.O. informed the Commission that F.A.O., after reviewing its commitments in the various fields as well as the needs of the Commission, had reached the conclusion that now that several national delegations contained scientists in stock assessment and with the reduction in the catch quotas it was no longer necessary for F.A.O. to continue its regular reporting on the state of the stocks. F.A.O. therefore wished to withdraw from regular stock assessment work. It would however like to continue to send observers to the Commission's meetings, in particular the scientific meetings, and occasionally contribute studies on specific subjects. The Commission expressed its deep appreciation and gratitude to F.A.O. for its great contribution to the stock assessment work and for its intention to continue to co-operate with the Commission in this work.

Difficulties in forming a firm estimate of the status of the fin whale stocks by the Scientific Committee arose from the difference in the methods and assumptions used in their analyses by the scientific groups. A meeting of a working group of the Scientific Committee was held in Honolulu from 13th to 25th March 1970 to review the methods of fin whale stock assessment. The Report of this meeting is given in Annex C to Appendix IV.

During the same period the Committee's working group met to study sperm whale biology and methods of assessment of sperm whale stocks. The group's report on this subject is given in Annex D to Appendix IV.

8. *Collection of Biological Data*

The Commission accepted a proposal of the Scientific Committee that the Bureau of International Whaling Statistics be asked to act as a central agency for the collection and processing of catch, effort and length distribution data for whale stock assessment. The Bureau has agreed to undertake the work for which funds are being made available to the Bureau by the Commission. F.A.O. and the National Institute of Oceanography of the United Kingdom are co-operating in this work.

9. *Economic Studies of Whaling Operations*

The Commission was advised by F.A.O. that the position was unchanged from the previous year, viz., that the data collected had so far been insufficient to enable a report to be prepared. The Commission decided not to pursue the matter at present.

10. *Finance*

The Commission reviewed its financial position at the Twenty-first Meeting and approved (i) subject to audit, the statement of income and expenditure for the financial year ended 31st May 1969 and (ii) the budget for 1969/70. It decided that the Extra-ordinary Budget should be discontinued since the funds allocated to it were now exhausted and the particular special whale stock investigations for which it had been established were largely completed.

The total expenditure for 1969/70 was estimated to total £6,560. This included a contribution of £500 to the National Institute of Oceanography towards the cost of whale marking which in recent years has been paid from the

Extra-ordinary Budget; and a payment of £500 to the Bureau of International Whaling Statistics for the collection and processing of catch effort and length distribution data on whales. An income of £5,250 was expected from 15 Contracting Governments contributing £350 each, the balance to be met from the accumulated balance.

A copy of the audited accounts for 1969/70 is shown at Appendix V. Expenditure was £6,630 compared with £4,745 (Ordinary Budget) and £1,068 (Extra-ordinary Budget) in the previous year. Income amounted to £5,250 which included the flat rate contributions from the Contracting Governments and £451 from interest on capital invested during the year. There was a balance in hand at the end of the year of £4,392.

11. *National Quotas*

The Commission was advised that representatives of Japan, Norway and the Union of Soviet Socialist Republics met in London under the Chairmanship of Mr. R. G. R. Wall and agreed on a quota distribution of the pelagic catch limit for the 1969/70 Antarctic season fixed by the Commission at 2,700 blue whale units (see para. 2). The following allocations were agreed:

Japan	1,493 blue whale units
Norway	231 blue whale units
U.S.S.R.	976 blue whale units

The Agreement operated until the end of the 1969/70 season.

12. *Infractions*

Appendix VI of this Report gives a summary of infractions of the Convention reported by Contracting Governments in respect of the 1969/70 Antarctic season and the 1969 season in waters outside the Antarctic.

13. *Permits to take Whales for Scientific Purposes*

The Commission was notified during the year of the following permits under Article VIII of the Convention:

Canada

(i) A permit for the taking of not more than 20 humpback whales for scientific purposes.

(ii) A permit for the taking of not more than 20 humpback whales for scientific purposes.*

(iii) A permit for the taking of not more than 40 fin whales for scientific purposes.

Japan

(i) A permit for the taking of 9 pigmy blue whales for research purposes.

(ii) A permit for the taking of up to 5 lactating sei whales and calves or suckling whales accompanied thereto for research purposes.

U.S.A.

(i) A permit for the taking of not more than 100 sperm whales for research purposes.

* This permit was issued as it had not been possible to obtain the requisite number of humpback whales under (i) which was issued on 26th May 1969.

(ii) A permit for the attaching of acoustic beacons to humpback whales and to make observations on certain behaviour patterns of the whales.
(iii) A permit for the taking of 3 sperm whales for maintaining in captivity for public viewing and research purposes.
(iv) A permit for the taking and maintaining alive in captivity not more than 4 sperm whales and 2 humpback whales for purposes of scientific studies.

14. *Withdrawal of Member Country*

The Commission was notified during the year by the Depository Government of the withdrawal of the Government of the Netherlands from the International Whaling Convention 1946. The withdrawal becomes effective on 30th June 1970.

15. *Constitution*

The constitution of the Commission at the Twenty-first Meeting is shown in Appendix I and that of the Technical, Scientific and Finance and Administration Committees in the Chairman's Report of the meeting in Appendix III.

R. STACEY
Secretary to the Commission

APPENDIX I

List of Commissioners and Advisers attending the Twenty-first Meeting of the Commission, June 1969

Chairman: Mr. I. Fujita

	Commissioners or Delegates	*Advisers*
Argentina	Mr. A. von der Becke	
Australia	Mr. W. C. Duggan	Mr. J. D. Murray
		Mr. S. M. Reilly
		Mr. W. Saleeba
Canada	Dr. W. M. Sprules	Miss V. M. Edelstein
		Mr. K. R. Allen
Denmark	Not represented	
France	Mr. R. A. Lagarde	Mr. C. Roux
Japan	Mr. I. Fujita	Mr. T. Wada
		Mr. K. Fujimura
		Mr. K. Kakudoh
		Mr. K. Hoketsu
		Dr. H. Omura
		Dr. T. Doi
		Mr. Y. Furuya
		Mr. T. Isogai
		Mr. T. Endo
		Mr. M. Takahashi
		Dr. S. Ohsumi
Mexico	Mr. R. Millan Morales	
New Zealand	Mr. P. Cotton	
Netherlands	Not represented	
Norway	Mr. I. Rindal	Mr. E. Moe
Panama	Not represented	
South Africa	Dr. B. v.D. de Jager	Mr. F. J. Cronjé
United Kingdom	Mr. J. Graham	Mr. P. Parkhouse
		Mr. A. J. Aglen
		Dr. R. Clarke
		Mr. R. Gambell
		Dr. N. A. Mackintosh
U.S.A.	Dr. J. L. McHugh	Mr. S. Blow
		Dr. D. G. Chapman
		Mr. D. W. Rice
		Mrs. M. Wells
U.S.S.R.	Mr. M. N. Sukhoruchenko	Mr. I. F. Denisenko
		Dr. V. G. Lafitsky
		Dr. M. V. Ivashin
		Mr. G. V. Zigalov
		Mr. V. M. Nikolaev
		Observers
Chile		Commander F. Thomas
Italy		Dr. E. Capodilupo

Portugal	Mr. E. De Magalhaes Feu
Food and Agriculture Organization of the United Nations	Mr. L. K. Boerema
International Council for the Exploration of the Sea	Mr. A. J. Aglen
The Fauna Preservation Society	Mr. R. S. R. Fitter
International Union for Conservation of Nature and Natural Resources (Survival Service Commission)	Dr. C. W. Holloway
	Dr. F. Fraser Darling
World Federation for the Protection of Animals	Dr. E. Simpson
International Society for the Protection of Animals	Mr. C. Platt

APPENDIX II

Ref: AP XXI 23rd April 1969

Dear Commissioner,

Circular Letter to all Commissioners
Agenda: Twenty-first Meeting, 1969

I enclose two copies of the Agenda for the Twenty-first Meeting of the Commission to be held at Riverwalk House, Millbank, London, S.W.1, from 23rd June to 27th June 1969. The opening session will begin on Monday, 23rd June at 10.30 a.m.

The Agenda has been amended in the light of comments received on the draft provisional agenda circulated with my letter of 21st March 1969.

The amendments which provide for consideration of the blue whale unit and possible action in connection with the International Observer Scheme have been made at the suggestion of the United States Government and the proposal to amend paragraph 11 of the Schedule has been made by the Japanese Government. The Japanese Government explains that its reasons for amending paragraph 11 are:

1. (i) Since restrictive measures have been already taken in the Pacific Ocean in terms of the number of factory ships and whale catchers, and the catch of whales and the period of whaling by factory ship type whaling, there will be no possibility of increased intensity of whaling activities in the North Pacific, even if a factory ship which has been used during a season in the Antarctic for the purpose of treating baleen whales is used again in the North Pacific for the same purpose within a period of one year from the termination of that season in the Antarctic.
   (ii) With the strengthening of the catch restriction of whales, both in the Antarctic and in the North Pacific, it has been an increasingly heavy economic burden for the Japanese whaling industry to maintain two kinds of factory ships, one for the Antarctic and the other for the North Pacific, to observe the provisions of paragraph 11.
2. Proposed Draft Amendment
   Insert the following after the phrase "in any other area":
   "except in the North Pacific Ocean and its dependent waters north of the Equator".

Copies of the financial statements referred to under Item 4 will be circulated as soon as possible after the end of the current financial year at 31st May 1969.

A meeting of the Scientific Committee is being convened to commence on Monday 16th June 1969 and the report to be discussed under Item 6 will not therefore be available until the beginning of the Commission's meeting.

A copy of the Agenda and this covering letter are being sent to each Contracting Government. Further copies may be obtained on application.

I should be glad to be informed by the 13th June, or earlier if possible, of the names of all those who will be present at the Twenty-first Meeting on behalf of your Government.

Yours faithfully,
R. STACEY
Secretary to the Commission

Agenda for the Twenty-first Meeting to begin at 10.30 a.m. on Monday 23rd June 1969 at Riverwalk House, London, S.W.1

1. Address of Welcome.
2. Arrangements for meeting and adoption of Agenda.
3. Appointment of Committees.
4. Finance and Administration:
   (a) Review of the Commission's financial position (accounts for 1968/69 covering Ordinary and Extra-ordinary Budget and Estimate for 1969/70 to be circulated with Paper IWC/21/3).
   (b) Review of the level of contribution and stock assessment levy from Contracting Governments.
5. Review of previous season's catches.
6. Report of the Scientific Committee (report to be circulated as Paper IWC/21/4).
7. Special scientific investigation of the whale stocks:
   (a) Reports and action arising therefrom.
   (b) Arrangements for continuation of stock assessment work.
8. Sperm whale stocks (paragraph 11 of Chairman's Report of 20th Meeting):
   (a) Report of Scientific Committee.
   (b) Action arising.
9. North Pacific whale stocks (paragraph 13 of Chairman's Report of 20th Meeting):
   (a) Report of Scientific Committee.
   (b) Report of Commissioners of North Pacific Whaling Countries.
   (c) Action arising.
10. International Observer Scheme.
11. Consideration of blue whale unit.
12. Exclusion of the North Pacific Ocean and its dependent waters north of the Equator from the application of paragraph 11 of the Schedule.
13. Economic studies of whaling regulations (paragraph 14 of the Chairman's Report of 20th Meeting).
14. Infractions (report to be circulated as Paper IWC/21/5).
15. Technical Committee Report (to be circulated during meeting).
16. Finance and Administration Committee Report (to be circulated during meeting).
17. Twentieth Annual Report (a draft will be circulated as Paper IWC/21/6).
18. Amendments to the Schedule:
   (a) Paragraph 1(a)—provision for extension or modification of arrangements under the International Observer Scheme (arising out of Item 10).
   (b) Paragraph 4(1)(a)—extension of prohibition on killing of blue whales in the North Atlantic Ocean after 24th February 1970.
   (c) Paragraph 5—position of the Sanctuary.
   (d) Paragraph 6(1)—extension or modification of prohibition on the killing of humpback whales in the North Atlantic Ocean after 8th November 1969.
   (e) Paragraph 7(a) and 8(d)—determination of opening and closing dates of Antarctic pelagic baleen season.
   (f) Paragraph 8(a)—pelagic catch limit in the Antarctic for 1969/70 by species or by blue whale units (blue whale units to be considered under Item 11).
   (g) Paragraph 8(b), (c) and (d)—any amendment arising from consideration of blue whale unit (Item 11).
   (h) Paragraph 11—exemption of the North Pacific Ocean and its dependent waters north of the Equator from the prohibition on the use of the factory ships as prescribed in this paragraph (arising out of Item 12).

(i) Provision for restriction of the catch of sperm whales (arising out of Item 8).
(j) Provision for restriction of the catch of whales in the North Pacific (arising out of Item 9).

19. Date and place of next meeting.
20. Reports from observers and appointment of observers for 1969/70.
21. Arrangements for Press Release.
22. Any other business.

APPENDIX III

CHAIRMAN'S REPORT OF THE TWENTY-FIRST MEETING

1. *Date and Place*

The Twenty-first Meeting of the International Whaling Commission was held at Riverwalk House, Millbank, London, S.W.1, from 23rd to 27th June 1969. The proceedings were conducted by the Chairman, Mr. I. Fujita (Japan).

2. *Representation*

Commissioners and Delegates of Contracting Governments represented Argentina, Australia, Canada, France, Japan, Mexico, New Zealand, Norway, South Africa, Union of Soviet Socialist Republics, United Kingdom and the United States of America. Observers attended from Chile, Italy, Portugal, the Food and Agriculture Organization of the United Nations, the Fauna Preservation Society, the International Council for the Exploration of the Sea, the International Society for the Protection of Animals, the International Union for the Conservation of Nature and Natural Resources and the World Federation for the Protection of Animals.

3. *Address of Welcome*

At the opening session an address was given by Mr. Norman Buchan, the Joint Parliamentary Under-Secretary of State for Scotland. Mr. Buchan referred to the fact that this was the twenty-first meeting of the Commission and remarked that in the ordinary course a twenty-first birthday is regarded as a milestone calling for celebrations or congratulations. He was not sure whether this would be entirely appropriate recalling the high ideals and aspirations that inspired the Commission in its early days for the rational exploitation of common resources under international control, contrasting with events which had led to the withdrawal of two countries from pelagic whaling in the Antarctic, joined last winter by another great whaling nation. But the flame started in 1946 still burned and he thought the Commission could congratulate itself on the fact that but for its work the whale stocks in some areas might well have been extinct altogether and that through the deliberations of the Commission there had been a greater readiness among member countries to recognize the danger signals and take action in time. He trusted that with the renewed vigour of maturity the Commission would tackle the continuing problems of conservation. The important agreement reached last year to restrict the catching of fin and sei whales in the North Pacific—the only large pelagic whaling area outside the Antarctic—was perhaps a happy augury for the next 21 years.

4. *Dr. Remington Kellogg*

The death was reported of Dr. Kellogg, the first Chairman of the Commission and the United States Commissioner until 1965. Tributes were paid to the contribution of Dr. Kellogg to the work of the Commission and the meeting stood in silence to his memory.

5. *Adoption of Agenda*

The agenda was adopted on the proposal of the Commissioner for the U.S.S.R. seconded by the Commissioner for the United States.

6. *Review of Previous Season's Catches*

Statistics relating to the catch outside the Antarctic in 1968 and the catch in the Antarctic in 1968/69 prepared by the Bureau of International Whaling Statistics were distributed. The delegate for Norway presented a report on behalf of Mr. Vangstein, the Director of the Bureau, who was unable to be present. He said that three Japanese and three U.S.S.R. expeditions participated in the Antarctic season of 1968/69. They limited their catches to the quotas allotted to them under the quota agreement. The total catch was 2,469 blue whale units, 731 less than the total limit of 3,200 units, this 731 being the quota allotted to Norway and not taken up. The activities of the expeditions were brought to a close before the official closing date, 7th April. There was a marked change in the relation between the sei and fin whale catches in the past season; in 1965/66 it was 7·6:1, in 1967/68 4·8:1 and in the last season 1·9:1. The activities of the expeditions moved somewhat eastwards and northwards compared with the previous season. In Areas IV and V about 63 per cent of the total catch in terms of BWU was taken as against about 47 per cent in 1967/68. About 2,680 sperm whales were caught in the Antarctic and 1,225 on the journey to and from those areas. Outside the Antarctic the largest catch is made in the North Pacific. Six pelagic expeditions, three from Japan and three from U.S.S.R., caught 1,717 blue whale units and 12,542 sperm whales. Mr. Vangstein said that reports on the catches outside the Antarctic were often received very late and the Bureau had to process them at the same time as the statistics from the last Antarctic season. In order to facilitate the work of the Bureau substantially he asked the Commissioners to use their best efforts to have the data concerning the catch outside the Antarctic forwarded to the Bureau as soon as possible.

7. *Scientific Committee*

The report by the Scientific Committee which met under the Chairmanship of Dr. D. G. Chapman (U.S.A.) is contained in meeting document IWC/21/4.

8. *Investigations of Whale Stocks*

A report on baleen whale stocks in the Antarctic during the 1968/69 season was provided by F.A.O. and this was examined by the Scientific Committee in conjunction with whale population studies in that area prepared by scientists of member countries. The report by F.A.O. was the latest in a series of annual reports on the state of the Antarctic stocks prepared for the Commission by the Organization. The observer from F.A.O. informed the Commission that F.A.O., after reviewing its commitments in the various fields as well as the needs of the Commission, had reached the conclusion that now that several national delegations contained scientists in stock assessment and with the reduction in the catch quotas it was no longer necessary for F.A.O. to continue its regular reporting on the state of the stocks. F.A.O. therefore wished to withdraw from regular stock assessment work. It would however like to continue to send observers to the Commission's meetings, in particular the scientific meetings, and occasionally contribute studies on specific subjects. The Chairman expressed on behalf of the Commission its deep appreciation and gratitude to F.A.O. for its great contribution to the stock assessment work of the Commission and for its intention to continue to co-operate with the Commission in this work.

9. *Pelagic Catch Limit in the Antarctic*

The Scientific Committee had agreed on an estimate of 5,000 whales (833 blue whale units) for the 1969/70 sustainable yield of sei whales in the Antarctic but was unable to reach agreement on the yield of fin whales for which the estimates ranged from 1,000 to 5,600 whales. The difference arose in methods and assumptions and the Scientific Committee proposed that it should meet early in 1970 to discuss and review methods and assumptions of fin whale stock assessment when these questions would be studied in greater detail and more precise estimates obtained. The Commission accepted the Technical Committee's recommendation that pending the more precise estimates to be made at the meeting early in 1970 the Antarctic catch limit in 1969/70 should be 2,700 blue whale units. It was accordingly agreed unanimously to amend paragraph 8(a) of the Schedule to the Convention by deleting "3,200" and substituting "2,700" and deleting "1968/69" and substituting "1969/70."

10. *Exclusion of the North Pacific Ocean and its Dependent Waters North of the Equator from the Restrictions on the Use of the Antarctic Factory ships*

The Japanese delegation had discussed this matter with other delegations concerned and because of the agreement on North Pacific whaling they had decided to withdraw their request that paragraph 11 of the Schedule be so amended as to allow factory ships to be used in the North Pacific immediately after service in the Antarctic. They intimated, however, that they would resubmit the proposal at the 1970 meeting.

11. *Length of Antarctic Season*

The Commission accepted the Technical Committee's recommendation that there should be no change in the opening and closing dates of the baleen whaling season in the Antarctic.

12. *The Sanctuary*

The Commission accepted the Technical Committee's recommendation that the Sanctuary should remain open in 1969/70.

13. *North Pacific Whale Stocks*

The Technical Committee reported that agreement had been reached by the Commissioners for the North Pacific countries on catch limits for the 1970 season for the pelagic fleets for fin, sei and sperm whales. The catch limit for fin whales would be 1,332 whales and for sei whales 4,924 whales, in each case a 10% reduction on the 1969 limit. The fin whale quota could be converted to sei whales and vice versa, in terms of blue whale units, provided that the total catch of either species did not exceed the 1969 quota for that species. For sperm whales the limit would be 11,273 whales, a 10% reduction on the 1968 catch. The whale catches of the land stations of Japan and the U.S.A. would not exceed the levels established for 1969. The Commissioners had also agreed that the countries would exert their best efforts to put into effect observer schemes for both pelagic and land station whaling.

14. *Sperm Whale Stocks*

The Scientific Committee had reported that the principal new information on sperm whale stocks related to the North Pacific where it recommended no further increase in the catch. In view of the agreement to limit the catch in the

North Pacific the Technical Committee did not make any recommendation to the Commission. Because of the lack of assessment of sperm whale stocks except in the North Pacific the Scientific Committee proposed to hold a meeting early in 1970 to study sperm whale biology and methods of assessment, and if possible to make assessments for all stocks.

15. *International Observer Scheme*

The North Pacific countries had reported their intention to exert their best efforts to put into effect observer schemes. Several countries indicated their willingness to co-operate with other countries in other areas in receiving observers and the Chairman urged the countries concerned to implement the International Observer Scheme at the earliest opportunity.

16. *Blue Whale Unit*

The Scientific Committee reaffirmed its opinion that from the viewpoint of maintaining all stocks, it was desirable to set separate quotas by species for the Antarctic catch rather than in terms of blue whale units. The Technical Committee did not recommend any action in regard to the Schedule but felt the Commission should keep a watchful eye on the situation.

17. *Economic Studies of Whaling Regulations*

The Technical Committee reported that it had been informed by F.A.O. that there had been no progress on the economic studies. The Commission agreed that a further request to F.A.O. would not be justified at present and this item should be excluded from the agenda for future meetings.

18. *Infractions*

The Technical Committee appointed an Infractions Sub-Committee to consider the reports on infractions of the Convention from the whaling countries. The average number of infractions was about 1·7 per cent of the total catch, the figures being much higher for sperm whales than for baleen whales. The Committee urged countries to continue to try to hold the percentage of infractions down.

19. *Ban on Killing Blue and Humpback Whales in North Atlantic Ocean*

The Scientific Committee reviewed the data relating to the stocks of blue and humpback whales in the North Atlantic. From limited evidence it seemed that there was some rebuilding of humpback stocks in the North-west Atlantic but there was nothing to suggest any substantial increase elsewhere in the North Atlantic. It recommended that the present ban on killing blue whales in the North Atlantic, which terminates on 24th February 1970, and that on killing humpback whales in the North Atlantic Ocean, which terminates on 8th November 1969, be extended for three years. In the meantime it urged that companies operating in that area should provide sighting data on the prohibited species. The Technical Committee accepted the recommendations and on the proposal of that Committee the Commission agreed unanimously to make the following amendments to the Schedule of the Convention:

paragraph 4(1)(a)
delete the words after "North Atlantic Ocean" and substitute for them "for three years ending on 24th February 1973"

paragraph 6(1)
delete "1969" and substitute "1972"

20. *Bryde's Whale*

At its meeting in 1968 the Scientific Committee had suggested that sei whales and Bryde's whales should be recognized as distinct species and suggested amendments to the Schedule for this purpose. It requested that this item with the appropriate amendments to the Schedule should be put on the agenda for the next meeting. The Technical Committee endorsed this and the Secretary was asked to include it in the agenda for the 1970 meeting.

21. *The Commission's 20th Report*

The draft report which had been circulated was approved subject to minor drafting amendments.

22. *Finance*

The report of the Finance and Administration Committee was considered by the Commission.

a. *The statement of income and expenditure for 1968/69*

The statement of income and expenditure for the year ended 31st May 1969 on the *Ordinary Budget* showed that expenditure amounted to £4,745 compared with £4,571 in 1967/68. There was an increase in the cost of the annual meeting and the payment of the Secretary's salary was for a full year. On the other hand the cost of administration was down as a result of a reassessment of staff times, as well as the expenditure on stationery, printing and postage. Income, apart from the contributions of £350 from each Contracting Government, included £247 from interest on investments. After the transfer of £86 to meet the excess expenditure in the Extra-ordinary Budget in accordance with the decision at the previous meeting, the balance at the end of the year was £752.

On the *Extra-ordinary Budget*, expenditure on travel and subsistence in connection with stock assessment work in 1968 amounted to £568 and a contribution of £500 was made to the National Institute of Oceanography in respect of the whale marking work. The total expenditure was therefore £1,068 which was met from the balance of £982 brought forward from the previous year and £86 transferred from the Ordinary Budget.

The statement of income and expenditure for 1968/69 was accepted on the proposal of the Chairman of the Finance and Administration Committee (the Commissioner for Canada), seconded by the delegate for Japan.

b. *The estimate for 1969/70*

The estimate for the Ordinary Budget for 1969/70 showed an accumulated balance at the end of the year of £2,597. In addition the contribution to the National Institute of Oceanography for whale marking would amount to £500 and the Scientific Committee had recommended the provision of £500 to enable the Bureau of International Whaling Statistics to undertake the collection and processing of catch, effort and length distribution data. The funds in the Extra-ordinary Budget were exhausted and it was decided that this expenditure should be met from the Ordinary Budget reducing the accumulated balance expected at the end of the year to £1,597. On the proposition of the Chairman of the Finance and Administration Committee, seconded by the delegate for Japan, the Commission accepted the revised estimate for 1969/70 (IWC/69/3B revised).

c. *Amount of contribution*

The Commission decided on the proposition of the Chairman of the Finance and Administration Committee, seconded by the Commissioner for the United States, that there should be no change in the contributions from member countries for 1969/70.

d. *The financial position of the Bureau of International Whaling Statistics*

The Finance and Administration Committee reported that the representative of Norway had referred to the statement made to the Committee at the 1968 meeting about the financial position of the Bureau of International Whaling Statistics. He said that his Government had taken measures to make funds available to enable the Bureau to continue until some other solution could be found. The Commission would be given ample and fair warning if and when it was necessary to change these arrangements. The Commission expressed its appreciation of the understanding shown and of the action taken by the Norwegian Government.

23. *Collection of Biological Data*

The Finance and Administration Committee considered a proposal by the Scientific Committee that the Bureau of International Whaling Statistics should be asked to act as a central agency for the collection and processing of catch, effort and length distribution data and that the sum of £500 should be earmarked for payment to the Bureau for that part of the work it was able to undertake in the current year. The Committee agreed with the Scientific Committee's proposal and, as recorded in paragraph 22b, to the inclusion of £500 for that purpose in the revised estimate for 1969/70.

24. *Date and Place of Next Meeting*

The Commission accepted the Finance and Administration Committee's recommendation that its next meeting should be held in London in the week commencing 22nd June 1970.

25. *Representation at Meetings of Other Organizations*

Invitations were received for the Commission to send observers to the Intergovernmental Oceanographic Commission's sixth meeting to be held in Paris in September and to the meeting of the International Council for the Exploration of the Sea to be held in Dublin from 29th September to 8th October. It was agreed that the Chairman should arrange in consultation with the Secretary for observers to attend these meetings on behalf of the Commission.

26. *Statements by Observers from Other Organizations*

Statements were made by Mr. L. K. Boerema of the Food and Agriculture Organization, Mr. A. J. Aglen of the International Council for the Exploration of the Sea, Mr. R. S. R. Fitter of the Fauna Preservation Society, Dr. C. W. Holloway of the International Union for the Conservation of Nature and Mr. C. Platt of the International Society for the Protection of Animals. A statement was made on the withdrawal of New Zealand from the Commission by Mr. P. Cotton who attended on behalf of the New Zealand Government.

27. *Constitution of Committees*

The membership of the Commission's Committees for the coming year was as follows:

Technical Committee: Australia, Canada, France, Japan, Norway, South Africa, Union of Soviet Socialist Republics, United Kingdom and United States of America. Dr. J. L. McHugh (United States of America) was elected Chairman.

Scientific Committee: Canada, France, Japan, Norway, Union of Soviet Socialist Republics, United Kingdom, United States of America, and the Food and Agriculture Organization of the United Nations (Adviser). Dr. D. G. Chapman (United States of America) was elected Chairman.

Finance and Administration Committee. The Chairman of the Commission nominated representatives from Canada, Japan, Mexico, Norway and the Union of Soviet Socialist Republics. Dr. W. M. Sprules (Canada) was elected Chairman.

I. FUJITA
Chairman

APPENDIX IV

REPORT OF THE SCIENTIFIC COMMITTEE

1. The Committee met at 10.00 a.m. on 15th June 1970 and following days in the Ministry of Agriculture, Fisheries and Food, London, under the Chairmanship of Dr. D. G. Chapman.

2. There were present

Australia	J. L. Bannister
	B. K. Bowen
Canada	K. R. Allen
	E. D. Mitchell
Japan	Y. Fukuda
	S. Ohsumi
	H. Omura
Norway	Å. Jonsgård
U.K.	S. G. Brown
	R. Clarke
	R. Gambell
	Mrs. C. Lockyer
	N. A. Mackintosh
U.S.A.	D. G. Chapman
	D. Rice
U.S.S.R.	M. V. Ivashin
	V. M. Nikolaev
Observers:	L. K. Boerema (F.A.O.)
	W. H. Dawbin (New Zealand)

3. Before commencing the business of the meeting the Chairman referred to the death of Professor Dr. Johan T. Ruud, a member of the Committee since its inception and sometime Chairman. The Chairman asked the members to stand in tribute to his memory.

RESEARCH AND INFORMATION

4. Progress reports and numerous other papers were available to the Committee. These are listed in Annex A with the numbers that were used to identify them.

5. The Committee accepted the reports of the special meetings in Honolulu on Antarctic fin whale stock assessment and on sperm whale biology and stock assessment. These are included as Annexes C and D to this report.

6. Mr. Brown provided a summary table (Annex E) showing the number of whales marked by area and species in the past year. He also presented a paper (Annex L) summarizing a study he had made at the Chairman's request on

marking problems and possible alternative marks. This subject was discussed thoroughly by the Committee. It was agreed that the *Discovery* mark or something rather similar to it is still the most feasible one. Some members would prefer to use it with a further increased charge.

7. Dr. Clarke called attention to his paper (Annex M) which includes certain recommendations to avoid killing or injuring whales in the marking operation. Several members felt that different operations needed different rules but it was agreed that all responsible for marking operations should take care to minimize injury of the whales.

8. Dr. Ohsumi noted the need for further investigations both of the rate of recovery of recaptured marks and of methods to improve the rate of recovery of such marks. Members are urged to carry out such studies.

9. Mr. Brown drew attention to the need for a locus to publish mark recovery data now that the *Norwegian Whaling Gazette* is not being published. It was agreed that he should add this information to his annual report on whale marking which is included as an Annex to the Committee's report.

10. The Committee recommends continuation of the co-ordination of the whale marking programme by N.I.O. and of the Commission's financial support to the international marking scheme at the previous level.

11. The Committee requests continuation of the sighting programme by S.C.A.R. and also requests the Secretary of the Commission to send a letter of thanks to the participants. It agreed with Mr. Brown that it would be very desirable to have a full analysis of the last three season's observations prepared before the next meeting of the Commission.

12. The Committee expressed its appreciation of the co-operation of whaling operators who have reported sightings of prohibited species and asks that the Secretary write asking for co-operation of other operators in this matter.

13. The Committee received a report through Dr. Jonsgard on the status of data compilation by the Bureau of International Whaling Statistics. This has been delayed because of delays in correspondence on the specific data requirements but the matter appears to be well in hand now. The first summaries have just been received. It was agreed that:

(i) Past North Pacific sperm whale data need be prepared only in the same detail on the NP-1, NP-2 and NP-3 forms, i.e., length data would be summarized by country, area and season and not by month and square as orginally requested.
(ii) Current and future sperm whale data from the North Pacific and all sperm whale data from other areas should be handled as originally requested (see Annex F).
(iii) Summaries of early data should be prepared working backwards to 1946/47 with the order of priorities as specified last year. In regard to the question of net catcher days for sperm whale effort, members agreed to look into the possibility of providing such data for all seasons.

14. The Committee recommends that the Commission again budget £500 for support of the proposed data summarization by the Bureau of International Whaling Statistics.

STATUS OF STOCKS

Antarctic Baleen Whales

Fin Whales

15. The Committee had the results of the special assessment meeting which reached agreement on a number of parameters including the mortality rate and the population size in 1957/58-1961/62. However there was disagreement on the present rate of recruitment and a number of other points were in doubt.

16. Papers by Allen, Chapman, Doi *et al.* were reviewed. Allen used his least squares method to study a number of questions left unanswered at the Honolulu meeting. In particular he examined a number of ways of expressing the recruitment rate derived from age composition data. His analyses point to a constant rate of recruitment equal to 0·05 of the exploited stock and if $M = 0{\cdot}04$ $r - M$ would then be 0·01. He explored the possibility that efficiency has increased faster than as measured by changes in tonnage but concluded that tonnage is probably an accurate estimate of efficiency. He also showed that whales between birth and recruitment have a natural mortality rate higher than that of older ones and the rate at the time of recruitment is intermediate between these two rates. He reviewed the question of difference of natural mortality rates between sexes, but the results were contradictory and hence inconclusive. He estimated the current sustainable yield, if $r - M = 0{\cdot}01$, as 600 whales. He considers the maximum probable value of $r - M$ on these data as 0·02 corresponding to a present sustainable yield of 1,200.

17. Doi, Ohsumi and Shimadzu noted the slight increase in CPUE of fin whales in 1969/70 over 1968/69 as well as the more appreciable increase in fin whale sightings. They examined the probable recruitment rate curve on the basis of the agreement reached at Honolulu, taking into consideration the density dependence of the parameters concerned and indicated the recruitment rate increased with decreasing stock size. They recalculated the stock and recruitment using the age at recruitment as agreed at Honolulu. From these they estimated the present sustainable yield to be 3,520 to 4,350.

18. Chapman obtained estimates of the fin whale population by areas using the agreed totals from the Honolulu meeting. He also reviewed the CPUE data by areas and months when sei catches were minimal. For Area III this analysis suggests a moderate population decrease since 1962/63, for Area IV a small increase. Because of lack of data this analysis covers only the smaller part of the total population but there is no evidence in this analysis to support an increase of $r - M$ above 0·04. This is the rate that can be derived from the agreed population estimates for 1958/59 to 1961/62. He estimated the sustainable yield for 1970/71 to be 2,600.

19. Much discussion was given to narrowing the differences of the estimates provided by the different scientists but the Committee was unsuccessful in reaching a single estimate for the sustainable yield in 1970/71 because of lack of good direct evidence. All members except Japan agreed that the recent level of fin whale catch in the Antarctic (2,700 average over the last five seasons) appears fairly close to the present sustainable yield. Japanese scientists believe the best estimate for 1970/71 is 3,520 to 4,350.

Sei Whales

20. The Committee reviewed analyses of the sei whale stock by Doi, Ohsumi and Shimadzu and by Chapman. Doi *et al.* noted the slight increase in CPUE of sei whales over that of 1968/69 and the appreciable increase in sightings. Chapman analysed the CPUE data by area, zone and month where appropriate and found the results rather contradictory. He suggested that the rate of net recruitment of sei whales needs to be studied further. Both estimates of present sustainable yield are about 5,000. The present total population level is above the level which gives maximum sustainable yield, though the population is probably below this level in some areas.

Blue, Humpback and Right Whales

21. The Japanese scientists have made a careful analysis of sighting data of their scouting boats. An average of their estimates of population over the past five seasons is as follows: blue whales 6,400 (including pigmy blue whales), humpback whales 1,700, right whales 1,500. No very clear trend is apparent in the sighting data of these species. The Committee recommends that the ban on taking these species in the southern hemisphere be continued.

Sperm Whales

22. The Committee reviewed the special report on sperm whale biology and stock assessment and agreed that a considerable advance had been made in our knowledge of this species. They also had available a mathematical model of sperm whale population dynamics provided by Dr. Ohsumi.

23. The Committee agreed that no sperm whale stock assessment meeting be held during the next year but it was suggested that members should come to the next Scientific Committee meeting prepared to discuss the question of further meetings on sperm whale biology and stock assessments.

Southern Hemisphere

24. The Committee observed that total catches in the southern hemisphere in the past three seasons have been:

Pelagic

Season	*S of 40°S Total*	*N of 40°S Total*	*Combined Total*
1967/68	2,568	1,288	3,856
1968/69	2,682	1,225	3,907
1969/70	3,090	2,300	5,390

Land Stations

	Australia			*South Africa*			*South America*			*Combined*
	♂	♀	*Total*	♂	♀	*Total*	♂	♀	*Total*	*Total*
1967	560	26	586	1,329	927	2,256	239	56	295*	3,137
1968	585	73	658	997	214	1,211			542†	2,411
1969	637	42	679	934	951	1,885			1,447‡	4,011

* Chile, Brazil and Peru.
† Brazil and Peru.
‡ Peru.

Some members believe that some stocks in the southern hemisphere show signs of depletion and therefore the Committee agrees that further analyses should be carried out as soon as possible by national groups. New population models need to be developed and additional data summaries received from the Bureau of International Whaling Statistics and from F.A.O. Members are urged to supply F.A.O. with the age-length keys still required.

North Pacific

25. In the North Pacific sperm whale catches have been

	Male	*Female*	*Total*
1968	12,740	3,617	16,357
1969	11,329	3,605	14,934

The Committee studied a tentative analysis by Ohsumi, Shimadzu and Doi estimating that the present sustainable yield of males in the northern part of the North Pacific Ocean is 4,290, and this male sperm whale stock has apparently now reached a level at which there is little or no further surplus, assuming that the female population is sustained at present levels. These Japanese scientists also estimated the female stock in the whole North Pacific Ocean to be 123,800 and the population level is still above the level of maximum sustainable yield for females. The maximum sustainable yield of female sperm whales is estimated to be 5,234.

26. The Committee agreed that it is desirable to slow down the decrease of male stock in view of apparent excessive catches and that further study should be made because of the uncertainty of estimates of the sustainable yield of both sexes combined. The Committee therefore recommends to the Commission that a further reduction in the catch of male sperm whales is desirable.

North Pacific Baleen Whales

Fin and Sei Whales

27. Catches of fin and sei whales in the North Pacific have been

	Fin whales	*Sei whales*
1968	1,882	5,739
1969	1,276	5,158

28. The Committee reviewed new assessments of both of these species prepared by Ohsumi, Shimadzu and Doi. These show that the present sustainable yield of fin whales is about 1,300 and of sei whales about 3,100.

29. Further in regard to sei whales this analysis shows the range of estimates of the present population to be 34,110-58,440 (average 46,275) and of the population that will give maximum sustainable yield to be 33,080-47,560 (average 40,320). It is further stated that "present population levels are still above those which give maximum sustainable yields" but some members felt that this was not necessarily so in view of the closeness of the lower limits. The Committee therefore wishes to remind the Commission of its statement of last year that "Since the size of the surplus is uncertain and higher levels of catch reduce the surplus more rapidly, the Commission is urged to take steps to ensure that the

sei whale stocks are not reduced to the level below that giving maximum sustainable yield. The danger of this can be reduced if the level of catch is reduced from the present high level."

Other Species

30. Japanese sighting data show that the blue, humpback and right whale populations remain at low levels with no tendency to increase yet observable. The Committee agrees that they need continued total protection for at least three more years.

31. Rice reported that the California gray whale census leads to a population estimate of 8,000 to 13,000 (best estimate 11,000) and the counts have been almost identical for the past three seasons. The Committee urges continued research on the gray whale census.

North Atlantic Baleen Whales

32. The Committee reviewed the paper by Allen on fin whale stocks off the Canadian Atlantic coast (Annex H). No recommendations are made with respect to North Atlantic stocks.

DATA COLLECTION AND OTHER MATTERS

33. The Committee expressed its thanks to the National Institute of Oceanography of the United Kingdom and Mr. Brown for efforts in distributing marking data and asks that N.I.O. continues to undertake this task.

34. The Committee also expressed its thanks to the F.A.O. and Mr. Boerema for the provision of age data derived from age-length keys and age data for the Honolulu sperm whale meeting. Mr. Boerema assured the Committee that, at least for the present, F.A.O. will continue to provide such age data using keys supplied by members, at no cost to the Commission.

35. The Committee expressed its thanks to the Bureau of International Whaling Statistics and to Mr. Vangstein for co-operation in regard to the data summarization.

36. The Committee noted with pleasure that the Commission plans to review the Schedule so that sei whales and Bryde's whales could be recognized as distinct species. The Committee hope that positive action is taken in this matter.

SUMMARY AND RECOMMENDATIONS TO THE COMMISSION

A. *Antarctic Baleen Whales*

1. Despite the progress made at the special meeting on fin whale stock assessment at Honolulu and despite much discussion at the present meeting, the Committee was unsuccessful in reaching a single estimate for the sustainable yield of fin whales in the Antarctic in 1970/71 because of lack of good direct evidence. All members except Japan agreed that the recent level of fin whale catch

in the Antarctic (2,700 average over the last five seasons) appears fairly close to the present sustainable yield. Japanese scientists believe the best estimate for 1970/71 is 3,520 to 4,350.

2. The estimated sustainable yield of sei whales in the Antarctic in 1970/71 is about 5,000. The present total population level is above the level which gives maximum sustainable yield, though the population is probably below this level in some areas.

3. The Committee reaffirms its opinion that from the viewpoint of maintaining all stocks, it is desirable to set separate quotas by species for the Antarctic catch rather than in terms of blue whale units.

4. The Committee sees no reason for closing the Sanctuary.

5. In regard to the opening date, the Committee wishes to reiterate its recommendation of the last five years that it would prefer to see no earlier opening date than the one now in force and sees no reason for recommending any change in the closing date.

6. The Committee recommends no change in the ban on killing blue and humpback whales in the waters south of the Equator.

B. *North Pacific Baleen Whales*

7. The best estimate of the present sustainable yield of fin whales in the North Pacific (excluding the East China Sea) is about 1,300. It is recommended that total catches of fin whales at land stations and in pelagic operations should be held below the estimated sustainable yield.

8. The present sustainable yield of sei whales is about 3,100. While the present population level may be above that which will give maximum sustainable yield, the Committee suggests that at the present level of catches any such surplus will soon be depleted. The Commission is urged to take steps to ensure that the sei whale stocks are not reduced to a level below that giving maximum sustainable yield.

9. The Committee recommends that the present ban on killing blue and humpback whales in the North Pacific be extended for at least three years beginning with the 1971 season.

C. *Sperm Whales*

10. Further analysis and new population models are needed for sperm whale stocks in the southern hemisphere.

11. The Committee notes that the estimated present sustainable yield of males in the northern part of the North Pacific Ocean is 4,290 and that the male sperm whale stock has now reached a level at which there is little or no further surplus, assuming that the female population remains at the present level. The female population level is still estimated to be above the level of maximum sustainable yield. The Committee recommends to the Commission that a further reduction in catch of male sperm whales is desirable.

12. The Committee recommends continuation of the arrangements with the National Institute of Oceanography whereby it acts as a central agency for whale marking data and recommends that the Commission continues to give financial support to the international marking scheme at the previous level.

13. The Committee recommends continuation of the arrangements with the Bureau of International Whaling Statistics to act as a central agency for the catch, effort and length distribution data and recommends that the Commission budget £500 for this work.

14. The Committee recommends that the Commission request F.A.O. to continue to act as a central agency for biological data.

15. The Committee recommends that the Secretary request continuation of the sighting programme by S.C.A.R. research ships and that the Commission request continued co-operation of the whaling companies in reporting sightings of prohibited species (at present blue, humpback, right and gray whales) in all areas.

ANNEX A

SCIENTIFIC COMMITTEE

Agenda for Meeting beginning 10.00 a.m. Monday 15th June 1970
at Room 460, Great Westminster House, Horseferry Road, London S.W.1

1. *Research and Information*

   1.1 Progress reports, including reports relative to special permits.
   1.2 Progress of whale marking and whale mark recoveries. Commission's contribution to whale marking.
   1.3 Reports of previous season's catches.
   1.4 Reports of the special meetings on Antarctic fin whale stock assessment and on sperm whale biology and stock assessment.
   1.5 Consideration of other data analyses.
   1.6 Sighting programme; consideration of forms for sighting data and of the data reports from 1969/70 season.
   1.7 Report on status of data compilations by Bureau of International Whaling Statistics.

2. *Status of Stocks and Recommendations to Commission*

   2.1 Southern baleen whales. Commission Agenda Item 18(c), (e), (f).
      2.11 Fin whales.
      2.12 Sei whales.
      2.13 Other species including blue and humpback whales.
   2.2 Sperm whales. Commission Agenda Item 8, 18(l).
   2.3 North Pacific baleen whales. Commission Agenda Item 9, 18(a), (d), (m).
      2.31 Fin whales.
      2.32 Sei whales.
      2.33 Other species including blue, humpback and gray whales.
   2.4 North Atlantic baleen whales.

3. *Data Collection and Other Matters*

   3.1 Review of the arrangements for exchange of data and for collection by a central agency; continuation of stock assessment work. Commission Agenda Item 7(b).
   3.2 Sperm whale data collection and reporting.
   3.3 Definition of sei and Bryde's whales. Commission Agenda Item 10, 18(g), (h), (k).

ANNEX B

SCIENTIFIC COMMITTEE DOCUMENTS

SC/22/1	Agenda
SC/22/2	Australia Progress Report
SC/22/3	Canada Progress Report
SC/22/4	Japan Progress Report
SC/22/5	Norway Progress Report
SC/22/6	South Africa Progress Report
SC/22/7	U.K. Progress Report
SC/22/8	U.S.A. Progress Report
SC/22/9	U.S.S.R. Progress Report
SC/22/10	Whaling in the Antarctic in the 1969/70 season.
SC/22/11	Antarctic season 1969/70 tables.
SC/22/12	Report of the special meeting on Antarctic fin whale stock assessment.
SC/22/13	Report of the special meeting on sperm whale biology and stock assessment.
SC/22/14	*Allen*: Notes on the assessment of Antarctic fin whale stocks.
SC/22/15	*Best*: Two allopatric forms of Bryde's whale on the west coast of South Africa.
SC/22/16	*Brown*: Consideration of the present technique of whale marking and future marking programmes.
SC/22/17	*Clarke*: The possibility of injuring small whales with the standard *Discovery* whale mark.
SC/22/18	*Chapman*: Analysis of 1969/70 catch and effort data for Antarctic baleen whale stocks.
SC/22/19	*Lockyer*: A new method of estimating age of sexual maturity in southern fin whales.
SC/22/20	*Mitchell*: Request for information on tagged whales in the North Atlantic.
SC/22/21	*Ohsumi, Shimadzu and Doi*: The seventh memorandum on the results of Japanese stock assessment of whales in the North Pacific.
SC/22/22	*Ohsumi*: A population model for sei whale in the North Pacific.
SC/22/23	*Ohsumi*: A trial to get mathematical models of population for sperm whale.
SC/22/24	*Doi, Ohsumi and Shimadzu*: Status of stock of baleen whales in the Antarctic 1970/71.
SC/22/25	*Allen*: A preliminary assessment of fin whale stock of the Canadian Atlantic coast.

ANNEX C

REPORT OF THE SPECIAL MEETING ON ANTARCTIC FIN WHALE STOCK ASSESSMENT

Honolulu, Hawaii, 13th–25th March 1970

Participants

Australia	J. L. Bannister
Canada	K. R. Allen
Japan	T. Doi
	S. Ohsumi
	R. Ohyama
	Y. Shimadzu
	T. Isogai
South Africa	P. B. Best
U.K.	R. Gambell
U.S.A.	D. G. Chapman (Chairman)
	D. W. Rice
U.S.S.R.	M. V. Ivashin
	Y. B. Riazantsev
F.A.O.	L. K. Boerema

Agenda

The revised agenda adopted for the meeting was as follows:

1. Re-evaluation of information on different stocks.
2. Review of age-length data and keys.
   (a) Pre-1962.
   (b) Post-1962.
3. Estimates of natural mortality rate (M).
4. Review and analysis of information on reproduction and recruitment.
   (a) Age of recruitment and maturity rate of pregnancy.
   (b) Reproduction and recruitment curves.
5. Population estimates based on catch and catch-per-unit-of-effort data.
   (a) Review of effort and catch-per-unit-of-effort.
   (b) Estimates from age-length keys.
   (c) DeLury-type estimates.
   (d) Estimates based on catchability (q) methods.
   (e) Least squares estimates.
6. Review and analysis of marking data.
7. Review and analysis of sighting data.
8. Population level to obtain maximum sustainable yield, and maximum sustainable yield.
9. Synthesis of results by several methods, including evaluation of comparative results both between areas and between species.
10. Other items relating to fin whale analysis.
11. Preparation of a report.

Appendix 1 includes a list of papers submitted to the meeting.

Acknowledgements

Particular thanks are due to Mr. R. Shomura, Director, and the secretarial and computing staff of the Bureau of Commercial Fisheries for their hospitality and the provision of the excellent facilities for the meeting, which did much to assist our work.

1. *Stock units*

The group reviewed information in F/1 on whale movements as indicated by mark recoveries and in F/7 on comparison of growth of fin whales in the several areas. The marking data show, as it has previously, there is a small degree of intermingling between adjacent areas but almost no evidence of large east–west movements. The average body length of whales 25 years and over is greatest in Area II and least in Area VI with a gradation between. Whales of Area I are intermediate in size between those of Areas II and VI.

The meeting also heard from Ivashin (F/13) suggesting a possible classification of different fin whale stocks in the southern oceans. The proposals of Laws (1960) were also recalled. The meeting agreed that the national groups should consider other subdivisions in their future analyses but for the present the traditional subdivisions into Areas I to VI are convenient.

2. *Age-Length Keys*

Ohsumi made available keys (F/10a and b) by sex and area for pre-1962 and post-1962. It was agreed that comparisons of these keys should be made. Allen indicated that he has used the Japanese key combining pre- and post-1962 data for the whole Antarctic and the Committee of Three key, which was developed from pre-1962 data and found no major differences in resulting recruitment and natural mortality rates. He also used a key for separate areas and with this did find some greater differences. As suggested in F/7, one age key should not be used to estimate the age composition of all whales but an age-length key should be made at least for each area and by sex. Ohsumi emphasized that there are evidences of changes in age and body length at sexual maturity and it was agreed that the present keys should be applied with caution to length data of earlier years. It was suggested that the age-length data based on ovulation counts made available to the Committee of Three should be reviewed and if found reasonable applied to early length data. These data are still retained in Seattle by Chapman.

3. *Natural Mortality Rate*

The meeting reviewed the estimates of natural mortality coefficient found in F/3 and IWC/21/Sc/18. These estimates are as follows:

	Sc/18	*F/3*
Males	0·034	0·035
Females	0·049	0·060

It was pointed out that the earplugs of older females are more difficult to read and this may explain part or all of this apparent difference between the sexes. It was agreed that the value of M equal to 0·04 is the best present estimate of the average natural mortality coefficient. However, members should study further the possibility that the indicated difference between the sexes is real. The possibilities of changes of M both with age and as a result of changes in stock condition must also be given further study. In this connection some tentative considerations are reported in F/8.

4. *Age of Recruitment*

There is substantial agreement on the median age of recruitment (i.e., the age at which 50 per cent of the year-class is recruited). Allen presented data used in his calculations from which the median age of recruitment is estimated at 4·7 years. Shimadzu states that the estimate from his data is about 5 years. Both of these estimates are derived using the age-length key calculated for the period 1957 to the present but applied to length data for all years since 1932. The increase in the proportion of younger animals in the catch in recent years would suggest a reduction in the age of recruitment (F/8).

5. *Age at Sexual Maturity*

The analysis of F/2 suggests that the age of sexual maturity in the early 1960's was 6 to 7 years in both sexes. This estimate is lower than the estimate given in IWC/21/Sc/18 which was 10 years. Ohsumi presented data showing a decline in the age at sexual maturity over the last 12 years. Additional data are needed, subdivided by areas. While the evidence is unclear, the age at sexual maturity is probably over 10 in unexploited stocks and may decrease to 6 or 7 in heavily exploited stocks.

6. *Pregnancy Rates*

Data on pregnancy rates are found in F/8 revised from IWC/21/Sc/18. This shows an increase in the pregnancy rate from around 0·30 in pre-war years to around 0·40 in the 1950's and early 1960's. The meeting also reviewed the possible range of pregnancy rates based on ovulation rates. These suggest a range from a low of 0·33 to a high of 0·50.

7. *Reproduction and Recruitment Curves*

No data on reproduction curves were presented but recruitment curves were available in IWC/21/Sc/18, F/3 and F/8 and some discussion on recruitment rates in F/4. There was considerable discussion of these recruitment curves; in particular Allen suggested that of his several alternatives he believes that the one given in Table 8 of F/3 is based on the most suitable data for this method. This suggests a net recruitment rate based on the total exploited stock of about 0·035 in the early 1950's and lower rates more recently that are difficult to explain, but may be due to increased selection of larger whales under the present lower quotas. He also explained some improvements that he had developed in his method of calculating recruitment rates. On the other hand Japanese scientists emphasized methods given in IWC/21/Sc/18 which they consider shows sustainable yield rate (corresponding to the net rate of recruitment) equal to 0·032 to 0·047 in early 1950's and 0·057 to 0·064 in the later 1960's. The recent decrease in the age at sexual maturity reported by Ohsumi might lead to increase in the recruitment rate. This needs further study and should be reviewed at the next meeting of the Scientific Committee.

8. *Population Estimates Based on Catch and Catch-per-Unit-of-Effort Data*

a. *Effort and catch-per-unit-of-effort*

Ohsumi reviewed his paper F/9 which notes many problems in measuring effort and catch-per-unit-of-effort. It was agreed that these problems deserve serious study and certainly catch-per-unit-of-effort is not a valid index of abundance under all conditions. However, catch-per-unit-of-effort is an important piece of information and must be considered along with other data.

Catch-per-unit-of-effort data for fin whales should be least biased for the period from 1953/54 to 1961/62 when fin whales constituted 80 per cent of the total annual baleen whale catch.

b. *Estimates from age composition derived from age-length keys*

No new estimates of this type were presented. Two such estimates were given in IWC/21/Sc/4 and IWC/21/Sc/18.

c. *DeLury-type estimates*

Further estimates of this type were available in F/4. To use these estimates it is necessary to have an independent estimate of the net recruitment rate. The value of net recruitment rate used was 0·03 but other alternatives were presented.

d. *Estimates based on the catchability coefficient (q) method*

No new estimates of this type were available but the estimates in IWC/21/Sc/18 were reviewed.

e. *Least squares estimates*

New and revised estimates by the method of least squares were presented in F/3 and F/5.

f. *Estimates based on recruitment curve*

Estimates based on a recruitment curve and iteration method made in IWC/21/Sc/18 were reviewed.

9. *Marking Data*

Some slight additional analyses were presented in F/4; in general these support the other methods of analysis but because of the variability of the data cannot be considered to be very useful.

10. *Sighting Data*

In the paper of Doi (F/6) a theoretical model is developed to convert sighting data to estimates of absolute abundance. This is a valuable contribution but more work remains to be done on checking the validity of the model and in obtaining observations to estimate parameters in the model.

11. *Maximum Sustainable Yield*

Allen estimated in F/3 that the maximum sustainable yield would be 10,000 to 12,000 at an exploited stock level of 250,000 to 300,000. Shimadzu referred to calculations in IWC/21/Sc/18 which showed the maximum sustainable yield is about 9,000–10,000 whales at a stock level of 220,000. The estimates of maximum sustainable yield are close, but there is some difference as to the stock level at which these might be obtained. The present stock level is much below that at which the maximum sustainable yield could be obtained.

12. *Synthesis of Different Estimates*

It is agreed that the CPUE is least biased by extraneous factors for the period 1954 to 1962 because throughout this period 80 per cent of the catch was in fin whales. Also the estimates by several different methods agree reasonably closely through much of this period. In view of the great effect that the recruitment rate has on estimates both of the present stock size and of the present sustainable yield, it is clearly very important that more precise estimates of the present net recruitment rate be obtained as soon as possible. The several estimates are given in Table 1.

TABLE 1
Estimates of Total Exploitable Population Size of Fin Whales (thousands)

	1958	*1962*
Least squares (F/3, Table 8)	171	93
Modified DeLury (F/4 recalculated with $r - M = 0{\cdot}04$)	176	108
q (IWC/21/Sc/18)	194	110
Reproduction curve (IWC/21/Sc/18) (Average of Cases 2 and 4)	146	91
Average	171·8	100·5

TABLE 2

Year	*Population size at beginning of season*	*Catch*	*Survival from catch and natural mortality*	*Recruitment*	*Population size at beginning of next season*
	(All figures in thousands)				
	(a) *Calculations of 1970 Fin Whale Population* ($r - M = 0{\cdot}02$)*				
1962	100·0	26·4	70·7	11·2	81·9
1963	81·9	18·6	60·8	10·3	71·1
1964	71·1	13·6	55·2	9·2	64·4
1965	64·4	7·3	54·8	8·2	63·0
1966	63·0	2·3	58·3	7·1	65·4
1967	65·4	2·9	62·5	6·0	68·5
1968	68·5	2·1	63·7	4·9	68·6
1969	68·6	3·0	63·0	4·3	67·3
1970	67·3				
	(b) *Calculations of 1970 Fin Whale Population* ($r - M = 0{\cdot}04$)†				
1962	100·0	26·4	70·7	15·0	85·7
1963	85·7	18·6	64·4	13·6	78·0
1964	78·0	13·6	61·8	12·2	74·0
1965	74·0	7·3	64·0	10·8	74·8
1966	74·8	2·3	69·6	9·4	79·0
1967	79·0	2·9	73·1	8·0	81·1
1968	81·1	2·1	75·8	6·9	82·7
1969	82·7	3·0	76·5	6·2	82·7
1970	82·7				
	(c) *Calculations of 1970 Fin Whale Population* ($r - M = 0{\cdot}049$ *in 1962 increasing to* $0{\cdot}057$ *in 1970*)‡				
1962	100·0	26·4	70·7	16·9	87·6
1963	87·6	18·6	66·2	15·5	81·7
1964	81·7	13·6	65·4	14·0	79·4
1965	79·4	7·3	69·2	12·5	81·7
1966	81·7	2·3	76·2	11·0	87·2
1967	87·2	2·9	80·9	9·4	90·3
1968	90·3	2·1	84·7	8·3	93·0
1969	93·0	3·0	86·4	7·8	94·2
1970	94·2				

* On the basis of these calculations, with $r - M = 0{\cdot}02$ the present sustainable yield is about 1·3 thousand (67·3 thousand × 0·02).

† On the basis of these calculations, with $r - M = 0{\cdot}04$ the present sustainable yield is about 3·3 thousand (8·27 thousand × 0·04).

‡ On the basis of these calculations, with $r - M = 0{\cdot}057$ the present sustainable yield is 5·4 thousand (94·2 thousand × 0·057).

To extend these estimates forward it is necessary to use information on the rate of recruitment. As pointed out in the section on reproduction and recruitment curves, the rate of net recruitment (based on the total exploited stock) is calculated by Allen to be 0·035 in the early 1950's decreasing to 0·02 or less in recent years; on the other hand the Japanese scientists assumed reproduction

curves with rates of net recruitment increasing from 0·04 to 0·06 in the 1950's and 1960's. If the average figures given in Table 1 are accepted, they imply a net recruitment rate of 0·04 approximately during the period 1958 to 1962. The following tables show calculations of present stock level and sustainable yield using these three sets of values for $r - M$, the net recruitment rate. More specifically the calculations detailed in Table 2 use the following parameter values in addition to r; $M = 0{\cdot}04$; age of 50% recruitment = 5; 1957 population level 187 thousand, 1962 population 100 thousand.

Appendix I

Contributed Papers
Fin Whale Stock Assessment Meeting

F/1	A note on the migrations and movements of fin whale in the Southern Hemisphere as revealed by whale mark recoveries	S. G. Brown
F/2	Revision of age of sexual maturity in southern fin whales	C. Lockyer
F/3	Estimates of total population size and recruitment for the fin whale stocks of the Antarctic	K. Radway Allen
F/4	Review of analysis of southern baleen whale stocks	D. G. Chapman
F/5	Supplementary note on least squares analysis of fin whale stocks 1953/54–1962/63	D. G. Chapman
F/6	Re-evaluation of population studies by sighting observations of whales	Takeyuki Doi
F/7	Comparison of growth of fin whales among various areas of the Antarctic Ocean	Seiji Ohsumi and Yasuhiko Shimadzu
F/8	Problems and some considerations on reproduction relationship of fin whale in the Antarctic	Yasuhiko Shimadzu
F/9	Some considerations on fishing effort and CPUE for the Antarctic fin whales	Seiji Ohsumi
F/10	Age length key of Antarctic fin whales; (a) male, (b) female	Japan
F/11	Computer applications for whale population, state analysis	A. A. Protcenko and B. I. Pokrovsky
F/12	About stochastic estimation of whale population state in Antarctic and North Pacific on the basis of computer usage	A. A. Protcenko and B. I. Pokrovsky
F/13	Locality of some commercial species of whales in the Southern Hemisphere	M. V. Ivashin

Other Paper Cited

LAWS, R. M. 1960. Problems of whale conservation. *Trans. 25th N. Amer. Wildlife Conf.*, 304–319.

ANNEX D

REPORT OF THE SPECIAL MEETING ON SPERM WHALE BIOLOGY AND STOCK ASSESSMENTS

Honolulu, Hawaii, 13th–24th March 1970

The meeting, in conjunction with the meeting on stock assessments of southern fin whales, was held at the laboratory of the Bureau of Commercial Fisheries.

Participants

Australia	J. L. Bannister
Canada	K. R. Allen
Japan	T. Doi
	S. Ohsumi
	R. Ohyama
	Y. Shimadzu
	T. Isogai
South Africa	P. B. Best
U.K.	R. Gambell (Chairman)
U.S.A.	D. G. Chapman
	D. W. Rice
U.S.S.R.	M. V. Ivashin
	Y. B. Riazantsev
F.A.O.	L. K. Boerema

Agenda

The revised agenda adopted for the meeting was as follows:

1. Review of scientific papers published previously.
2. Stock units.
   (a) Identification of stock units by marking experiments.
   (b) Identification by morphometric, biochemical and ecological studies.
3. Age and growth.
   (a) Growth curve and age-length key.
   (b) Development stages.
      (i) birth, (ii) weaning, (iii) sexual maturity, (iv) social maturity, (v) physical maturity.
4. Reproduction.
   (a) Ovulation rate.
   (b) Pregnancy rate.
   (c) Duration of breeding cycle.
   (d) Reproduction curve.
   (e) Recruitment.
5. Ecology.
   (a) Geographical distribution by sex and age.
   (b) Number of females per breeding male.
   (c) Natural mortality (age composition).
6. Fishing effort.
   Standardization and calculation.

7. Methods of stock assessment.
   (a) Using results of marking experiments.
   (b) Using results of whale sightings.
   (c) Using catch, effort and age composition data.
8. Models for stock condition and its evaluation.
9. Future research.
10. Preparation of report.

1. *Scientific Papers*

In addition to previously published scientific papers dealing with various aspects of sperm whale biology, the meeting had before it 20 contributed papers and documents. These are listed in Appendix 1 and, together with the published works, they formed the basis for most of the discussions.

2. *Stock Units*

There is little new evidence to modify the groupings adopted at the 1963 Seattle and subsequent sperm whale meetings, in which three breeding stocks in the North Pacific and separate populations off the coasts of each southern continent were postulated. These divisions in the southern hemisphere are primarily ones of convenience for assessment purposes, and possibly do not correspond exactly to independent biological units. Some new marking results (Brown, Sp/1; Masaki, Sp/9; Ivashin, Sp/17) and morphometric data (Clarke and Paliza, Sp/4) are not inconsistent with the previous views, but taken with Japanese data on catches of females southeast of Australia and New Zealand (Ohsumi and Nasu, Sp/7), they do not exclude the possibility of mixing between at least some groups.

3. *Age and Growth*

The 1968 Oslo meeting on age determination in whales decided that a rate of formation of one dentinal growth layer per year should be assumed in sperm whale teeth (IWC 19, p. 136). This is supported by new evidence (Gambell, Sp/2). In reviewing all the evidence now available, the present meeting agreed that this rate of formation is the most reasonable for the greater part of the life-span.

a. *Growth curve and age-length key*

Growth curves obtained from four sperm whale fisheries were used for providing data on age-at-length at various stages of the life cycle (see (b) below).

From data analysed by F.A.O., no single age-length key could be produced for male sperm whales in the southern hemisphere, since although U.S.S.R. (pelagic), Western Australia (coastal) and South African (west coast) data were similar, the Japanese (pelagic) records were not consistent with them. By analogy with the situation in the North Pacific, differences would be expected between pelagic and coastal age-length keys because of segregation and the different legal size limits. However, for the present, it was decided that F.A.O. should be asked to produce separate age compositions based both on the Japanese and the other combined keys, and to use further material to be provided after the meeting.

b. *Developmental stages*

(i) Birth

The length at birth is now estimated to be a little more than 4 m. (13 ft.) in most areas.

(ii) Weaning

There are no new direct data on body length or age at weaning, but indirect evidence on the age is available from the duration of lactation (see section 4c).

(iii and iv) Sexual and social maturity

In females, the length at sexual maturity is still estimated at 28–30 ft. (8·5–9·1 m.), and the age at 8–11 years. Under exploitation the age may decrease, as in the fin whale. Australian figures are possibly closest to the unexploited state, where the length is estimated as 29 ft. (8·8 m.), and the age about 11 years.

In males, the situation is more complex because of the slow maturation of the testes from the centre outwards. Immature, maturing and mature tissues can be distinguished histologically, and based mainly on the work of Best (1969), the following maturity stages are recognized:

Puberty; the length and age when 50% of the whales are immature at the centre of the testis (at a length of 30–32 ft. (9·1–9·8 m.) and age 9–10 years).

Sexual maturity; the length and age when 50% of the whales are immature and 50% mature or maturing at the periphery of the testis (length 39 ft. (11·9 m.), age 19 years).

Social maturity or harem-master status (length 45 ft. (13·7 m.), age 25–27 years). This behavioural stage appears to correspond to the stage when equal proportions of the males are immature and mature at the periphery of the testis (maturing animals not included). It is possible that this status can be attained by any bull which has reached sexual maturity.

(v) Physical maturity

Estimates for males, based on growth curves and epiphysical fusion, vary from 50–53 ft. (15·2–16·1 m.) and ages 45–60 years. For females, the ranges are 34–36 ft. (10·4–11·0 m.) and 25–30 years.

4. *Reproduction*

a. *Ovulation rate*

There are now available several regressions of ovarian corpora counts on dentinal growth layers, as below:

Japanese coast	0·31	(Ohsumi, 1965)
North Pacific pelagic	0·38	(Japanese, new data)
Californian coast	0·33	(Rice and Wolman, Sp/3)
Western Australian coast	0·38	(Bannister, Sp/12)
South African west coast	0·44	(Best, Sp/14)
South African east coast	0·45	(Gambell, Sp/2)

Two different methods of ovary examination were used in obtaining the above results; palpation and cutting (Japan) and serial sectioning (all others).

Another method of calculating the ovulation rate, depending solely on estimates of the length of the breeding cycle and reproductive data, gave the following results:

	Ovulations per cycle	*Cycle length (yr)*	*Mean ovulations per year*	
Californian coast	1·15–1·36	3	0·38–0·45	(Rice and Wolman, Sp/3)
South African east coast	1·82	4	0·45	(Gambell, Sp/2)
South African west coast	2·12	4	0·53	(Best, new data)

b. *Pregnancy rate*

The only method of estimation is from the proportion of pregnant females in the catch, adjusted to allow for a gestation period extending over more than one year. If the catch is not representative, biased results may be obtained. The following new estimates are available:

South African east coast	16–19%	(Gambell, new data)
South African west coast	22	(Best, 1968)
North Pacific	19–29	(Masaki, Sp/10)
Western Australian coast	24+	(Bannister, new data)
Californian coast	33	(Rice and Wolman, Sp/3)

Japanese data (Masaki, Sp/10) from the North Pacific show a gradation in the pregnancy rate from a high in the west to a low in the east, which could reflect differences in the stock condition.

c. *Duration of the breeding cycle*

The only new evidence on the main season of mating is from the Californian coast, where it extends from April through August with a peak in June (Rice and Wolman, Sp/3). This is a little later in time than the northern hemisphere estimates reviewed at the 1966 Honolulu sperm whale meeting (IWC 17, p. 123), which showed the average month of conception as either April or May. The southern hemisphere estimates are mainly mid-summer, December–January off South Africa and Australia, with September indicated in the S.E. Pacific. In all areas, the length of gestation is estimated within the narrow limits of 14–16 months.

From the bimodal size distribution of the largest corpora albicantia and the depths of mammary glands, the duration of lactation is given as 24–25 months for sperm whales off the east coast of South Africa (Gambell, Sp/2). This estimate is in line with the most recent published data for other areas (Ohsumi, 1965; Best, 1968). Data presented for the Californian coast, however (Rice and Wolman, Sp/3), suggest (as Clarke (1956) proposed) that lactation may only last one year, the largest corpora albicantia in these females not being distinctly bimodal in distribution. An estimate of about 4 months for the length of lactation off Western Australia (Bannister, Sp/12) is based solely on the proportion of lactating females in the catch and so cannot be considered very reliable.

Estimates of the duration of lactation as one year or less seem unlikely compared with the length of weaning of 22 ft. put forward by Clarke (1956), and with the number of growth layers (4–6) found in teeth of sperm whales close to the length of weaning (IWC 19, p. 134).

There is no direct evidence on the length of the resting period, which is generally calculated so as to make up the cycle to a complete number of years. Gambell (Sp/2) has estimated that it lasts 8–9 months and Rice and Wolman (Sp/3) 11 months, and these periods cover the range of published estimates.

From the pregnancy data given above, the length of the breeding cycle ranges from 3–5 years. Using ovulation evidence, the cycle appears more likely to be 4 years off South Africa and 3 years off California.

d. *Reproduction curve*

In order to draw an accurate reproduction curve it is necessary to obtain, in addition to information concerning such biological parameters as age at sexual maturity, age at recruitment, pregnancy rate, natural mortality rate, etc., information on the changes of these parameters in response to changes in stock size.

Our present knowledge of these changes is insufficient, but for the purpose of expediting proper stock management, national groups are urged to obtain a

reproduction curve as soon as possible. This must be based on the present knowledge and most reasonable hypotheses.

With regard to pregnancy rate, there are no observations available in the same stock at different levels of exploitation. Although the data across the North Pacific conform with the expectation that pregnancy rate will increase as exploitation increases, the situations off the Californian and South African east coast appear to contradict this.

e. *Recruitment*

Ages at full recruitment are as follows:

	Males	*Females*	
Japanese coast	15	21	(Shimadzu, Sp/11)
North Pacific, Area III	18	22	
North Pacific, Area IV	22		
North Pacific, Area V	18		
South African east coast	22	18–20	(Gambell, new data)
South African west coast	18	20	(Best, Sp/14)
Californian coast	17*	—	(Rice and Wolman, Sp/3)
Western Australian coast	22–26	—	(Bannister, Sp/12)
Antarctic, Areas II, III, IV and V	28	—	(F.A.O., Sp/5)

These variations probably reflect differences in legal size limits, characteristics of the operations, the stock condition and segregation.

The age at which 50% of the stock are recruited must be estimated, and calculation based on the method developed by Allen (1966) seems to be the most reliable in this respect.

5. *Ecology*

a. *Geographical distribution by sex and age*

Japanese data (Ohsumi and Nasu, Sp/7) show that females are confined to waters north of the 9°C isotherm in the Indian and Pacific Ocean sectors of the southern hemisphere. Such a clear boundary has not been demonstrated in the North Pacific, where the oceanic structure is more complicated. The entry of male sperm whales into the New Zealand grounds in spring appears to be associated with the inflow of warmer water (Gaskin, Sp/18), and this may be further confirmation of the influence of oceanographic conditions on sperm whale distribution.

Male sperm whales seem to segregate from mixed schools from puberty as defined above (Ohsumi, Sp/8; Best, Sp/15). Evidence from diatom film (Bannister, Sp/12; Best, in press) suggests that males of 39 ft. (11·9 m.) and greater caught off Western Australia and the west coast of South Africa have spent some time south of the Antarctic Convergence. Cyamid infestation (Best, 1969) shows that males of the same size are subject to environmental conditions different from those experienced by smaller males and females. Estimates of total mortality may therefore include a factor representing emigration in addition to the natural and fishing mortalities.

b. *Number of females per breeding male*

Three estimates are available for the average number of females in mixed schools:

* Including special permit whales.

	Total	*Mature*	
South African east coast	15	—	(Gambell, new data)
South African west coast	11-17	10–15	(Best, Sp/15)
Japanese data, N. Pacific and Indian Ocean	21	14	(Ohsumi, Sp/8)

The Japanese results were obtained by applying the size and sex composition of 3 schools caught under special permit to data on sightings by scouting boats of 157 mixed schools. The South African east coast results are from aircraft sightings of 61 mixed schools and the average proportion of females in the catches of small sperm whales. The South African west coast results relate to catches of 7 mixed schools.

There is a strong tendency for only one big bull to be associated with such schools, so the best estimate of the number of mature females per breeding male is 10–15, but this might change as an effect of exploitation (Best, Sp/15).

c. *Natural mortality*

The following estimates of total mortality rates from lightly exploited stocks or the older age-groups of exploited stocks are available:

	Females	*Males*	
South African west coast	0·09	—	(Best, Sp/14)
South African east coast	0·08	—	(Gambell, new data)
California coast	0·07	—	(Rice and Wolman, Sp/3)
Western Australian coast	0·07	—	(Bannister, new data)
North Pacific, pelagic	0·06	0·05-0·07	(Shimadzu, Sp/11)

The best figure for natural mortality seems to be 0·06 for adults of both sexes.

6. *Fishing Effort*

Standardization and calculation

For coastal operations it was decided that corrections for changes in catcher efficiency should employ the factor most appropriate to local conditions, for instance tonnage, horsepower or area swept.

In Japanese coastal operations horsepower is used because of its effect on the towing speed when tonnage was limited. Off South Africa tonnage is used because catch rates are then better correlated with independent aircraft sightings. The efficiency of the Western Australian fishery seems to be more closely linked with the operations of the spotter aircraft than with changes in catcher horsepower or tonnage. There have been no changes in the Californian fishing efficiency, as the same catchers are still in operation.

Sperm whale catch rates in the Antarctic baleen whaling season are of little value, so assessments will have to be based on the operations before and after this period. In the North Pacific pelagic fishery there does not seem to be such a strong bias against sperm whales, so the whole season's data can be used.

It was decided to ask the B.I.W.S. for compilations of gross and net catcher-days-worked (CDW) for the pelagic pre- and post-baleen whale season in the southern hemisphere by month and 10° square. Similar data are requested for the whole whaling season in the North Pacific.

Net CDWs are defined as catcher days on which at least one sperm whale is caught by boats of that factory ship or land station.

Gross CDWs are the total number of catcher days spent on the grounds.

In order to enable the B.I.W.S. to provide comparable data for coastal whaling, it is recommended that the relevant statistics in terms of catcher-days with any corrections for efficiency as national groups may think appropriate, are collected and forwarded to the B.I.W.S.

7. *Methods of Stock Assessment*

a. *Using results of marking experiments*

No new analyses of mark returns have been made since the 1968 Rome meeting, at which it was shown that the exploitation rates in the North Pacific so calculated tend to be lower than by other methods. National groups were asked to refine their marking data by separating them into coastal and pelagic operations (10° squares), and by sex (recovery data only) in time for the June 1970 meeting of the Scientific Committee.

The meeting noted the small number of sperm whales marked in the southern hemisphere, and urged that marking be accelerated, particularly in that area.

b. *Using results of whale sightings*

The paper by Doi (F/6) presented a new theoretical model for the evaluation of sightings data for estimating stock sizes. There are still a number of difficulties in the model, particularly concerning the movement of whales in relation to the track of the sighting vessel, and the average duration of dive of a whale. The latter parameter has especial significance for sperm whales, since the various size groups have different diving behaviour, and they can stay submerged for much longer periods than baleen whales. Further refinement of the model is in progress, and data on diving times for all species are currently being collected in the Antarctic by Japanese expeditions.

c. *Using catch, effort and age composition data*

Because of the difficulties of collecting adequate effort statistics for sperm whaling on pelagic grounds, little use has been made of this approach so far. Coastal whaling statistics are more accurate, but because most stocks on these grounds do not appear to have undergone very marked changes in size and there is uncertainty about their boundaries, few assessments have yet been made, but ways of using the data must be further explored.

8. *Models for Stock Conditions and its Evaluation*

At the 1968 Rome meeting on sperm whale assessments (IWC 19, pp. 41–46), theoretical models were developed for estimating sustainable yields of male and female sperm whales based on a given number of mature females in a breeding stock. In the present meeting Chapman developed a further model showing the yields of males for several conditions of the female stock, which will be revised before the London meeting of the Scientific Committee, so that the various parameters now reviewed can be used to give improved assessments.

A method of estimating stock sizes based on total mortality rates calculated from age distributions of adult males was demonstrated by Chapman and Boerema (Appendix 2). Results obtained from this model using rather incomplete southern hemisphere data available at the meeting are included in the Appendix. This method can yield improved estimates when fuller catch statistics are obtained from the B.I.W.S., though caution has to be used in interpreting these results because of the differential distribution of the stocks between the Antarctic and warmer waters.

9. *Future Research*

As a result of the discussions in this meeting, a number of subjects requiring particular study were identified, and possible methods of approach were suggested as follows.

a. *Stock units*

There is as great a need as ever for direct evidence on stock limits and migrations by means of conventional marking programmes. The meeting noted that Canada and Japan are experimenting with radio tags which could yield valuable information on short term movements of whales.

b. *Age and growth*

Further studies on the rate of layer formation in the dentine of young sperm whales are required, using small animals caught under special permit. A fuller understanding of the microstructure and histology of teeth could also help in determining the exact rate and time of formation of the layers.

The age and size at weaning need to be demonstrated more reliably, through the capture of calves under special permit.

c. *Social maturity*

Some method of recognizing breeding bulls by histological or other techniques is desirable, if such identification is possible, to follow possible changes in the age and/or size at social maturity in response to changes in stock condition under exploitation.

d. *Breeding cycle*

Further estimates of the frequency of ovulation are required from as many stocks as possible, since these provide a useful, independent, check on the likely duration of the breeding cycle. The duration of this cycle is still in a little doubt, and further evidence of the length of the lactation and resting phases would be helpful.

Using all the available biological information, it is desirable that mathematical models of the reproduction curve are developed to predict the likely changes which may be expected as a result of changes in the stock condition.

e. *Ecology*

More information on the geographical distribution and seasonal movements of sperm whales, by sex and age, is needed. Japan has programmes based on sightings by her research vessels which should yield valuable data particularly in areas outside the main whaling grounds.

The number of females per breeding bull needs further study, together with information on changes in this number as stock conditions alter. The capture of more whole schools of sperm whales, under special permit, and analysis of suitable sightings records seem the best techniques to use.

Acknowledgements

Particular thanks are due to Mr. R. Shomura, Director, and the secretarial and computing staff of the Bureau of Commercial Fisheries for their hospitality and the provision of excellent facilities for the meeting, which did much to assist our work.

Appendix 1

Contributed Papers

Sp/1	Sperm whale marking and mark recoveries	Brown
Sp/2	The reproductive cycle, ovulation rate and tooth layer counts in sperm whales off Durban	Gambell

Sp/3	Sperm whales in the eastern North Pacific: Progress report on research, 1959–1969	Rice and Wolman
Sp/4	Morphometry of the world stocks of sperm whales	Clarke and Paliza
Sp/5	Notes on sperm whale age-composition tables	F.A.O. (Mackett)
Sp/6	Notes on sperm whale age-composition tables	F.A.O. (Boerema)
Sp/7	Range of habitat of the female sperm whale with reference to the oceanographic structure	Ohsumi and Nasu
Sp/8	Some investigations on the school structure of sperm whale	Ohsumi
Sp/9	Study on the stock units of sperm whale in the North Pacific	Masaki
Sp/10	Differences between pregnancy rates of sperm whales in the North Pacific by area	Masaki
Sp/11	Natural mortality coefficient and rate of exploitation for sperm whales in the North Pacific	Shimadzu
Sp/12	The biology and status of the sperm whale off Western Australia	Bannister
Sp/13	Age-length keys for sperm whales in the North Pacific	Japan
Sp/14	Age, growth and mortality	Best
Sp/15	Social groupings	Best
Sp/16	Progress report on sperm whale research, U.S.S.R.	Ivashin
Sp/17	Some results of marking sperm whales by the U.S.S.R. in the southern hemisphere	Ivashin
Sp/18	Further information on the sperm whales of the Cook Strait region of New Zealand	Gaskin
F/6	Re-evaluation of population studies by sighting observations of whales	Doi
F/9	Some considerations on fishing effort and CPUE for the Antarctic fin whales	Ohsumi

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Appendix 2

An Example of Estimation of Stock Size of Sperm Whales in the Southern Hemisphere, Based on Mortality Rates Estimated from Age Distributions of Adult Males

D. G. Chapman and L. K. Boerema

Estimates of total mortality rates of male sperm whales 28–42 years of age in the Antarctic, calculated by logarithmic regression from age distributions given in Sp/6, are given in Table 1. The average figure for the whole Antarctic in the years 61/62 to 68/69 is 0·25. Separate estimates using the data from Australia plus Area IV give a value of 0·21 and using the data from Donkergat plus Area III a value of 0·25 (from data in Sp/5). The reliability of these combined estimates will be affected by the distribution of the stock between the Antarctic and warmer waters.

Rough estimates of the average catches of males of 28 years and over in the same years are 400 per year in Area IV plus Australia, 570 per year in Area III and South Africa, and 1,500 per year in the total Antarctic plus South Africa plus Australia (Sp/5 plus information from Gambell for Durban). These figures are under-estimates because they do not contain the catches of Norway and other pelagic whaling countries in the Antarctic which have finished their operations. They also do not contain the catches of adult males (over 27 years) by land stations in the southern hemisphere other than those mentioned. The average annual catches of males of all ages in the last 15 years were roughly 1,500 in Area IV plus Australia, 2,000 in Area III and South Africa, and 10,000 in the whole southern hemisphere.

These figures can be used for a very preliminary estimation of the stock size of mature (10 years and older) female sperm whales in the areas concerned.

$C_{>27m}$ = catch of males of 28 years and over

C_{10-27m} = catch of males younger than 28 years

R_{28m} = recruitment of males at 28 years old

R_{10m} = backcalculated number of males of 10 years old from which R_{28m} have survived

R^1_{10m} = backcalculated number of whales of 10 years old from which the survivors were caught before reaching 28 years

t_a = average age of whales caught of less than 28 years old

$$R_{28m} = C_{>27m} \times \frac{F + M}{F} = R_{10m} \times e^{-(28-10)M}$$

$$R^1_{10m} = C_{10-27m} \times e^{-(t_a-10)M}$$

Total number of male whales in the stock at 10 years old is $(R_{10m} + R^1_{10m})$, which is about equal to the total number of females in the stock at 10 years old.

Hence, the total number of females of 10 years and older in the stock is

$$N_{f>10} = \frac{(R_{10m} + R^1_{10m})}{1 - e^{-Z_f}}$$

Applying these calculations to the figures given above, taking the average age of males caught between 10 and 28 years of age as 19 and Z_r as 0·07, the following estimates are obtained: Female stock of 10 years of age and older belonging to the same stocks as the males in Area IV and Australia—47,000; in Area III plus South Africa—57,000; in the whole Southern Hemisphere—300,000.

These estimates are a rough approximation only. They can be improved by more precise estimation of the average numbers, ages and mortalities, and better knowledge of stock units, and by including all catches of males of 28 years and older. They refer to the exploited stocks only and do not include other, un- or lightly exploited stocks. The reliability of the estimates depends to a large extent on the assumption that the slopes of the age distribution curves of the males of 28 years and older represent mortality only and do not include an effect of migration into or out of the fishery. The effect of migration between lower and higher latitudes requires further consideration.

TABLE I
Total Mortality Rates for Male Sperm Whales in the Antarctic*

	Year							
Area	*61/62*	*62/63*	*63/64*	*64/65*	*65/66*	*66/67*	*67/68*	*68/69*
II W	0·23	0·25	0·14	0·09	0·21	0·11	0·15	0·09
II E	0·20	0·20	—	—	—			
III W	0·15	—	0·22	—	—	—		
III E	0·21	0·26	0·31	0·24	0·24	0·28	0·25	0·20
IV	0·19	0·23	0·22	0·16	—	0·26	0·25	0·26
V	0·10	0·12	0·25	0·28	0·11	0·21	0·25	0·24
VI	—	—	—	—	0·06	0·16	0·10	0·20
I	—	—	—	0·30	—	—	—	—
Total	0·25	0·24	0·28	0·29	0·22	0·22	0·27	0·25

* These are calculated from the data of Sp/6 using logarithmic regression applied to estimated numbers of whales 28–42 years of age. Bold figures are based on small samples and may have low reliability.

ANNEX E

WHALE MARKING—PROGRESS REPORT, 1970

by S. G. Brown

Whale Research Unit
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(Revised)

The following information is available on whale marking during 1968 and 1969, and in the Antarctic season 1969/70 (see Table 1).

A total of 416 whales was marked in the southern hemisphere, including 18 blue, 43 fin, 47 sei, 7 humpback, 15 right and 286 sperm whales. 254 whales were marked in the northern hemisphere, including 3 blue, 44 fin, 42 sei, 4 humpback, 1 right and 154 sperm whales. Information on the distribution of marking in the different regions is given in the Progress Reports on Whale Research presented to the Scientific Committee.

In 1969 for the North Pacific information is available on marks recovered from 3 fin, 4 sei and 11 sperm whales. Twelve marks were recovered in the North Atlantic in 1969.

The Scientific Committee has agreed that details of marks recovered in the Antarctic, which were formerly published annually in the *Norwegian Whaling Gazette*, should now be given in this report. The present report therefore includes details of returns from the 1968/69 and 1969/70 Antarctic whaling seasons.

Whale Marks Recovered in the Antarctic Whaling Season 1968/69

Fifteen whale marks found during the Antarctic whaling season 1968/69 were reported to the N.I.O. (see Table 2). This is a small increase on the number returned in the previous season. No pre-war marks were recovered, the oldest return is in the 14 year-group of post-war marks. There are 5 marks fired and recovered during the 1968/69 season (0-group).

Thirteen marks were returned from fin whales. Nos. 25678/80 possibly came from the same whale. Two whales crossed from Area III to Area IV, and one from Area IV to Area III in the interval between marking and capture. All 5 whales in the 0-group returns were captured within a few days of marking and they show very little movement from the marking areas.

Two marks were returned from sei whales, both in the 5-year-group. No. 18935 shows movement from Area II into Area III.

Whale Marks Recovered in the Antarctic Whaling Season 1969/70

Fifteen whale marks found during the Antarctic whaling season 1969/70 have been reported to the N.I.O. (see Table 3). No pre-war marks were recovered. There is one mark from a fin whale in the U.S.S.R. series.

Ten marks were returned from fin whales. Of the 3 returns after one year, 2 show a return to the marking area, and one a movement from Area III into Area IV.

TABLE 1
Whales Marked During 1968, 1969 and in Antarctic Season 1969/70

	Blue	*Fin*	*Sei*	*Humpback*	*Minke*	*Right*	*Sperm*	*Bottle-Nosed*	*Pilot*	*Total*
					Southern Hemisphere					
Antarctic 1969/70 (International scheme—Japan)	8	37	30	2	—	12	44	—	—	133
Antarctic 1969/70 (U.S.S.R.)	—	1	2	5	—	3	—	—	—	11
North of 40°S (U.S.S.R.)	10*	4	9	—	—	—	203	—	—	226
Australia 1968	—	—	—	—	—	—	10	—	—	10
Australia 1969	—	—	—	—	—	—	5	—	—	5
South Africa	—	1	6	—	—	—	24	—	—	31
Total	18	43	47	7	—	15	286	—	—	416
					Northern Hemisphere					
North Atlantic										
Canada 1969 (May–June)	3	32	5	4	2	—	1	2	2	51
France 1969	—	2	—	—	—	—	—	—	—	2
U.S.S.R. 1969/70	—	—	—	—	—	—	6	—	—	6
North Pacific										
Japan 1969	—	9	34	—	—	1	120	—	—	164
U.S.S.R. 1969/70	—	1	3	—	—	—	27	—	—	31
Total	3	44	42	4	2	1	154	2	2	254

* 4 Pigmy Blue Whales.

TABLE 2
Marks Recovered in the Antarctic Season 1968/69

Mark no.	*Date marked*	*Date recovered*	*Years*	*Position marked*	*Position recovered*	*Sex*	*Length in feet*
			Fin Whales				
13485	21.xi.54	31.i.69	14	52°26′S, 25°47′E	45°26′S, 66°28′E	Female	72
20538	20.xii.58	26.iii.69	10	63°41′S, 160°58′E	59°13′S, 158°32′E	Female	69/70
22518	15.xii.59	13.3.69	9	60°09′S, 102°12′E	57°55′S, 90°50′E	Male	68
25678*	26.xi.62	6.iii.69	6	57°46′S, 54°28′E	44°51′S, 76°01′E	Female	70
25680*	26.xi.62	7.iii.69 (from refrigerator vessel)	6	57°45′S, 54°29′E	43°56′S, 77°52′E (approx.)	—	—
25703	26.xi.62	18.ii.69	6	57°41′S, 54°12′E	45°40′S, 56°30′E	Female	72
25771	5.xii.62	1.iii.69	6	59°20′S, 66°28′E	43°05′S, 72°25′E	Female	67
26768	13.ii.67	6.iii.69 (from boiler)	2	57°25′S, 80°55′E	44°02′S, 50°49′E (approx.)	—	—
27430	3.i.69	9.i.69	0	57°12′S, 80°54′E	57°02′S, 82°43′E	Male	63
27458	24.i.69	24.i.69 (from refrigerator vessel)	0	56°07′S, 73°50′E	56°20′S, 76°32′E (approx.)	—	—
27463	24.i.69	24.i.69 (from refrigerator vessel)	0	56°31′S, 73°46′E	56°20′S, 76°32′E (approx.)	—	—
27895	13.ii.69	19.ii.69	0	44°05′S, 59°29′E	44°40′S, 59°35′E	Female	62
27901	13.ii.69	19.ii.69	0	44°04′S, 59°31′E	44°35′S, 59°35′E	Male	69
			Sei Whales				
18935	18.i.64	14.xii.68	5	54°20′S, 22°51′W	41°21′S, 06°23′E	Male	45
25866	12.ii.64	6.i.69	5	43°23′S, 174°27′E	41°53′S, 159°50′E	Male	49

* Possibly from the same whale.

TABLE 3
Marks Recovered in the Antarctic Season 1969/70

Mark no.	*Date marked*	*Date recovered*	*Years*	*Position marked*	*Position recovered*	*Sex*	*Length in feet*
			Fin Whales				
11449	5.i.58	4.ii.70	12	59°16′S, 20°48′E	45°45′S, 33°48′E	Female	70
20991	31.xii.58	15.ii.70 (from refrigerator vessel)	11	64°13′S, 131°54′E	54°34′S, 83°59′E (approx.)	—	—
21069	4.i.59	10.ii.70	11	61°15′S, 71°22′E	53°50′S, 84°55′E	Female	73
25548	7.xii.61	7.i.70	8	57°40′S, 61°24′E	43°49′S, 65°40′E	Female	69
20465	23.xi.63	25.i.70 (from refrigerator vessel)	6	50°54′S, 25°38′E	42°27′S, 39°34′E (approx.)	Female	78
27327	8.xii.67	23.iii.70	2	40°56′S, 88°40′E	52°21′S, 80°24′E	Male	63
27437	3.i.69	4.ii.70	1	57°13′S, 80°55′E	53°28′S, 81°05′E	Male	67
27464	24.i.69	22.iii.70 (from refrigerator vessel)	1	56°31′S, 73°46′E	51°25′S, 78°18′E (approx.)	—	—
27616	14.ii.69	29.i.70	1	45°02′S, 55°46′E	53°10′S, 83°50′E	Male	59
28305	6.ii.70	3.iii.70	0	59°49′S, 85°58′E	53°01′S, 86°06′E	Female	57
			Sei Whales				
18285	22.viii.69	11.ii.70	½	30°03′S, 32°31′E	44°04′S, 50°54′E	Male	41
18290	22.viii.69	24.ii.70 (from refrigerator vessel)	½	29°31′S, 32°20′E	45°30′S, 71°25′E (approx.)	—	—
28614	22.xi.69	17.xii.69 (from refrigerator vessel)	0	40°35′S, 112°15′E	41°11′S, 114°51′E (approx.)	—	—
28145	28.xii.69	6.i.70 (from refrigerator vessel)	0	40°09′S, 38°38′W	41°50′S, 12°49′E (approx.)	—	—
			U.S.S.R. Series				
650641 (Fin)		8.ii.70 (from refrigerator vessel)			53°51′S, 84°30′E (approx.)	—	—

Four marks were returned from sei whales and 3 of these are of especial interest. The whales bearing Nos. 18285/90 were both marked off Durban on 22nd August 1969. No. 18285 was recovered from a 41 ft. male whale on 11th February 1970 in position 44°04′S, 50°54′E. No. 18290 was recovered on a refrigerator vessel on 24th February 1970 in approximate position 45°30′S, 71°25′E. These two records demonstrate a migration southwards from warmer waters in the southern spring and provide additional evidence of the minimum range of migration in this species.

No. 28145 is of interest in providing further evidence of extensive movement during the whaling season. The whale was marked on 28th December 1969 in position 40°09′S, 38°38′W and the mark was recovered on a refrigerator vessel on 6th January 1970 in approximate position 41°50′S, 12°49′E. Assuming that this position is close to the position where the whale was killed, the animal had moved approximately 2,200 miles eastwards from Area II into Area III within 10 days, an average of at least 220 miles per day.

ANNEX F

CENTRAL STORAGE AND PROCESSING OF CATCH/EFFORT AND LENGTH STATISTICS

The Scientific Committee has requested the B.I.W.S. to provide data on catch, effort and length composition of all whales in the Antarctic and on sperm whales also outside the Antarctic, broken down by species, sex, month, 10° square and country, and summaries of these data by area and year.

At the Honolulu meeting it was specified that sperm whale effort should be given in gross and net catcher days work, and with respect to the Antarctic this effort should be given only for the period outside the baleen whale season (with data on corresponding catches). Furthermore, with respect to land station catches, the Honolulu meeting recommended that the relevant statistics in terms of catcher days with any corrections for efficiency as national groups may think appropriate are collected and forwarded to the B.I.W.S. for inclusion in the data processing system.

The B.I.W.S., in carrying out this task, agreed that the data requested would be too unwieldy to handle if they were provided in printed tables. The detailed data are, therefore, put on tape from which copies can be provided on request.

In addition, summary tables are prepared which are printed and provided on request. Members of the Scientific Committee actively engaged in whale stock assessment have been put on a general distribution list for these summary tables (Chapman, Allen, Doi, Ohsumi, Jonsgard, Gambell, Ivashin; for sperm whales also Bannister, Best), and copies are also sent to F.A.O.

These summary tables include:

- Catch in numbers of baleen and sperm whales, by 10° square, month, country, species and sex, and gross catcher days, for the Antarctic baleen whale season, as well as summaries of these data by all countries together, by series and area. These tables are prepared and circulated immediately after the closure of each season.
- Catch in numbers of sperm whales, by 10° square, month, country and sex, and gross and net catcher days, for the Antarctic *outside* the baleen whale season, and for all areas outside the Antarctic throughout the year. These latter include tables for the North Pacific, for catches made by pelagic expeditions in the Southern Hemisphere outside the Antarctic, and for land stations.

At present, data on gross and net catcher days for areas outside the Antarctic are available as follows: for one country carrying out pelagic whaling in the North Pacific, for some land stations, and for all pelagic expeditions in the southern hemisphere. It is expected that more complete data on effort will soon become available for general distribution.

Effort in gross and net catcher days for pelagic whaling is defined as in section 6 of the report of the 1970 Special Meeting on Sperm Whales at Honolulu.

Effort data for land stations will be given in four different ways:

(a) *Gross catcher days*, based on number of catchers operating and length of open season.

(b) *Estimated net catcher days*, based on number of catchers and number of days on which at least one whale, of whatever species, has been caught.

For those land stations for which national groups can provide more detailed figures for effort, these should also be given.

(c) *Actual net catcher days*, based on the number of days each catcher has been active even if no catch has been made.

(d) *Corrected net catcher days*, based on the data of (c) but including any correction factor (e.g., for catcher tonnage, effect of spotting planes, etc.) which national groups may think appropriate.

3. Total length distribution, and average length, of the pelagic catches of baleen and sperm whales in the Antarctic (by season, which for sperm whales includes catches made during and outside the baleen whale season together) and of the pelagic catches of sperm whales outside the Antarctic (by calendar year), all broken down by species, sex, country, statistical area and 10° zone (series). Summaries of these data will be given for all zones (series) of one area together by country, as well as summaries for all countries.

   For the Antarctic data, Area II is divided into two subareas (W and E, 60°–30°W and 30°–0°W respectively), and Area III is also subdivided into two subareas (III W, 0°–20°E, and III E, 20°–70°E).

   For the North Pacific, length compositions of those "zones" which fall partly in the Bering—or Okhotsk—Sea, are given both for the whole "zone" as well as for the catches in that part of the "zone" falling within the Bering—or Okhotsk—Sea separately.

4. Total length distribution and average length of the land station catches of baleen and sperm whales by country, by subarea as defined by the national group concerned, by species, by sex, by month, as well as an annual summary.

The Scientific Committee decided at the present meeting, that because past North Pacific sperm whale length compositions are available in the member countries concerned in summary form by area and season, and not by month and square, and considering that the further breakdown by month and square would be difficult to prepare, these past data should be provided by the B.I.W.S. in summary form by area and season only. From 1969 onward, however, these data will be provided as specified in 3 and 4 above.

The availability of cards with detailed length compositions by month and 10° square makes it possible for the Bureau to provide any other combination of the data whenever required.

All data presently prepared cover the period 1961–1969 (Antarctic until season 1969/70).

ANNEX G

NOTES ON THE ASSESSMENT OF ANTARCTIC FIN WHALE STOCKS

by K. Radway Allen

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Recruitment Rate

Further studies have been conducted on the recruitment rate of the Antarctic stocks, using the Japanese age data and employing the same techniques as reported at the Honolulu Special Meeting of the Scientific Committee. Further refinements have been introduced into the techniques, particularly for determining the age at which recruitment is complete in each year, and in estimating the value of T. The corrected numbers of recruits to the exploited stock from each year-class are compared with the size of the exploited stock in Fig. 1. It is apparent that the relationship is still essentially linear and that there are no great changes in recruitment rate with stock size. This is examined in more detail in Fig. 2, which compares the recruitment rates calculated on various bases with the size of the exploited stock or of the stock of females of seven years and over. In Fig. 2A the base of comparison is the same as that in Fig. 1. In Fig. 2B the recruitment has been determined as the number of 3-year-olds to eliminate the effects of changes in age at recruitment on the number of recruits entering the exploited stock. This effect is also eliminated in Fig. 2C by extrapolating the numbers of recruits at the age at which they become exploited to the numbers that would survive to 12 years if no exploitation took place. In Fig. 2D the recruitment rate is expressed as the proportion of the stock of females seven years and over, and is compared with the size of this component of the parent population.

The essential form of the data is very similar in all four sections of the figure. Relatively high and consistent recruitment rates occurred up to about 1952 and the rate then declined quite rapidly to a stable level which extended to until at least 1962. The high points shown in some sections for 1963 and 1964 may be due to inaccurate extrapolation to full recruitment of partially exploited year-classes and are not considered significant.

Since the age-length keys on which the age distributions are based were obtained in the late 1950's and early 1960's, there may well be bias in the calculated age distributions for the earlier years. It is, therefore, not known whether the apparent high recruitment rate prior to 1962 should be considered significant. Thus the rate of recruitment to the exploited population appears to be about 0·05 of the exploited stock, or about 0·115 of the stock of mature females, and there is little evidence that it has changed significantly with the size of the stock.

Changes in Catch Efficiency

The suggestion has sometimes been made that during the 1950's and 1960's the efficiency of the catchers was increasing more rapidly than their tonnage,

and the assumption that efficiency was proportional to tonnage has, therefore. led to errors in the population estimates. It has, therefore, seemed worthwhile to examine what the effects would be on the population estimates if such increases had occurred. For this purpose population estimates have been made for the total Antarctic by the method of comparison of actual and expected catches. The natural mortality rate has been assumed to be 0·04 and the annual recruitment rates for each sex have been calculated from the age distributions. The basic estimates have been made over the period 1954 to 1963 when the results were at least affected by the catch of other species. These basic estimates have been extrapolated back to 1950 and forward to 1970.

In the tests, population estimates were made on the assumption that between 1954 and 1963, catcher efficiency increased steadily by 2%, 4% or 6% per year in addition to the increase corresponding to the increase in average tonnage. In Fig. 3 the resulting estimates are compared with those obtained on the assumption that tonnage was a true indicator of catcher efficiency. It is apparent that any assumpion of additional increase in catcher efficiency leads to smaller population estimates which also decline proportionately more rapidly. The most significant aspect of this difference is, however, in the resulting estimates of present population. Even an annual increase of 2% in efficiency leads to about a 40% reduction in average population levels over the last five years, while 4% or 6% increases lead to very much greater reductions. It is quite apparent, on comparison with other indications of the present state of the stocks, that there cannot have been an increase in efficiency as large as 4%, and that it is unlikely that there was any increase in efficiency beyond that indicated by the change in tonnage. This comparison indicates, therefore, that tonnage is probably an accurate indicator of catcher efficiency.

Changes in Mortality Rate with Age

At the Special Meeting in Honolulu, the Scientific Committee pointed out the need to examine further the possibility of changes in natural mortality rate with age. Further analysis of recruitment rates has brought to light two pieces of evidence bearing on this point.

As was noted above, the average recruitment rate per mature female appears to be approximately 0·115. The report of the Special Meeting notes that in the 1950's and early 1960's, the pregnancy rate was approximately 0·40. Ignoring the occurrence of unsuccessful pregnancies, the average survival from birth to recruitment is approximately 0·115/0·40 = 0·2875. The total value of M over this period is, therefore, approximately 1·25. Since the average age at recruitment is approximately five years, the average annual value of M over this period is about 0·25.

The second approach to the problem is obtained from the value of T found in the recruitment estimates. This is the ratio of the survival rate of newly recruited animals to the survival rate of the entire recruited stock. This is fairly consistently less than 1·0 in most years and for both sexes, and the average value for the entire range of data is 0·905. Since, by definition, all recruited animals, whether new recruits or not, are fully subject to the fishery, this value represents the ratio of the natural mortality rates. It was accepted by the Scientific Committee that the present best estimate of natural mortality rates for the exploited population is 0·04. The average natural mortality rate for the new recruits appears, therefore, to be about 0·14.

Combining these two results, it appears that for the pre-recruits over the age range 0 to 5, the average annual value of M is about 0·25, while for the new recruits over the range 4 to 7 years, the average value is about 0·14. These two figures appear consistent with each other and indicate a fairly rapid reduction in annual mortality rate over the earlier years of the life of the whales. Since the

mortality rate is not likely to fall abruptly from 0·14 to 0·04 immediately after recruitment is complete, and since the value of 0·04 for the recruited stock is largely based on data for older animals, the value of 0·14 for 4- to 7-year-olds should be regarded as probably a slightly low estimate.

Supplement to Annex G

Estimated Total Antarctic Fin Whale Population

The following figures have been calculated by the actual and expected catch method for initial populations for 1953/54 to 1962/63, extrapolated back to 1949/50 and forward to 1969/70. M has been taken as 0·04 and recruitment has been calculated annually from the age distributions using the data given in the first part of this paper.

Season	*Population (1000s)*	*Season*	*Population (1000s)*
1949/50	313·7	1960/61	134·3
1950/51	306·6	1961/62	114·5
1951/52	282·0	1962/63	93·5
1952/53	276·1	1963/64	78·2
1953/54	262·0	1964/65	71·4
1954/55	253·1	1965/66	65·6
1955/56	232·0	1966/67	63·3
1956/57	207·2	1967/68	61·3
1957/58	190·2	1968/69	60·0
1958/59	177·8	1969/70	58·0
1959/60	158·0		

The extrapolated population for the beginning of the 1970/71 season is 56,300.

Sustainable Yield

In these calculations M has been 0·04, and the average value of r has been approximately 0·05. Thus $r - M$ is about 0·01. On this basis the long-term sustainable yield at the present stock level appears to be slightly under 600. The parent stock from which current recruitment is derived is that of about 1966/67; this was not much, if at all, larger than the present exploited stock and therefore the temporary additional recruitment available from this source is small.

If however, the value of $r - M$ under present conditions is as high as 0·02, the current sustainable yield would be 1,100–1,200. There is little concrete evidence to support a higher value of $r - M$ and therefore a higher sustainable yield.

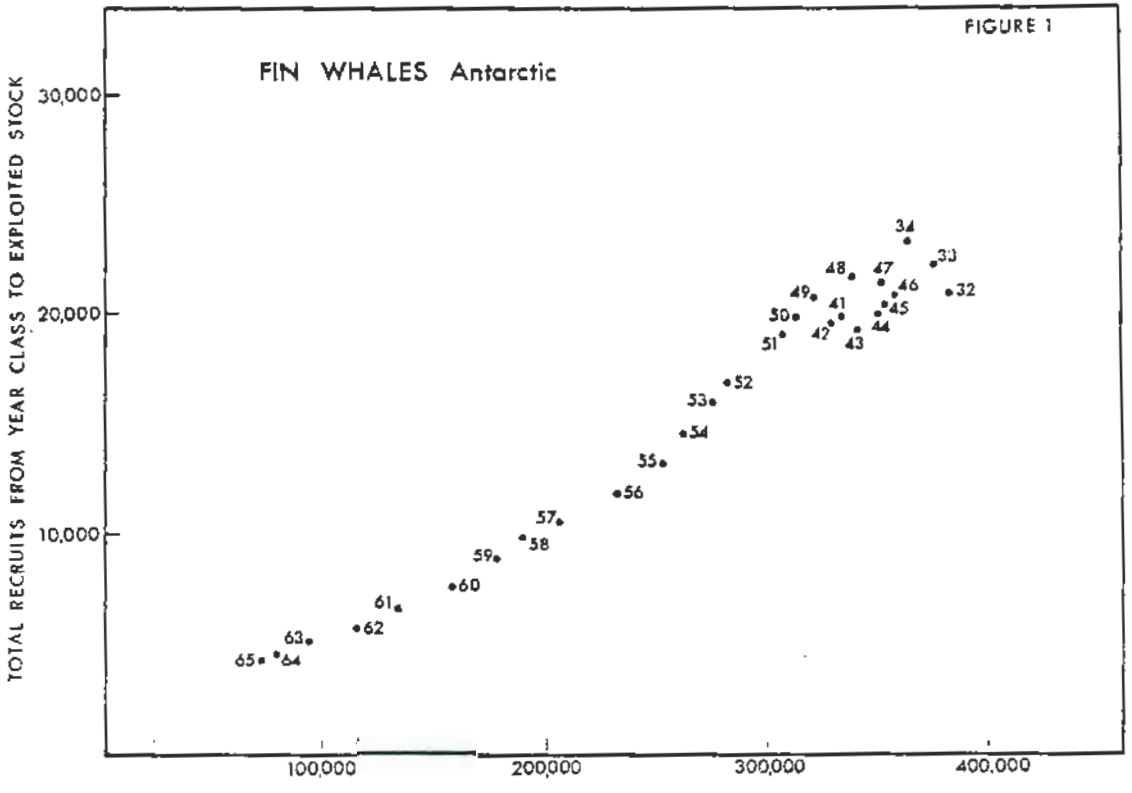
FIGURE 1
FIN WHALES Antarctic
TOTAL RECRUITS FROM YEAR CLASS TO EXPLOITED STOCK
30,000
20,000
10,000
100,000
200,000
300,000
400,000
34
33
48
47
46
49
41
45
32
50
42
44
51
43
52
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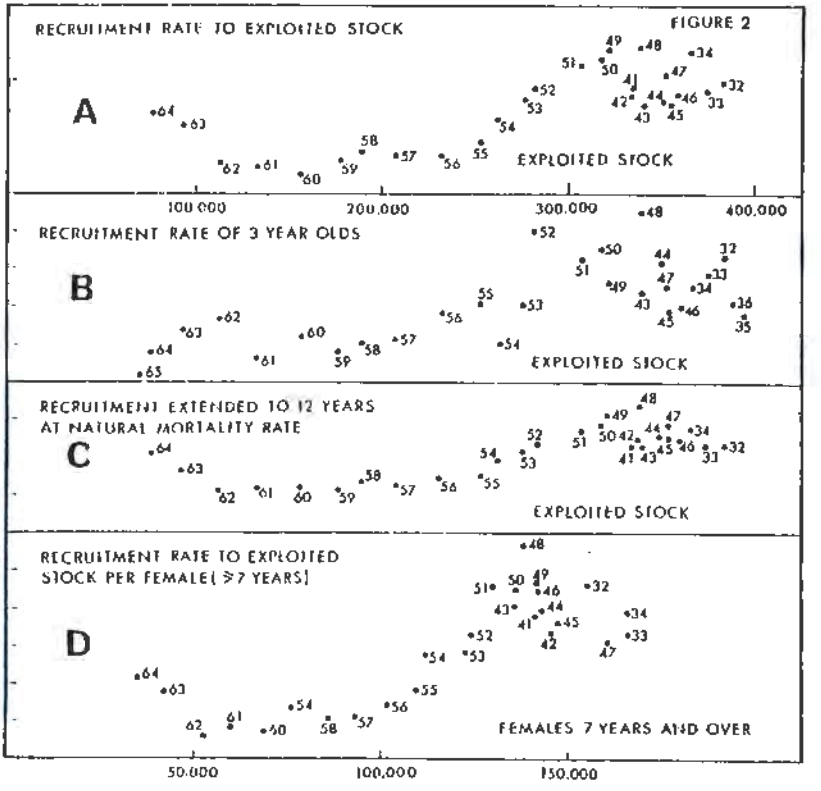
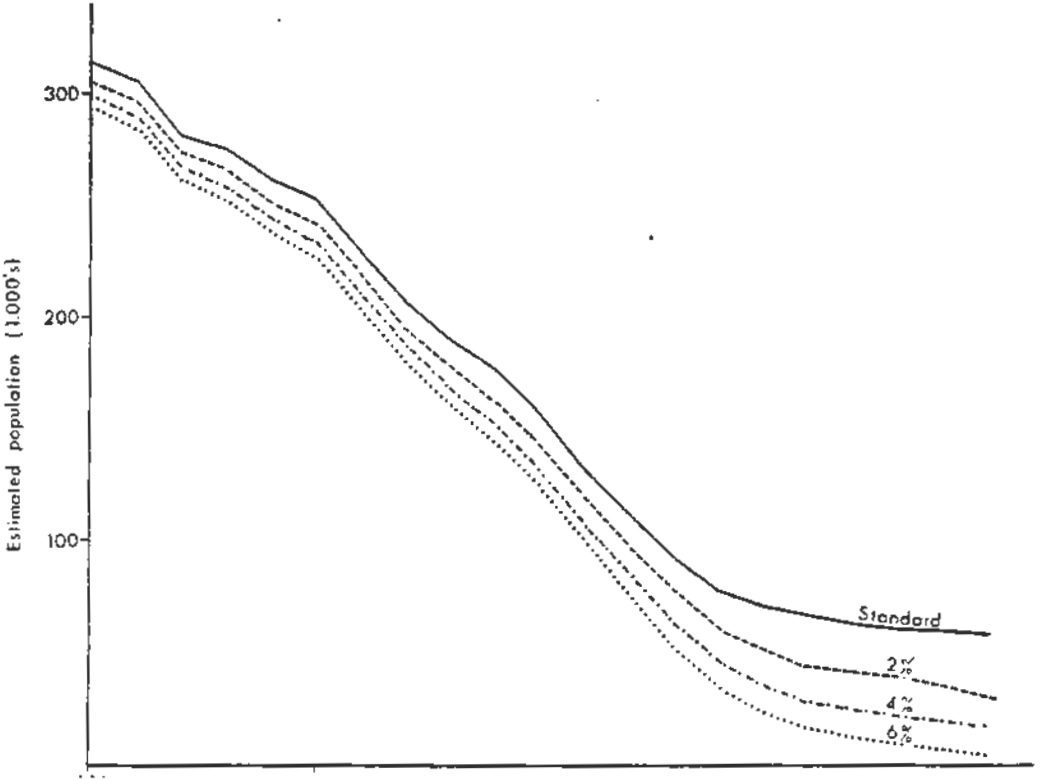
64
65


RECRUITMENT RATE TO EXPLOITED STOCK
FIGURE 2
A
EXPLOITED STOCK
100,000
200,000
300,000
400,000
RECRUITMENT RATE OF 3 YEAR OLDS
B
EXPLOITED STOCK
RECRUITMENT EXTENDED TO 12 YEARS
AT NATURAL MORTALITY RATE
C
EXPLOITED STOCK
RECRUITMENT RATE TO EXPLOITED
STOCK PER FEMALE(≥7 YEARS)
D
FEMALES 7 YEARS AND OVER
50,000
100,000
150,000

Effect of assumed increases in catching efficiency Figure 3



ANNEX II

A PRELIMINARY ASSESSMENT OF FIN WHALE STOCKS OFF THE CANADIAN ATLANTIC COAST

by K. Radway Allen

Fisheries Research Board of Canada
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Catching Areas

Three whaling stations have been operating recently in eastern Canada. ese are Blandford in the southern part of Nova Scotia, and Dildo and illiamsport on the east coast of Newfoundland. Their catches of fin whales have :n

	1964	*1965*	*1966*	*1967*	*1968*	*1969*
ndford	56	108	263	309	262	144
ldo	—	6	164	168	219	167
lliamsport	—	—	—	262	219	181

Separation of stocks

Several independent lines of evidence suggest that there is some separation ween the stock fished on the Nova Scotia coast and that currently fished on east coast of Newfoundland.

1. *Marking results*

A preliminary review of marking results up to the end of the 1969 season ows that of whales marked off the Nova Scotia coast and recaptured in later sons, 21 have been recovered at Blandford and only 1 at a Newfoundland aling station.
No marks attached in Labrador or Newfoundland waters have been recovered the Nova Scotia station.

2. *Length and age*

Length distributions show that large whales are much more frequent in the ches off Newfoundland than off Nova Scotia. The percentages of males of ft. or more, and of females of 64 ft. or more in the catches of the three tions up to the end of 1969 are

	Williamsport	*Dildo*	*Blandford*
Males	32·7	26·3	9·3
Females	34·9	24·1	5·5

This difference appears to be due to difference in growth in the two stocks her than to differences in age. This is shown by the average sizes of animals 25 years or more aged by Dr. E. D. Mitchell from two of the stations.

	Dildo	*Blandford*
Males	58·6 ft.	55·2 ft.
Females	62·7 ft.	59·7 ft.

These differences are statistically significant at well above the 0·01 level.

c. *Changes in abundance*

Data on catch per unit effort as a measure of abundance are available for all three stations only for the years 1968 and 1969. Conditions of operation and the form of the records kept make it necessary to use different forms of catch per unit effort for some of the stations. At Williamsport the daily catch is usually limited to two whales, even when more are available, so that the catch per hours hunting and chasing (excluding time spent towing) is the best measure to use. At Dildo, however, catch per day is the only measure available for the whole period. At Blandford, catch-per-unit-effort can be calculated in either form. For the last two seasons the average catch-per-unit-effort for the three stations have been

	1968	*1969*	*Ratio 1969:1968*
Williamsport (catch/hr.)	0·29	0·27	0·92
Dildo (catch/day)	1·51	1·39	0·92
Blandford (catch/hr.)	0·32	0·20	0·62
Blandford (catch/day)	1·93	1·33	0·69

The relative change in abundance from 1969 to 1968 is thus practically identical for Williamsport and Dildo, and very different for Blandford where the ratio is quite similar for the two methods. This suggests that the effect on the stocks of recent catching has been the same at the two Newfoundland stations and different at Nova Scotia.

3. *Stock Assessments*

a. *Nova Scotia*

Four years' data are available for the Blandford station and there has been a progressive decline over this time in the catch-per-unit-effort. An assessment can therefore be appropriately made by the method of comparing actual and expected catches. For this purpose natural mortality and recruitment parameters have been based on Antarctic data. The value of M has been taken as 0·04, and recruitment as 0·05 of the parent stock, i.e., the stock 5 years earlier. Since there have been only 4 seasons (prior to 1970) of substantial catches recruitment has been considered as constant and derived from a virgin stock, and the average stock over the 1966 season has been assumed to be at 90% of the unexploited level.

The resulting stock estimates are

	Catch	*Catch/day*	*Initial stock*
1966	263	3·26	1,248
1967	309	2·23	1,035
1968	262	1·93	759
1969	144	1·33	569

The extrapolated estimate of the stock at the beginning of the 1970 season is 484.

b. *Newfoundland*

It is not possible to make an estimate of the stock fished by the present Newfoundland whaling stations in the same way both because of the shorter

time-series of available data and because of the comparatively small change which has so far occurred there as a result of the catching operations.

A very tentative estimate of the average stock in 1968 can, however, be made if we assume that the 8% reduction in catch-per-unit-effort, which was noted above as occurring at both stations from 1968 to 1969, was the direct result of catching. We may then calculate S_{68}, the mean stock in 1968, from

$$\frac{S_{68} - (481 + 311)/2}{S_{68}} = 0.92,$$

if recruitment and natural mortality are ignored. From this, S_{68} is approximately 5,000.

Another approach may be made by examining the long, but sporadic, history of whaling in Newfoundland and Labrador. In this there have been several periods when quite large catches have been taken for several successive seasons. As far as is known operations were terminated, in at least some cases, for economic or other reasons rather than as a result of a great decline in the stocks of fin whales. The larger operations may therefore give some indication of the size of the sustainable yield which may be obtained from the fin whale stocks concerned. Some decline in stocks was occurring in some instances, and, since the operations only continued for a few seasons, stocks would still be supported by recruitment from stocks of initial size. The largest average catches may therefore be somewhat greater than the continuing sustainable yield.

The following table summarizes the principal whaling activity on the Newfoundland-Labrador coast prior to the present phase.

Period	*Total catch*	*Average catch*
1903–5	1,495	498
1906–9	1,002	250
1912–15	620	155
1923–30	2,026	253
1935–39	859	215
1940–44	471	94
1945–51	3,250	464
1965–69	1,386	267

Thus there have been two previous periods in which catches of 450–500 have been sustained for some years. This suggests that the total stock around Newfoundland and Labrador may be capable of supporting a continuing catch at, or somewhat below, the 400–450 level. However some of the stations involved in these earlier catches were located on the south and east coasts of Newfoundland. They may therefore have been operating on the stocks now fished from Nova Scotia rather than those subject to the present Newfoundland operations.

The very preliminary nature of these results, as well as the basically different ways in which the estimates of stock and sustainable yield have been obtained, make it inappropriate to combine them to attempt to obtain an estimate of net recruitment rate. However, it may be noted that the relatively high ratio of estimated sustainable yield to estimated stock, compared to the Antarctic, suggests that the former may be overestimated, or the latter underestimated or both.

This would imply a stock somewhat greater than that estimated earlier, but supports the broad conclusion that the fin whale stock in the Newfoundland area is substantially larger than that available to the Nova Scotia operations.

Acknowledgements

Dr. E. D. Mitchell has contributed a great deal of data and valuable advice in the preparation of this report.

ANNEX I

ANALYSIS OF 1969/70 CATCH AND EFFORT DATA FOR ANTARCTIC BALEEN WHALE STOCKS

by D. G. Chapman

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1. *Introduction*

The analysis of current catch and effort data to determine the effect of pelagic operations in the Antarctic on the baleen whale stocks there, is now more difficult because of several factors. One of these is the variation in interest between and within seasons as between fin and sei whales. This has been recognized for some time. The second problem is new and arises with the reduction of catches to about the level of sustainable yield. The 1969/70 catches were

Fin whales	2,996
Sei whales	5,830

Both of these are quite close to the medium estimates made in 1969 of sustainable yield in 1969/70. Thus if those estimates were reasonably correct the 1969/70 operations should have little effect on the population size. In so far as the fleets tend to concentrate in different areas in different seasons, locally there may be reduction in stock abundance which should be balanced by slight increases in the areas that received little or no effort in 1969/70. In former years large catches resulted in marked changes in CPUE, sufficiently large so as to overwhelm the random fluctuations, that result from weather variations, differential densities of the whale herds, etc.

At previous meetings and in analyses by scientists of the member countries of the Commission, a number of aspects of the population dynamics of the Antarctic baleen whale populations have been thoroughly explored and fairly definite conclusions reached. Some questions remain not fully resolved and it is important to utilize any new data to attempt to answer such questions. Such points are given primary consideration in the following analysis.

2. *General Summary*

At the outset are included some tables which extend those given in IWC/21/7. These show catch and effort by the Antarctic pelagic expeditions for the period 1959/60 to 1969/70 (Table 1), percentage distribution of catcher days in each season by area from 1962/63 to 1969/70 (Table 2) and the percentage distribution of catcher days by series (Table 3). Also shown in Table 4 are detailed catch and CPUE results for both fin and sei whales by month, series and area for 1969/70. Table 5 gives a summary of sei whale catches by area since 1959/60.

3. *Fin Whales*

At the special meeting at Honolulu on fin whale stock assessment it was agreed the best estimate of the total exploited population at the beginning of

TABLE 1
Catches and Effort by the Antarctic *Pelagic* Expeditions

Season	Catcher days	Average catcher tonnage	Catches			Catch/uncorrected catcher day		
			Fin	Sei	BWU	Fin	Sei	BWU
1959/60	21,356	633	26,415	3,234	13,746	1·24	0·15	0·64
1960/61	23,998	642	27,374	4,310	14,405	1·14	0·18	0·60
1961/62	29,952	657	26,364	4,716	13,968	0·88	0·16	0·47
1962/63	22,504	703	18,636	5,482	10,232	0·83	0·24	0·45
1963/64	20,407	709	13,853	8,256	8,448	0·68	0·40	0·41
1964/65	17,521	715	7,303	19,845	6,980	0·42	1·13	0·40
1965/66	13,146	743	2,312	17,558	4,083	0·18	1·34	0·31
1966/67	11,775	754	2,882	12,350	3,500	0·24	1·05	0·30
1967/68	9,783	769	2,152	10,352	2,801	0·22	1·06	0·29
1968/69	8,363	787	3,014	5,770	2,469	0·36	0·69	0·30
1969/70	7,948	805	2,996	5,830	2,469	0·38	0·73	0·31

TABLE 2
Percentage Distribution of Catcher Days in Each Season by Area

Season	Sub-area II W	Sub-area II E	Area III 0-70°E	Area IV 70-130°E	Area V 130°E-170°W	Area VI 170-120°W	Area I 120-60°W	All areas
1962/63	13·1	14·0	41·7	12·4	5·6	2·7	10·5	100
1963/64	12·4	28·8	32·5	9·6	16·2	—	0·5	100
1964/65	41·7	18·0	9·8	13·0	17·0	—	0·5	100
1965/66	28·2	21·2	19·0	4·7	19·2	7·4	0·2	100
1966/67	4·1	5·7	43·8	19·4	15·6	11·6	—	100
1967/68	—	5·8	28·1	23·1	27·0	16·0	—	100
1968/69	0·4	3·1	30·6	27·6	23·5	14·8	—	100
1969/70	6·7	3·4	43·0	28·4	15·1	3·4	—	100

TABLE 3
Percentage Distribution of Catcher Days by Series

Season \ Series	D 40-50°S	A 50-60°S	B 60-70°S	C 70-80°S	All series
1962/63	22·3	45·3	32·3	0·1	100
1963/64	22·7	62·4	14·9	—	100
1964/65	38·3	52·2	9·5	—	100
1965/66	54·7	19·9	25·4	—	100
1966/67	44·4	15·0	39·1	1·5	100
1967/68	36·7	31·6	31·7	—	100
1968/69	47·4	28·1	24·5	—	100
1969/70	66·4	13·6	20·0	—	100

1957/58 was 171·8 thousand, for 1961/62 100·5 thousand. It was further agreed that the average mortality rate is 0·04, that the net recruitment rate in the period prior to 1962 has been in the range 0·02–0·04. Possible changes in the net recruitment rate ($r - M$) since that time were unclear and three values were studied: $r - M = 0·02$, $r - M = 0·04$ and $r - M = 0·049$ in 1962 increasing to 0·57 in 1970. The tables below show the estimates by area for the fin whale population in 1962 and anticipation of these estimates to 1970 using the intermediate recruitment rate, i.e., $r = 0·08$, $r - M = 0·04$. Table 6 shows the

TABLE 4
Effort, Catch by Species and CPUE by Area, Zone and Month 1969/70*

	December	*January*	*February*	*March*	*April*	*Total*
Area I	—	—	—	—	—	None
Area II						
D	501-12-948	301-20-330	—	—	—	802-32-1278
	0·02; 1·89	0·07; 1·10	—	—	—	0·04; 1·59
A and B	—	—	—	—	—	None
Area III						
D	392-23-417	1208-439-941	1060-853-478	706-211-161	—	3366-1526-1997
	0·06; 1·06	0·36; 0·78	0·80; 0·45	0·30; 0·23	—	0·45; 0·59
A	—	—	26-18-0	—	—	26-18-0
	—	—	0·27; 0·00	—	—	0·27; 0·00
B	—	—	26-2-0	—	—	26-2-0
	—	—	0·08; 0·00	—	—	0·08; 0·00
Area IV						
D	580-23-1058	271-6-712	50-16-30	79-23-2	—	992-68-1802
	0·04; 1·82	0·02; 2·63	0·32; 0·60	0·29; 0·02	—	0·07; 1·82
A	—	395-308-53	292-321-48	169-296-14	—	856-925-115
	—	0·78; 0·13	1·10; 0·16	1·75; 0·08	—	1·08; 0·13
B	—	288-51-8	117-20-0	—	—	405-71-8
	—	0·18; 0·03	0·17; 0·00	—	—	0·18; 0·02
Area V						
D	—	—	—	120-0-13	—	120-0-13
	—	—	—	0·00; 0·11	—	0·00; 0·11
A	—	—	141-75-64	24-0-19	—	165-75-83
	—	—	0·53; 0·45	0·00; 0·79	—	0·45; 0·50
B	—	34-8-4	452-133-169	432-105-205	—	918-246-378
	—	0·21; 0·11	0·29; 0·37	0·24; 0·47	—	0·27; 0·41
Area VI						
D	—	—	—	—	—	None
A	—	—	—	34-2-14	—	34-2-14
	—	—	—	0·06; 0·41	—	0·06; 0·41
B	—	—	—	238-31-142	—	238-31-142
	—	—	—	0·13; 0·60	—	0·13; 0·60

* The five figures for each month, zone, area are CDW (uncorrected)–catch of fin whales–catch of sei whales; CPUE (fin); CPUE (sei).

TABLE 5
Catches of Sei Whales by Area 1959/60–1969/70

Season	*I*	*II*	*III*	*IV*	*V*	*VI*	*Total*
1959/60	159	1,498	230	526	1,649	232	4,294
1960/61	102	1,938	336	103	563	2,030	5,072
1961/62	1,629	1,696	427	633	409	369	5,163
1962/63	807	1,812	1,457	631	430	345	5,482
1963/64	28	4,459	1,984	274	1,820	--	8,565
1964/65	40	16,076	443	1,564	2,207	---	20,330
1965/66	32	12,722	2,724	436	1,014	599	17,527
1966/67	-	1,540	6,865	2,826	717	402	12,350
1967/68	---	195	2,352	2,271	3,327.	2,207	10,352
1968/69	73	188	1,771	1,030	2,156	552	5,770
1969/70	- -	1,278	1,997	1,925	474	156	5,830
Total	2,870	43,402	20,586	12,219	14,766	6,892	100,735

proportions of the total population by area in 1958 as estimated by the modified De Lury method (taken from SM/F/4, Table 1A with $r - M = 0{\cdot}04$) and by the q method (taken from Sc/21/18, Table 8).

TABLE 6
Initial Population by Areas, 1957/58, 1961/62 (Fin whales)

	Area						
	I	*II*	*III*	*IV*	*V*	*VI*	*Total*
Proportions by modified De Lury method	0·051	0·233	0·387	0·171	0·094	0·064	100·0
Proportions by q method	0·082	0·246	0·370	0·139	0·100	0·063	100·0
Numbers by Area, 1958	8·8	40·0	66·5	29·4	16·1	11·0	171·8
Numbers by Area, 1962	7·7	28·7	37·4	14·4	7·0	5·3	100·5

The numbers in Table 6 have been estimated using the proportions in line 1 of the table applied to the average estimate of the total for 1958, namely 171·8 thousand. These estimates have then been extrapolated forward to 1962 (with $r = 0{\cdot}08$, $M = 0{\cdot}04$) and adjusted to the 1962 total estimate, 100·5 thousand. The proportions in the second line might have been used as a starting point; different values of r were tried but the final results for 1962 differ little from those given in Table 6.

The 1962 estimates extrapolated to 1970 (with $r = 0{\cdot}08$, $M = 0{\cdot}04$) are shown in Table 7.

The total of these six area population estimates for the beginning of the 1969/70 season is 81·3 thousand (to be compared with the slightly less accurate extrapolation, 82·7 thousand from the total Antarctic figures given in the report of the Special Meeting Table 2b).

From the catch statistics it is seen that fin whale catches have been so low in Areas I, II, V and VI as to preclude any useful analysis from the CPUE data in these areas. We turn therefore to the data from Areas III and IV to confirm whether the extrapolations shown in these tables seem reasonable and to shed any light upon present value of the net recruitment rate, r.

Area IV

From Table 4 it is seen that there were considerable catches of fin whales in 1969 and 1970 in Zones A and B of this area and furthermore catches of sei whales were much smaller than those of fin whales. In fact in only two months

TABLE 7
Estimates of Fin Whale Stocks by Area 1961/62–1969/70
(all figures are in thousands)

Season	Initial Population	Catch	Recruitment	Final Population Estimate
		(a) *Area I*		
1961/62	7·7	2·5	0·7	5·7
1962/63	5·7	1·4	0·7	4·8
1963/64	4·8	—	0·6	5·2
1964/65	5·2	—	0·6	5·6
1965/66	5·6	—	0·6	6·0
1966/67	6·0	—	0·6	6·4
1967/68	6·4	—	0·5	6·7
1968/69	6·7	0·1	0·4	6·5
1969/70	6·5	—	0·4	6·8
		(b) *Area II*		
1961/62	28·7	6·6	3·2	24·4
1962/63	24·4	5·6	3·0	21·0
1963/64	21·0	7·3	2·9	16·0
1964/65	16·0	4·5	2·6	13·6
1965/66	13·4	0·6	2·4	14·9
1966/67	14·9	0·1	2·3	16·5
1967/68	16·5	0·2	2·0	17·6
1968/69	17·6	—	1·7	18·5
1969/70	18·5	—	1·3	20·0
		(c) *Area III*		
1961/62	37·4	11·8	5·4	30·0
1962/63	30·0	9·0	5·3	25·4
1963/64	25·4	4·8	4·8	24·6
1964/65	24·6	1·2	4·3	26·8
1965/66	26·8	1·0	3·8	28·6
1966/67	28·6	1·6	3·0	28·9
1967/68	28·9	0·8	2·4	29·4
1968/69	29·4	0·6	2·0	29·6
1969/70	29·6	1·5	2·0	29·0
		(d) *Area IV*		
1961/62	14·4	3·1	2·3	13·1
1962/63	13·1	1·7	2·1	13·0
1963/64	13·0	0·6	1·6	13·5
1964/65	13·5	0·8	1·3	12·1
1965/66	13·5	0·1	1·3	14·1
1966/67	14·1	0·4	1·2	14·3
1967/68	14·3	0·7	1·0	14·0
1968/69	14·0	1·6	1·1	13·0
1969/70	13·0	1·1	1·1	12·5
		(e) *Area V*		
1961/62	7·0	1·1	1·2	6·9
1962/63	6·9	0·6	1·3	7·3
1963/64	7·3	1·1	1·2	7·2
1964/65	7·2	0·7	1·1	7·3
1965/66	7·3	0·4	0·8	7·4
1966/67	7·4	0·3	0·6	7·4
1967/68	7·4	0·2	0·6	7·5
1968/69	7·5	0·4	0·6	7·4
1969/70	7·4	0·3	0·6	7·4
		(f) *Area VI*		
1961/62	5·3	1·1	1·2	5·2
1962/63	5·2	0·3	0·9	5·6
1963/64	5·6	—	0·6	6·0
1964/65	6·0	—	0·6	6·4
1965/66	6·4	0·2	0·6	6·6
1966/67	6·6	0·5	0·5	6·4
1967/68	6·4	0·2	0·4	6·4
1968/69	6·4	0·3	0·4	6·3
1969/70	6·3	—	0·4	6·4

(Jan. 1967/68, Feb. 1966/67) have sei whale catches been appreciable in these zones of Area IV in all the months and seasons of exploitation there. To make meaningful comparisons we make comparisons with the CPUE of the 1962–64 seasons. It should be noted that 1963 was the last season of substantial fin whale catches in Area IV prior to the concentration (in general) on sei whales. Because of the length of the comparison period it is important to adjust the effort for changes in catcher efficiency. The usual tonnage adjustment is made, i.e., the CDW are multiplied by (average tonnage/1,000). Three such comparisons for Zones A and B are

$$\frac{1970\ \text{CPUE}}{1963\ \text{CPUE}} = 1{\cdot}01$$

$$\frac{(1969 + 1970)\text{CPUE}}{(1962 + 1963 + 1964)\text{CPUE}} = 1{\cdot}06$$

$$\frac{(1969 + 1970)\text{CPUE}}{1963\ \text{CPUE}} = 1{\cdot}10$$

The estimated increase in the Area IV fin whale population from mid 1962/63 to mid 1969/70 derived from Table 7(d) is 2 per cent which agrees closely with the lower of these CPUE ratios. These comparisons suggest that $r - M$ may be indeed close to 0·04.

Area III

The CPUE data for this area is more difficult to analyse. Zones A and B of Area III have never yielded extensive catches of seis and hence effort in these zones may be regarded as devoted for the most part to fin whales. On the other hand only small amounts of effort have been expended in these zones in the past three seasons.

For Zones A and B combined the CPUE (Effort = CDW × Tonnage/1,000) are as follows:

61/62	*62/63*	*63/64*	*64/65*	*65/66*	*66/67*	*67/68*	*68/69*	*69/70*
0·84	1·55	1·31	1·07	0·49	0·47	1·00	0·52	0·50
	1·13						0·75	

The ratio of CPUE for 67/68 to 69/70 to that of the 61/62–63/64 period is 0·66.

In Zone D fin whale catches considerably exceeded sei whale catches in February and March 1970. The ratio of CPUE in February and March 1970 to the corresponding months in 1963 (again weighted for tonnage changes) is 0·73/1·12, i.e., 0·65. These results agree very well. The ratios are rather less than the ratio of the average populations in the two seasons as calculated in Table 7 above (the population ratios with $r - M = 0{\cdot}04$ is 1·06). The CPUE ratios are much more consistent with populations calculated on the basis of $r - M = 0{\cdot}02$ (the ratios of such average populations is 0·77). In any case the CPUE ratios contradict very strongly the hypothesis that r has increased above 0·04 during the 1960's.

4. *Sei Whales*

Several comprehensive studies have been made on the sei whale stocks but all of these have been handicapped by the recent development of the sei whale catches, the difficulty of measuring CPUE in a two species fishery and the lack of adequate mark recapture data, among other factors. A summary of the then best

estimates of sustainable yield by areas is found in the 19th Report of the Commission, page 86. A more extensive review was subsequently prepared by Gulland and others (SC/21/6); also a theoretical study by Doi and Ohsumi (SC/21/19) has been done. The results agreed to at the 20th meeting and the subsequent summaries of Gulland *et al.* are shown in Table 8, together with catches in the past two seasons.

TABLE 8
Estimates of Population Size and Sustainable Yields of Sei Whales by Area

	Area						
	I	*II*	*III*	*IV*	*V*	*VI*	*Total*
Estimate of initial population in 1968/69 (000's) from SC/21/6	11·3	19·8	12·4	6·8	12·2	10·9	73·4
Estimate of sustainable yield from SC/21/6	470	1,670	930	510	730	580	4,890
Estimate of sustainable yield from Tokyo meeting	310	1,900	850	535	1,145	635	5,375
Catch 1968/69	73	188	1,771	1,030	2,156	552	5,770
Catch 1969/70	0	1,278	1,997	1,925	474	156	5,830

The following discussion is an application of modified De Lury analysis to the catches and CPUE of the recent season. It is clearly impossible to draw any new conclusions in regard to Area I, which has had little exploitation since 1962/63 (a total catch of 173 sei whales in seven seasons). There is every reason to believe that the present yield (that would leave this population unchanged) is quite small. The lack of interest in this area and the comparison with fin whale yields in Area I suggest that its sei population is indeed low and perhaps less than 11·3 thousand. However it is quite clear that the stock in this area is above that level at which the maximum sustainable yield is obtained and consequently there is a small surplus available for catching above the sustainable yield.

Area II

After two years of negligible activity, the fleets operated in Zone D of this area during this past season. The modified De Lury equation used by Gulland can be adapted to the CPUE effort data here for the months of December and January. There were operations in these months in 1966/67 and in 1969/70. The 1969/70 CPUE (adjusted for tonnage) is 2·02 whereas it was 2·20 in 1966/67. The basic equation is

$$N_1 = \frac{\frac{1}{2}C_1 + C_I + \frac{1}{2}C_2 - R}{1 - ((\text{CPUE})_2/(\text{CPUE})_1)}$$

Here N_1 = average population in the first season (1966/67)
C_1 = catch in the first season (1966/67)
C_I = catch in intermediate seasons
C_2 = catch in the final season (1969/70)
R = recruitment over the intervening three seasons.

Inserting actual data yields

$$N_1 = \frac{1,792 - R}{0{\cdot}08} = 22,400 - 12{\cdot}5R$$

If the recruitment were as the estimate reported in Table 8, viz., 1,670–1,900 per year or 5,000–5,700 in 3 seasons, the resulting estimate of N_1 is negative. In other words if the recruitment were 1,670–1,900 per year, the CPUE should

have increased by 8–16 per cent rather than falling 8 per cent. However, as indicated with small changes, the sampling errors may mask real effects. While no firm conclusion can be reached, the evidence suggests that the present sustainable yield in Area II is not as great as 1,900 sei whales.

Area III

In Area III we again analyse the sei CPUE in Zone D in December and January. In the most recent seasons, catches in February and later were in the majority fin whales. The required CPUE data (adjusted for tonnage) is

1966/67	*1967/68*	*1968/69*	*1969/70*
2·86	1·34	1·03	1·08

The Area III catches in these seasons are

6865	2352	1771	1997

Proceeding as was done in Area II we have

$$N_{1967} = \frac{4{,}608 - R_{67}}{0{\cdot}53} = 8{,}694 - 1{\cdot}89R_{67}$$

$$N_{1968} = \frac{2{,}062 - R_{68}}{0{\cdot}23} = 8{,}965 - 4{\cdot}35R_{68}$$

$$N_{1969} = \frac{1{,}884 - R_{69}}{-0{\cdot}05} = 20R_{69} - 37{,}680$$

The first two estimates are inconsistent with the estimate of the 1968/69 initial population being as high as 12,400; they additionally suggest a very low recruitment. On the other hand, the third estimate suggests that the recruitment must have exceeded 1,884 which is unlikely if the population total is of the order of 12,400. Again with a small change there is little conclusive evidence.

Area IV

The CPUE data for December and January for Zone D, together with total catch of sei whales in the Area are as follows:

	1966/67	*1967/68*	*1968/69*	*1969/70*
CPUE	1·64	2·16	1·41	2·64
Catch	2,826	2,271	1,030	1,925

The two sharp increases in CPUE suggest that these data are not appropriate for this type of analysis. If the data of the last two seasons are pooled to yield a combined CPUE of 2·09 we have

$$N_{1967} = \frac{2{,}613 - R}{0{\cdot}03}$$

where R refers to the recruitment in 1968 and 1969 or

$$N_{1967} = 87{,}100 - 33{\cdot}3R$$

This suggests a population of about 20,000 with a recruitment of about 1,000 per year. These figures do not agree with previous estimates.

Stock Reduction 1959/60–1969/70

In SC/21/6 is given an estimate of the reduction in the sei whale stocks since heavy exploitation began. This can be and is calculated slightly differently below. Since for sei whales, the age of recruitment is about 17, all whales taken in this period were at least 6 years of age in 1959/60. It is unlikely, therefore, that any compensatory change in recruitment has occurred over this period. If this is the case the reduction in stock in k years with catches $C_1, C_2, \ldots, C_k$ is easily seen to be

$$C_1 e^{-M(k-1)} + C_2 e^{-M(k-2)} + \cdots + C_{k-1} e^{-M} + C_k$$

where M is the natural mortality rate prevailing in the unexploited population. If we set $M = 0{\cdot}065$ as estimated by Doi and Ohsumi (*Norwegian Whaling Gazette*, March/April 1967) and use the data of Table 5, we obtain the following estimates of stock reduction in the period referred to.

Reduction in Sei Whale Stock 1959/60–1969/70

	Area						
	I	*II*	*III*	*IV*	*V*	*VI*	*Total*
Stock reduction in 000's	1·7	31·0	16·5	9·9	11·2	5·1	75·4

If the original total stock was about 150,000, the present total stock is near 75,000 which agrees closely with the estimate in SC/21/6. Stock as defined here refers to the exploited stock, i.e., age 17 and over in the region south of 40° South latitude.

It should be pointed out that since estimates of r for sei whales have been derived in part by analogy from those for fin whales, and since the fin whale recruitment rates are now known to be much lower than the original estimates it is possible that the estimates of gross recruitment rate and hence of sustainable yield of the sei whale stocks may be too high. It is also possible that the lags in these systems are much larger than has been appreciated so that the response of the stocks to exploitation may take a long period of years.

Summary

The most optimistic estimate of the fin whale stock in 1970 is about 81 thousand with an estimated sustainable yield of about 3 thousand. The only firm evidence suggests that if anything, this estimate is high rather than low so that it would be prudent management to estimate the fin whale contribution to the quota to be less than 1,500 BWU.

The results of analysis of CPUE for sei whale catches are for the most part unclear or contradictory, though some calculations suggest that recent population estimates (of 75,000 for the whole Antarctic exploited stock) are not unreasonable. This would support an estimate of the sustainable yield for the whole Antarctic as about the same as last year, i.e., about 5,000.

ANNEX J

THE SEVENTH MEMORANDUM ON THE RESULTS OF JAPANESE STOCK ASSESSMENT OF WHALES IN THE NORTH PACIFIC

by S. Ohsumi, Y. Shimadzu and T. Doi

1. *Introduction*

During the 1969 North Pacific season, 6 expeditions (3 U.S.S.R. and 3 Japanese) and 8 land stations (1 U.S.A. and 7 Japanese) were operated. The catch statistics of the operations are shown in Table 1.

TABLE 1
Catch of Whales by Species and Area in the North Pacific in 1969

Area	*CDW*	*Fin*	*Sei*	*Bryde's*	*Sperm*	*BWU*
American coast	222	31	10	—	68	17·2
Area II	1,959	205	302	—	3,331	152·8
Area III	1,162	90	951	—	1,533	203.5
Area IV	2,278	468	1,322	—	3,014	454·3
Area V	1,990	373	1,964	—	2,092	513·8
Area VI	1,087	33	143	—	1,228	40·3
Asian coast	2,587	76	466	89	3,668	130·5
Total	11,282	1,276	5,158	89	14,934	1,512·5

The number of whales caught decreased compared with that in 1968 (Fin, 68%; Sei, 90%; Bryde's, 52%; and Sperm, 92%).

Whaling activity moved eastward from Areas V and VI to Areas IV and II.

We did not deal with the fin whale stock in the East China Sea, where no whaling operation was carried out in the 1969 season as in 1968. Therefore, the data on that stock were not included in this paper.

2. *Fin Whale*

2.1. *Index of abundance of fin whales in the pelagic whaling ground*

An index of abundance was calculated using corrected CPUE (by tonnage of catcher boats and by country) and taking size of each area into account. Table 2 shows the yearly change of the index by area.

TABLE 2
Index of Abundance of Fin Whales in the Pelagic Ground of the North Pacific (by CPUE)

	II	*III*	*IV*	*V + VI*	*Total*
1965	5·37	13·87	11·35	9·39	39·98
1966	5·68	9·85	8·43	9·11	33·07
1967	3·85	3·23	5·18	7·68	19·94
1968	3·93	3·31	6·85	4·55	18·64
1969	1·63	1·92	4·59	2·94	11·08

The index of abundance has continuously decreased since 1965. In 1969 it decreased by 40% over the previous year.

2.2. *Index of abundance by means of whale sighting*

An index of abundance based on whale sighting data (see Section 6 of this report) was calculated as shown in Table 3. These indices (described in Sub-

TABLE 3
Index of Abundance of Fin Whales in the Pelagic Ground of the North Pacific (by Whale Sighting)

	II	*III*	*IV*	*V + VI*	*Total*
1965	2,180	2,970	9,410	2,060	16,630
1966	840	2,240	9,230	720	15,620
1967	2,090	2,580	3,040	3,050	10,760
1968	—	2,820	1,430	7,900	12,150
1969	1,820	930	1,410	3,920	7,880

sections 2.1 and 2.2) show similar development in the west longitudinal areas, but not in the east longitudinal areas. In the latter areas, the index based on CPUE has been decreasing ,whereas the whale sighting index shows an increase for the period from 1965–69.

These indices would tend to underestimate the population because of species selection. Since 1965, the ratio of sei whale catches to fin whale catches has been increasing continuously, being 1·00, 1·54, 2·68, 3·17 and 4·04 in respective seasons from 1965 to 1969. Therefore change in species preference would affect apparent value of CPUE as in the case of the fin whale in the Antarctic Ocean.

2.3. *Estimation of stock size based on reproduction curve and catch method*

It is very important to know the historical change of population.

The catch statistics of fin whales in the Asian side of the North Pacific are available from 1910 and about 500 to 1,000 animals were killed every year until 1951. On the other hand, in the eastern side of the North Pacific yearly catches were less than 200 until pelagic operations started in 1954. Since then the catch of fin whales increased yearly until it reached 3,300 in 1964, but it has decreased recently. Considering available information on stock units of the fin whale distributed in the North Pacific Ocean and on such differences in the history of catch as mentioned above, we divided the population into two units, the Asian stock (excluding the stock from the East China Sea) and the American stock bounded by 180°E, to estimate the historical change of population.

Method The method used here is the same as the one which we developed and applied to the Antarctic fin whale population assessment at the last meeting (IWC/SC/21/18).

That is,

$$N_{t+1} = (N_t - C_t)e^{-M} + R_{t+1} \tag{1}$$

where N = stock size at the beginning of a season
C = catch in the season
M = natural mortality coefficient
R = recruitment at age t,

$$R_{t+1} = K(S_{t-t_r}) \tag{2}$$

K = rate of reproduction
S = stock size of mature females

Eq. (2) shows reproduction relationship.

If we put $N = N_0$ at the beginning of 1910, we can trace the change in stock size using eqs. (1) and (2).

Parameters Parameters involved in these equations were decided as follows:

(a) As we do not have much data on reproduction relationship, Model Case 4 for the Antarctic fin whale was applied for both the Asian and the American side stocks.

(b) $M = 0.04$. A value of 0.046 was reported for the fin whale in the North Pacific area (Nemoto *et al.*, 1968), another value of 0.0415 was reported for the fin whale in the Antarctic Ocean (Doi *et al.*, 1969). However, at the Honolulu Meeting in March 1970, the best estimate of average natural mortality coefficient at the latest stock level of the Antarctic fin whale was agreed to be 0.04. Therefore, $M = 0.04$ was adapted to calculate the first approximation.

(c) $t_r = 6$. Although we do not have any data on age at recruitment in earlier seasons, judging from age composition data for 1967–1969 seasons $t_r = 6$ is suitable.

(d) S/N. Ratio of mature females to total exploitable population is one of the important factors to estimate recruitment from eq. (2). In the course of calculation the yearly changes of S/N are estimated from data on sexual maturity rate of the female.

(e) To estimate the marginal reproduction rate in initial population, age at sexual maturity is taken as 10 years old.

(f) N_0. Initial population sizes in 1910 are not known today. The populations at the commencement of pelagic operations (1952) were estimated as about 7,800 to 10,000 for the Asian side stock and about 23,000 to 24,000 for the American side stock using modified De Lury's method and q-value method.

Considering the history of the catch described above, the ratio (N_0 in 1910)/(N in 1952) of the Asian side stock will be much larger than that of the American side stock which will be not so much more than 1·0. The values of N_0 were estimated after completing some trial and error methods.

Results calculated Estimated range of N_0 within permissible factors is 17–18 thousand whales for the Asian side stock and 25–27 thousand whales for the American side stock. Yearly changes in stock sizes are shown in Figs. 1A and 1B both for the Asian and the American sides. The American side stock remained at a fairly high level until 1950, but thereafter it decreases rapidly due to intensive exploitation. On the other hand the Asian side stock has experienced gradual decline.

Estimated stock size and Actual Sustainable Yield in 1970 season are shown in Table 4 together with MSY level and MSY.

Stock size in 1970 is estimated as 13,000–17,700 whales, and Actual Sustainable Yield is 1,270–1,350 whales which exceeds MSY because of time lag of recruit-

TABLE 4
Stock Size and ASY in 1970

	Asian side	*American side*	*Total North Pacific*
Initial stock size	17,000–18,000	25,000–27,000	42,000–45,000
Stock size, 1950	9,970–12,090	24,930–26,450	34,900–38,540
Stock size, 1970	5,080–7,540	7,890–10,130	12,970–17,670
ASY, 1970	450–480	820–870	1,270–1,350
MSY level	10,600–11,300	15,600–16,900	26,300–28,100
MSY	480–510	700–760	1,180–1,270

ment to catchable stock. That is, in 1963 the American side stock was more than 60% of N_0 but decreased as far as 32–38% of N_0 in 1970, and so recruitment in 1970 which is descendant from parent stock in 1963 provide some surplus over natural death of the present stock.

· Present status of stock is about 50–60% of MSY level.

3. *Sei Whale*

3.1. *Index of abundance of sei whales distributed in the pelagic whaling ground*

Index of abundance was calculated, using corrected CPUE and taking size of each area into account, as shown in Table 5.

TABLE 5
Index of Abundance of Sei Whales in the Northern Part of the North Pacific (Using Catch and Effort Data)

	II	*III*	*IV*	*V + VI*	*Total*
1965	8·63	14·83	9·30	7·64	40·40
1966	7·70	15·00	12·87	14·18	49·75
1967	17·23	15·70	27·50	20·33	80·76
1968	19·06	30·96	14·24	24·87	89·13
1969	8·40	28·26	15·42	17·26	69·34

It had increased until 1968 and decreased for the first time in 1969.

3.2. *Index of abundance by means of whale sighting*

On the basis of the method as described in Section 3, an index of abundance was also obtained by means of whale sighting.

TABLE 6
Index of Abundance in the Northern Part of the North Pacific (by Means of Whale Sighting)

	II	*III*	*IV*	*V*	*VI*	*Total*
1965	845	2,824	7,104	1,200	—	11,972
1966	1,560	3,650	3,096	8,254	—	16,560
1967	—	534	9,861	10,668	122	21,186
1968	2,214	15,065	5,029	11,351	2,835	36,494
1969	2,294	11,233	10,962	5,090	—	29,579

Tendency of yearly change of the index is fairly similar to that obtained by using CPUE in the previous Subsection 3.1. However, in order to get correct values of the index, we should take account of the yearly change in latitudinal range of investigated area, which had spread southward until the 1968 season but ceased in 1969.

3.3. *Estimation of fishing rate by means of whale marking*

TABLE 7
Fishing Rates and Population Sizes Obtained with Whale Marking Data

	0-Year	*1–2 Yrs.*	*Total yrs.*	*Average*	*Average catch*	*Population size*
	%	%	%	%		
1964/65	12·2	0·0	7·7	6·6	2,106	31,900
1966/67	22·1	18·9	17·6	19·5	4,605	23,600
1968/69	4·5	11·7	7·7	8·0	4,801	60,000

Table 7 shows fishing rates and population sizes calculated with whale marking data.

There are many variations in fishing rates which were obtained by means of whale marking, so that it is difficult to get accurate figures.

3.4. *History of catch and change of population size, and Actual Sustainable Yield*

Until our previous paper, we had assessed populations of sei whales in the pelagic whaling ground and in the coastal waters, separately. However, there is a long history of whaling for sei whales in the North Pacific, and the stage of population in 1952 which we regarded as the initial population for the pelagic whaling in our previous paper was actually not the initial one. Therefore, we should assess the population of sei whales considering the history of whaling, which had started long before 1952.

Identification of stock units of sei whales in the North Pacific has not been established, but it does not seem erroneous at present to separate it into Asian and American stock units at 180° of longitude.

Initial population sizes The history of catch of sei whales in the North Pacific is shown in Figs. 2A and 2B. The amount of catch from the American stock was small until 1953, so that the population level in 1954 seemed to be about the initial population level. The population size of the American stock (Areas II-IV) was 28,270–52,540 in 1954 as described in the previous report (IWC/SC/21/23). On the basis of the figures, we re-estimated the initial population size to be 30,000–50,000 ,including sei whales distributed along the American coast.

In the case of sei whales of the Asian side about 500-600 whales, including a small number of Bryde's whales, were caught every year until the pelagic whaling began in the northern part of the North Pacific in 1952. In our previous report, as mentioned above, regarding the populations in 1952 as the initial ones, we estimated them to be 16,610–17,160 in Areas V and VI, and 14,000–15,500 in the waters off the coast of Japan. Based on these figures, the initial population size in the Asian side was recalculated to be 30,610–32,660, including sei whales in the waters off the Japanese coast.

Change of population size Change of population sizes of American and Asian sides were calculated, adapting the above mentioned initial population sizes and catches in each year, into the new population model of the sei whale in the North Pacific as shown with the following formula.

$$N_{t+1} = (N_t - C_t)e^{-M} + R_{t+1}$$

The results of calculation are shown in Figs. 2A and 2B.

MSY and present population level The present population size and MSY population level are shown in Table 8. MSY and the present Actual Sustainable Yield are also shown in the same table.

The present population levels are still above those which gives MSY for both stocks.

TABLE 8
Population Assessment of Sei Whales

	Asian side	*American side*	*Whole North Pacific*
Initial population	28,000–32,000	30,000–50,000	58,000–82,000
MSY population	15,680–18,560	17,400–29,000	33,080–47,560
MSY	1,186–1,355	1,270–2,117	2,456–3,452
Population in 1970	16,700–20,560	17,410–37,880	34,110–58,440
ASY in 1970	1,511–1,588	1,519–1,611	3,030–3,199

4. *Bryde's Whale*

In the North Pacific Bryde's whales have been caught mainly in the waters off Japan's coastal land stations. Depending on the various conditions of warm water masses in the adjacent waters of Japan, there has been a large yearly fluctuation in the catch amount (8–504) and migration intensity near the coast of Japan.

The stock size was reported in the Third Memorandum of Results of Japanese Stock Assessment of Whales in the North Pacific (see page 91, IWC 17th Report of the Commission) estimated to be 5,000–18,000 during the years 1955–64. According to the general knowledge concerning other species of whales and roughly constant history of catch amount on a long-term view, the present stock condition does not seem to be much different from the above mentioned figures, and the sustainable yield is supposed to be about the same as average annual catch, 200–300.

Furthermore, although we do not have enough data to assess the stock condition accurately, the present population does not seem to have been depleted under the level which gives maximum sustainable yield of 300–600.

5. *Sperm Whale*

5.1. *Index of abundance of male sperm whales distributed north of 50°N*

Using the correcled CDW with the same method as for fin and sei whales, the CPUE of male sperm whales north of 50°N was calculated. Then the index of abundance was calculated with the CPUE, taking size of each area into account, as shown in Table 9.

TABLE 9
Index of Abundance of Male Sperm Whales North of 50°N

	II	*III*	*IV*	*V*	*VI*	*Total*
1963	1·60	8·19	11·21	21·78	0·23	43·01
1964	2·80	6·25	11·13	16·18	0·02	56·38
1965	2.42	12·06	12·38	15·12	—	41·98
1966	—	11·12	9·34	12·30	0·12	32·88
1967	4·39	12·38	9·35	11·50	1·16	38·78
1968	—	16·03	14·23	17·36	0·79	48·41
1969	1·52	9·46	8·35	14·36	0·19	33·88

The index shows generally a decrease in recent years, although marked fluctuations are apparent in each area.

5.2. *Index of abundance by means of whale sighting*

From the data of whale sighting carried out with scouting boats belonging to whaling expeditions, an index of abundance was also obtained independently as shown in Table 10.

TABLE 10
Index of Abundance by Means of Whale Sighting

	II	*III*	*IV*	*V*	*VI*	*Total*
1965	27·79	103·24	116·10	164·81	—	411·95
1966	10·03	38·12	46·38	116·88	—	211·40
1967	—	53·79	29·10	94·34	2·44	179·67
1968	—	170·84	55·09	90·33	16·80	333·06
1969	78·04	49·14	29·87	47·80	—	203·85

As in the case of the sei whale, tendency of yearly change in the index is fairly similar to that obtained by using CPUE in the previous Subsection 4.2.

5.3. *Estimation of initial and recent stock sizes of male sperm whales north of 50°N by means of q-value*

Using the modified De Lury method, initial stock sizes and q-value (0·892) had been obtained in the last report (IWC/SC/21/23). The population size in each year and for each area was calculated with q-value and index of abundance. They are shown in Table 11.

TABLE 11
Estimation of Stock Sizes Using q-value ($\times 10^{-3}$)

	II	*III*	*IV*	*V*	*VI*	*Total*
Initial	4·40	15·70	23·30	28·20	1·40	73·00
1965	2·71	13·52	13·88	16·95	--	47·06
1966	--	12·47	10·47	13·78	0·13	36·85
1967	4·92	13·88	10·48	12·89	1·30	43·47
1968	--	17·97	15·95	19·46	0·89	54·27
1969	1·70	10·61	9·36	16·10	0·21	37·98

Present stock level is at 52–59% of initial stock.

5.4. *Estimation of amount of recruitment of male sperm whales north of 50°N*

Change of stock size was obtained with q-value and index of abundance in Areas IV and V since 1954. Amount of recruitment may be calculated with the following formula:

$$N_{t+1} = (N_t - C_t)e^{-M} + R_{t+1}$$

Where N is stock size, C is amount of catch, M is natural mortality coefficient (set as 0·06) and R is amount of recruitment. The calculated amount of recruitment has a large fluctuation. However, as the amount of catch of females has increased only recently in the North Pacific, it is estimated that the stock size of females has remained at the level of initial stage. Therefore, the amount of recruitment must have remained constant until recent years. The average amounts of recruitment were calculated to be 1,340 and 2,200 in Areas IV and V respectively, and the average rate of recruitment to the initial population would be 6·9%.

5.5. *Change of CPUE of male sperm whales south of 50°N*

As shown in Table 12, CPUE of males which are distributed in the waters south of 50°N in the pelagic ground has gradually decreased.

TABLE 12
CPUE of Male Sperm Whales South of 50°N

	II	*III*	*IV*	*V*	*VI*	*Total*
1963	3·19	1·70	1·03	—	0·88	1·68
1964	7·98	1·46	4·67	2·41	6·57	4·68
1965	7·58	5·60	3·64	3·55	4·60	4·66
1966	0·33	4·22	3·18	2·94	5·00	3·18
1967	3·53	2·82	3·71	2·72	6·28	3·78
1968	3·84	4·44	3·86	2·75	2·91	3·39
1969	2·13	2·15	2·37	1·60	1·64	2·38

5.6. *Estimation of initial population size of male sperm whales south of 50°N with the modified De Lury method*

Population sizes of the male sperm whale which are distributed in the waters south of 50°N in the pelagic whaling ground in 1964 were calculated by the modified De Lury method as follows:

II	*III*	*IV*	*V*	*VI*	*Total*
9,900	9,000	21,600	12,100	8,300	60,900

5.7. *Change of population size and amount of recruitment*

Supposing that population size is proportional to CPUE, population sizes in each area and each season are calculated using initial population and CPUE.

Table 13 shows change of population sizes of males distributed in the waters south of 50°N. Average amount of recruitment and rate of recruitment were calculated using the same method as that in the waters north of 50°N. They are 1,890 whales and 3·1% respectively.

5.8. *Population size of male sperm whales in the northern part of the North Pacific*

The total population of the male sperm whale distributed in the northern part of the North Pacific, mainly in the waters north of the polar front of the North Pacific, is estimated by adding the two results of north and south of 50°N which were obtained in the previous sections.

TABLE 13
Population Sizes of Male Sperm Whales in the Waters South of 50°N ($\times 10^3$)

	II	*III*	*IV*	*V*	*VI*	*Total*
1964	9·9	9·0	21·6	12·1	8·3	60·9
1965	10·4	9·4	18·3	13·2	5·7	57·0
1966	0·5	7·1	16·0	10·9	6·2	40·7
1967	4·9	4·7	18·6	10·1	7·8	46·1
1968	5·3	7·5	19·4	10·2	3·1	45·5
1969	2·9	3·6	11·9	6·0	2·0	26·4

Population size at the beginning of 1970 season was calculated with the following formulas:

$$N_{1970} = \left(N_{1969} - \frac{C_{1969}}{2}\right)e^{-M} + R$$

$$R = rN_0$$

where r = rate of recruitment
N_0 = initial population size

Initial population size of males distributed in the northern part of the North Pacific was estimated to be 133,900, it had decreased to 63,600 at the beginning of 1970. This value is 47·5% of the initial population level, and it is just the minimum population level to maintain reproduction with the initial number of females.

The sustainable yield of males at the present population level was estimated to be 4,290, which is 6·75% of the population.

5.9. *Population of female sperm whales in the whole North Pacific*

Catch of females in the North Pacific increased since 1967 and reached 3,605 in 1969.

TABLE 14
Population Sizes of Male Sperm Whales in the Northern Part of the North Pacific ($\times 10^3$)

	II	*III*	*IV*	*V*	*VI*	*Total*
Initial						
N50°N	4·4	15·7	23·3	28·2	1·4	73·0
S50°N	9·9	9·0	21·6	12·1	8·3	60·9
Total	14·3	24·7	44·9	40·3	9·7	133·9
1969						
N50°N	1·7	10·6	9·4	16·1	0·2	38·0
S50°N	2·9	3·6	11·9	6·0	2·0	26·4
Total	4·6	14·2	21·3	22·1	2·2	66·4
Beginning of 1970						
N50°N	1·8	11·4	10·2	16·9	0·3	40·6
S50°N	1·9	3·2	10·8	5·5	1·6	23·0
Total	3·7	14·6	21·0	22·4	1·9	63·6

Initial population size of males distributed in the North Pacific was 133,900. According to Ohsumi (1966), if 80% of males over 15 years of age are distributed in the northern part of the North Pacific, the total initial population of males over 15 years of age in the North Pacific would be about 167,000. If the age distribution of females is the same as that of males, the total population size of mature females may be calculated with the following formula:

$$\frac{N}{S} = e^{-(t_c - t_m)M}$$

where N = population size of male
S = population size of mature female
t_m = age at sexual maturity of female
t_c = age at beginning of catch of male

Now, N = 167,000, t_c = 15, t_m = 9 and M = 0·06, then S is calculated as follows:

$$S = 239{,}000$$

If the female age at recruitment is 20 years, the exploitable stock size of female is 123,800, and if the catch of female is represented with the population model of female (see Fig. 2 in Ohsumi's paper, "A trial to get mathematical models of population for sperm whale"), MSY becomes 5,234. In the North Pacific female catches have been less than 5,234 and the population level is still above the level of MSY.

6. *Prohibited Whales*

Whale sighting is the only method with which we may estimate tendency of change of abundance on the prohibited whales.

We have whale sighting data obtained by using scouting boats. Index of abundance is calculated in each small square (5° latitude 10° longitude square) and summed up under the following formula.

$$\text{I.A.} = \sum \frac{n_i \cdot A_i}{m_i}$$

where I.A. = index of abundance
n_i = number of whales sighted in i-square
m_i = steaming miles in i-square
A_i = area size of i-square

The range of covered areas is 150°E–130°W, 40° N–65°N, excluding Okhotsk Sea.

6.1. *Blue whale*

TABLE 15
Index of Abundance of Blue Whales

	II	III	IV	V	VI	Total
1965	143	528	937	371	—	1,978
1966	201	212	76	150	—	638
1967	—	214	610	1	31	856
1968		237	341	660	112	1,426
1969	75	76	223	256	-	629

Since 1966 the tendency of the index seemed to increase until 1968, and then dropped back to the 1966 level in the 1969 season. Therefore, it seems necessary to continue protecting this species for some years until the tendency of recovery becomes clear.

6.2. *Humpback whale*

TABLE 16
Index of Abundance of Humpback Whales by Means of Whale Sighting

	II	III	IV	V	VI	Total
1965	227	754	269	62	- -	1,312
1966	- -	977	1,358	42		2,377
1967	-	1,716	670	26	-	2,412
1968	—	835	74	141	164	1,212
1969		509	313	143		965

There is no apparent tendency of change of abundance on this species. Stock size of this species might be somewhat larger than that of the blue whale, but protection is still necessary.

6.3. *Right whale*

TABLE 17
Index of Abundance of Right Whales by Means of Whale Sighting

	II	III	IV	V	VI	Total
1965	—	12	126	15	—	153
1966	—	83	11	74	- -	168
1967	—	107	353	—	—	460
1968	—	-	- -	96	- -	96
1969	—	-	13	106	- -	119

Although the catching of right whales has been prohibited for many years, population size is still small, and tendency of recovery is not apparent.

6.4. *Gray whale*

There has been no record of finding this species in the areas investigated during the past seasons, so that we cannot estimate population of this species.

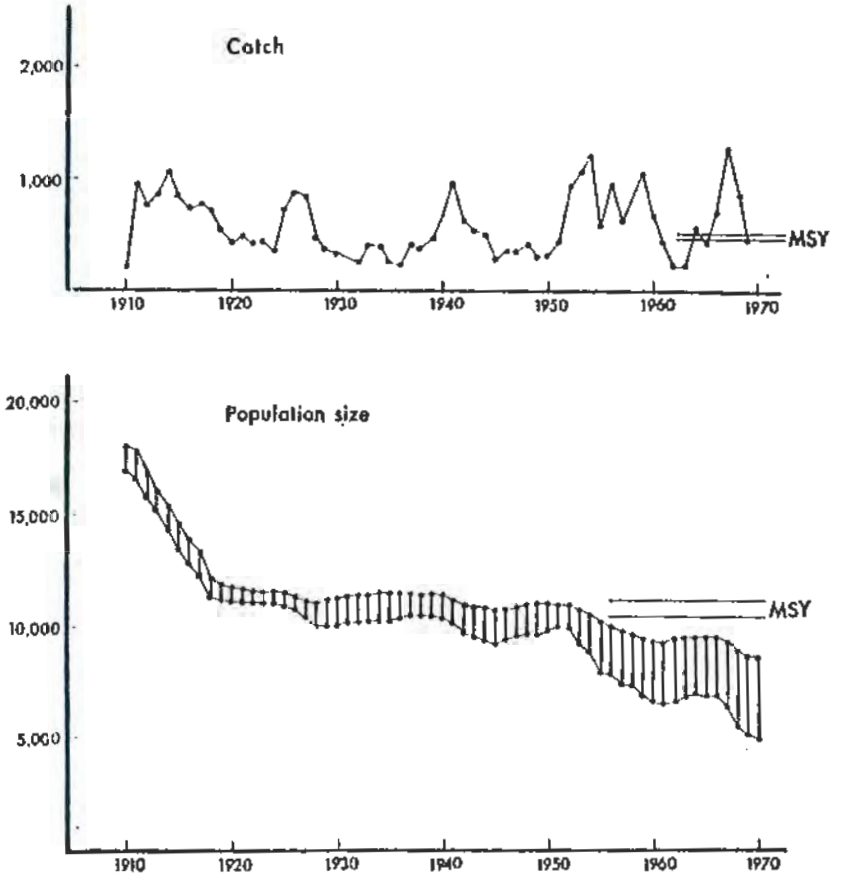

Fig.1o Change in annual catch and population size of the fin whale in the Asian side of the North Pacific

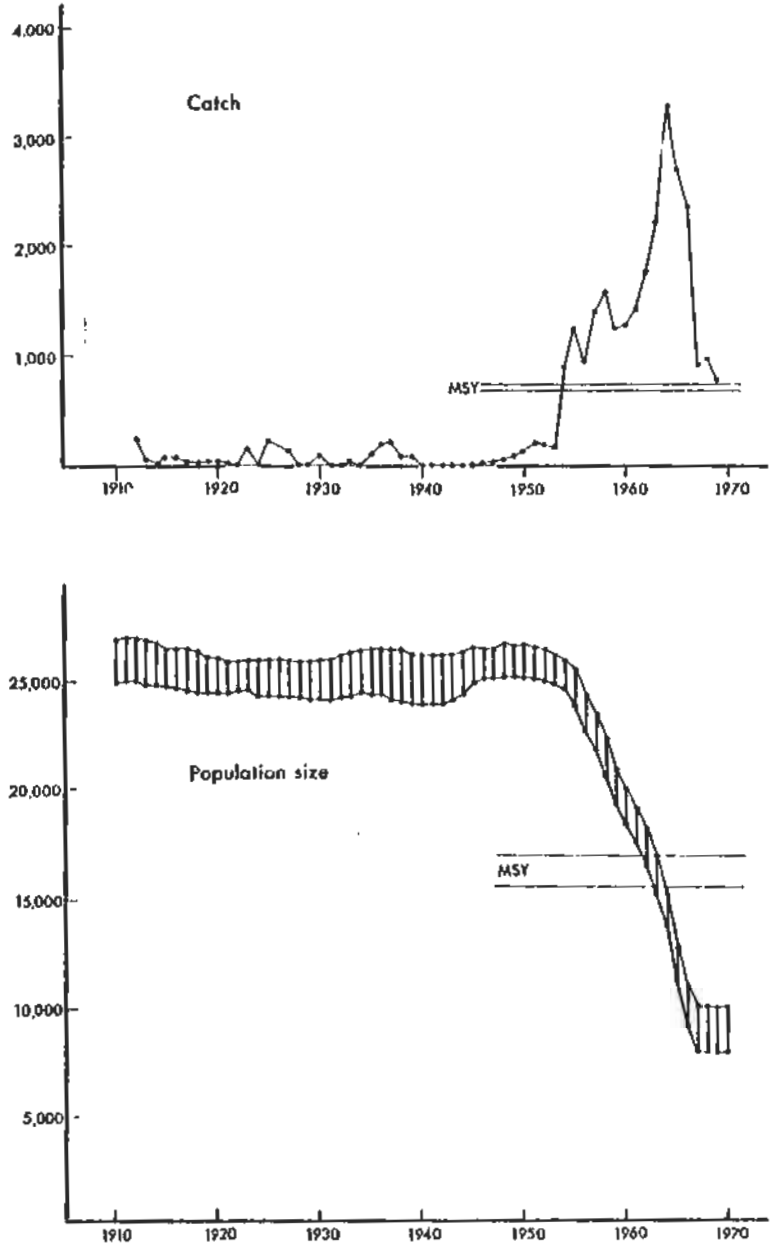

Fig. 1b Change in annual catch and population size of the fin whale in the American side of the North Pacific

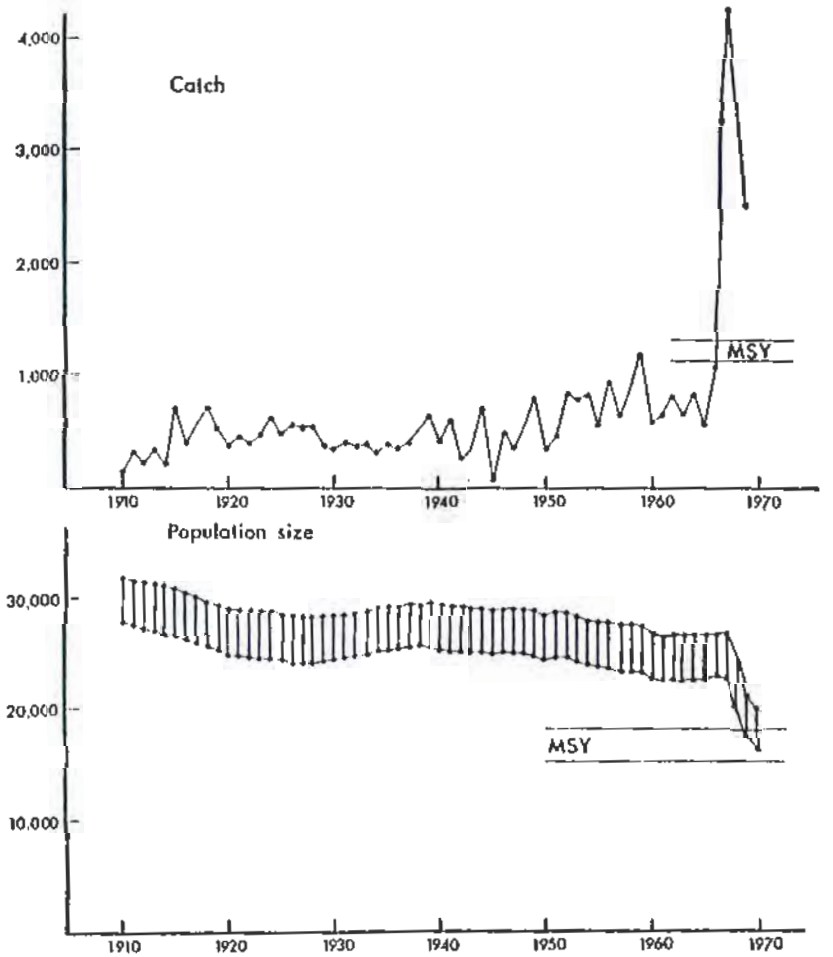

Fig. 2a Change in annual catch and population size of the sei whale in the Asian side of the North Pacific

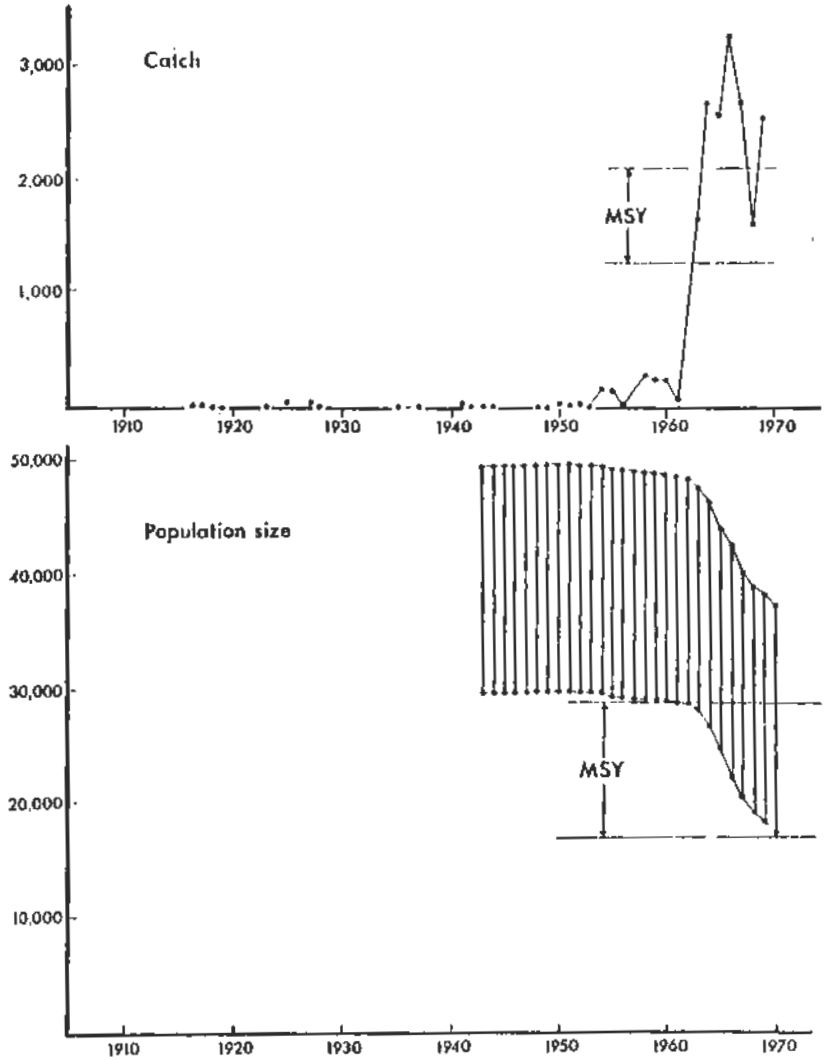

Fig. 2b Change in annual catch and population size of the sei whale in the American side of the North Pacific

ANNEX K

STATUS OF STOCKS OF BALEEN WHALES IN THE ANTARCTIC, 1970/71

by T. Doi, S. Ohsumi and Y. Shimadzu

1. *Introduction*

At the last I.W.C. meeting we introduced the advanced method of stock assessment of fin and sei whales in the Antarctic in two documents. They were registered as Document Nos. IWC/SC/21/18 and IWC/SC/21/19.

In this paper, using mainly the above method and combining the catch result in 1969/70 season, we reassessed the stock conditions of fin and sei whales. We also tried to predict future change of the stock condition for the purpose of establishing a long-term project for rational utilization of fin and sei whales in the Antarctic.

On the status and change of stock condition of the prohibited whale species such as blue, humpback and right whales, we had no data available except those by means of sighting.

2. *Fin Whale*

2.1. *Change of CPUE*

Yearly changes in catch and CPUE of the fin whale caught in the Antarctic areas from 1961/62 to 1969/70 are shown in Table 1.

In the 1969/70 season, CPUE of fin whales continued a tendency to recovery from a minimum in 1965/66, when the ratio of the fin whale catch in total baleen was the lowest. At the worst, we may easily believe that the fin whale population has not been decreasing since the 1965/66 season judging from the increasing tendency of CPUE in recent years, although reliability on CPUE is not so high compared with years when fin whales were more than 80% of the total baleen whale catch.

2.2. *Change of population size by means of whale sighting*

Data on whale sighting were collected in the 1969/70 season by Japanese scouting boats. Distribution index was estimated according to the method described by Nasu and Shimadzu (1969, SC/21/22), which employed isodensity lines. Table 2 shows the yearly estimation of population by area.

Observed areas did not cover the Antarctic areas entirely as shown in Table 2, in particular the main distribution areas of fin whales—south of 60°S—were excluded. The values in the table therefore indicate an underestimated fin whale population. In the 1969/70 season estimated values are about 2·6 times of the previous season, an irregularly high rate compared with earlier seasons. It would be clear from these values that the successive tendency of the fin whale population in these 4 seasons is towards recovery.

2.3. *Present status of stock and sustainable yield*

At the Honolulu meeting held in March 1970, the lowering of age at recruitment was discussed and age at 50% recruitment is lowered as far as 5 years in

TABLE 1
Catch and CPUE of Fin Whales

Seasons	CDW	Average tonnage	Catch							CPUE						
			II	III	IV	V	VI	I	Total	II	III	IV	V	VI	I	Total
1961/62	29,952	657	6,650	11,847	3,129	1,098	1,120	2,520	26,364	0·80	1·04	0·99	0·62	0·59	0·74	0·88
1962/63	22,504	703	5,570	8,977	1,725	645	346	1,373	18,636	0·91	0·96	0·62	0·51	0·56	0·58	0·83
1963/64	20,407	709	7,319	4,753	603	1,144	—	34	13,853	0·87	0·72	0·31	0·35	—	0·36	0·68
1964/65	17,521	715	4,528	1,199	766	747	—	66	7,306	0·44	0·67	0·34	0·25	—	0·89	0·42
1965/66	13,146	743	636	1,008	64	385	204	17	2,314	0·10	0·41	0·10	0·15	0·22	0·38	0·18
1966/67	11,775	754	81	1,554	372	304	530	44	2,885	0·07	0·29	0·16	0·16	0·39	1·10	0·24
1967/68	9,783	769	173	780	749	223	227	—	2,152	0·30	0·29	0·33	0·10	0·12	—	0·22
1968/69	8,363	787	32	552	1,627	413	260	130	3,014	0·11	0·22	0·71	0·21	0·27	0·45	0·36
1969/70	7,948	801	32	1,546	1,064	321	33	—	2,996	0·04	0·45	0·47	0·27	0·12	—	0·38

TABLE 2
Estimated Population by Sighting (Areas between 40°S and 60°S) (unit $\times 10^3$)*

Season	*I*	*II*	*III*	*IV*	*V*	*VI*	*Total*
1966/67	+	+	4·5–6·4 +	3·7–5·3 +	0·8–1·1 +	+	9·1–12·8 +
1967/68	+	+	3·0 4·3 +	6·0–8·4 +	0·8–1·2 +	0·8–1·1 +	10·6–15·0 +
1968/69	+	+	7·0 9·9 +	5·4–7·6 +	0·6–0·8 +	0·3–0·5 +	13·3–18·8 +
1969/70	+	5·0–7·1 +	16·7–23·7 +	12·5–17·8 +			34·3–48·6 +

* Low figures are for A (finding rate) = 1·0 and high figures are for A = 0·7.

recent years. So we recalculated the population for Cases 2 and 4 which were reported in our previous report (IWC/SC/21/18) employing younger age at recruitment based on age composition data. Results are shown in Table 3.

TABLE 3
Estimated Stock Size of Fin Whales in the Antarctic (unit $\times 10^3$)

Season	*t'*	*Stock size*				*Recruitment of next season*			
		Case 2	*Case 2'*	*Case 4*	*Case 4'*	*Case 2*	*Case 2'*	*Case 4*	*Case 4'*
1929/30	7		378·5				15·4		
1944/45	7	282·0	282·0	278·6	278·6	18·6	18·6	17·9	17·9
1945/46	7	287·5	287·5	283·5	283·5	18·8	18·8	18·6	18·6
1946/47	7	285·8	285·8	281·7	281·7	18·8	18·8	18·7	18·7
1947/48	7	279·1	279·1	275·0	275·0	18·8	18·8	18·7	18·7
1948/49	7	266·3	266·3	262·3	262·3	18·7	18·7	18·7	18·7
1949/50	7	255·8	255·8	252·0	252·0	18·8	18·8	18·7	18·7
1950/51	7	244·9	244·9	241·2	241·2	18·8	18·8	18·7	18·7
1951/52	7	235·0	235·0	231·4	231·4	18·9	18·9	18·7	18·7
1952/53	7	222·8	222·8	219·1	219·1	18·9	18·9	18·7	18·7
1953/54	6·5	210·7	210·7	206·9	206·9	18·9	18·9	18·7	18·7
1954/55	6·5	194·5	194·5	190·6	190·6	18·8	18·8	18·7	18·7
1955/56	6·5	177·9	177·9	174·1	174·1	18·8	18·6	18·7	18·6
1956/57	6·0	162·6	162·4	158·9	158·8	18·6	18·3	18·6	18·3
1957/58	6·0	147·9	147·4	144·4	144·0	18·3	18·0	18·3	18·1
1958/59	6·0	133·8	133·0	130·4	129·9	18·0	17·5	18·1	17·6
1959/60	5·5	120·4	119·1	117·2	116·2	17·7	17·0	17·8	17·0
1960/61	5·5	106·7	104·8	103·8	102·0	17·3	16·2	17·3	16·0
1961/62	5·5	92·0	89·1	89·2	86·2	16·6	15·3	16·6	14·9
1962/63	5·0	78·9	74·8	76·2	71·6	15·7	14·2	15·3	13·6
1963/64	5·0	73·4	68·0	70·5	64·3	15·5	13·0	14·3	12·4
1964/65	5·0	72·1	64·4	68·1	60·3	13·7	12·0	13·1	11·2
1965/66	5·0	75·9	66·8	71·4	62·0	12·6	10·8	12·0	9·9
1966/67	5·0	83·2	72·7	78·3	67·2	11·6	9·2	10·8	8·5
1967/68	5·0	88·6	76·2	83·1	70·2	10·1	7·9	9·7	7·2
1968/69	5·0	93·3	78·9	87·3	72·4	9·2	7·4	8·3	6·4
1969/70	5·0	95·8	80·2	89·2	73·0	8·0	7·0	7·2	6·1
1970/71	5·0	97·0	81·1	89·9	73·3	7·5	7·3	6·8	6·2

A revised estimation is shown in the Table as Case 2', and Case 4' corresponding to Case 2 and Case 4, respectively. Stock sizes at the beginning of 1970/71 season are smaller than our previous result because of lower values of age at recruitment. Tendency of change in stock size is *very* similar between Cases 2 and 2', and Cases 4 and 4', implying recovery of population after a minimum in the 1964/65 season. Recovery rates of stock sizes in 1970/71 season are 26% and 22% of 1964/65 season's stock sizes for Case 2' and Case 4' respectively.

Estimated stock sizes and Actual Sustained Yields for the next season are shown in Table 4.

TABLE 4
Population of Fin Whales in the Antarctic

	Population size	*ASY*
Initial	378,500	
1970/71	73,300-81,100	3,520-4,350
MSY	227,000-236,600	9,500-10,600

Population is recovering gradually, but present status is still about 30% of the level which gives MSY. The Actual Sustainable Yields in the 1970/71 season are 3,520 and 4,350 according to Case 4' and Case 2' respectively.

2.4. *Discussion*

2.4.1.

There are three reports concerning reproduction relationship of fin whales. They are by Doi *et al.* (1969, IWC/SC/21/18), by Allen (1970, SM/70/F/3) revised from his previous report (1969, IWC/SC/21/2) and by Chapman (SM/70/F/4). The most important difference between these three is the nature of reproduction rate curves. Doi *et al.* employed models on the rate which increases according to decrease of parent stock size, whereas Allen showed decreasing rate according to decrease of stock based on analysis of age composition data and Chapman described the rate to be constant. Recent tendency of stock was calculated to increase (Doi *et al.*) and to continue to decrease (Allen).

It is for us to resolve such fundamental problems, to obtain more accurate estimates on stock size and on SY to achieve better stock management of fin whales. Two ways may be employed. They are,

A. To analyse reproduction rate curves
B. To obtain evidence which shows clearly the tendency of changing stock in recent years, such as,
   (1) CPUE
   (2) Estimation by whale sighting
   (3) Some other biological factors

Hereafter we discuss these subjects briefly.

A. *Analysis of reproduction rate curves* Reproduction rate (K) is expressed with the following mathematical model, taking sex ratio of foetus as 50%,

$$K = \tfrac{1}{2} p e^{-t_r M'}$$

where p = pregnancy rate
t_r = age at recruitment
M' = natural mortality coefficient for ages less than t_r

In this expression t_r means a fixed age for a knife-edge recruitment model or some average values of several ages for a sequential recruitment model. Although our knowledge on the nature of the above mentioned factors to get K-values is limited, the best estimated values available at present are shown in the table attached to Fig. 1. Combining these parameters, calculation was made to find out the course of reproduction rate curve. Results are shown in Fig. 1. Our previously reported curves (Cases 2 and 4) are very close to the present theoretical ones ($K(1)$). On the other hand curves have not yet been produced which demonstrate decrease of reproduction rates according to decrease of stock size. Judging from this result, reproduction rate curves such as shown by Allen (1970) are too hard to be understood with factual evidence. A further study is needed to analyse this problem more accurately.

B. *Other information* Estimated population by analysis of whale sighting shown in Table 2 might indicate evidence of a recovering fin whale population since 1967. This is one of the major factors to judge whether the population is increasing or not.

Other biological evidence is average body length shown in Table 5.

TABLE 5
Average Body Length of Fin Whales Caught by Pelagic Operation

Year	*Male*	*Female*	*Year*	*Male*	*Female*
1930	64·79	67·70	1963	64·10	67·82
1939	65·73	68·92	1964	64·70	68·59
1946	66·07	69·20	1965	63·56	67·10
1950	65·98	69·07	1966	64·00	67·21
1955	65·07	67·97	1967	64·74	67·76
1960	64·99	68·13	1968	65·14	68·42
1961	65·07	68·36	1969	65·2	68·0
1962	64·44	68·19			

Average body length had been decreasing since 1949 in post-war seasons and it reached a minimum in 1965 both for male and for female. Since then it has shown a remarkable increase of over one foot for both sexes for only four years. Such a rapid increase had never before been experienced in the history of Antarctic whaling. In each season from 1965/66 to 69/70, respective catches of fin whales were 2·3, 2·9, 2·2, 3·0 and 3·0 thousands, and CPUE were 0·237, 0·324, 0·286, 0·462 and 0·471 (tonnage corrected). These data would support the thought that whalers have experienced much more allowance in selecting larger fin whales in recent years than previously. The fin whale population has therefore been gradually increasing in these few years.

2.4.2.

In the report of the Honolulu meeting on stock assessment of fin whales in the Antarctic, three cases are shown in Table 2(a), (b) and (c) for change in stock size in 1962 and after. The stock size calculated on the basis of Cases (a), (b) and (c) in the Honolulu Meeting Report, including the latest data of 1969/70 season are as follows:

	Case (a)	*Case (b)*	*Case (c)*
Stock size	65,700	82,500	95,200
Value of SY	1,300	3,300	5,400

They are different in the rate of net recruitment to total catchable stock in these years; the values are 0·02, 0·04 and the variable one, 0·049 in 1962 and increasing to 0·057 in 1970 for Cases (a), (b) and (c) respectively.

It should be noted that the parameters employed in Case (a) are somewhat similar to Allen's, and those in Cases (b) and (c) to Chapman's and Doi's *et al.* respectively, but the method employed in the Honolulu meeting differs from each of them. The pattern of change in calculated stock size from these three cases are very similar. They reached a minimum in 1965 and then tended to increase. This tendency is the same as in Cases 2 and 4. In those three cases recovery of population in 1970/71 is by 4·3, 11·5 and 19·9% of that in the lowest season.

As the value of $M = 0{\cdot}04$ was agreed at the meeting, net recruitment rate of 0·02 means $K = 0{\cdot}088$ (as K is for female recruitment), provided that pregnancy rate is 0·5, $t_r = 5$, ratio of mature females in total catchable stock is 0·34, which leads to too high a value of M', 0·209, to be accepted. Allen (1970) also explains in his report a net recruitment of 0·035 in the early 1950's. Thus lower rates more

TABLE 6
Catch and CPUE of Sei Whales

Season	CDW	Average tonnage	Catch							CPUE						
			II	III	IV	V	VI	I	Total	II	III	IV	V	VI	I	Total
1961/62	29,952	657	1,249	427	633	409	369	1,629	4,716	0·15	0·04	0·20	0·23	0·19	0·48	0·16
1962/63	22,504	703	1,812	1,457	631	430	345	807	5,482	0·30	0·16	0·23	0·34	0·56	0·34	0·24
1963/64	20,407	709	4,150	1,984	274	1,820	—	28	8,256	0·49	0·30	0·14	0·55	—	0·30	0·40
1964/65	17,521	715	15,584	443	1,564	2,207	—	40	19,838	1·50	0·26	0·69	0·74	—	0·54	1·13
1965/66	13,146	743	12,718	2,756	442	1,008	599	35	17,558	1·96	1·12	0·69	0·40	0·63	0·78	1·34
1966/67	11,775	754	1,553	6,860	2,825	717	402	3	12,360	1·43	1·33	1·24	0·39	0·30	0·08	1·05
1967/68	9,783	769	194	2,352	2,271	2,653	2,880	—	10,350	0·33	0·86	1·00	1·14	1·54	—	1·06
1968/69	8,363	787	188	1,771	1,030	2,156	552	73	5,770	0·64	0·69	0·45	1·10	0·58	0·25	0·69
1969/70	7,948	801	1,298	1,997	1,925	474	33	—	5,852	1·62	0·58	0·85	0·39	0·57	—	0·73

recently obtained are difficult to explain. On these points (a) is very doubtful to take into account.

Case (c), which explains the increasing rate of recruitment according to decrease of stock size, would be more reliable than Case (b) as shown in the previous section.

2.4.3. Conclusion

We have discussed the rate of reproduction and tendency of change in population in recent years. The analysis of recruitment rate curve based on the best knowledge for some fundamental factors, produced evidence that the rate would not decrease according to decrease of stock. Yearly change in CPUE and estimated stock size based on whale sighting showed a recovering tendency of fin whale stock.

This is also supported by increase of average body length.

The evidence available since 1965 therefore suggests that the fin whale population in the Antarctic is recovering.

3. *Sei Whale*

3.1. *Change of CPUE*

Table 6 shows yearly change of catch and CPUE of sei whales in the Antarctic.

CPUE of the sei whale decreased gradually until 1968/69 season but increased by about 5·8% of 1968/69 in 1969/70, although amount of catch increased 1·4% in the same season.

3.2. *Change of population size by means of whale sighting*

Based on the same method as expressed in Subsection 2.2, the population sizes of sei whales for the Antarctic seasons 1966/67–1969/70 were calculated and shown in Table 7.

TABLE 7
Population Size of Sei Whales by Means of Whale Sighting (× 1,000 whales)

	I	*II*	*III*	*IV*	*V*	*VI*	*Total*
1966/67	+	+	13·9 19·7	9·3 12·2 +	19·2–27·3 +	5·2–7·3 +	46·9–66·5 +
1967/68	+	+	6·6 9·4 +	7·0–10·0	12·8–14·0 +	15·6–22·1 +	42·0–59·6 +
1968/69	+	+	4·3–6·1 +	4·6–6·5 +	7·1–10·1 +	3·7–5·3 +	19·7–27·9 +
1969/70	+	9·5–13·4 +	9·0–12·8 +	12·2–17·3 +	+	+	30·7–43·5 +

The ranges of investigation did not cover whole Antarctic areas, but estimated population sizes in Areas III and IV in 1969/70 season were larger than those in 1968/69 season.

3.3. *Present status of stock and sustainable yield*

At the last I.W.C. meeting, we reported our method of stock assessment (Doi and Ohsumi, SC/21/19).

Following the same method, the present status of estimated population is as follows:

TABLE 8
Population of Sei Whales in the Antarctic

	Population size	*ASY*
Initial	150,000	0
1970/71	82,720	5,010
MSY	52,700–51,400	4,180–6,450

Present status of population level is still above the level which gives MSY.

4. *Prohibited Whales*

4.1. *Blue whale*

Using the whale sighting data on number of whales sighted, steaming miles and amount of observed area, the index of abundance is calculated as in Table 9.

TABLE 9
Index of Abundance of Blue Whales by Means of Whale Sighting

Sector	*1965/66*	*1966/67*	*1967/68*	*1968/69*	*1969/70*
IID	60	—	—	—	—
IIIE	—	1,270	690	—	4,030
IIID	2,800	3,350	9,590	11,720	8,570
IIIA	1,080	—	900	1,450	—
IVE	—	—	—	—	380
IVD	—	1,630	—	—	1,560
IVA	—	—	580	420	470
IVB	—	—	240	—	—
VE	—	—	3,400	—	—
VD	—	1,020	160	—	—
VA	—	—	370	—	—
VB	—	—	920	—	—
VIA	—	—	—	80	—
VIB	—	—	—	800	

Blue whales distributed in E and D sectors are assumed to be pigmy blue whales, and those distributed in A and B sectors will be ordinary blue whales. According to the above table, it is estimated that the stock size of the pigmy blue whale is larger than that of the ordinary blue whale.

It is difficult to estimate the change of stock size in the whole of the Antarctic, because of lack of data covering the area and the investigation area has changed year by year. We can only estimate the change of abundance of blue whales (possibly pigmy blue whales) in sector IIID. It seemed to increase until the 1968/69 season, and then decreased in the 1969/70 season.

4.2. *Humpback whale*

TABLE 10
Index of Abundance of Humpback Whales

	1965/66	*1966/67*	*1967/68*	*1968/69*	*1969/70*
IID	260	1,560	—	—	110
IIA	—	—	—	—	1,000
IIIE	—	—	—	—	580
IIID	170	50	280	—	170
IIIA	360	—	—	—	790
IVE	—	—	—	250	1,150
IVD	—	4,890	40	90	350
IVA	—	160	370	310	190
IVB	—	—	120	—	320
VE	—		—	—	—
VD	—	820	80	—	—
VA	—	—	180	—	—
VB	—	—	150	—	—
VID	—	—	—	170	—
VIA	—	—	190	—	—
VIB	—	—	460	—	—

There is a large yearly fluctuation in the index of abundance of humpback whales, and no clear-cut tendency of its change was witnessed.

4.3. *Right whale*

TABLE 11
Index of Abundance of Right Whales

	1965/66	*1966/67*	*1967/68*	*1968/69*	*1969/70*
IIE	--	3,290	--	-	1,330
IID	140	2,610	-	--	830
IIA	—	—	--	--	140
IIIE	—	—	-	--	290
IIID	220	220	280	80	140
IIIA	--	—	—	—	—
IVD	--	--	730	60	3,940
IVA	--	330	—	—	140
VD	—	--	560	30	—
VA	--	--	—	650	—
VID	—	--	160	—	—
VIA	--	--	190	410	—

The index of abundance of the right whale is the lowest among the above mentioned three species and there is a large fluctuation in it.

4.4. *Ratios of abundance and estimation of stock size judging from the stock size of fin whales*

Stock size of the fin whale has been already estimated in each season. Provided that the indices of abundance of the prohibited whale species are proportional to that of the fin whale, the estimated stock sizes of these species are shown in Table 12.

TABLE 12
Ratios of Abundance and Estimation of Stock Size

	1965/66	*1966/67*	*1967/68*	*1968/69*	*1969/70*
	*Ratio of index of abundance to that of fin whales**				
Blue	0·0646	0·0454	0·0798	0·1446	0·1045
Humpback	0·0129	0·0567	0·0113	0·0104	0·0287
Right	0·0059	0·0238	0·0119	0·0106	0·0511
	Stock Size				
Fin	64,400	69,950	73,200	75,650	76,600
Blue	4,160	3,180	5,840	10,940	8,000
Humpback	830	3,970	830	790	2,200
Right	380	1,660	870	800	3,910

* Figures are obtained in sectors D, A and B.

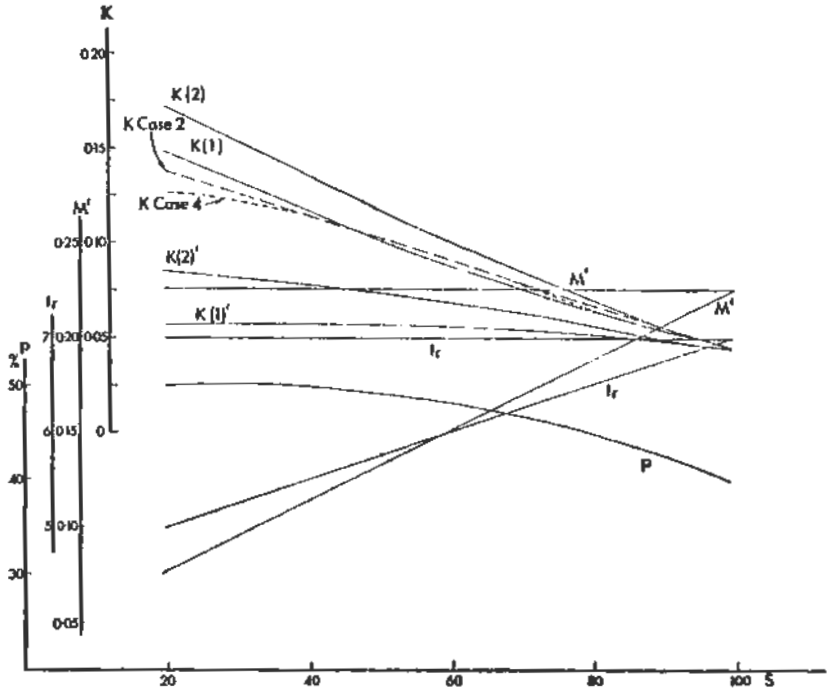

Fig. 1 Change of K, p, M', and t_r accompanied with the change of S

K: Rate of recruitment (No. of recruit/S)
S: No. of mature females,
p: Pregnancy rate,
M': Natural mortality coefficient for pre-recruited ages,
t_r: Age at recruitment,

Combination of parameters for calculation of K values

	p	M'	t_r
K(1)'	0·4–0·5	Constant 0·213	Constant 7 (Theoretical)
K(1)		0·213 – 0·075	
K(2)'		Constant 0·213	7·5 (Actual)
K(2)		0·213 – 0·075	

Left side figures are for $N = N_0$, and right side for $N = 1/5\ N_0$

ANNEX L

CONSIDERATION OF THE PRESENT TECHNIQUE OF WHALE MARKING AND FUTURE MARKING PROGRAMMES

by S. G. Brown
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At the meeting of the Scientific Committee of the I.W.C. in June 1969 some questions were raised about the whale marking at present carried out under the international scheme for marking in the southern hemisphere. It was suggested, for example, that new methods of marking whales might perhaps be employed. At the request of Dr. Chapman, since the N.I.O. co-ordinates this scheme, I undertook to discuss the matter informally by correspondence during the year and to report to the 1970 meeting of the Committee.

A letter (Appendix 1) requesting comments on the present scheme and suggestions for improvements was therefore prepared and copies were sent to the following 15 biologists in November 1969. The biologists concerned have all had experience of whale marking, or have been actively interested in marking programmes: Mr. Bannister (Australia), Mr. Best (South Africa), Dr. Budker (France), Dr. Robert Clarke (U.K.), Dr. Dawbin (Australia), Mr. Gambell (U.K.), Dr. Gaskin (Canada), Dr. Ivashin (U.S.S.R.), Dr. Jonsgård (Norway), Dr. Mackintosh (U.K.), Dr. Mitchell (Canada), Dr. Ohsumi (Japan), Dr. Omura (Japan), Mr. Rice (U.S.A.), Dr. Sergeant (Canada). By the end of April 1970, replies had been received from 11 correspondents and on the basis of these replies the following notes have been prepared. The comments received are grouped under the headings used in the circular letter.

1. *Suitability of the Marks at Present Available*

There is general agreement that the standard marks are satisfactory for marking large baleen whales and they have on occasion been successfully used on sperm whales. In a separate paper Dr. Clarke discusses the possibility of injuring small whales, including sperm whales, with the standard *Discovery* mark, and recommends precautions he considers should always be observed when marking whales.

The increased charge mark designed for marking sperm whales is considered to be satisfactory for marking small sperm whales by Mr. Bannister and for sperm whales marked at short range by Dr. Jonsgård but he feels that at the more normal range they might not fully penetrate the blubber. Mr. Best gives instances of incomplete penetration at short ranges and he has arranged to carry out a series of test firings of marks at different ranges into sperm whale carcasses at Durban to provide more information on this problem. Mr. Gambell is also of the opinion that an increase in the charge strength of these marks might be appropriate.

The streamer mark which was designed to advertise its presence to the whalers on the platform has apparently been unsuccessful. We have no evidence that the presence of the streamers has drawn the attention of flensers to the presence of a mark. Dr. Jonsgård suggests that there may be a possibility that streamer

marks hitting the whale are later lost because of the streamers and Dr. Ivashin suggests that the streamers may facilitate the penetration of infection.

The ·410 mark was designed for the marking of calves of large whales and adults of smaller species. There is a strong recommendation from Dr. Dawbin and Mr. Bannister that this mark should always be used on calves rather than the standard mark which has caused injury to humpback whale calves in the past. Mr. Best reports variable results in their use on sperm whale calves, some being effective hits, others ricochets. Dr. Jonsgård reports their successful use on minke whales, even on small animals, and Dr. Mitchell on calves, smaller species and also the larger whales, recovery from the latter being facilitated by the detailed butchery of the carcasses at Canadian stations for the production of meat products.

2. *Present Methods of Marking*

No suggestions have been made for new methods of marking in place of the present use of whale catchers accompanying the whaling fleets in the Antarctic and the use of chartered whale catchers elsewhere. In the case of chartered catchers, however, it is generally felt that the results to be expected from the marking should be carefully considered against the costs involved.

3. *Marking Programmes*

There is some divergence of opinion on this question. Mr. Bannister feels that the present Antarctic programme is far too limited. In his view marking on a small scale on the whaling grounds has little value though it is probably better than no marking at all. He feels that the use of chartered vessels to mark away from the whaling grounds is important.

Dr. Gaskin also questions the value of the present programmes which he suggests are of little use in providing information for population estimates or for studying migrations with the Antarctic baleen whale stocks at their present low levels. He wonders if the Antarctic programme is not being continued more out of habit than necessity. He suggests that a programme in the northern Indian Ocean might yield valuable results but feels that the costs involved would be hard to justify at the present time.

Dr. Mackintosh feels that it is better to continue marking on the present reduced scale than to stop altogether since there may be value in a long continuing series of records which is lost if the series is interrupted. He also suggests that it is important to expand the marking programme for sperm whales.

Mr. Best believes that regular marking cruises are preferable to sporadic ones and feels that if an annual programme of Antarctic marking can be continued with probably one off South Africa, useful results should be obtained. Mr. Gambell agrees with this view and feels that both the Antarctic programme and marking off South Africa should be expanded.

Dr. Mitchell feels that the present Antarctic programme should be expanded in view of the continuing need for information on Antarctic whales.

To provide some information for a possible discussion on future Antarctic marking programmes I have prepared a short note on the results and costs of the five most recent seasons' marking programmes (Appendix 2).

4. *Publication of Results*

There is general agreement among the six correspondents commenting on this question (Messrs. Bannister, Best, Gambell, Gaskin, Jonsgård and Mitchell) that the present system of publication of the results of Antarctic marking should continue if possible. In the event that publication in the *Norwegian Whaling*

Gazette is no longer possible, it is suggested by Messrs. Bannister, Best and Gambell that the present marking progress report, published as an Appendix to the Report of the Scientific Committee in the Report of the Commission, should include a list of marks recovered annually. Mr. Bannister feels that it might more profitably include also an analysis of the results. Mr. Gaskin asks if cyclo-styled lists of mark recoveries can be circulated to members.

In this connection Mr. Best and Dr. Mitchell raise questions about national responsibilities for publication of the results of whale marking and I feel that if there is an opportunity this matter should again be reviewed by the Scientific Committee.

5. *Co-ordination of Marking*

Messrs. Bannister, Best and Jonsgård are the only correspondents to comment on the present arrangement for co-ordination of the international scheme by the N.I.O.; they all agree that the present arrangements are quite satisfactory.

6. *New Marking Methods*

Only four correspondents comment on the possibility of developing new marks and methods of marking. Mr. Bannister feels that new methods of marking fish should be examined to see if any of them might be applicable to marking cetaceans. Dr. Gaskin tentatively suggests the possible use of a mark incorporating a power source, operated by the body heat of the whale, to transmit signals which, even at very short range, would greatly increase the rate of recovery of marks. Dr. Sergeant mentions the use of radio tags on dolphins by Dr. W. E. Evans (U.S.A.) and experiments by Dr. W. E. Schevill on their use with the larger whales.

Mr. Best feels that in the present state of the whaling industry, it would be senseless to scrap a proven method of marking in favour of a new experimental method, unless the latter was an external mark which had been fully proven after trials on smaller cetacea in captivity.

Appendix I

Consideration of the Present Technique of Whale Marking and Future Marking Programmes

At the meeting of the Scientific Committee of the I.W.C. in June some questions were raised about the whale marking at present carried out under the International scheme for marking in the southern hemisphere. Among other things it was suggested that new methods of marking whales might be employed, e.g., recent developments in the techniques of fish marking might perhaps be applicable to whales. No recommendation was made in the Scientific Committee's report to the Commission but at the request of Dr. Chapman, since the N.I.O. co-ordinates this scheme, I undertook to discuss the matter informally by correspondence during the year and to report to the next meeting of the Committee if any points had arisen which might be taken up by the Committee as a whole.

I am therefore writing to ask if you will be kind enough to give me your views on the present marking techniques and on any improvements which you may feel can be made. It may be useful at this time to consider also any changes which might be made in the type of marking programme at present carried out under the International scheme, or other current marking schemes.

It may be helpful to consider questions under the following headings:

1. Suitability of marks at present available, i.e., 12 bore standard marks, increased charge marks for marking sperm whales, streamer marks. ·410 marks for calves and smaller species of whales.
2. Present methods of marking. Use of whale catchers for marking in the Antarctic by courtesy of Japanese whaling companies and with the co-operation of the Far Seas Fisheries Research Laboratory.
   Use of chartered whale catchers for marking elsewhere, e.g., South Africa.
3. Marking programmes. At present there is an annual marking programme in the Antarctic. In the 1968/69 season, 93 whales were marked (under the International scheme)—1 blue, 36 fin, 28 sei, 28 sperm whales.
4. Present system of publication of results. By annual statements of marking carried out appearing in the Scientific Committee's reports to the I.W.C.
   By annual lists of marks recovered in the *Norwegian Whaling Gazette* (question of continuation of publication).
   By reviews of Antarctic marking progress, and detailed analyses of results published at irregular intervals.

The Scientific Committee has agreed "that the present arrangement whereby the N.I.O. acts as a central organization to co-ordinate whale marking is very satisfactory," but I will welcome any comments on these arrangements which you may have.

Yours sincerely,
S. G. BROWN

Appendix 2

A Note on the Results and Costs of Recent Antarctic Whale Marking carried out under the International Marking Scheme

This brief note on the results and costs of the last five seasons' whale marking carried out in the Antarctic under the International marking scheme has been prepared to provide information for possible discussion in the I.W.C. Scientific Committee on future marking programmes.

The note covers marking during the five Antarctic seasons 1963/64, 1964/65 and 1966/67 to 1968/69 inclusive (there was no marking programme in the 1965/66 season). During this period the marking was carried out entirely by whale catchers and other vessels of Japanese whaling expeditions with the co-operation of The Whales Research Institute, Tokyo; the Tokai Regional Fisheries Research Laboratory and, most recently, the Far Seas Fisheries Research Laboratory.

Numbers of Whales Marked and Recoveries of Marks

The number of whales of the three chief species marked and the number of these marked whales recaptured from which marks have been returned are given in Table 1. A total of 427 whales are estimated to have been effectively marked (126 fin, 152 sei and 149 sperm whales) and marks have been returned from 36 whales, 12 fin and 24 sei whales (10% and 16% respectively of those marked). No marks have been returned from sperm whales. Additionally, 2 blue, 10 humpback, 2 right, 7 minke, 4 beaked whales and 4 pilot whales were marked but of these species only minke whales are at present hunted in the Southern Hemisphere.

All recovered whale marks provide some biological information; some individual recoveries may give important new information on movements or migrations, the value of others lies in their confirming or adding a little more

detail to the general picture of movements built up from a series of recoveries over a number of years. In general the 0-group returns and the 1-group and 2-group returns provide most information on movements during the whaling season and on the degree of dispersal of animals from one season to the next. Returns from the older year-groups are usually of less value in the study of whale movements but become of increasing importance for studies of age determination if accompanied by anatomical material (e.g., ear plugs, baleen plates or ovaries).

The distribution of the 36 returns by year-groups is given in Table 1. Seven fin and 13 sei whales were recaptured in the same season as they were marked (0-group). There are 3 fin and 6 sei whales in the 1-group, and 2 fin and 2 sei whales in the 2-group returns. Three returns are in older year-groups and from one of these a baleen plate was obtained.

Of the 12 returns from fin whales, 4 are of special interest in providing additional information on movements between the Antarctic whaling Areas during the whaling season or in later seasons and another is one of only two recoveries to date (of some 650 fin whale returns) from a whale marked on two separate occasions on different days.

Marks have been returned to date from only 27 sei whales marked under the International scheme. The 24 recoveries noted in Table 1 have therefore been of considerable importance in providing most of the information so far available from whale marking about the movements of this species in the Antarctic.

Costs of Marks, Shipping Charges and Rewards

Details of the costs borne by the Japanese whaling companies and the three research laboratories are not available so that the total figure for costs given in this note is a minimum figure. In view of this, it has not been considered necessary for the purposes of this note to obtain an exact figure for the cost of the marks used and the shipping charges incurred during the five seasons. The figures given for the different items of expenditure are therefore in some cases approximate but they are close to the actual costs incurred.

The total number of marks fired during these marking expeditions was 1,347 (1,029 standard, 72 streamer and 246 increased charge marks).

Cost	£	£
Standard marks 1,029 (= 1,030, say 500 at 20s. 0d. and 530 at 25s. 0d. to allow for increasing costs of marks during period)	1,160	
Streamer marks 72 (= 70 at 20s. 0d.)	70	
Increased charge marks 246 (= 250 at 26s. 0d.)	325	
		1,555
Packing and shipping charges of marks to Japan. 1966/67 = £25, 1967/68 = £26, 1968/69 = £27 (= say £75) and 2 earlier seasons at say £40		115
Rewards for returned marks		
Japanese recoveries: 37 marks at 20s. 0d.	37	
Norwegian recoveries: 4 marks at 100s. 0d.	20	
U.S.S.R. recoveries: 1	—	
42 marks from 36 whales		57
Total cost of marks, shipping charges and rewards		£1,727

The minimum cost of marking each of the 427 whales has therefore been approximately £4 and of obtaining each of the 42 marks returned to date approximately £40.

TABLE 1
Antarctic Marking and Returns from Marked Whales in Seasons 1963/64–1968/69

Season	Species	No. of whales marked		Marked whales returned						Total returned
				0-Gp	1-Gp	2-Gp	3-Gp	4-Gp	5-Gp	
1963/64	Fin	49	89	2	2	1	–	–	–	5
	Sei	19		1	2	1	–	1	2	7
	Sperm	21		—	—	—	—	—	—	—
1964/65	Fin	1	83	—	—	—	—	—		—
	Sei	49		10	3	1	—	—		14
	Sperm	33		—	—		—	—		—
1966/67	Fin	23	88	—	1	1				2
	Sei	24		2	1	—				3
	Sperm	41		—	—	—				—
1967/68	Fin	16	73	—	—					—
	Sei	31		—	—					—
	Sperm	26		—	—					—
1968/69	Fin	37	94	5						5
	Sei	29		—						—
	Sperm	28		—						—
Totals	Fin	126	427	7	3	2	–	—	–	12
	Sei	152		13	6	2	—	1	2	24
	Sperm	149		—	—	—	—	—	—	—

ANNEX M

THE POSSIBILITY OF INJURING SMALL WHALES WITH THE STANDARD *DISCOVERY* WHALE MARK

by Robert Clarke
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Research on the Effects of Marking Large Whalebone Whales

In 1953 the late Professor Dr. Johan T. Ruud, Dr. Åge Jonsgård and I made experiments at Steinshamn, Norway, firing standard *Discovery* whale marks into dead whales and tracing the marks during the working up of the carcases, to see whether the marks were likely to injure live whales during actual whale marking. The whales marked were fin, blue and sei whales between 48 and 72 feet long. We concluded "that marking with the present *Discovery* mark is in general harmless to whales, provided that where circumstances permit, the marksman shall aim at the region around the dorsal fin and try to avoid the region around and behind the flipper. We also recommend that the hind part of the tail near the flukes should be avoided in case marks go clean through without record. In future whale marking voyages an attempt should be made to smear the marks with a bacteriocidal ointment before they are fired, so as to prevent infection of the wound of penetration . . ." (Ruud, Clarke and Jonsgård, 1953). Reporting on the whale marking voyage of the *Enern* to the Antarctic later that year we said "we are now convinced, since the *Enern*'s voyage and after carefully examining all possible contingencies, that no problem of serious injury arises and that the mark itself, smeared with penicillin to prevent sepsis, is a satisfactory and valid agent in whale marking practice" (Clarke and Ruud, 1954).

Problems of Marking Small Whales

Since the above findings came from our experience of marking large whalebone whales, they include no recommendation on the minimum size at which whales should be marked. However, I had already come to believe, from the voyage of R.R.S. *William Scoresby* in 1950, when numbers of sperm whales were marked, that whales judged to be less than about 38 feet long should not be marked with the *Discovery* mark. This was the minimum length adopted when marking whales in Chilean and Ecuadorean seas in 1958 and 1959 (Clarke, 1962). However, a minimum at 38 feet would exclude not only the younger male sperm whales but virtually all the females, since few of these grow larger than 38 feet, so during a subsequent voyage off the coast of Chile in 1964 I revised the minimum length to 36 feet (11 metres). If this figure be criticized as arbitrary, then I do not regard it so, for it is based on my recollection of the Steinshamn experiments combined with experience of marking hundreds of whales and observing thousands more at sea. There is a requirement for experiments on small whales like the trials made at Steinshamn, but meanwhile I regard 36 feet as an absolute minimum. This applies, of course, not only to sperm whales but to all species of whales. In whales smaller than 36 feet, the mark, although aimed to penetrate into the dorsal muscle as recommended, has a greater chance of

striking the backbone with the likelihood of damaging the periosteum or even the bone itself, leading to conditions which might handicap the whale or even cause its death. And of course, the smaller the target the more chance there is of a badly aimed shot hitting the region around and behind the flipper when the mark would be likely to enter the thorax and eventually kill the whale.

Apart from the need to observe a minimum size, which applies to all species of whales, there are other factors relevant to the safe marking of sperm whales. Firstly, a mark with an increased powder charge for sperm whales is now in use. This mark was developed at my request after I had observed off Chile in 1958 that sometimes (but not always) marks with the standard charge fired into sperm whales protruded from the hard blubber; the marks with increased charges were effective off Ecuador and the Galapagos Islands in 1959 (Clarke, 1962), and I have since used them off Chile in 1964 and currently several colleagues are using them. Secondly, it is often possible to approach sperm whales very closely, so that point blank ranges of a few metres are not uncommon compared with the 35–45 metre ranges typical of marking whalebone whales. I consider that these two factors emphasize the need to avoid marking small sperm whales less than 36 feet long. The third factor applies to sperm whales of all sizes. At Steinshamn in 1953 we recommended that the mark should be aimed at the region around the dorsal fin, because in whalebone whales the body cavity is shallow there, terminating at the anus, vertically below the dorsal fin. But in sperm whales the anus is 3–5% of the body length behind the posterior border of the dorsal fin. Thus, if a mark is fired according to the Steinshamn recommendation into the region of the dorsal fin of a sperm whale, and if the mark hits low on the flank (as can happen when the sperm whale, in its characteristic fashion, "rounds out" for sounding and exposes a good deal of body surface in the region of this dorsal fin) there is a possibility that the mark will enter the body cavity when it may be expected that death will eventually ensue. So sperm whales should be marked behind the dorsal fin, where there is plenty of target area in this species.

The Steinshamn results included a recommendation that bacteriocidal ointment be smeared on the marks to prevent infection of the wound of entry. On all whale marking expeditions in which I myself have since taken part, marks have been smeared with an antibiotic ointment, usually penicillin. But I do not recollect seeing any mention of this practice in the reports of other whale marking voyages; and my impression is that the precaution is not much taken elsewhere, if taken at all. It has been said that the ointment is more a salve for the marksman's conscience than the whale's flesh, but I do not accept this. It seems to me a sensible precaution which should work as intended, and since we are in conscience bound to do everything we can to make marking safe, then we should use it.

The Present Position in Marking Small Whales

I have earlier in 1966 drawn attention in the Scientific Committee to the dangers of marking small sperm whales with the *Discovery* mark (IWC 17th Report, 1967, p. 78), but a good deal of such marking seems to be going on. A colleague tells me that he marks sperm whales of all sizes other than calves. Mejía (1964) accompanying whalecatchers engaged in actual whaling off Peru, deliberately restricted the marking to sperm whales of less than 9 metres (30 feet), because gunners are prohibited from taking these whales according to the regulations of the Permanent Commission of the South Pacific. Ivashin and Rovnin (1967), reporting on Russian whale marking in the North Pacific, say "The young whales were mainly marked. It is necessary to mention that according to our observations a mark fired from a small distance at a young whale may injure the animal very seriously, sometimes even causing its death, this happened in the case of two young sperm whales."

Recommendation

Although marking is a most valuable method of investigating the whale stocks, I think all will agree that any marking which is likely severely to injure or kill whales is ethically, scientifically and economically indefensible. I am aware of the urgent need to mark small sperm whales, including calves, and of the fact that the small .410 mark, which appears safe to use on calves, is likely not to be found when these calves have grown into adults and some of them are shot. I have been thinking that a small mark, still a 12-bore but say 18 cm. long instead of the 25 cm. standard mark, might be used on small sperm whales. However that may be, and whatever improved methods may be developed in the future, I consider that whenever the standard mark is used we must simply forego the marking of small sperm whales in spite of the numerous and tempting targets these gregarious whales from time to time present.

In summary I propose that the recommendations of the Steinshamn trials be revised as follows:

Marking with the standard *Discovery* mark is considered in general to be harmless to whales if the following precautions are observed.

1. No whales judged to be smaller than 36 feet (11 metres) should be marked.
2. When marking all species of whales, the marksman should avoid the region around and behind the flipper.
3. When marking whalebone whales, the marksman should aim for the region around the dorsal fin.
4. When marking sperm whales the marksman should aim for the region behind the dorsal fin.
5. Whalemarks should always be smeared with bacteriocidal ointment before firing, to prevent infection of the wound of penetration.

References

CLARKE, R. 1962. *Whale observation and whale marking off the coast of Chile in 1958 and from Ecuador towards and beyond the Galapagos Islands in 1959.* Norsk Hvalfangsttid., 51 Arg. no. 7, 265–287.

CLARKE, R. and RUUD, J. T. 1954. *International co-operation in whale marking: The voyage of the* Enern *to the Antarctic 1953.* Norsk Hvalfangsttid., 43 Arg. no. 3, 128–146.

IVASHIN, M. V. and ROVNIN, A. A. 1967. *Some results of the Soviet whale marking in the waters of the North Pacific.* Norsk Hvalfangsttid., 56 Arg. no. 6, 123–135.

MEJÍA, J. 1964. *Marcación de cachalotes frente al Peru.* Inf. Inst. Invest. Recurs. mar, Callao, no. 26, 8 pp.

RUUD, J. T., CLARKE, R. and JONSGÅRD, Å. 1953. *Whale marking trials at Steinshamn, Norway.* Norsk Hvalfangsttid., 42 Arg. no. 8, 429–441.

APPENDIX V

INTERNATIONAL WHALING COMMISSION
INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MAY 1970

Previous Year £ s. d	EXPENDITURE	£ s. d.	£ s. d.
	Secretary's Remuneration—		
750 — —	Salary	750 — —	
133 1 9	National Health contributions including Selective Employment Tax	167 13 2	917 13 2
1,638 2 4	*Administrative, Clerical and Typing Staff provided by Ministry of Agriculture, Fisheries and Food: Rent for the Secretary's Office, and overhead expenses of the Ministry*		1,810 13 —
655 11 —	*Stationery, Printing and Postage*		1,021 8 7
1,482 19 11	*Cost of Meeting* 21st Annual Meeting June 1969		1,880 5 5
85 14 10	*Contribution to Extra-Ordinary Budget*		— — —
567 17 6	*Stock Assessment Work: Travelling and Subsistence, Expenses of Scientists*		— — —
	Whale Marking		
500 — —	Contribution to National Institute of Oceanography		500 — —
— — —	Contribution to Bureau of International Whaling Statistics, Norway		500 5 —
1,101 11 5	*Balance:* being excess of income over expenditure, transferred to Balance Sheet		— — —
£6,914 18 9			£6,630 5 2

Previous Year £ s. d	INCOME	£ s. d.
	Contributions for 1969/70	
5,600 — —	15 Contracting Governments at £350 each	5,250 — —
	Other Income	
247 1 3	Interest on Investments	450 17 9
	Extra-Ordinary Budget	
982 2 8	*Balance brought forward*	— — —
85 14 10	Contribution from Ordinary Budget	— — —
— — —	*Balance:* being excess of expenditure over income, transferred to Balance Sheet	929 7 5
£6,914 18 9		£6,630 5 2

INTERNATIONAL WHALING COMMISSION
BALANCE SHEET 31ST MAY 1970

Previous Year £ s. d.	LIABILITIES	£ s. d.	£ s. d.	Previous Year £ s. d.	ASSETS	£ s. d.	£ s. d.
	Creditors—			1,129 2 9	*Cash at Paymaster General*		441 6 9
1,702 14 1	Ministry of Agriculture, Fisheries and Food	23 10 11					
300 — —	Others	1,300 — —			**Outstanding contributions—*		
			1,323 10 11		Panama 1969/70	341 7 3	
	Contribution from the Government of Mexico paid in				Argentina 1969/70	350 — —	
241 — 6	*advance*		— — —		Mexico 1969/70	1 7 10	
				2,888 15 5			692 15 1
	Income & Expenditure Account—				*Investment in Local Authority*		
	Ordinary Budget			3,500 — —	*Loans*		4,500 — —
	Balance at 31st May 1969	5,321 — 9			*Sundry debtors—*		
	Less				Accrued interest on Local Authority Loans		81 2 5
	Balance transferred from 1969/70	929 7 5		46 17 2			
5,321 — 9			4,391 13 4				
£7,564 15 4			£5,715 4 3	£7,564 15 4			£5,715 4 3

* Remittances in settlement of the outstanding contributions were received from the Government of the Republic of Panama in July 1970 and the Government of the Republic of Argentina in October 1970.

(*Signed.*) R. STACEY
Secretary
International Whaling Commission
22nd October 1970

I have examined the above Account and Balance Sheet. I have obtained all the information and explanations that I have required, and I certify, as the result of my audit, that in my opinion the above Account and Balance Sheet are correct.

Exchequer and Audit Department
10th November 1970

(*Signed.*) B. D. FRASER
Comptroller and Auditor General

APPENDIX VI

SUMMARY OF INFRACTIONS

Antarctic season 1969/70						*Outside Antarctic 1969*				
Whales taken	*Undersized whales*		*Lactating whales*	*Whales lost*	*Whales remaining in sea over 33 hours*	*Whales taken* (2)	*Undersized whales*		*Lactating whales*	*Whales lost*
	No.	*%*					*No.*	*%*		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
				Blue Whales						
—	—	—	—	—	—	—	—	—	—	—
				Fin Whales						
3,001	20	0·66	8	1	—	1,975	11	0·56	10	—
				Other Baleen Whales						
5,852	13	0·22	8	4	—	5,445	25	0·46	2	2
				Sperm Whales						
(1) 5,383	339	6·30	13	8	—	17,614	407	2·31	13	31

Note:

(1) The number of sperm whales taken in the Antarctic season includes the catch of the Antarctic pelagic expeditions north of 40° south latitude.

(2) The numbers shown of whales taken outside the Antarctic do not include the catch of the countries from whom no infractions reports were received.

APPENDIX VII

TABLE SHOWING OIL PRODUCTION ETC. 1959/60 TO 1969/70

	Antarctic pelagic whaling					*Oil production in barrels†*		
*Year**	*Baleen season*	*No. of floating factories*	*No. of catchers*	*No. of humpbacks taken‡*	*No. of blue whale units§*	*Oil production in barrels†*	*Land stations South Georgia*	*Outside the Antarctic*	*Total oil production in barrels†*
1959/60	28 Dec. 59–7 April 60	20	220	1,338	15,512	2,050,892	97,546	733,192	2,881,630
1960/61	28 Dec. 60–7 April 61	21	252	718	16,433	2,123,157	109,727	692,852	2,925,736
1961/62	12 Dec. 61–7 April 62	21	261	309	15,253	2,001,961	49,815	744,376	2,796,152
1962/63	12 Dec. 62–7 April 63	17	201	270	11,306	1,495,779	—	925,045	2,420,824
1963/64	12 Dec. 63–7 April 64	16	190	2	8,429	1,299,476	41,282	887,722	2,228,480
1964/65	12 Dec. 64–7 April 65	15	172	—	6,987	1,017,611	45,805	929,194	1,992.610
1965/66	12 Dec. 65–7 April 66	10	128	1	4,085	634,299	9,964	865,391	1,509,654
1966/67	12 Dec. 66–7 April 67	9	121	—	3,511	600,666	No whaling	874,983	1,475,649
1967/68	12 Dec. 67–7 April 68	8	97	—	2,804	419,046	No whaling	825,954	1,244,000
1968/69	12 Dec. 68–7 April 69	6	85	—	2,472	423,880	No whaling	817,732	1,241,612
1969/70	12 Dec. 69–7 April 70	7	85	—	2,477	461,285	No whaling	Not yet available	Not yet available

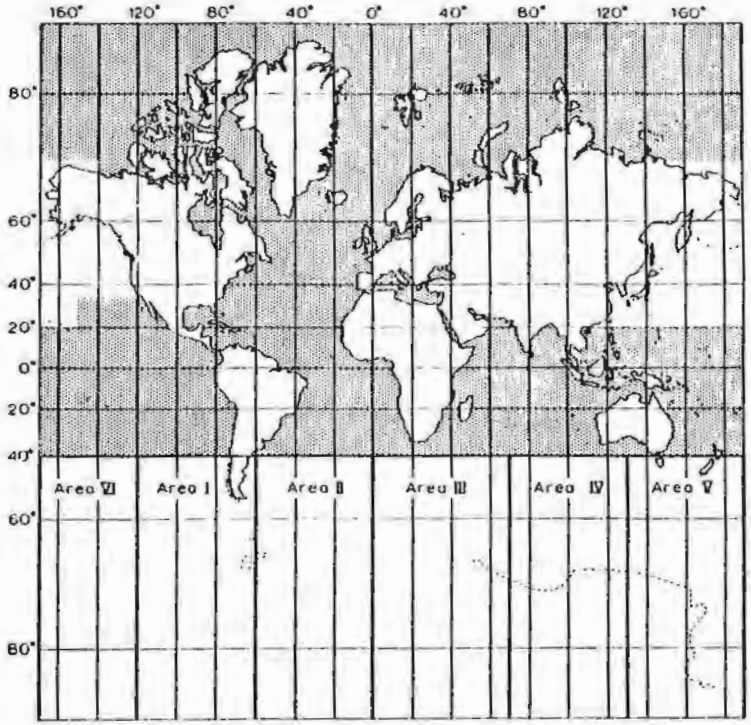
* The years indicated in this column cover not only the Antarctic Season, but also the catches outside the Antarctic in the second of the two years. The 1969/70 figures are provisional.

† Barrel—170 kg. (Barrel—abt. $\frac{1}{7}$ long ton of 1,016 kg.).

‡ The catch of humpbacks 1959/60 to 1962/63 was confined to certain days and thereafter prohibited.

§ In 1959/60, the limit governing the Antarctic pelagic whaling countries was 15,000 blue whale units. The limit was suspended in 1960/61 and 1961/62, and reduced to 10,000 units in 1963/64. No catch limit was agreed upon for the 1964/65 season, but the limit was further reduced for the 1965/66 season to 4,500 units, for the 1966/67 season to 3,500 units and to 3,200 units for 1967/68 and 1968/69. For the 1969/70 season the limit was set at 2,700 blue whale units.

APPENDIX VIII



Map of world showing Antarctic areas and (dotted) regions closed to factory ships for the purpose of taking and treating baleen whales.

APPENDIX IX

LIST OF REPORTS RECEIVED BY THE COMMISSION DURING THE TWENTY-FIRST YEAR, ENDED 31ST MAY 1970

Food and Agriculture Organization of the United Nations

Upwelling and Fish Production by D. H. Cushing, Fisheries Laboratory, Lowestoft. Fisheries Technical Paper No. 84. (18.8.69)

Fisheries Reports, No. 68. Proceedings of the Symposium on the Living Resources of the African Atlantic Continental Shelf between the Straits of Gibraltar and Cape Verde. (13.10.69)

Technical Conference on Marine Pollution and its Effects on Living Resources and Fishing, Rome, 9th–18th December 1970. Prospectus. (13.10.69)

Yearbook of Fishery Statistics. Catches and Landings 1968. (25.11.69)

Bulletin of Fishery Statistics. Yearbook of Fishery Statistics: notes 1968. (22.1.70)

Yearbook of Fishery Statistics. Fishery Commodities 1968. (22.1.70)

Report of the I.O.F.C. Working Party on Stock Assessment in Relation to Immediate Problems of Management in the Indian Ocean. Rome, 30th September to 3rd October 1969. Fisheries Reports No. 82. (13.2.70)

Synopsis of Biological Data on West African Croakers Pseudotolithus Typus, P. Senegalensis and P. Elongatus. Prepared by A. R. Longhurst, Institute of Marine Resources and Scripps Institution for Oceanography, University of California, San Diego. Fisheries Synopsis No. 35, Rev. 1, 1969. (13.2.70)

Symposium on Investigations and Resources of the Caribbean Sea and Adjacent Regions. Preparatory to C.I.C.A.R. Fisheries Report No. 761, Rome 1969. (23.2.70)

Proceedings of the World Scientific Conference on the Biology and Culture of Shrimps and Prawns: Mexico City, Mexico, 12th–21st June 1967. Fisheries Reports No. 57, Vol. 3. (16.3.70)

1969—Research Fleet of the World by Norio Fujinami. Fisheries Technical Paper No. 93. (18.3.70)

Department of Fisheries; List of Publications and Documents 1948–1969. Fisheries Circular No. 100 (rev. 1). (18.3.70)

Proceedings of the Conference on Fish Behaviour in Relation to Fishing Techniques and Tactics. Fisheries Reports No. 63, Vol. 3. (3.4.70)

Careers in Marine Science. Fisheries Technical Paper No. 90. (3.4.70)

Synopsis of Biological Data on Smelt, prepared by T. N. Belyania. Fisheries Synopsis No. 78. (9.4.70)

Indo-Pacific Fisheries Council

Proceedings 13th Session, Brisbane, Queensland, Australia, 14th–25th October 1968, Section 1; I.P.F.C. Secretariat, Regional Office for Asia and the Far East, Bangkok, Thailand, 1968. (8.9.69)

Inter-American Tropical Tuna Commission

Bulletin, Vol. 13, No. 1. (10.6.69) Annual Report 1968. (14.7.69) Bulletin Vol. 13, No. 2 (31.7.69) Bulletin, Vol. 14, No. 2. (7.5.70)

International Commission for the Northwest Atlantic Fisheries

Statistical Bulletin, Vol. 17 for the year 1967. Issued from the headquarters o the Commission, Dartmouth, N.S., Canada, 1969. (8.7.69)

International Council for the Exploration of the Sea

Co-operative Research Report, Series A, No. 13, and Series B. (27.8.69)

Report of 57th Statutory Meeting: Dublin, 1969. (22.12.69)

Co-operative Research Report, Series A, Report No. 17—Atlanto-Scandian Herring. (30.4.70)

Co-operative Research Report, Series A, Report 16—North East Arctic Fishery. (30.4.70)

International North Pacific Fisheries Commission

Statistical Yearbook 1968. (26.5.70)

National Institute of Oceanography

Discovery Reports, Vol. XXXV, pp. 135–178. Spirorbis Species (Polychaeta: Serpulidae) from the South Atlantic by Tegwyn Harris (Department of Zoology, Exeter University), 1969. Cambridge University Press. (15.7.69)

Natural Environment Research Council. Collected Reprints, Vol. 16, 1968. (29.10.69)

United Nations Educational, Scientific and Cultural Organization

International Marine Science, Vol. VII, No. 3, November 1969. (2.2.70)

International Marine Science. A Quarterly prepared jointly by U.N.E.S.C.O. and the F.A.O. Vol. VII, No. 4, February 1970. (7.5.70)

Belgium

W. M. A. De Smet. Deux cetaces rares de notre cote. Extrait du Bulletin les Naturalists Belges, T.51-3, 1970. Bruxelles, 1970. (6.4.70)

France

Stranding of Pilot whales (Globicephala Melaena (trail)) on the Coast of Normandy—France, by Paul Budker, Director, Laboratoire de Biologie des Cetaces (E.P.H.E.)—Museum—Paris. Reprinted from Norsk Hvalfangst-Tidende, 1968, pp. 17–19. (27.6.69)

On the Stranding of a Calf Fin Whale at Le Pouldu (South Brittany—France) by Paul Budker, Director, Laboratoire de Biologie des Cetaces (E.P.H.E.)—Museum—Paris and M. H. Du Buit, Laboratoire de Biologie Marine, College de France, Concarneau. Reprinted from Norsk Hvalfangst-Tidende 1968, No. 1, pp. 13–16. (27.6.69)

Japan

The Ocean Research Institute, University of Tokyo. Collected Reprints, 1968, Vol. 7. (22.9.69)

Bulletin of the Ocean Research Institute, University of Tokyo. Measurement of Gravity and Magnetic Field aboard a Cruising Vessel by Yoshibumi Tomoda, Keijiro Ozawa and Jiro Segawa. No. 3, September 1968. (22.9.69)

Bulletin of the Ocean Research Institute, University of Tokyo. The Biology of a Sergestid Shrimp—Sergestes Lucens Hansen by Makato Omori. No. 4, March 1969. (22.9.69)

The Scientific Reports of the Whales Research Institute No. 21, June 1969. (8.10.69)

Size Composition and Sexual Maturity of Bilfish Caught by the Japanese Longline Fishery in the Pacific Ocean, East of 130° West by Susumu Kume and James Josph. Bulletin 2. Sept. 1969. Far Seas Research Laboratory, Skimizu, 24, Japan. (7.5.70)

Norway

Studies on the Meroplankton in the Inner Oslofjord. I. Composition of the Plankton at Nakkholmen During a Whole Year. Thomas A. Schram, Institute of Marine Biology, Section A and C, University of Oslo, Norway. Reprinted from Ophelia, Vol. 5, Dec. 1968, pp. 221–243. (30.6.69)

A Review of Norwegian Biological Research on Whales in the Northern North Atlantic Ocean after the Second World War by Åge Jonsgård. Reprinted from Norsk Hvalfangst-Tidende, 1968, No. 6, pp. 164–167. (30.6.69)

Note on the Attacking Behaviour of the Killer Whale (Orcinus Orca) by Åge Jonsgård. Reprinted from Norsk Hvalfangst-Tidende, 1968, No. 4, pp. 84–85. (30.6.69)

Another Note on the Attacking Behaviour of the Killer Whale (Orcinus Orca) by Åge Jonsgård. Reprinted from Norsk Hvalfangst-Tidende, 1968, No. 6, pp. 175–176. (30.6.69)

A Preliminary Report on the "Harøybuen" Cruise in 1968 by Åge Jonsgård and Ivar Christensen. Reprinted from Norsk Hvalfangst-Tidende, 1968, No. 6, pp. 174–175. (30.6.69)

Hvalradets Skrifter, Scientific Results of Marine Biological Research. Edited by Universitetets Institutt for Marin Biologi and Statens Institutt for Hvalforskiing. No. 52, An Analysis of the Phytoplankton of the Pacific Southern Ocean: Abundance, Composition, and Distribution during the Brategg Expedition, 147–148, by Grethe Rytter Hasle. (19.1.70)

Venezuela

Boletin Bibliografico Numero 6, 1968. Instituto Oceanografico, Universidad de Oriente, Cumana, Venezuela. (16.1.70)

Boletin del Instituto Oceanografico de la Universidad de Oriente, Vol. VII, No. 1. Junio 1968. (19.2.70)

Lagena—Universidad de Oriente Instituto Oceanografico. Indice 1965—Editor, Rafael A. Curra. Cumana—Diciembre. Indice 1966—Numeros 17 and 18. (9.4.70)

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