



Serial No. 3208  
(B.y.)

ICNAF Summ.Doc. 74/8

REPORT OF STANDING COMMITTEE ON RESEARCH AND STATISTICS (STACRES)<sup>1</sup>

Fourth Special Commission Meeting - January 1974

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<sup>1</sup> Also January 1974 Meeting Proceedings No. 1.

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REPORT OF STANDING COMMITTEE ON RESEARCH AND STATISTICS (STACRES)

Fourth Special Commission Meeting - January 1974

Chairman: A. W. May

Rapporteur: V. M. Hodder

STACRES met at FAO, Rome, Italy, during 14-18 January 1974 with representatives present from 12 member countries and observers from FAO and the German Democratic Republic (Bulgaria, Iceland, Italy and Romania were not represented). A further meeting was held on 29 January to consider items arising from the Commission Meeting and to discuss the plan of work prior to the 1974 Annual Meeting. The Assessments Subcommittee met at the Sea Fisheries Institute, Hamburg, Fed. Rep. Germany, during the week of 7-12 January with representatives from seven countries (Canada, Fed. Rep. Germany, Japan, Poland, USSR, UK and USA) and an observer from FAO. The main tasks at those meetings were: (a) assessments of various species and stocks proposed for regulation in 1974, (b) consideration of a proposal to establish an ICNAF data base for detailed catch and effort statistics and associated sampling data, and (c) coordinated surveys for fishery assessment, including hydro-acoustic surveys. The Reports of the Assessments Subcommittee, the Special Working Group on ICNAF Data Base Improvement, and the Working Group on Coordinated Surveys, presented by their respective Chairmen, Mr D.J. Garrod, Mr J.G. Pope (acting for Mr R.C. Hennemuth) and Dr J. Messtorff, were adopted by STACRES and are included as Appendices I, II and III to this Report. Brief summaries of these reports, together with other matters considered by STACRES are given below.

I. ASSESSMENTS (APP. I)

1. Review of Fisheries

Provisional statistics were available from most member countries for their fisheries in 1973, allowing a preliminary estimate of total catches for all major species. The following brief review is confined to those stocks for which substantial changes in 1973 catches occurred relative to 1972. The cod catch in SA 1<sup>1</sup> declined to 70,000 tons (111,000 tons in 1972), and in Div. 2J-3KL declined to 390,000 tons (455,000 tons in 1972). The catch of cod in Div. 3NO was 68,000 tons (102,000 tons in 1972). The redfish catch doubled in SA 2 + Div. 3K (20,000 to 40,000 tons) and was halved in Div. 3M (42,000 to 20,000 tons). The catch of silver hake in Div. 4VWX increased from 114,000 to 283,000 tons. The catch of red hake in Subdiv. 5Ze decreased from 40,000 to 25,000 tons. Capelin catches in SA 2 + Div. 3K increased from 46,000 to 132,000 tons, and in Div. 3LNOPs from 25,000 to 131,000 tons. The 1973 catches of cod in Div. 2J-3KL, and Div. 3NO, and of mackerel in SA 5 + 6, were considerably below the TACs established for these stocks in 1973. The capelin catch in 1973 was above the TAC established for 1974.

Recent catches and proposed TACs for the stocks, for which quota regulation is to be considered at the present meeting, are listed in Table 1. A similar tabulation for all species under quota regulation, and including the above, may be found in Table 1 of Appendix I (Report of the Assessments Subcommittee).

2. Mackerel

Interpretation of data from the 1973 fishery was critical to the assessment for mackerel, and these data could be interpreted in different ways relative to fishing mortality and recruitment to the fishery. Using the extremes given by these interpretations as limiting situations leads to a recommended TAC in the range of 251,000 to 312,000 tons for SA 5 + 6. It is suspected that mixing occurs between mackerel in these areas and those fished in SA 3 and 4, but it is not yet possible to give advice on a catch level appropriate to the mackerel fishery in these northern areas.

3. Herring

Advice on TACs for 1974 is broadly the same for all stocks, i.e. that the TACs should not exceed those agreed for 1973. While it is believed that the stocks in Div. 5Y and Div. 5Z + SA 6 have begun to recover, it is certain that they had not increased to the MSY levels by the end of 1973. An increase in TACs in 1974 cannot, therefore, be recommended. It is considered that these TACs will allow the minimum stock requirements at the end of 1974, as defined by the Commission last year, to be met. In Div. 4XW(b) catch estimates in 1974 are dependent largely on estimates of the size of the 1970 year-class. Assuming this to follow the pattern expected in the other stocks, it is recommended that the TAC in 1974 be at the same level as in 1973 (90,000 tons).

The provision of advice to the Commission has become more difficult because of uncertainties regarding:

- a) identification of components of the fisheries and hence catch quantities on which assessments should be based in order to be related to the TAC; and

<sup>1</sup> Subareas 1 to 5 and Statistical Area 6 are hereinafter referred to as SA 1 to 6.

Table 1. Recent catches and proposed TACs for stocks to be considered for regulation at this Commission Meeting.

| Species                  | Stock Area | Nominal Catches ('000 tons) |                 |                  |                   | TACs ('000 tons) |                 |                   |                  |                  |                  |
|--------------------------|------------|-----------------------------|-----------------|------------------|-------------------|------------------|-----------------|-------------------|------------------|------------------|------------------|
|                          |            | 1966-70 <sup>1</sup>        | 1971            | 1972             | 1973 <sup>2</sup> | 1972             | 1973            | 1974 <sup>3</sup> |                  |                  |                  |
| Cod                      | 4TVn       | 60                          | 67              | 77               | 59                | -                | -               | 70 <sup>4</sup>   |                  |                  |                  |
|                          | 4X         | 31                          | 23              | 22               | 26                | -                | -               | 8 <sup>5</sup>    |                  |                  |                  |
| Redfish                  | SA 2 + 3K  | 25                          | 19              | 20               | 40                | -                | -               | 25                |                  |                  |                  |
| Red hake                 | 5Ze        | ...                         | 6               | 40               | 25                | -                | -               | 20 <sup>6</sup>   |                  |                  |                  |
| Amer. plaice             | SA 2 + 3K  | 13 <sup>7</sup>             | 5               | 9                | 5                 | -                | -               | 8                 |                  |                  |                  |
|                          | 3M         | 4 <sup>7</sup>              | 1               | 1                | +                 | -                | -               | 2                 |                  |                  |                  |
|                          | 3Ps        | 12 <sup>7</sup>             | 7               | 7                | 12                | -                | -               | 10                |                  |                  |                  |
| Gr. halibut              | SA 2 + 3K  | 30                          | 24              | 30               | 28                | -                | -               | 30                |                  |                  |                  |
| RN. grenadier            | SA 2       | 3                           | 57              | 3                | 7                 | -                | -               | 30                |                  |                  |                  |
|                          | SA 3       | 19                          | 18              | 21               | 15                |                  |                 |                   |                  |                  |                  |
| Herring                  | 4W(b)      | 16                          | 23              | 16               | 13                | 65 <sup>9</sup>  | 90 <sup>9</sup> | 90 <sup>9</sup>   |                  |                  |                  |
|                          | 4X(a)      | 174 <sup>8</sup>            | 69 <sup>8</sup> | 144 <sup>8</sup> | 122 <sup>8</sup>  |                  |                 |                   |                  |                  |                  |
|                          | 4X(b)      |                             |                 |                  |                   |                  |                 |                   |                  |                  |                  |
|                          | 5Y         |                             |                 |                  |                   |                  |                 |                   | 45 <sup>10</sup> | 51 <sup>10</sup> | 62 <sup>10</sup> |
|                          | 5Z + 6     | 259                         | 267             | 175              | 200               |                  |                 |                   | 150              | 150              | 150              |
| Mackerel                 | SA 3       | +                           | 1               | 2                | 2                 | -                | -               | -                 |                  |                  |                  |
|                          | 4VWX       | 12                          | 17              | 13               | 25                | -                | -               | -                 |                  |                  |                  |
|                          | SA 5 + 6   | 83                          | 349             | 387              | 360               | -                | 450             | 251-312           |                  |                  |                  |
| Argentine                | 4VWX       | 6                           | 7               | 6                | 2                 | -                | -               | 50 <sup>11</sup>  |                  |                  |                  |
|                          | SA 5       | 8                           | 7               | 33               | 2                 |                  |                 |                   |                  |                  |                  |
| Capelin                  | SA 2 + 3K  | 1                           | +               | 46               | 132               | -                | -               | 250 <sup>13</sup> |                  |                  |                  |
|                          | 3LNOPs     | 2                           | 3               | 25               | 131               |                  |                 |                   |                  |                  |                  |
| O. Finfish <sup>12</sup> | SA 5 + 6   | 151                         | 146             | 147              | ...               | -                | -               | 150               |                  |                  |                  |
| Squids                   | SA 3       | 2                           | 2               | +                | 1                 | -                | -               | -                 |                  |                  |                  |
|                          | SA 4       | +                           | 7               | 2                | 8                 | -                | -               | -                 |                  |                  |                  |

- 1 Average catch for 1966-70 period.
- 2 Provisional statistics.
- 3 TACs recommended by STACRES, January 1974.
- 4 Seasonal partition of TAC to be considered.
- 5 Recommended TAC for offshore stock only.
- 6 Recommended TAC for Div. 5Z (E of 69°).
- 7 Catches for 1970 only.
- 8 Catches include juveniles which are estimated as 62 (1966-70), 22 (1971), 64 (1972), 24 (1973).
- 9 TACs pertain to adult catches only.
- 10 Catches include juveniles which are estimated as 20 (1966-70), 8 (1971), 20 (1972), 16 (1973).
- 11 TAC for 4VWX + SA 5; partition equally between 4VWX and SA 5 to be considered; also consider removal from "other finfish" in SA 5 + 6.
- 12 Other finfish excludes all regulated species and also excludes menhaden, billfishes, tunas and large sharks (ICNAF Summ.Doc. 74/4).
- 13 Partition of TAC between areas to be considered (suggested maximum 150,000 tons in Div. 3LNOPs).

b) identification of adult as opposed to juvenile fisheries.

Since meaningful assessments should be based on the total catch of each stock, clarification of the first point by the Commission would assist in providing clear advice.

#### 4. Other Finfish in Subarea 5 and Statistical Area 6

The existence of the second tier overall TAC limits the risk of unrestricted increase in catches, but it can only be completely overcome by establishing a TAC for the "other finfish" group as a whole. A TAC of 150,000 tons is recommended, and this would allow limited development in some fisheries, notably argentine, dogfish and skates. On the other hand, STACRES considered that argentine might be managed

more appropriately by separation from the "other finfish" category, and because of the overlap with stocks in Div. 4VWX, might be treated in a manner similar to that agreed for pollock. Should this be done, consideration of a downward adjustment of the "other finfish" TAC would be appropriate.

5. Other Stocks

Advice on catch levels for 1974 from other stocks for which the Commission will consider establishing TACs and quota allocations at this meeting is summarized in Table 1. The Commission should be aware that in most cases the TACs are suggested as a practical figure to prevent an undesirable sudden expansion of fishing in SA 2, 3 and 4, rather than to provide adequate management of the individual species.

6. Review of TACs at the 1974 Annual Meeting

It is vital, for purposes of reviewing groundfish TACs at the Annual Meeting in June, that 1973 catches and sampling data be available to scientists before the meeting takes place. STACRES therefore

recommends

*that all countries be requested to provide:*

- a) *revised monthly catches for 1973 of each groundfish stock for which TACs will be considered; and*
- b) *sampling data for 1973 pertaining to these catches.*

These data should be airmailed to reach the Secretariat not later than 31 March 1974, on appropriate forms to be provided by the Secretariat.

II. ICNAF DATA BASE IMPROVEMENT (APP. II)

1. Further research on topics relevant to the terms of reference of this Special Working Group is essential if it is to be able to give the specific information and recommendations requested. In adopting the Report of the Working Group, STACRES therefore

recommends

- a) *that a pilot study be conducted for Div. 5Z to examine the implications and cost of reporting catch and effort data in finer detail on a routine basis than at present;*
- b) *that all member countries fishing in Div. 5Z report the detailed catch and effort statistics required, in accordance with the Protocol set out in Annex 1 of the Report of the Special Working Group on ICNAF Data Base Improvement;*
- c) *that the Commission make funds available to the Secretariat for the purpose of processing this pilot study in an amount up to \$6,000.00;*
- d) *that all member countries supply the Secretariat with a document describing in detail their various fisheries and sampling schemes in the ICNAF Area;*
- e) *that all member countries examine their current sampling schemes for possible bias and report the results of these investigations as research documents at the 1974 Annual Meeting;*
- f) *that the Secretariat request by Circular Letter information on age validation studies already conducted on ICNAF stocks and for comments relevant to those stocks for which age reading was considered to be a problem, and report the results of the survey at the 1974 Annual Meeting so that STACRES can consider initiating suitable studies where problems exist;*
- g) *that the countries, nominated in the Report of the Special Working Group on ICNAF Data Base Improvement, conduct certain statistical studies and report the results as research documents to the 1974 Annual Meeting;*
- h) *that the Assistant Executive Secretary assess the costs to the Commission of requiring the Secretariat to accommodate the reporting and processing of raw sampling data, assuming the current level of sampling; and*
- i) *that the terms of reference of this Working Group be extended to include all aspects of biological sampling of catches.*

### III. COORDINATED SURVEYS (APP. III)

With the agreement of STACRES, the Working Group agreed to broaden the scope of discussions to include all survey work, not only those for groundfish.

#### 1. Stratification Schemes for Groundfish Surveys

A revised stratification scheme for SA 2 and a proposed scheme for Div. 3K were presented and it was noted that these stratifications had been used successfully in 1973 surveys. However, attempts to use a stratified random sampling scheme in SA 1 were unsuccessful, implying that some other sampling design is required for this area.

It was suggested that stratification schemes for SA 2-6 be brought together (including calculations of stratum sizes) for review and standardization. The Secretariat was requested to solicit this information by Circular Letter and collate the material for presentation at the 1974 Annual Meeting.

#### 2. Hydro-acoustic Surveys

In view of the potential importance of this technique for fish abundance estimation, a special meeting was held at which Mr J. Suomala (USA) presented details on the methodology of hydro-acoustic equipment calibration as well as on the necessary instrumentation, which can be provided by National Marine Fisheries Service, Woods Hole, USA, for deployment on vessels undertaking cooperative surveys. The measurement of aquatic biomass by means of hydro-acoustical methods cannot at this time be considered to be a reliable information source for ICNAF deliberations and decisions. However, properly developed and executed hydro-acoustic experiments and subsequent surveys will likely result in additional information on the rate of change of pelagic fish abundance in the ICNAF Area.

It was noted that arrangements have already been made to conduct basic hydro-acoustic experiments in cooperation with USA, USSR and Polish research vessels during the first half of 1974. Other member countries are encouraged to participate in such experiments. The USA will be preparing a manual for such hydro-acoustic joint surveys.

#### 3. Reporting of Survey Data

US scientists will review the various procedures and techniques associated with their stratified-random groundfish surveys and will present a document at the 1974 Annual Meeting. The Working Group will then discuss the desirability and feasibility of including this in a proposed manual on surveys to be produced by the Secretariat.

The desirability of obtaining data on the physical environment in time for use by STACRES in their deliberations was discussed. Proposals will be forthcoming at the 1974 Annual Meeting concerning programs for monitoring the physical environment.

#### 4. Survey by R/V Professor Siedlecki

The Polish Government has offered the R/V *Professor Siedlecki* for a cooperative survey of herring and mackerel in SA 5 and 6. Participation of scientists from other countries is invited, and initial expressions of intent to participate were made by scientists from Canada, France (St. Pierre Laboratory), Fed. Rep. Germany, Spain and USA. Plans for this survey will be discussed within STACRES at the 1974 Annual Meeting.

#### 5. Manual on ICNAF Groundfish Surveys

To promote standardization of techniques used in groundfish surveys, STACRES

recommends

*that a Manual on ICNAF Coordinated Groundfish Surveys be produced subsequent to the 1974 Annual Meeting with format and content to be decided at that meeting.*

### IV. STEERING AND PUBLICATIONS

#### 1. Organization and Operation of STACRES

The Subcommittee briefly reviewed the present organization and operation of STACRES in the light of the functions of the various Subcommittees and Working Groups. An organizational chart giving the present setup was circulated to Subcommittee members with a view to having a full discussion on the subject at the 1974 Annual Meeting.

2. Annual List of Vessels

The ICNAF *List of Vessels* is normally published triennially, the last in 1972 for the calendar year 1971. Noting that requests for this publication have increased substantially, especially for use on inspection vessels, STACRES

recommends

- a) that the complete list be published for 1974; and
- b) that the list be updated annually in a summary document which would indicate additions to and/or deletions from the most recent published *List of Vessels*.

3. Review of Statistical Bulletin Format

The publication and distribution of *Statistical Bulletin*, Vol. 22 for the year 1972, has been delayed, largely due to the incorporation of the many changes recommended at the 1973 Annual Meeting, but also to the late receipt of STATLANT 21B statistics from two countries. The 1972 issue, which should be ready for distribution in late February 1974, contains four parts:

Part I. Tabular Summaries of Catches, 1958-72, for all TAC species; 15 tables, 8 pages.

Part II. Fishery Statistics, 1972; 7 tables, 196 pages.

Part III. Seal Statistics, 1972; 2 tables, 2 pages.

Part IV. Corrections and Additions to Previous Bulletins; 6 tables, 23 pages (including monthly catch and effort data for German Dem.Rep. for the years 1969, 1970 and 1971).

4. Review of Status of Redbook, Parts I, II and III

The Subcommittee noted that *Redbook*, Parts I and II, contain reports which record the proceedings of STACRES and research conducted by member countries, while Part III, containing selected papers from the Annual Meetings, is more closely associated with ICNAF *Research Bulletin* and consequently has a significantly larger mailing list than Parts I and II. Since both the National Research Reports and the Selected Papers are published in the Meeting Document series, there was some question as to whether these needed to be published in *Redbook*, Parts II and III, as the latter required considerable editing at the Secretariat. A final decision on this matter was deferred to the 1974 Annual Meeting.

The Subcommittee noted some of the problems associated with the quality of the material selected for publication in both the *Redbook* and the *Research Bulletin*, especially the lack of attention by some authors in the proper revision of papers submitted. The need for guidelines in the selection, editing and refereeing of papers was stressed and the Secretariat was requested to ask the heads of institutes concerned with ICNAF research for comments on this matter.

5. Distribution of Publications and Meeting Documents

A brief review of the problems indicated that a fuller discussion was required than was possible at this meeting and the matter was deferred to the 1974 Annual Meeting.

V. OTHER MATTERS

1. ICNAF Statistics

In light of discussions within the Panels relative to statistics of national fisheries, STACRES agreed that it would be desirable to remind the Commission of the following statistical definitions and procedures:

- a) Nominal catches. Catch figures in the ICNAF *Statistical Bulletins* are of "nominal catch", defined as the live weight equivalent of the landings. The nominal catch should include all fish landed as food, however processed, plus all whole fish reduced to fish meal. It should not include fish discarded at sea.
- b) Discards. These are whole fish thrown overboard at sea that have not been processed in any way. Statistics on discards should be supplied on the forms provided annually by the Secretariat for that purpose.

STACRES wished to emphasize the importance of accurate reporting of both types of statistics in relation to provision of advice on TACs for the various stocks.

2. Delimitation of Division 4X Offshore Cod Stock

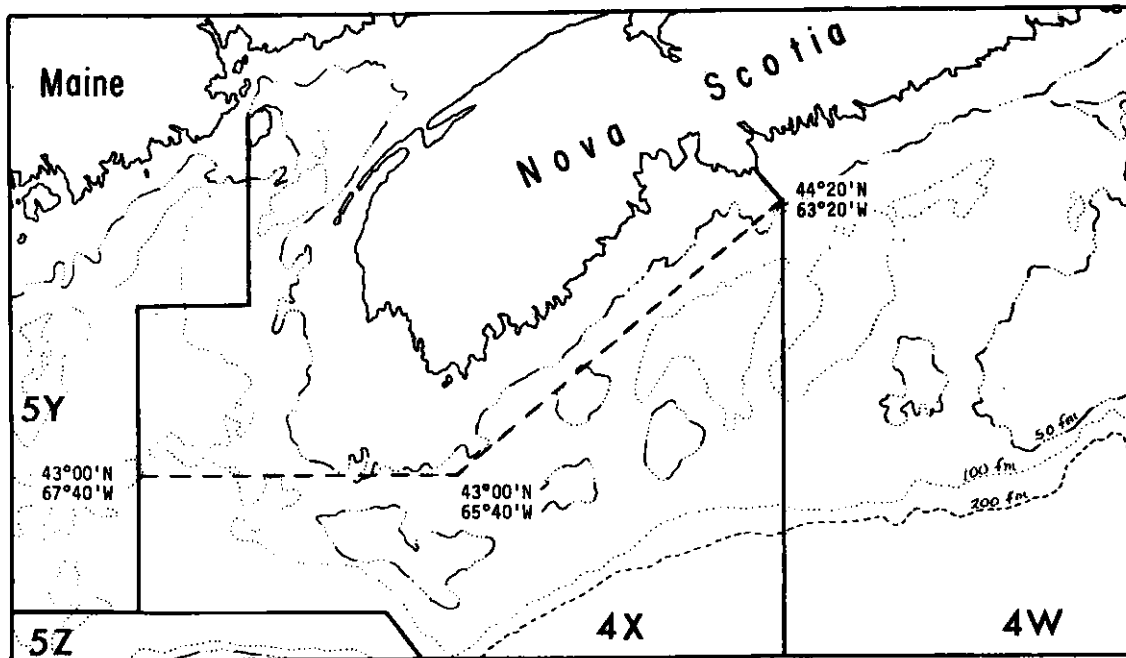
It was anticipated that the Commission would require a delimitation of the area occupied by the Div. 4X offshore cod stock. Accordingly STACRES

recommends

*that the following wording would achieve the appropriate distinction between fisheries on offshore and inshore stocks:*

*"that the Contracting Governments take appropriate action to include in the offshore 4X cod quota all cod catches made in that portion of Div. 4X of Subarea 4 lying south and east of the straight lines connecting the coordinates in the order listed:*

44°20'N, 63°20'W                      43°00'N, 65°40'W                      43°00'N, 67°40'W



3. Identification of Components in the Herring Fisheries

After STACRES informed the Commission of the problems listed in Section I, paragraph 3 above, the Chairman of the Herring Working Group (Mr T.D. Iles) was requested by the Commission to elaborate on the problems. STACRES at its final session took note of the statement accepted by the Commission, a copy of which is at Appendix IV.

4. STACRES Report

It was agreed that the Chairmen of STACRES Subcommittees and Working Groups would forward editorial suggestions as necessary to the Assistant Executive Secretary, who will be responsible for production of the Report in the Redbook series.

5. Annual Meeting, May - June 1974

It was noted that the 1974 Annual Meeting of the Commission will be held at Halifax, Canada, during 4-15 June 1974. STACRES accordingly

recommends

*that the scientific meetings of STACRES and its various subcommittees and working groups should meet in the Halifax - Dartmouth area during 21-31 May 1974.*

Since some overlap of subcommittee and working group meetings will be necessary, STACRES advises that national delegations should be prepared, if at all possible, to accept such an arrangement.



APPENDIX I - REPORT OF ASSESSMENTS SUBCOMMITTEE

Chairman: D. J. Garrod

The Subcommittee met at the Institut für Seefischerei, Hamburg, 7-12 January, and continued its meetings at the Fisheries Division, FAO, Rome, during the following week. Its task was to recommend TACs for 1974 for herring, mackerel, red hake, and "other finfish" in SA 5 and 6 and for a number of species in SA 2, 3 and 4 not regulated by agreement at the 1973 Annual Meeting (Comm.Doc. 74/1 and 2).

1. Review of Preliminary Statistics of Nominal Catches and Fishery Trends in 1973

Table 1 summarizes the nominal catches and TACs of the stocks for which catch regulations have been agreed or are under consideration. Since 1973 nominal catches by Spain were not available, the preliminary statistics for 1973 include for Spain quantities which are assumed to have remained at the 1972 level or to have reached the TAC allocated to Spain in 1973 where applicable.

Table 1. Summary of previous stock assessments: recent catches for 1966-72 and provisional catches for 1973, with allocated TACs for 1972-74 (TACs recommended by STACRES in parentheses). Asterisks (\*) denote stocks to be dealt with at the January 1974 meeting.

| Species     | Stock area | MSY | Nominal catches<br>(000 tons) |      |      |                   | TACs (000 tons) |                        |                        | F <sub>max</sub><br>(F <sub>0.1</sub> ) | F <sub>74</sub>       |
|-------------|------------|-----|-------------------------------|------|------|-------------------|-----------------|------------------------|------------------------|---|-----------------------|
|             |            |     | 1966-70                       | 1971 | 1972 | 1973 <sup>a</sup> | 1972            | 1973                   | 1974                   |   |                       |
| Cod         | SA 1       | 300 | 304                           | 121  | 111  | 70                | -               | -(102)                 | 107.0 (80)             | 0.6                                     | <0.6                  |
|             | 2GH        | 30  | 62                            | 13   | 14   | 3                 | -               | -                      | 20.0 (20)              | 0.7                                     |                       |
|             | 2J + 3KL   | 550 | 657                           | 421  | 455  | 390               | -               | 665.5(650)             | 656.7(650)             | 0.4                                     | 0.4                   |
|             | 3M         | 35  | 28                            | 25   | 57   | 28                | -               | -                      | 40.0 (35)              | 0.5                                     | 0.5                   |
|             | 3NO        | 130 | 140                           | 118  | 102  | 68                | -               | 103.5 (70)             | 101.1 (85)             | 0.2                                     | 0.2                   |
|             | 3Ps        | 60  | 66                            | 60   | 44   | 53                | -               | 70.5 (70)              | 70.0 (70)              | 0.3                                     | 0.3                   |
|             | 3Pn + 4RS  |     | 83                            | 84   | 58   | 60                | -               | -                      | -                      |   |                       |
|             | 4TVn       |     | 60                            | 67   | 77   | 59                | -               | -                      | *                      |   |                       |
|             | 4VsW       | 60  | 62                            | 53   | 62   | 57                | -               | 60.5 (60)              | 60.0 (60)              | 0.45                                    | 0.5                   |
|             | 4X         |     | 31                            | 23   | 22   | 26                | -               | -                      | *                      |   |                       |
|             | 5Y         | 10  | 7                             | 8    | 7    | 6                 | -               | 10.0 (10)              | 10.0 (10)              |   |                       |
| 5Z          | 35         | 39  | 28                            | 25   | 28   | -                 | 35.0 (35)       | 35.0 (35)              |                        |   |                       |
| Haddock     | SA 3       |     | 8                             | 5    | 4    | 4                 | -               | -                      | -                      |   |                       |
|             | 4VW        | 25  | 14                            | 13   | 5    | 5                 | 4.0 (0)         | 4.0 (0)                | 0 (0)                  | 0.5                                     |                       |
|             | 4X         | 18  | 32                            | 18   | 13   | 15                | 9.0 (0)         | 9.0 (0)                | 0 (0)                  | 0.5                                     |                       |
|             | 5YZ        |     | 53                            | 12   | 7    | 6                 | 6.0 (0)         | 6.0 (0)                | 0 (0)                  |   |                       |
| Redfish     | SA 2 + 3K  |     | 25                            | 19   | 20   | 40                | -               | -                      | *                      |   |                       |
|             | 3LN        |     | 20                            | 34   | 29   | 38                | -               | -                      | 28.0 (20)              |   | Gen. production study |
|             | 3M         |     | 4                             | 8    | 42   | 20                | -               | -                      | 40.0 (..)              |   |                       |
|             | 3O         |     | 14                            | 20   | 16   | 10                | -               | -                      | 16.0 (15)              |   | Gen. production study |
|             | 3P         |     | 28                            | 28   | 26   | 17                | -               | -                      | 25.0 (23)              |   | Gen. production study |
|             | 4VWX       |     | 25                            | 62   | 50   | 45                | -               | -                      | 40.0 (30)              |   | Av. catch 1962-71     |
| 5YZ         |            | 11  | 20                            | 19   | 15   | -                 | 30.0 (30)       | 30.0 (30)              |                        | Av. catch over stable period            |                       |
| Silver hake | 4VWX       |     | 26                            | 129  | 114  | 283               | -               | -                      | 100.0 (50-100)         |   |                       |
|             | 5Y         |     | 17                            | 8    | 7    | 9                 | -               | 10.0 (10)              | 10.0 (10)              |   |                       |
|             | 5Ze        | 160 | 110                           | 70   | 78   | 62                | -               | 80.0 (80)              | 80.0 (80)              |   |                       |
|             | 5Zw + 6    |     |                               | 30   | 31   | 64                | -               | 80.0 (80)              | 80.0 (80)              |   |                       |
| Red hake    | 5Ze        |     | 2 <sup>3</sup>                | 6    | 40   | 25                | -               | -                      | * (50-                 |   |                       |
|             | 5Zw + 6    | 40  | 11 <sup>3</sup>               | 24   | 36   | 38                | -               | 40.0 (40)              | 50.0 <sup>1</sup> (70) |   |                       |
| Pollock     | 4VWX       |     | 17                            | 12   | 20   | 29                | -               | 50.0 (50) <sup>2</sup> | 55.0 (50)              |   |                       |
|             | SA 5       |     | 9                             | 14   | 13   | 12                | -               |                        |                        |   |                       |

Table 1. Continued

| Species                          | Stock area | MSY | Nominal catches<br>(000 tons) |                 |                  |                   | TACs (000 tons)     |                     |                    | F <sub>max</sub><br>(F <sub>0.1</sub> ) | F <sub>74</sub> |
|----------------------------------|------------|-----|-------------------------------|-----------------|------------------|-------------------|---------------------|---------------------|--------------------|---|-----------------|
|                                  |            |     | 1966-70                       | 1971            | 1972             | 1973 <sup>9</sup> | 1972                | 1973                | 1974               |   |                 |
| A. plaice                        | SA 2 + 3K  |     | 13 <sup>3</sup>               | 5               | 9                | 5                 | -                   | -                   | *                  | (0.5)                                   | 0.5             |
|                                  | 3M         |     | 4 <sup>3</sup>                | 1               | 1                | +                 | -                   | -                   | *                  |   |                 |
|                                  | 3LNO       |     | 67 <sup>3</sup>               | 68              | 59               | 46                | -                   | 60.5 (60)           | 60.0 (60)          |   |                 |
|                                  | 3Ps        |     | 12 <sup>3</sup>               | 7               | 7                | 12                | -                   | -                   | *                  |   |                 |
| Witch                            | 2J + 3KL   |     | 18 <sup>3</sup>               | 16              | 17               | 22                | -                   | -                   | 22.0 (17)          |   |                 |
|                                  | 3NO        |     | 7 <sup>3</sup>                | 15              | 9                | 7                 | -                   | -                   | 10.0 (10)          |   |                 |
|                                  | 3Ps        |     | 3 <sup>3</sup>                | 2               | 2                | 3                 | -                   | -                   | 3.0 (3)            |   |                 |
| Yellowtail                       | 3LNO       |     | 26 <sup>3</sup>               | 37              | 39               | 30                | -                   | 50.0 (50)           | 40.0 (40)          | (0.7)                                   | 0.75            |
|                                  | 5 (E 69°)  | }   | 35                            | 24              | 30               | 28                | 16.0(16)            | 16.0 (16)           | 16.0 (16)          |   |                 |
|                                  | 5 (W 69°)  |     |                               |                 |                  |                   | 10.0(10)            | 10.0 (10)           | 10.0 (10)          |   |                 |
| Gr. halibut                      | SA 2 + 3KL |     | 30                            | 24              | 30               | 28                | -                   | -                   | *                  |   |                 |
| A. plaice<br>Witch<br>Yellowtail | 4VWX       | 32  | 13                            | 14              | 11               | 12                | }                   | }                   | }                  | 32.0 (32)                               |                 |
|                                  |            |     | 13                            | 18              | 11               | 13                |                     |                     |                    |   |                 |
|                                  |            |     | 7                             | 2               | 2                | 2                 |                     |                     |                    |   |                 |
| Flounders(ex<br>yellowtail)      | SA 5 + 6   |     | 28                            | 27              | 24               | 18                | -                   | 25.0 (25)           | 25.0 (25)          |   |                 |
| RN grenadier                     | SA 2 + 3   |     | 22                            | 75              | 24               | 16                | -                   | -                   | *                  |   |                 |
| Herring                          | 4VW(a)     |     | 46                            | 72              | 33               | 25                | -                   | -                   | 45.0 (45)          |   |                 |
|                                  | 4W(b)      |     | 16                            | 23              | 16               | 13                | } 65.0 <sup>6</sup> | } 90.0 <sup>6</sup> | } *                |   |                 |
|                                  | 4X(a)      | }   | 174 <sup>4</sup>              | 69 <sup>4</sup> | 144 <sup>4</sup> | 122 <sup>4</sup>  |                     |                     |                    |   |                 |
|                                  | 4X(b)      |     |                               |                 |                  |                   | 45 <sup>5</sup>     | 51 <sup>5</sup>     | 62 <sup>5</sup>    |   |                 |
|                                  | 5Y         |     | 259                           | 267             | 175              | 201               | 150.0               | 150.0               | *                  |   |                 |
| 5Z + 6                           |            |     |                               |                 |                  |                   |                     | *                   |                    |   |                 |
| Mackerel                         | SA 3       |     | +                             | 1               | 2                | 2                 | -                   | -                   | *                  |   |                 |
|                                  | SA 4       |     | 16                            | 23              | 21               | 35                | -                   | -                   | *                  |   |                 |
|                                  | SA 5 + 6   |     | 83                            | 349             | 387              | 366               | -                   | 450.0               | (245)*             |   |                 |
| Argentine                        | 4VWX       |     | 6                             | 7               | 6                | 2                 | -                   | -                   | *                  |   |                 |
|                                  | SA 5       |     | 8                             | 7               | 33               | 3                 | -                   | -                   | *                  |   |                 |
| Capelin                          | SA 2 + 3K  |     | 1                             | +               | 46               | 132               | -                   | -                   | } 250.0*           |   |                 |
|                                  | 3LNOPs     |     | 2                             | 3               | 25               | 131               | -                   | -                   |                    |   |                 |
| O. finfish <sup>7</sup>          | SA 5 + 6   |     | 151                           | 146             | 147              | ...               | -                   | -                   | *                  |   |                 |
| Squids                           | SA 3       |     | 2                             | 2               | +                | 1                 | -                   | -                   | *                  |   |                 |
|                                  | SA 4       |     | +                             | 7               | 2                | 8                 | -                   | -                   | *                  |   |                 |
|                                  | SA 5 + 6   |     | 7                             | 22              | 49               | 52                | -                   | -                   | 71.0 (50-80)       |   |                 |
| All finfish<br>and squids        | SA 5 + 6   |     | 911                           | 1125            | 1145             | ...               | -                   | -                   | 923.9 <sup>8</sup> |   |                 |

<sup>1</sup> Red hake TAC in 1974 pertains to Div. 5Z (W 69°) + SA 6.

<sup>2</sup> Pollock TAC in 1974 pertains to Div. 4X + SA 5.

<sup>3</sup> Catches for 1970 only.

<sup>4</sup> Catches include juveniles which are estimated as 62 (1966-70), 22 (1971), 64 (1972), 24 (1973).

<sup>5</sup> Catches include juveniles which are estimated as 20 (1966-70), 8 (1971), 20 (1972), 16 (1973).

<sup>6</sup> TACs pertain to adult catches only.

<sup>7</sup> Other finfish excludes all regulated species and also excludes menhaden, billfishes, tunas and large sharks (ICNAF Summ.Doc. 74/4).

<sup>8</sup> Overall TAC pertains to all finfish (except menhaden, billfishes, tunas and large sharks) and squids (ICNAF Summ.Doc. 74/4).

<sup>9</sup> Provisional data.

The preliminary statistics show that the TAC for cod in Div. 2J-3KL was not reached, mainly due to a reduction in fishing activity caused by severe ice conditions. A shortfall is also expected on the TAC for cod in Div. 3NO, but at present there is no information on changes in fishing activity in that area. There was also a considerable shortfall on the TAC for mackerel in SA 5 and 6. The other fisheries remained at levels similar to those of 1972, except for silver hake (Div. 4VWX) and capelin (SA 2 and 3). Nominal catches of silver hake more than doubled from 114,000 tons in 1972 to 283,000 tons in 1973, believed to have resulted from an increase in stock size coupled with an increase in fishing activity. Nominal catches of capelin increased to 263,000 tons, already exceeding the TAC for 1974 established at the 1973 Annual Meeting to control the development of the fishery.

The recommended TACs for those species stocks for which regulation will be considered at this meeting of the Commission are given in Table 2.

Table 2. Recommended 1974 TACs (together with those for 1972 and 1973) for species stocks under consideration at this January 1974 Meeting of the Commission.

| Species                    | Stock area    | TACs (000 tons) |                 |                    |
|----------------------------|---------------|-----------------|-----------------|--------------------|
|                            |               | 1972            | 1973            | 1974 <sup>1</sup>  |
| Cod                        | 4TVn          | -               | -               | 70 <sup>2</sup>    |
|                            | 4X (offshore) | -               | -               | 8                  |
| Redfish                    | SA 2 + 3K     | -               | -               | 25                 |
| Red hake                   | 5Z (E of 69°) | -               | -               | 20                 |
| Amer. plaice               | SA 2 + 3K     | -               | -               | 8                  |
|                            | 3M            | -               | -               | 2                  |
|                            | 3Ps           | -               | -               | 10                 |
| Gr. halibut                | SA 2 + 3KL    | -               | -               | 30                 |
| RN grenadier               | SA 2 + 3      | -               | -               | 30                 |
| Herring                    | 4XW(b)        | 65 <sup>3</sup> | 90 <sup>3</sup> | 90 <sup>3</sup>    |
|                            | 5Y            | 30 <sup>3</sup> | 25 <sup>3</sup> | 25 <sup>3</sup>    |
|                            | 5Z + SA 6     | 150             | 150             | 150                |
| Mackerel                   | SA 3 + 4      | -               | -               | - <sup>4</sup>     |
|                            | SA 5 + 6      | -               | 450             | 251-312            |
| Argentine                  | 4VWX          | -               | -               | } 50 <sup>5</sup>  |
|                            | SA 5          | -               | -               |                    |
| Capelin                    | SA 2 + 3K     | -               | -               | } 250 <sup>6</sup> |
|                            | 3LNOPs        | -               | -               |                    |
| Other finfish <sup>7</sup> | SA 5 + 6      | -               | -               | 150                |
| Squids                     | SA 3 + 4      | -               | -               | - <sup>4</sup>     |

<sup>1</sup> TACs recommended by Assessments Subcommittee, January 1974.

<sup>2</sup> Seasonal partition of TAC to be considered.

<sup>3</sup> TACs pertain to catches of adults only.

<sup>4</sup> No TACs recommended.

<sup>5</sup> Partition equally between Div. 4VWX and SA 5 to be considered; also removal from "other finfish" in SA 5 + 6.

<sup>6</sup> Partition of TAC between areas to be considered (suggested maximum 150,000 tons in Div. 3LNOPs).

<sup>7</sup> Excludes all regulated species and also excludes menhaden, billfishes, tunas and large sharks; reduction of TAC to be considered if definitive TAC decided for argentinians in SA 5.

2. Mackerel

a) Subareas 3 and 4 (Res.Doc. 74/8, 9)

Nominal catches of mackerel in SA 3 and 4 reached 37,000 tons in 1973. These were taken from a group of mackerel which spawn in a different area from the major stock in SA 5 and 6, but it is suspected that, if they are drawn from a separate stock, both stocks may be mixed together at the time of the fishery in SA 5 and 6. If this is so, it may influence the allocation of the existing TAC between subareas; if they are not mixing, it may be necessary to establish a separate TAC for mackerel in SA 3 and 4.

The information is not yet sufficient to assess the degree of mixing between mackerel in SA 5 and 6 and in SA 3 and 4, or to estimate the quantity of mackerel in SA 3 and 4, and thus it is not yet possible to advise the Commission on a level of catch for mackerel which would be appropriate to the fishery in these northern areas. However, the importance of the degree of mixing of mackerel between the two areas must be stressed, since it could influence the efficiency of the existing management of mackerel in SA 5 and 6. There is an urgent need for further research on the distribution of the mackerel involved, with a particular need for a co-ordinated tagging program.

b) Subarea 5 and Statistical Area 6 (Res.Doc. 74/10)

Nominal catches of mackerel in 1973 reached 366,000 tons, substantially less than the TAC of 450,000 tons. The reassessment of the stock was actually based on a nominal catch of 372,000 tons estimated on the data available at Hamburg. The catches contained a high percentage of 2-year-old fish from the 1971 year-class, and 4-year-old fish from the strong 1969 year-class.

The interpretation of data from the 1973 fishery depends heavily on one biological factor, whether or not the distribution of mackerel shoals enables the fleet to concentrate on particular age-groups within the stock. One view is that all fish above a certain size, except perhaps the very largest, are all equally likely to be fished; the other view is that because mackerel do shoal by size, if some age-groups are more abundant in particular years, then the fleet would be capable of concentrating its activity on that more abundant section of the stock. The first view leads to the interpretation that in 1973 the fishing mortality was low and fish were not fully available to the fishery until they were 5 years old. The other leads to the interpretation that in 1973 the fishing mortality was high, with recruitment to the fishery at a comparatively early age, the pattern of fishing having been influenced either by fluctuation in year-classes or by the effect of fishing on stock structure. It is not yet possible to distinguish between these two interpretations, so the Subcommittee used each as a limiting situation in an assessment based on an agreed estimate of age composition of the catches.

Other parameters used in the assessment are listed in the Report of the Mackerel Working Group at Annex 1. These were agreed to give the best available representation of the stock, although, as always, there remain other options that could take account of variations with time of the parameters. As yet there is no definitive evidence that this has occurred. The results of the assessment are summarized in Table 3.<sup>1</sup>

The two interpretations of the fishery also lead to different views on the level of fishing mortality that could be advised as an objective for the Commission in 1974. Both indicate that the level of exploitation is harvesting close to the sustainable yield; if fishing mortality is low, it would be possible to allow some increase, but, if it is high, then fishing mortality should be reduced. With a low fishing mortality, the biomass of the stock will remain essentially the same in 1974, if the 1973 level of fishing is maintained; if fishing mortality is high, the biomass will decline. This decline may or may not be biologically significant, but the Subcommittee considered that, at least, the trend should not be accelerated by allowing fishing mortality to increase above the 1973 level until the true situation has been determined. It is possible to estimate a TAC for 1974, provided that fishing mortality remains at the 1973 level, but it is not yet possible to advise what that level is or what it should become under management. If fishing mortality is low and is maintained at that level in 1974, catches are expected to reach 312,000 tons, but, if fishing mortality is high and is maintained in 1974, because the biomass has been depleted to a greater extent in earlier years, the expected catch in 1974 would be lower at 251,000 tons. At present there is no scientific basis for choosing either 251,000 or 312,000 tons as being the more appropriate level, except that a TAC towards the lower end

<sup>1</sup> The fishery 1968-1973 was reconstructed to estimate correctly the known number of fish in the catches and then converted to weight landed, using an estimated average weight of each age. The data available related to mackerel in SA 4 which are known to be larger per age-group than those in SA 5 and 6, so the initial projection of catch weight had to be corrected to obtain the correct observed catch weight.

of the range would provide more safeguards for the future in the event of fishing mortality being at the higher of the two limits.

The different interpretations of this fishery will be resolved as the time series of data increases, but in the short term there is a crucial need for a measurement of stock size, independent of that estimated from the commercial fishery data.

Table 3. Summary of mackerel assessment for Subarea 5 and Statistical Area 6.

| Hypothesis | 1973 F | % Recruitment to fishery by age |    |    |     |     |
|------------|--------|---------------------------------|----|----|-----|-----|
|            |        | 1                               | 2  | 3  | 4   | 5+  |
| (1)        | 0.9    | 25                              | 50 | 90 | 100 | 100 |
| (2)        | 0.4    | 10                              | 30 | 40 | 60  | 100 |

|                | Year | Recruitment at age 1 (10 <sup>6</sup> ) | F (100%) average of age-groups 5 to 9 | Yield (000 tons) | Population biomass (age 2 and older) at end of year (000 tons) |
|----------------|------|---|---------------------------------------|------------------|--|
| Hypothesis (1) | 1967 |   |                                       |                  | 424  |
|                | 1968 | 5801                                    | 0.028                                 | 60               | 756  |
|                | 1969 | 2082                                    | 0.067                                 | 108              | 923  |
|                | 1970 | 2322                                    | 0.42                                  | 200              | 959  |
|                | 1971 | 1011                                    | 0.44                                  | 349              | 745  |
|                | 1972 | (1450)                                  | 0.73                                  | 386              | 520  |
|                | 1973 | (2320)                                  | 0.90                                  | 372              | 320  |
|                | 1974 | 2320                                    | 0.90                                  | 251              | 283  |
| Hypothesis (2) | 1967 |   |                                       |                  | 495  |
|                | 1968 | 7146                                    | 0.028                                 | 60               | 897  |
|                | 1969 | 2936                                    | 0.05                                  | 108              | 1134   |
|                | 1970 | 4410                                    | 0.31                                  | 200              | 1313   |
|                | 1971 | 3203                                    | 0.34                                  | 349              | 1262   |
|                | 1972 | (1790)                                  | 0.47                                  | 382              | 1260   |
|                | 1973 | (2860)                                  | 0.40                                  | 372              | 1068   |
|                | 1974 | 2860                                    | 0.40                                  | 312              | 1021   |

( ) 1972: recruitment at age 1 = 25% of 1967 year-class.  
 ( ) 1973: recruitment at age 1 = 40% of 1967 year-class.

c) Age at Capture and Size Limit Considerations

The assessment for mackerel, carried out at the 1973 Annual Meeting, has established that delaying the age at first capture by avoiding the capture of very young fish (0, 1 and 2 years old) would improve the yield per recruit and the biomass of the adult stock. Seasonal or area closure of the fishery could not achieve this, but research is in hand to determine whether it could best be achieved by regulation of mesh size or a minimum size limit and to estimate how the degree of benefit would vary according to the level at which a regulation might be set. For example, it may be appropriate to establish a minimum size limit close to the length at maturity (30 cm), similar to that imposed in the Norwegian national fishery in the North Sea on mackerel for fishmeal.

3. Herring

Nominal catches of herring in the Convention Area and in SA 6 in 1973 totalled about 475,000 tons, 86% of the 1972 level of 548,663 tons. There was a larger decline in catches from the Gulf of St. Lawrence and Newfoundland (SA 3 and Div. 4RST). The TAC and actual catches for the southern stocks are listed in Table 2 of the Report of the Herring Working Group at Annex 2. Catches by non-members in 1973 from the Div. 5Y and the Div. 5Z + SA 6 stocks were higher than had been anticipated in the proposal for these stocks, but total catches by all countries in Div. 5Y were less than expected, the decrease being thought to be due to a change in availability.

a) Georges Bank Stock (Div. 5Z and SA 6)

The 1973 TAC for Georges Bank herring was 150,000 tons, and the 1973 catch was just over 200,000 tons. Updating the 1973 assessment gave new values of F in 1973 which indicated a redistribution of fishing mortality between age-groups, particularly towards the relatively large 1970 year-class, which provided a large part of the 1973 catch and is expected to make up a larger proportion of the catch in 1974. The year-class is now believed to be considerably larger than the 1966 year-class.

Estimates of the 1974 fishing mortality, catch and the expected stock at the end of 1974 were made assuming that the 1970 year-class might be 1.0, 1.5 or 2.0 times the 1966 year-class, the latter being considered by some scientists to be a realistic rather than an optimistic view. The results are summarized in Table 4 below and are shown in Fig. 2 of the Report of the Herring Working Group (Annex 2).

Table 4. Georges Bank herring assessment: population size as a function of 1974 catch for different assumed levels of 1974 F and of the size of the 1970 year-class.

| 1970 y.c.<br>as % of<br>1966 y.c. | 1974 Stock size <sup>1</sup> |                   | 1974 F by age |      |      |      | Mean<br>F <sup>2</sup> | 1974 Catch                   |                   | 1975 Stock size <sup>1</sup> |                   |
|-----------------------------------|------------------------------|-------------------|---------------|------|------|------|------------------------|------------------------------|-------------------|------------------------------|-------------------|
|                                   | Number<br>(10 <sup>6</sup> ) | Weight<br>(000 t) | 3             | 4    | 5    | 5+   |                        | Number<br>(10 <sup>6</sup> ) | Weight<br>(000 t) | Number<br>(10 <sup>6</sup> ) | Weight<br>(000 t) |
| 100%                              | 726                          | 155               | 0.33          | 0.31 | 0.26 | 0.10 | 0.28                   | 286                          | 51                | 795                          | 152               |
|                                   |                              |                   | 0.98          | 0.94 | 0.77 | 0.30 | 0.83                   | 662                          | 118               | 463                          | 92                |
|                                   |                              |                   | 1.31          | 1.26 | 1.03 | 0.40 | 1.11                   | 783                          | 140               | 358                          | 73                |
|                                   |                              |                   | 1.97          | 1.88 | 1.54 | 0.60 | 1.66                   | 946                          | 170               | 221                          | 48                |
| 150%                              | 1378                         | 272               | 0.18          | 0.31 | 0.26 | 0.10 | 0.24                   | 387                          | 70                | 1238                         | 230               |
|                                   |                              |                   | 0.35          | 0.63 | 0.51 | 0.20 | 0.49                   | 685                          | 124               | 973                          | 182               |
|                                   |                              |                   | 0.62          | 1.05 | 0.90 | 0.35 | 0.85                   | 1012                         | 184               | 686                          | 130               |
|                                   |                              |                   | 0.89          | 1.57 | 1.29 | 0.50 | 1.21                   | 1238                         | 225               | 491                          | 94                |
| 200%                              | 2028                         | 389               | 0.12          | 0.31 | 0.26 | 0.10 | 0.25                   | 522                          | 95                | 1648                         | 304               |
|                                   |                              |                   | 0.25          | 0.63 | 0.51 | 0.20 | 0.49                   | 921                          | 168               | 1294                         | 239               |
|                                   |                              |                   | 0.43          | 1.05 | 0.90 | 0.35 | 0.86                   | 1354                         | 247               | 914                          | 170               |
|                                   |                              |                   | 0.62          | 1.57 | 1.29 | 0.50 | 1.23                   | 1650                         | 301               | 660                          | 123               |
| 200%                              |                              |                   | 0.20          | 0.52 | 0.42 | 0.17 | 0.41                   | 829                          | <u>150</u>        | 1375                         | <u>255</u>        |

<sup>1</sup> Stock size at beginning of the year.

<sup>2</sup> Weighted over age-groups by stock size in numbers.

In setting the TAC for 1973, the Commission agreed

- i) that the TAC for 1974 should be established to restore the adult stock (4 years and older at the beginning of the year as it was then defined) to a minimum level of 225,000 tons by the end of 1974; and
- ii) that the TAC for 1974 could only be increased over that of 1973 if the adult stock at the end of 1973 had reached a level which will provide the MSY at the end of 1974.

The second constraint means that the adult stock would have to reach the MSY level of 500,000 tons by the end of 1973 if the TAC were to be increased in 1974. Since Table 4 shows that for all assumptions the stock at the end of 1973 (beginning of 1974) was in all cases less than 500,000 tons, the TAC for 1974 should not be increased over 150,000 tons.

The first constraint requires that the TAC for 1974 be set at a level providing a minimum adult stock of 225,000 tons at the end of 1974. It can be seen in Table 4 that a TAC of 150,000 tons can be taken in 1974 and the constraint met, provided that the 1970 year-class exceeds the 1966 year-class by more than 1.5 times. If the 1970 year-class is 2.0 times the 1966 year-class, the adult stock at the end of 1974 would be increased to 255,000 tons for a 1974 TAC of 150,000 tons. From the evidence available, and particularly that concerning the 1970 year-class, the Subcommittee recommends that the TAC for 1974 remain at 150,000 tons.

b) Gulf of Maine Stock (Div. 5Y)

The catches (metric tons) in the juvenile and adult herring fisheries on this stock in 1973 were as follows:

|                          | Adult Fishery | Juvenile Fishery | Total         |
|--------------------------|---------------|------------------|---------------|
| USA - Ages 1-3           | 1,124         | 15,110           | 16,234        |
| - Age 4 & older          | 4,878         | 1,259            | 6,137         |
| Canada - Ages 1-3        | 276           |                  | 276           |
| - Age 4 & older          | 3,833         |                  | 3,833         |
| FRG ( Age compositions ) | 690           |                  | 690           |
| GDR ( not yet reported ) | 5,284         |                  | 5,284         |
| <b>Total</b>             | <b>16,085</b> | <b>16,369</b>    | <b>32,454</b> |

The separation between juvenile and adult fisheries has changed in the last year, owing to an unusual distribution of the stock and to changes in the seasonal distribution of fishing. As a result, 3-year-old herring have been caught in fisheries that have in the past traditionally been based on 4-year-old and older herring. The assessment carried out has taken account of 3-year-olds that did appear in the "adult" fisheries, but the method of assessment will have to be adjusted in future years to take account of the total catch of 3-year-olds. The total catch in the adult herring fisheries was 16,085 tons and the TAC for adult herring in 1973 was 25,000 tons.

The assessment for this stock was updated, using the same assumptions concerning the 1970 year-class as were applied to the assessment of Georges Bank herring. The results are summarized in Table 5 below and are illustrated in Fig. 1 of the Report of the Herring Working Group (Annex 2).

Table 5. Gulf of Maine (Div. 5Y) herring assessment: stock size in 1974, 1975 and 1976 for different assumed levels of the 1970 year-class with a 1974 adult catch of 25,000 tons.

| 1970 Year-class as % of 1966 year-class | 1974 Catch (Age 3 and older) | F (100%) | F (1970 Year-class) | Stock size at start of year (age 4 and older in 000 tons) |      |      |
|---|------------------------------|----------|---------------------|---|------|------|
|   |                              |          |                     | 1974  | 1975 | 1976 |
| 100%                                    | 25,000                       | 1.21     | .42                 | 64  | 37   | 40   |
| 150%                                    | 25,000                       | 0.90     | .32                 | 85  | 55   | 55   |
| 200%                                    | 25,000                       | 0.70     | .25                 | 106   | 72   | 71   |

Advice to the Commission is also subject to two constraints on this stock:

- i) that the TAC for 1974 should be established to restore the adult stock ( 4 years and older as then defined) to a minimum level of 60,000 tons at the end of 1974; and
- ii) that the TAC for 1974 could only be increased over that of 1973 if the adult stock at the end of 1973 had reached a level which would provide the MSY at the end of 1974.

Interpreting the second constraint as before, if the TAC in 1974 is to be increased over the TAC in 1973, the stock at the end of 1973 should be capable of providing a catch at the MSY level at the end of 1974 (i.e. should have reached 110,000 tons). Table 5 shows that the stock at the end of 1973 (beginning of 1974) will be less than 110,000 tons and, since the second constraint is not met, the TAC should not be increased. Table 5 also shows that the minimum stock at the end of 1974 (60,000 tons) could be met by a TAC of 25,000 tons, assuming, as for Georges Bank herring, that the 1970 year-class exceeds the 1966 year-class by more than 1.5 times. This is uncertain in the Gulf of Maine stock, so the evidence is not strong enough to recommend a reduction in quota below 25,000 tons.

c) Nova Scotia Stock (Div. 4XW(b)) (Res.Doc. 74/13)

Catches from the Nova Scotia stock are classified according to whether herring are greater or less than the minimum length criterion (23 cm). Catches in the various sections of the fishery were as follows:

|                      | Catch by size category (tons) |                    | Total   |
|----------------------|-------------------------------|--------------------|---------|
|                      | Adults (>23 cm)               | Juveniles (<23 cm) |         |
| Canada - Purse seine | 57,069                        | 7,162              | 64,231  |
| - Weir               | 14,339                        | 16,984             | 31,323  |
| - Gillnets           | 5,715                         |                    | 5,715   |
| - Misc. gear         | 945                           |                    | 945     |
| Sub-total            | 78,068                        | 24,146             | 102,214 |
| Japan                | 1,271                         |                    | 1,271   |
| USSR                 | 31,042                        |                    | 31,042  |
| FRG                  | 228                           |                    | 228     |
| Sub-total            | 32,541                        |                    | 32,541  |
| TOTAL                | 110,609                       | 24,146             | 134,755 |

The TAC for 1973 was 90,000 tons.

Stock distribution within this area is confused by the separation of fisheries along the Nova Scotia and New Brunswick coasts and offshore in the Bay of Fundy. It was considered desirable to attempt an assessment with data for all fisheries exploiting the Nova Scotia stock (excluding the New Brunswick inshore fisheries) as a single unit and then to estimate the TAC for 1974 in relation to the principle of the constraints adopted by the Commission for the Georges Bank and Gulf of Maine stocks, i.e. by reference to the expected catch in the adult fisheries. Owing to the complexity of the fisheries in Div. 4XW(b), it is not possible to provide a reliable estimate of the catch in 1974, but it is clear that it will also be determined largely by the size of the 1970 year-class. Assuming this to follow the pattern expected in the other stocks, estimates of catch in 1974 ranged above and below the TAC for 1973, and so the Subcommittee recommends that the TAC for 1974 for the adult fishery be held at the same level as in 1973.

d) Conclusions re Herring TACs

The advice on TAC for 1974 is broadly the same for all stocks. Although it is believed that the stocks in Div. 5Y and Div. 5Z + SA 6 have begun to increase, it is certain that they had not increased to the MSY level by the end of 1973, and therefore, according to the constraints laid down by the Commission, an increase in TAC in 1974 cannot be recommended. It is less clear what level of TAC should be set in 1974 to ensure that these stocks will reach the minimum prescribed level by the end of 1974, because this depends almost entirely on the size of the 1970 year-class. The best judgement available indicates it to be at least 1.5 times the 1966 year-class, which will just enable the TAC for 1973 to be maintained through 1974 and still meet the minimum requirements for the Georges Bank and Gulf of Maine stocks at the end of 1974. The Subcommittee recommends that the TACs for 1974 remain at the 1973 levels for all stocks, but it must emphasize that more precise estimates can only be achieved in future years by improved estimates of the size of new year-classes. In this connection it must also be noted that the young fish survey data suggest that the next year-class to recruit (1971 year-class) will be rather small. If the 1970 year-class is smaller than anticipated and if it is fished more heavily to achieve the recommended TACs (if adopted), then it becomes less likely that the present levels of TAC can be maintained in 1975.

The provision of advice to the Commission has become difficult owing to uncertainties within the Subcommittee regarding:

- i) the identification of components of the fisheries and hence of the quantity of catch on which the stock assessment should be based in order to be related to the TAC (meaningful assessment should be based on total catch of each stock); and
- ii) the identification of adult as opposed to juvenile fisheries, where landings are classified according to the 23 cm size limit, when the adult stock is defined in terms of herring age 4 years and older at the beginning of the year and when, for biological reasons, mature fish of 3 years old appear in the catches.



Clarification of these points by the Commission would assist the Subcommittee in providing better advice.

e) Other Matters

- 1) Ageing. A set of conventions to be used in reporting herring age data to ICNAF was agreed upon and is listed in the Report of the Herring Working Group at Annex 2.
- ii) Larval and juvenile surveys (Res.Doc. 74/14, 15, 16, 17, 18). Preliminary results of the 1973 ICNAF Herring Larval Surveys proved valuable and, besides confirming and extending knowledge relevant to stock identity, indicated an increase in the spawning stock size on Georges Bank. The Subcommittee recommends that these surveys be continued and also suggests that attempts should be made in 1974 to link up the larval and juvenile surveys by use of larval-collecting gear simultaneously with juvenile gear during the juvenile surveys.

4. Other Fish in Subarea 5 and Statistical Area 6

a) Red Hake in Division 5Z and Statistical Area 6 (Res.Doc. 74/19)

At its 1973 Annual Meeting, the Commission considered regulations for red hake in two management areas (east and west of 69°W in Div. 5Z) and, at its Special Meeting in Ottawa, agreed to a 1974 TAC of 50,000 tons for red hake in the area west of 69°W. The 1974 TAC for red hake east of 69°W is to be considered at this meeting, following reassessment of the state of the stock.

Nominal catches from the Georges Bank stock (Div. 5Z east of 69°W) decreased from 29,200 tons in 1972 to an estimated 18,400 tons in 1973 (i.e. 74% of the catch in the whole of Subdiv. 5Ze, as judged from the proportional distribution of effort in the area and assuming that the distribution of effort remained the same). It is possible that the proportion of the total catch of red hake caught on Georges Bank changed in 1973. The 1973 survey data indicated that the stock doubled in size from the autumn of 1972 to the autumn of 1973. These and data from earlier surveys suggest that the 1969, 1971 and 1973 year-classes are strong, and that both USA and USSR assessments indicated a stock biomass of 43,000-48,000 tons at the beginning of 1974. Assuming  $M = 0.4$  and fishing mortality not to exceed  $F_{max} = 0.75$ , the TAC for 1974 should be 20,000 tons.

Nominal catches from the Southern New England - Middle Atlantic stock (west of 69°W) remained approximately the same in 1973 as in 1972, at about 43,000 tons. The 1973 US autumn survey indicated that the stock size decreased by 50% from the autumn of 1972 to the autumn of 1973. A US reassessment of the stock west of 69°W, based on the same techniques as were used to reassess the Georges Bank stock, indicates a stock biomass there of 76,000 tons at the beginning of 1974. This is 25% lower than the estimate of 100,000 tons used at the 1973 Annual Meeting as a basis for the recommended TAC of 50,000 tons which was agreed at the 1973 Special Meeting in Ottawa. The downward adjustment of stock size is supported by the results of the US autumn groundfish surveys. Taking this into account and applying the same level of exploitation recommended for the Georges Bank stock, the TAC set for 1974 in Div. 5Z (W of 69°) and SA 6 might be too high.

b) "Other Finfish" in Subarea 5 and Statistical Area 6

Table 6 summarizes the nominal catches of the various species within the "other finfish" category and in Table 7 these are grouped according to trends in recent years. The total nominal catches of other finfish have averaged 146,000 tons in the last three years, 36% being unsorted and miscellaneous species. Taken overall, nominal catches reached a peak in 1969 but have since declined to the level of earlier years, a greater decline in some (ocean pout, sculpins, scup, black sea bass, alewife and butterfish) being offset by an increase in nominal catches of argentine, dogfish and skates. These trends are confirmed by groundfish survey data, but no assessments are available. Hence, although the increase in fishing, which led to peak landings in 1969 and has since maintained them, must have decreased the biomass to some extent, it is not possible to decide on the level of exploitation and its overall effect, or on the effect of possible natural changes.

In view of the observed decline in several species, it is desirable to avoid the possibility of an unrestricted increase in catches. The existence of the second-tier overall TAC agreed at the 1973 Special Meeting in Ottawa limits this risk, but it can only be completely overcome by establishing a TAC for this "other finfish" group as a whole. However, within the overall group there are species fisheries which may be capable of further development, notably those for argentine, dogfish and skates. The Subcommittee considers that, by careful management of national fleets, limited development of particular species fisheries would be possible within a TAC of

150,000 tons for "other finfish" and that the collection of data in such a fishery could be presented to later meetings to justify the allocation of a separate TAC for it. Likewise there are species (e.g. alewife), which are important to restricted small directed fisheries and which might at a later date merit conservation by separation from the "other finfish" group.

Discussion of argentine in SA 4 (see Section 5 below) indicated that this species might be managed more appropriately by separation from the "other finfish" category at the present time and regulated in a manner comparable to that agreed for pollock. If the Commission does decide to regulate argentine separately, then an appropriate adjustment should be made to the 1974 TAC for "other finfish".

Table 6. Contributions of species to the nominal catches of "other finfish", 1970-72. (Group 1 includes species or categories showing no consistent trend in nominal catches in recent years; Group 2 includes species showing a decline in nominal catches following a peak in 1969; and Group 3 includes species showing an increase in nominal catches in recent years.)

| Group | Species (Common name) | Average nominal catch<br>1970-1972 (tons) | Percentage contribution to<br>average 1970-72 catch |
|-------|-----------------------|---|---|
| 1     | Angler                | 2,932                                     | 2.0   |
|       | Cusk                  | 1,624                                     | 1.1   |
|       | King whiting          | 120                                       | 0.1   |
|       | Northern puffer       | 382                                       | 0.3   |
|       | Sea robins            | 1,843                                     | 1.3   |
|       | White hake            | 2,780                                     | 1.9   |
|       | Wolffish              | 246                                       | 0.2   |
|       | Bluefish              | 1,775                                     | 1.2   |
|       | Shad                  | 2,004                                     | 1.4   |
|       | Misc., USA            | 11,725                                    | 8.0   |
|       | Groundfish (NS)       | 5,016                                     | 3.4   |
|       | Pelagic (NS)          | 415                                       | 0.3   |
|       | Other fish (NS)       | 31,232                                    | 21.3  |
| 2     | Ocean pout            | 6,137                                     | 4.2   |
|       | Sculpin               | 5,156                                     | 3.5   |
|       | Scup                  | 4,699                                     | 3.2   |
|       | Black sea bass        | 805                                       | 0.5   |
|       | Alewife               | 28,645                                    | 19.6  |
|       | Butterfish            | 8,400                                     | 5.7   |
| 3     | Argentine             | 13,793                                    | 9.4   |
|       | Dogfish               | 10,367                                    | 7.1   |
|       | Skates                | 6,357                                     | 4.3   |
| Total |                       | 146,453                                   | 100.0   |

Table 7. Nominal catches ('000 tons) of species groups (as defined in Table 6), 1963-1972.

|         | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 |
|---------|------|------|------|------|------|------|------|------|------|------|
| Group 1 | 93   | 97   | 92   | 66   | 43   | 58   | 68   | 45   | 72   | 68   |
| Group 2 | 54   | 40   | 50   | 64   | 64   | 85   | 125  | 66   | 59   | 37   |
| Group 3 | 4    | 18   | 12   | 45   | 9    | 13   | 21   | 11   | 25   | 61   |
| Total   | 151  | 155  | 154  | 167  | 114  | 152  | 206  | 117  | 156  | 166  |

5. Regulation of Additional Species in Subareas 2, 3 and 4

Canada has requested advice on allowable catches of a number of species listed in Comm.Doc. 74/1 and 2. Several of these species (e.g. Greenland halibut and American plaice) provide relatively small fisheries in the areas defined and very few biological or population data are available. Also the TAC for capelin has been established on a different basis from many other TACs agreed by the Commission, and, taking them together, the Commission should be aware that the TACs of these less well-known species have been suggested as practical figures to prevent an undesirable sudden expansion of fishing in SA 2, 3 and 4 as a whole, rather than to provide adequate management of the individual species.

These TACs will be reviewed as more data (e.g. discarding at sea) become available, and for some species it may be possible to increase the fishery, as the distribution of the stocks and the true potential catch from the area are better understood.

a) Redfish in Subarea 2 and Division 3K (Res.Doc. 74/5)

There was no fishery for redfish in SA 2 and Div. 3K prior to 1958. In that year a directed fishery commenced with catches reaching 150,000 tons. Catches were 187,000 tons in 1959 but decreased to 130,000 tons in 1960 and 55,000 tons in 1961; they were around 20,000 tons in 1962 and 1963 but increased to 56,000 tons in 1964. There was a steady decline to 20,000 tons by 1968 and catches up to 1972 remained remarkably stable at about this level. The 1973 provisional catch, however, was 40,000 tons.

Catch per day fished was at a high level of 40 tons in 1958 when the fleet fished the accumulated stock of old redfish. However, there was a very sharp decline to 13 tons per day by 1961. Some increase was evident in 1962 and 1963 (to 20 tons per day), but thereafter the catch per unit effort decreased to 12-15 tons per day during 1966 to 1971. In view of the stability of the catch per unit effort in the latter period, it is very likely that the increased catch in 1973 resulted from increased effort on the stock.

Standardized fishing effort, using 6-, 8-, and 10-year averaging periods, was used to construct a Schaefer-type yield curve. The best fitting relation, using a 10-year average of fishing effort, gave MSY at a fishing effort of some 2,000 standard days. Under equilibrium conditions this would give an MSY of 40,000 tons. At present the stock has been depressed below the MSY level by the heavy fishing on the accumulated stock in the late 1950s and early 1960s; at the current stock level a catch of about 25,000 tons in 1974 would enable the stock to recover towards the MSY level, and this is proposed as the TAC for 1974.

b) Greenland Halibut in Subarea 2 and Divisions 3K and 3L (Res.Doc. 74/2)

The general distribution of Greenland halibut in the Northwest Atlantic extends from Arctic regions to Georges Bank, but the only fishable concentrations are in SA 1 and 2 and in Div. 3K and 3L. During the 1950s and early 1960s the only real fishery for this species in SA 2 and 3 was by Canada in the inshore area. Between 1962 and 1966-67 the Canadian catch increased rapidly from about 600 tons to 16,600 tons. At the same time landings by other countries (mainly Poland, USSR and non-members) also increased, causing total landings to increase from 700 tons in 1962 to 27,000 tons by 1967 and 36,000 tons by 1969-70. Catches were somewhat lower in 1971 (24,000 tons) and 1972 (30,000 tons) and provisional figures for 1973 indicate the catch to be about 27,000 tons.

Returns from tagging programs tend to support the consideration that Greenland halibut in SA 2 and Div. 3K and 3L constitute a single stock. Since very few mature fish are taken in coastal waters, it is very likely that major spawning occurs in deeper water offshore areas.

No detailed assessment is at present possible for this stock. However, as part of the overall management regime, it is recommended that a 1974 TAC of 30,000 tons would be appropriate, this being close to the level of recent catches. As more knowledge of the distribution becomes available and detailed assessments are made, this level of catch may be adjusted in future.

c) Roundnose Grenadier in Subareas 2 and 3 (Res.Doc. 74/6)

The fishery for grenadiers (predominantly roundnose grenadier, *Macrourus rupestris*) is at present conducted mainly by USSR vessels fishing at depths of 600-1,200 m. It is a deep-water species whose availability to the fishery can vary sharply according to hydrographic conditions. Excepting an outstanding catch of 75,000 tons in 1971, catches have fluctuated around 20,000 tons since 1967, taking immature fish believed to be moving from shallow into deeper water.

Due to the slow growth rate of roundnose grenadier, annual production is expected to be only a small proportion of the biomass of the stock as a whole, but the data available are not adequate to establish what proportion of the total stock recent catches represent, because the distribution

of the species extends beyond the depth of recent trawling operations. However, the data do indicate that the fishery is taking the potential yield of that part of the stock which is at present being fished.

Preliminary estimates of sustainable yield indicate that this may be in the range of 24,000-37,000 tons. If a TAC for roundnose grenadier is to be set as part of a regime to regulate fishing in SA 2 and 3 as a whole, then a catch of 30,000 tons in 1974 is recommended. This would allow the fishery to be maintained at the average level of 1967-1973, and it would also allow some increase over the most usual level (20,000 tons), so that the fishery could be extended and, in being extended, provide a basis for better estimates of the potential catch.

d) American Plaice in Subareas 2 and 3 (Res.Doc. 74/3)

SA 2 and Div. 3K. From a knowledge of the extent of migration in Div. 3L and 3N it is quite probable that very little mixing occurs between adult plaice in Div. 3K and those to the south in Div. 3LNO. Research vessel cruises to SA 2 and Div. 3K do not indicate particularly large concentrations but rather a number of relatively small aggregates scattered throughout the area. Total catches from the stock increased from 300 tons in 1962 to a peak of 13,000 tons in 1970, but were lower in 1971 (5,348 tons) and 1972 (9,070 tons). Provisional statistics indicate the 1973 catch to be about 4,500 tons. No detailed assessment is available at present, but as part of an overall management regime aimed at preventing sudden diversion of effort to any unregulated stock, a 1974 TAC of 8,000 tons is recommended, which is about the average level of recent catches.

Div. 3M. This stock is distinct from the Grand Bank stock, as indicated by vertebral averages, age at sexual maturity and growth rate. The total stock is probably relatively small, and the only substantial landings reported were in 1965 and 1966 by the USSR which listed about 5,000 and 4,000 tons respectively of unspecified flounders, presumably plaice. No stock assessment was possible but, judging from recent catches, a TAC of 2,000 tons is recommended for 1974 to prevent diversion of fishing effort to this stock.

Subdiv. 3Ps. This stock is considered to be separate from the Grand Bank stock by the geographic separation of the latter area and also because no American plaice tagged on the Grand Bank were recovered on St. Pierre Bank or in adjacent localities. Except for relatively large catches taken in 1968 (8,350 tons) and 1969 (4,340 tons) by the USSR, the fishery has been mainly by Canada, with small quantities landed annually by the France (St. Pierre) fishery. Total catches increased from 1,000 tons in 1962 to 3,500 tons in 1967. The catches in 1968-72, however, ranged from 6,500 to 14,000 tons. Provisional figures for 1973 indicate a total catch of about 12,000 tons. No assessment was possible for this stock, but, to prevent sudden diversion of fishing effort to it, a TAC of 10,000 tons is recommended for 1974, close to the average catch for the past five years.

e) Argentine in Subareas 4 and 5 (Res.Doc. 74/21, 22, 23)

The fishery for argentine in the ICNAF Area began in 1963 with landings of 12,300 tons, increasing to 49,000 tons by 1966. In 1967-70 landings were lower, ranging from 5,500 to 8,100 tons, but then increased to 38,800 tons in 1972. Preliminary statistics indicate that 1973 nominal catches were low (about 5,000 tons). Almost all of these and earlier catches came from SA 4 and 5, with SA 4 catches in 1963-1972 averaging 6,300 tons and SA 5 catches averaging 10,800 tons. The USSR is the main country involved in this fishery, although Japan has taken significant quantities in recent years.

The argentine is distributed along the edge of the continental shelf, predominantly in depths of 100-300 fathoms. Stock separation studies indicate that there is a cline of stock units along the edge of the shelf with little inter-mixing among these, although there are areas of high concentration, particularly during the spawning season of March - May. The Fundian Channel area between Georges Bank (Subdiv. 5Ze) and Browns Bank (Div. 4X) is one such area which sustained high catches in 1972 (36,000 tons).

Argentine is a slow-growing, long-lived (20-30 years) species with a low fecundity and probably also a low natural mortality rate. Thus, the ratio of sustainable yield to biomass is low. Canadian research vessel surveys in 1958-68, a period when exploitation was low, give biomass estimates of 200,000-300,000 tons on the Scotian Shelf (Div. 4VWX). Yield per recruit curves are flat-topped with no  $F_{max}$ . Taking the alternative ( $F_{0.1}$ ), Canadian estimates give  $F_{0.1} = 0.20$  and the expected sustainable yield as slightly higher than 20,000 tons. Soviet analysis for the Fundian Channel area indicates a biomass of 100,000 tons in 1972 and an  $F_{0.1} = 0.30$ , implying a sustainable yield of 30,000 tons from this area. As exploitation rates have probably been low in most of the recent years, somewhat higher catches than the sustainable yield could be expected in the immediate future, by fishing at  $F_{opt}$ , until the accumulated stock is removed.

These estimates of yield are not directly comparable, because one refers to Div. 4VWX and the other to part of Div. 4X and part of SA 5. As there is no precise separation of stocks between SA 5 and Div. 4X and it is possible that some argentine catches in SA 5 are from Div. 4X stocks, it is not possible at this time to define the potential yield from SA 4 distinct from that of SA 5. Thus, it may be desirable to manage argentine, as for pollock, and combine SA 4 and 5 for management purposes. A suitable 1974 TAC would be 50,000 tons for the combined subareas, but if the fishery develops to this level and the accumulated stock is cropped, then it is likely that the TAC should be lowered. To prevent local over-exploitation, it would be appropriate to divide this TAC equally between Div. 4VWX and SA 5.

f) Squid in Subareas 3 and 4

Nominal catches of squid in SA 3 and 4 have so far been relatively small (less than 10,000 tons) and they are based mainly on *Illex illecebrosus*, a different species from *Loligo* which provides the fishery in SA 5 and 6. Some biological information concerning *Illex* has been presented to the Subcommittee, but nothing is yet known about the size of the stock or about its population dynamics, and no advice can yet be given to the Commission.

g) Partition of the 1974 TAC for Capelin in Subareas 2 and 3 (Res.Doc. 74/7, 11, 12)

On the recommendation of the Assessments Subcommittee, the Commission at its 1973 Annual Meeting agreed to set a 1974 TAC of 250,000 tons for the capelin fishery in SA 2 and 3, recognizing at the time that the potential yield was perhaps substantially higher. To ensure rational development of the capelin fishery, particularly in view of the vital role played by capelin in the trophic ecology of the area, the Assessments Subcommittee in 1973 also recommended that future increases in the TAC should be related to the rate at which new information allowed the full potential of the resource to be assessed. Such an assessment should as far as possible take account of interactions between capelin and other species. Although recognizing that there was at least a partial separation of the capelin in the Southeast Shoal area (Div. 3NO) of Grand Bank from those further north, the Subcommittee did not recommend a division of the capelin quota, mainly because of the lack of definitive stock discrimination data.

The total catch of capelin in SA 2 and 3 was about 263,000 tons in 1973. New information on differences in growth rate of capelin in the Newfoundland - Labrador area (Res.Doc. 74/11), together with available data on seasonal distribution and probable migration patterns, suggest that a minimum stock breakdown of capelin would include Div. 2J-3K as one stock complex and Div. 3LNOPs as another. Total removals from the Div. 3LNOPs complex increased substantially in 1973 to about 130,000 tons, mainly from Div. 3NO. Since the capelin fishery in Div. 3NO occurs under conditions conducive to large catches and normally precedes the fishery in the northern area, the possibility exists that the MSY level of the Div. 3LNOPs stock complex may be reached in 1974, without the necessary data required to accurately assess its true potential. Thus it is considered desirable that the 1974 TAC for capelin be partitioned into two components corresponding to the two stock complexes defined above, with a maximum allocation of 150,000 tons for the Div. 3LNOPs stock complex. This level would allow some expansion in the Southeast Shoal fishery for new entrants. It is evident from the ecology of capelin that this species suffers heavy natural mortality after spawning, so that in terms of the effect of the fishery on the interaction between capelin and other species it may become desirable to allocate the potential catch between adult and juvenile fisheries as well as between areas.

h) Cod in Division 4T and Subdivision 4Vn

Components of at least three cod stocks spend part or all of the year in Sydney Bight (Subdiv. 4Vn). The large southern Gulf of St. Lawrence stock, which spends the summer months in Div. 4T, migrates in December to deep waters along the edge of the Laurentian Channel, particularly in Subdiv. 4Vn. The return migration occurs during April and May. The eastern Scotian Shelf cod (i.e. those from Sable Island - Banquereau area in Div. 4VsW) show some movement to the north in spring and summer, supporting a small otter trawl fishery in Subdiv. 4Vn in summer. Distinct local stocks support inshore longline, handline and gillnet fisheries around Cape Breton (Subdiv. 4Vn), also in the summer months. Nominal catches have been assigned to stocks by considering Div. 4T catches in all months and Subdiv. 4Vn catches in the months January - April inclusive as coming from the main southern Gulf of St. Lawrence stock. May to December catches were assigned to the offshore fishery if caught by otter trawl and to the inshore fishery if caught by other gears.

Div. 4TVn (spring) cod. Nominal catches from the southern Gulf of St. Lawrence stock declined from 70,000 tons in 1963 to 41,000 tons in 1967 and then increased to 68,000 tons in 1972. The catches in 1972 contained a large proportion of small fish aged 4 and 5, and the number (although not the weight) removed was the highest in the period studied (1960-72). Catches increased from 1967 with increasing stock abundance, but fishing mortality also increased in 1969 and 1970. Changes in catch and catch per effort did not vary proportionally in 1971 and 1972, suggesting

that effort, and thus mortality, was increasing. As  $F$  ranged from 0.4 to 0.5 in 1960-70 on fully recruited age-groups, it is unlikely that an increase would result in any substantial sustainable increase in yield. As  $F$  may well have been above this average in 1971 and 1972, catches in 1974 should not exceed the long-term average of 60,000 tons.

Subdiv. 4Vn (May - December) inshore cod. Catches from inshore stocks in Subdiv. 4Vn ranged from 4,200 tons to 6,200 tons in 1962-72, the average being 4,920 tons. This small population has been stable in the period 1960-68, with an average  $F$  of 0.35 on fully recruited age-groups. This  $F$  is probably close to that maximizing yield per recruit and a substantially larger sustained yield is unlikely to result from increasing  $F$ . Thus, 1974 removals should not exceed 5,000 tons.

Subdiv. 4Vn (May - December) offshore cod. The offshore summer fishery in Subdiv. 4Vn ranged from 2,200 tons to 6,600 tons in 1962-72, averaging 4,440 tons. Previous assessments of the Div. 4VsW stock did not take these fish into account in establishing a 1974 TAC of 60,000 tons. The fishery in Subdiv. 4Vn is small in relation to that in Div. 4VsW, and inclusion in the analysis would not result in major changes in conclusions, in that the Div. 4VsW stock is fully exploited and perhaps over-exploited. Thus, catches from Subdiv. 4Vn of this stock should not be allowed to increase. Therefore, 1974 catches should not exceed 5,000 tons.

Conclusions. In total, the 1974 cod catches from all of Div. 4TVn should not exceed 70,000 tons. It should be noted that a single TAC for the entire area would not necessarily result in the optimum distribution of mortality on stocks. Over-exploitation of the southern Gulf of St. Lawrence stock in Subdiv. 4Vn in the spring could result, with subsequent under-exploitation of those stocks fished in Subdiv. 4Vn in summer. This would further result in dislocation of fisheries by Canadian inshore fishermen in Sydney Bight and the southern Gulf of St. Lawrence. However, this could be in part avoided by setting one TAC of 10,000 tons for Subdiv. 4Vn in May - December inclusive and another TAC of 60,000 tons for Subdiv. 4Vn in January - April inclusive plus Div. 4T.

i) Cod in Division 4X Offshore (Res.Doc. 74/25)

Cod on the offshore banks (Browns and LaHave) of Div. 4X belong to a discrete stock which mixes very little with the complex of inshore stocks around southwestern Nova Scotia and the Bay of Fundy. Catches from the offshore stock increased from 2,900 tons in 1962 to 19,000 tons in 1969 and then declined to 9,200 tons in 1970 and to 7,300 tons in 1972. Fishing mortality has been considerably above that giving maximum yield per recruit ( $F_{max} = 0.35$ ), with a resultant decline in stock abundance. Given that the 1962-68 year-classes represent average recruitment to this stock, maximum sustainable yield is about 13,000 tons. However, with catches exceeding this in 1966-69, and indications from research vessel surveys that the stock continued to decline in 1970-72 and that mortality remained high, fishing at  $F_{max}$  would not give this high a yield in 1974. A decline in catches in 1970 corresponded to the imposition of the haddock quota regulations in this area, and as these fisheries are closely related, it is difficult to determine how much the decline in catch was due to lower cod abundance and how much to lower effort. However, there is sufficiently strong evidence of earlier over-exploitation to recommend that 1974 catches should not exceed the current level of about 8,000 tons.

6. Coordinated Groundfish Surveys

STACRES agreed that the Working Group on Coordinated Groundfish Surveys should include consideration of matters related to pelagic surveys and hydro-acoustic surveys. The Report of the Coordinated Surveys Working Group is at Appendix III, and a summary of the activities of this Group is given in Section III of the STACRES Report.

7. Review of TACs at the 1974 Annual Meeting

The Subcommittee will be required to review TACs for all groundfish species at the 1974 Annual Meeting. It is vital that this review should have at its disposal sampling data from national fisheries in 1973 and these should be available to scientists for revising their assessments before the meeting takes place. The Subcommittee therefore

recommends

*that all countries be requested to provide:*

- a) *revised monthly catches in 1973 of each species stock under regulation; and*
- b) *sampling data from 1973 pertaining to these catches.*

These data should be airmailed to reach the Secretariat not later than 31 March 1974. Forms will be provided by the Secretariat for submission of these data and countries are urged to use them. The Secretariat will circulate the catch data and a list of the sampling data which will be available on request.

ANNEX 1 - REPORT OF THE AD HOC MACKEREL WORKING GROUP

Chairman: E. L. Cadima

Rapporteur: T. D. Iles

The Mackerel Working Group met at the Sea Fisheries Institute, Hamburg, Fed. Rep. Germany, during 7-9 January 1974 to evaluate the status of the mackerel stock in SA 5 and 6 based on the most recent data and information available. Participants were present from Canada (R.G. Halliday, T.D. Iles, W.T. Stobo, G.H. Winters), Fed.Rep. Germany (A. Schumacher, H. Dornheim, D. Schnack), Japan (F. Nagasaki), Poland (J. Popiel, A. Paciorowski), USSR (A.S. Bogdanov, V.A. Richter, O.V. Bakarín), UK (D.J. Garrod, J.G. Pope), USA (B. Brown, V. Anthony, E.D. Anderson), and FAO (E.L. Cadima).

1. The Fishery in Subarea 5 and Statistical Area 6 in 1973

Provisional statistics reported to the January 1974 Special Meeting by countries fishing in SA 5 and 6 indicate that the total nominal catch in 1973 was about 366,000 tons (Table 1). This is substantially below the 1973 TAC of 450,000 tons and is less than the 1972 catch of 387,000 tons, the first decrease in catch since the fishery began to develop on a large scale in 1968. Young fish of age-groups 2 and 3 constituted 42% of the 1973 catch in numbers, with age-2 fish being the dominant group (26% by number) of all age-groups present.

Table 1. Nominal catches of mackerel from SA 5 and 6 in 1972 and 1973.

| Country          | Nominal catches (000 tons) |                   |
|------------------|----------------------------|-------------------|
|                  | 1972                       | 1973 <sup>1</sup> |
| Bulgaria         | 23.6                       | 25.3              |
| Canada           | -                          | 0.1               |
| Fed.Rep. Germany | 0.8                        | 1.5               |
| Italy            | 0.8                        | 1.0               |
| Japan            | 1.1                        | 0.5               |
| Poland           | 142.0                      | 117.2             |
| Romania          | 2.5                        | ...               |
| USSR             | 134.1                      | 142.2             |
| USA              | 2.0                        | 1.9               |
| German Dem.Rep.  | 80.5                       | 76.7              |
| Total            | 387.4                      | 366.4             |

<sup>1</sup> Provisional data, as on 15 January 1974.

2. Stock Identity, Inter-relationships and Migrations (Res.Doc. 74/8, 9)

The assumption that the mackerel in the ICNAF Area are divided into two biologically distinct stocks (northern and southern) with some "mixing" in SA 5 and 6 during the winter was discussed on the basis of new information (Res.Doc. 74/8, 9). It was not possible to estimate the degree of mixing of these two spawning stocks, although it was accepted that mixing occurs. A tagging experiment on a substantial scale would be required if the problem is to be resolved, and it was recommended that this matter be discussed at the 1974 Annual Meeting.

3. Data and Parameters Used for Assessmenta) Catch Statistics for 1973

Based on preliminary information available on 7 January 1974, a 1973 catch of 372,000 tons of mackerel was estimated to have been taken, and this figure was used in the assessment. It consisted of catches (000 tons) by Bulgaria (27.9), Canada (0.1), Fed.Rep. Germany (1.5), German Dem.Rep. (80.7), Japan (0.5), Poland (117.2), USSR (142.0) and USA (1.9). However, reports available to the Secretariat later in the meeting gave the 1973 catches listed in Table 1.

b) Catch-per-effort Data, 1968-73

Various catch-per-effort data were considered with a view to analyzing trends in abundance of mackerel during 1968-73. Polish catch-per-day for B-18 trawlers showed an increase from 1971 to 1973, during a period when learning was not considered to be a factor affecting the catches. Taking the relative abundance indices for 1968-71 (catch-per-hour, with learning), as given in Res.Doc. 73/14 (see also *Redbook* 1973, Part I, page 88), and calculating values for 1972 and 1973 (assuming the proportionality between the catch-per-day and catch-per-hour values for 1971), a set of indices is obtained showing a continuous decrease from 1968 to 1971 followed by an increase to 1973 (Table 2). A second set of relative abundance indices (Res.Doc. 74/10) showed a continuous decline in catch-per-effort from 1968 to 1972, and a decline in abundance from 1972 to 1973 was indicated by the US spring bottom trawl survey. No agreement could be reached on trends in abundance, and the Group decided to take both sets of abundance indices for the assessments (Table 2).

Table 2. Mackerel catch per unit effort, 1968-73.

| Year | Polish B-18<br>trawlers<br>Catch/day (tons) | Res.Doc. 73/4<br>Catch/hr (tons)<br>with learning | Res.Doc. 74/10<br>Catch/hr (tons)<br>with learning |
|------|---|---|--|
| 1968 | 25.6  | 1.80  | 1.96   |
| 1969 | 27.5  | 1.32  | 1.52   |
| 1970 | 32.7  | 1.05  | 1.07   |
| 1971 | 31.9  | 0.91  | 0.86   |
| 1972 | 32.1  | 0.97 <sup>1</sup>                                 | 0.54   |
| 1973 | 35.1  | 1.06 <sup>1</sup>                                 | 0.40 <sup>2</sup>                                  |
|      |   | Hypothesis (2)                                    | Hypothesis (1)                                     |

<sup>1</sup> Estimated from catch per day of Polish B-18 trawlers assuming proportionality of 1971 and learning factor equal to 1.

<sup>2</sup> Provisional estimate.

c) Growth Data

The Group decided to consider the following observed average weights by age-groups of mackerel in SA 4 (Res.Doc. 74/9) as more applicable to mackerel in SA 5 and 6 than those calculated from von Bertalanffy parameters, as had been done for the assessment at the 1973 Annual Meeting.

| Age (yr)   | 1  | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  |
|------------|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Weight (g) | 95 | 175 | 266 | 350 | 432 | 506 | 564 | 615 | 659 | 693 |

This particular set of weight data proved to be inconsistent with the age compositions adopted for the period 1968-73, and the results of the assessment were later corrected for this discrepancy (see Section 4 below).

d) Age Composition of Catches

The age composition data for the period 1968-73, accepted as the basis for assessment (Table 3), were prepared by scientists of Bulgaria, German Dem.Rep., Poland and USSR from sampling data collected during the period on commercial fishing vessels. Monthly age composition data were adjusted to monthly nominal catches and combined to give numbers caught in each year by age in Div. 5Z and SA 6.

e) Natural Mortality (M)

The range of values of the natural mortality coefficient (m) from 0.2 to 0.4, used at the 1973 Annual Meeting, was adopted for the assessment, and estimates of the population structures during 1968-73 were calculated for M = 0.2, 0.3 and 0.4. After comparing the results, the Group adopted M = 0.3 for use in the final calculations.



Table 3. Age composition of mackerel catches in Div. 5Z and SA 6 during the period 1968-1973.

| Year | Numbers by age-group (millions) |       |       |       |       |       |       |      |      |      |     |     | Total number (10 <sup>6</sup> ) | Catch (000 tons) | Mean weight (g) |
|------|---------------------------------|-------|-------|-------|-------|-------|-------|------|------|------|-----|-----|---------------------------------|------------------|-----------------|
|      | 0                               | 1     | 2     | 3     | 4     | 5     | 6     | 7    | 8    | 9    | 10  | 11+ |                                 |                  |                 |
| 1968 | 2.1                             | 63.7  | 90.8  | 49.8  | 9.9   | 9.1   | 4.3   | 0.8  | 0.4  | 0.1  | +   | -   | 231.0                           | 59.6             | 258             |
| 1969 | 2.7                             | 133.4 | 171.3 | 82.6  | 20.0  | 6.2   | 5.5   | 4.8  | 2.5  | 1.6  | 0.9 | -   | 431.5                           | 108.3            | 251             |
| 1970 | 2.9                             | 131.3 | 28.9  | 349.4 | 174.0 | 39.7  | 13.9  | 12.5 | 19.6 | 18.0 | 9.0 | -   | 799.2                           | 199.8            | 250             |
| 1971 | 1.1                             | 100.4 | 278.0 | 104.2 | 530.6 | 227.8 | 45.5  | 13.7 | 10.7 | 9.1  | 4.8 | -   | 1325.9                          | 348.7            | 263             |
| 1972 | 10.9                            | 41.4  | 74.3  | 278.4 | 217.8 | 407.4 | 109.0 | 32.7 | 8.5  | 13.1 | 8.9 | -   | 1202.4                          | 386.0            | 321             |
| 1973 | -                               | 87.2  | 332.9 | 209.1 | 243.6 | 163.9 | 190.9 | 34.1 | 13.0 | 6.6  | 4.1 | 1.2 | 1286.6                          | 371.8            | 289             |

f) Total Mortality (Z)

Depending on which set of catch-per-effort data was used, opinion varied on the best estimate of Z for 1973. The Group finally agreed to use two values (representing the extremes of opinion) for assessment purposes: 0.7 and 1.2 (for fully recruited age-groups).

g) Partial Recruitment

Two recruitment patterns were chosen to represent the two views on recruitment, as follows:

| Age (years)    |   | 1  | 2  | 3  | 4   | 5+  |
|----------------|---|----|----|----|-----|-----|
| Hypothesis (1) | % | 25 | 50 | 90 | 100 | 100 |
| Hypothesis (2) | % | 10 | 30 | 40 | 60  | 100 |

4. Results of Assessments

The number of possible calculations (using cohort analysis techniques) implied by the ranges of individual parameters agreed on was reduced to four, characterized as follows:

| Hypothesis <sup>1</sup> | M   | Z (age 5 and over) | Partial recruitment (%) by age |    |    |     |     |
|-------------------------|-----|--------------------|--------------------------------|----|----|-----|-----|
|                         |     |                    | 1                              | 2  | 3  | 4   | 5+  |
| (1)                     | 0.3 | 1.2                | 25                             | 50 | 90 | 100 | 100 |
| (1a)                    | 0.3 | 1.2                | 10                             | 30 | 40 | 60  | 100 |
| (2)                     | 0.3 | 0.7                | 10                             | 30 | 40 | 60  | 100 |
| (2a)                    | 0.3 | 0.7                | 25                             | 50 | 90 | 100 | 100 |

<sup>1</sup> Hypothesis (1) and (2) correspond to the two different opinions as to both the estimates of Z and the partial recruitment patterns, and give the extreme cases to be discussed.

Comparison of the initial results of the calculations (as catch in weight), i.e. using the mean weight-at-age data for SA 4 (Section 1(c) above), with the observed catches in the fishery indicated a discrepancy, as shown in Fig. 1. A linear relationship (correlation coefficient  $r = 0.996$ ) is clearly demonstrated, and this was used to correct the catches and population biomasses. It was concluded that the Canadian mackerel samples in SA 4 were taken at a time of the year when condition factors were higher than the average in the SA 5 and 6 mackerel fishery.

The two hypotheses give widely different results in terms of population size and possible projected catches (Table 4), and there is no clear-cut evidence to allow a choice between the projected catches. Both cases indicate a decline in biomass in recent years. However, the yield-per-recruit curves derived from the calculations in Table 5, within the range of values of F for each of the hypotheses ( $F = 0.4$  and  $F = 0.9$ ), are very similar (Fig. 2). For Hypothesis (1) the fishery is fully exploited

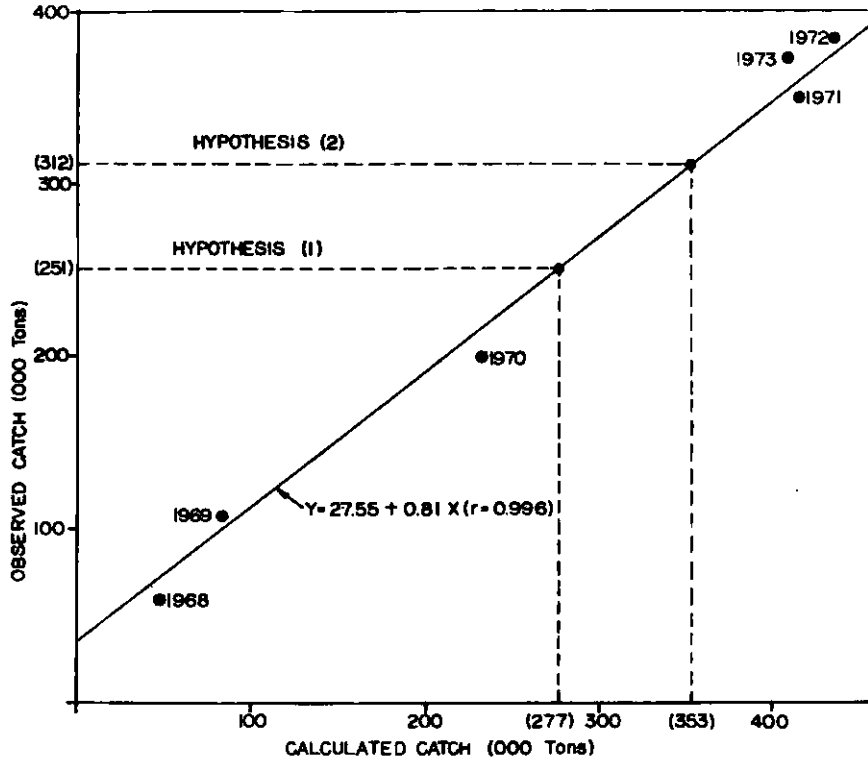


Fig. 1. Relationship between calculated and observed mackerel catches for the period 1968-73.

Table 4. Summary results of the mackerel stock assessment in Div. 5Z and SA 6.

| Hypothesis | 1973 F | % Recruitment to fishery by age |    |    |     |     |
|------------|--------|---------------------------------|----|----|-----|-----|
|            |        | 1                               | 2  | 3  | 4   | 5+  |
| (1)        | 0.9    | 25                              | 50 | 90 | 100 | 100 |
| (2)        | 0.4    | 10                              | 30 | 40 | 60  | 100 |

|                | Year | Recruitment at age 1 (10 <sup>6</sup> ) | F (100%) average of age-groups 5 to 9 | Yield (000 tons) | Population biomass (age 2 and older) at end of year (000 tons) |
|----------------|------|---|---------------------------------------|------------------|--|
| Hypothesis (1) | 1967 |   |                                       |                  | 424  |
|                | 1968 | 5801                                    | 0.028                                 | 60               | 756  |
|                | 1969 | 2082                                    | 0.067                                 | 108              | 923  |
|                | 1970 | 2322                                    | 0.42                                  | 200              | 959  |
|                | 1971 | 1011                                    | 0.44                                  | 349              | 745  |
|                | 1972 | (1450)                                  | 0.73                                  | 386              | 520  |
|                | 1973 | (2320)                                  | 0.90                                  | 372              | 320  |
|                | 1974 | 2320                                    | 0.90                                  | 251              | 283  |
| Hypothesis (2) | 1967 |   |                                       |                  | 495  |
|                | 1968 | 7146                                    | 0.028                                 | 60               | 897  |
|                | 1969 | 2936                                    | 0.05                                  | 108              | 1134   |
|                | 1970 | 4410                                    | 0.31                                  | 200              | 1313   |
|                | 1971 | 3203                                    | 0.34                                  | 349              | 1262   |
|                | 1972 | (1790)                                  | 0.47                                  | 382              | 1260   |
|                | 1973 | (2860)                                  | 0.40                                  | 372              | 1068   |
|                | 1974 | 2860                                    | 0.40                                  | 312              | 1021   |

( ) 1972: recruitment at age 1 = 25% of 1967 year-class.  
 ( ) 1973: recruitment at age 1 = 40% of 1967 year-class.

at  $F = 0.9$ ; for Hypothesis (2) the fishery is approaching full exploitation (about 86% of maximum sustainable yield). It follows that the amount of recruitment to the fishery at age 1 has much more influence on estimates of possible catch than the partial recruitment pattern. It also follows that significant increases in  $F$  will not produce significant increases in yield per recruit.

If no increase in effort is allowed in 1974, the projected catches are 251,000 tons by Hypothesis (1) (i.e.  $F = 0.9$ , recruitment complete at age 4) and 312,000 tons by Hypothesis (2) (i.e.  $F = 0.4$ , recruitment complete at age 5). Catches in 1974 significantly higher than these, in both instances, will be achieved only with large increases in  $F$ . There will be, again in both cases, a corresponding decline in the biomass for 1975, unless the size of incoming year-classes are larger than anticipated. There is no scientific basis for choosing between the two catch levels as a recommended TAC for 1974.

Table 5. Mackerel catches and population biomasses in SA 5 and 6 for a range of  $F$ s under the two hypotheses considered, with  $M = 0.3$ .

| Hypothesis | 1973 F | % Recruitment to fishery by age |    |    |     |     |
|------------|--------|---------------------------------|----|----|-----|-----|
|            |        | 1                               | 2  | 3  | 4   | 5+  |
| (1)        | 0.9    | 25                              | 50 | 90 | 100 | 100 |
| (2)        | 0.4    | 10                              | 30 | 40 | 60  | 100 |

|                | F   | Z    | 1974 catch (000t) | Biomass (age 2 and over) at end of 1974 (000t) | Equilibrium catch, population biomass and yield per recruit |                                 |                   |
|----------------|-----|------|-------------------|--|---|---------------------------------|-------------------|
|                |     |      |                   |  | Catch (000t)  | Biomass (age 2 and over) (000t) | Yield/Recruit (g) |
| HYPOTHESIS (1) | .1  | .4   | 41                | 516  | 135   | 1350                            | 58                |
|                | .2  | .5   | 79                | 484  | 197   | 999                             | 85                |
|                | .3  | .6   | 114               | 454  | 228   | 786                             | 98                |
|                | .4  | .7   | 146               | 426  | 244   | 645                             | 105               |
|                | .5  | .8   | 176               | 401  | 253   | 545                             | 109               |
|                | .6  | .9   | 204               | 378  | 258   | 472                             | 111               |
|                | .7  | 1.0  | 230               | 356  | 260   | 416                             | 112               |
|                | .8  | 1.1  | 254               | 336  | 260   | 372                             | 112               |
|                | .9  | 1.2  | 277               | 317  | 260   | 336                             | 112               |
|                | 1.0 | 1.3  | 298               | 300  | 260   | 306                             | 112               |
|                | 1.2 | 1.5  | 336               | 269  | 257   | 260                             | 111               |
| HYPOTHESIS (2) | 1.5 | 1.8  | 385               | 230  | 253   | 211                             | 109               |
|                | 1.8 | 2.1  | 425               | 198  | 248   | 177                             | 107               |
|                | .1  | .4   | 98                | 1450   | 145   | 1826                            | 51                |
|                | .2  | .5   | 189               | 1373   | 217   | 1462                            | 76                |
|                | .3  | .6   | 274               | 1301   | 258   | 1227                            | 90                |
|                | .4  | .7   | 353               | 1233   | 283   | 1064                            | 99                |
|                | .5  | .8   | 427               | 1171   | 299   | 942                             | 105               |
|                | .6  | .9   | 497               | 1113   | 309   | 849                             | 108               |
|                | .7  | 1.0  | 562               | 1058   | 316   | 774                             | 110               |
|                | .8  | 1.1  | 623               | 1007   | 321   | 712                             | 112               |
|                | .9  | 1.2  | 680               | 960  | 324   | 660                             | 113               |
| 1.0            | 1.3 | 734  | 915               | 326  | 616   | 114                             |                   |
| 1.2            | 1.5 | 832  | 835               | 328  | 544   | 115                             |                   |
| 1.5            | 1.8 | 960  | 731               | 328  | 463   | 115                             |                   |
| 1.8            | 2.1 | 1130 | 596               | 325  | 372   | 114                             |                   |

Each of the possible levels for TAC is associated with a set of assumptions as to the level of  $F$  (i.e. a measure of the proportion actually being removed) and to a particular recruitment pattern which represents the availability of age-groups to the fishery. For those two different 1974 possible catches, the consequences in terms of biomass changes by 1975 of the two hypotheses are as follows:

|                |     |     |
|----------------|-----|-----|
| 1974 Catch     | 251 | 312 |
| Hypothesis (1) | 88  | 70  |
| Hypothesis (2) | 100 | 96  |

This gives the 1975 initial biomass as percent of 1974 initial biomass for two levels of 1974 catch under two sets of assumptions as to 1973 F (= 1974 F) and recruitment pattern.

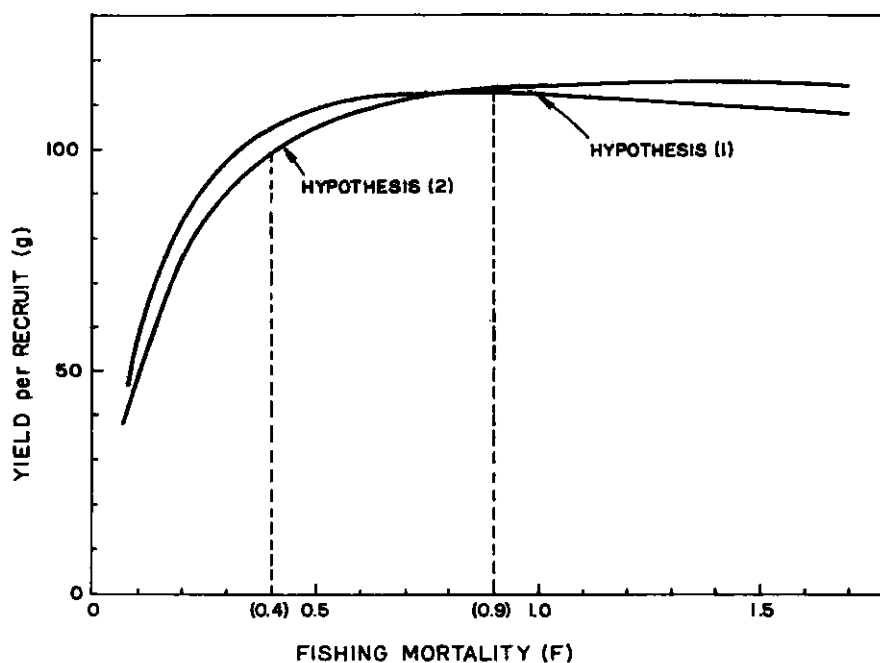


Fig. 2. Yield per recruit curves for mackerel in SA 5 and 6.

5. Age at First Capture and Size Limit Considerations

Assessments carried out at the 1973 Annual Meeting established that delaying the age at first capture of mackerel by avoiding the capture of very young fish (0, 1, and 2 years old) would improve yield per recruit and the biomass of the adult stock. Seasonal or area closure of the fishery could not achieve this, but research is in hand to determine whether it could best be achieved by regulation of mesh size or a minimum size limit and to estimate how the degree of benefit would vary according to the level at which a regulation might be set. For example, it may be appropriate to establish a minimum size limit close to the length at maturity (30 cm) similar to that imposed in the Norwegian national mackerel fishery in the North Sea for fishmeal.

It is reported that selectivity experiments are expected to give results that may be available for consideration at the 1975 Mid-term Meeting.

6. The Fishery in Subareas 3 and 4

Nominal catches of mackerel in SA 3 and 4 reached 37,000 tons in 1973. These were taken from a group of mackerel which spawn in a different area from the major stock in SA 5 and 6, but it is suspected that, if they are drawn from a separate stock, both stocks may be mixed together at the time of the fishery in SA 5 and 6. If this is so, it may influence the allocation of the existing TAC between subareas; if they are not mixing, it may be necessary to establish a separate TAC for mackerel in SA 3 and 4. The information is not yet sufficient to decide on the degree of mixing between mackerel in SA 5 and 6 on the one hand and in SA 3 and 4 on the other or to estimate the quantity of mackerel in SA 3 and 4, and therefore it is not yet possible to advise the Commission on a level of catch for mackerel which would be appropriate to the fishery in these northern areas.

It is urged that member countries should initiate research programs, giving special emphasis to those which can elucidate stock relationships, the mixing problem and estimates of potential recruitment.

ANNEX 2 - REPORT OF THE HERRING WORKING GROUP

Chairman: T. D. Iles

Rapporteur: W. T. Stobo

The Herring Working Group met during 7-12 January 1974 at the Institute for Sea Fisheries, Hamburg, Fed. Rep. Germany, with representatives present from Canada, Fed. Rep. Germany, Japan, Poland, USSR, UK and USA. The main tasks of the Group were to revise the assessments made at the January 1973 Mid-term Meeting for the Nova Scotia (Div. 4XW(b)), Gulf of Maine (Div. 5Y), and Georges Bank (Div. 5Z + SA 6) herring stocks. The Group also reviewed recommendations in regard to ageing techniques and the current status of herring larval and juvenile surveys. The following research documents were reviewed: larval surveys (Res.Doc. 74/14, 15, 16, 17, 18); assessments (Res.Doc. 74/13).

1. Stock Identity, Relative Size and Inter-relationships

a) Juvenile Stage

The results of the 1973 herring juvenile surveys (Res.Doc. 73/84), updated by data of Fed.Rep. Germany survey samples, were reviewed as indicators of future recruitment potential. Fed.Rep. Germany age data showed that for the Georges Bank area and the area to the south and west the 1971 year-class made up only about 1% of the total numbers in survey hauls, whereas the 1970 year-class accounted for about 90%. This indicates that the 1971 year-class is much smaller than the 1970 year-class.

The coastal juvenile fisheries caught many fewer fish of the 1971 year-class in 1973 than of the 1970 year-class in 1972; for the New Brunswick (weir) fisheries the proportion was 34%, for Maine 50% and for Nova Scotia 22%. The Maine figures for 1973 included considerably greater amounts of purse-seine caught fish, which probably results in overestimating the relative size of the 1971 year-class. It was not possible to accept either set of estimates (i.e. from the juvenile surveys or the juvenile fisheries) as reliable quantitative indices of year-class size, but it was agreed that the 1971 year-class is relatively poor and that it can be accepted tentatively as being the same size as the 1969 year-class, the poorest on record. This will not affect estimates of total allowable catch for 1974 which will be dependent largely on the 1970 year-class, but it does have implications for TACs in 1975 and later years.

b) Larval Stage

The ICNAF larval herring survey program was continued in 1973. Offshore cruises with standardized sampling methods at the standard stations were carried out by Fed.Rep. Germany, Poland, USA and USSR. No stations were occupied in the coastal Gulf of Maine. The Canadian larval cruises were restricted to the Bay of Fundy and southwest Nova Scotia. Preliminary reports (Res.Doc. 74/14, 16, 17, 18), containing some qualitative and quantitative results, were presented. The results of the Canadian cruises were not available. In most areas larger concentrations of larvae, both large and small, were observed in 1973 than in 1972. The distribution of small larvae (<10 mm) delimited the same distinct spawning areas that had been observed previously in the areas surveyed, i.e. Georges Bank, Nantucket Shoals and off southwest Nova Scotia.

Georges Bank. The abundance of small larvae (<10 mm) in 1973 was about ten times greater than in 1972, indicating that larval production was an order of magnitude greater.

Nantucket Shoals. An increase in numbers of small larvae was recorded, compared to 1972, but to a much smaller degree than on Georges Bank (less than twofold).

Nova Scotia. Larval abundance was in the same range as in 1972. The significant increase in larval abundance in 1973 on the Georges Bank - Nantucket Shoals area indicates an increase in spawning stock size in 1973 relative to that in 1972.

The results of the 1971 and 1972 larval surveys were reviewed (Res.Doc. 74/15). It was agreed that larval surveys can provide much information on stock relationships. Concentrations of larvae less than 10 mm observed in 1971 and 1972 defined four main spawning areas: Georges Bank, Nantucket Shoals, the coastal Gulf of Maine, and southwest Nova Scotia. The distribution of larvae greater than 15 mm tend to overlap in the Georges Bank - Nantucket Shoals area, but the relative discreteness of the distribution between the areas of the three major stock complexes (Georges Bank - Nantucket Shoals, coastal Gulf of Maine, and southwest Nova Scotia) is maintained.

The value of larval surveys increases as analysis of data over an increasingly long time series becomes possible. Coupled with juvenile surveys, they may improve our knowledge of larval mortality and the size of the incoming year-classes. All participants agreed that the surveys

should be continued. The suggestion was made that larval sampling with Bongo nets should be made simultaneously with juvenile sampling, as the Fed.Rep. Germany will attempt to do in 1974.

## 2. Review of Ageing Techniques

The recommendations of a herring ageing workshop held in December 1972, with participants from Canada and USA (Res.Doc. 73/2), were discussed. It was agreed that they be adopted as the conventions for statistical and sampling reporting and are listed here.

- a) That the generally accepted 1 January birthday for fishes of the Northwest Atlantic be adopted for herring.
- b) The term age-group should be used instead of age because it is inclusive of both spring and autumn spawners. A fish is placed in age group 0 in the year of its birth; on 1 January of the year following its birth, it enters age-group 1 and progresses to subsequent age-groups in similar fashion. Arabic numerals should be substituted for the conventional Roman numerals for ease of tabulation; thus, age-group eight would be designated as 8-group rather than VIII-group.
- c) Year-class designation of main importance for stock assessment purposes and age-composition data, should be reported to ICNAF on this basis.
- d) The year-class is determined by subtracting the age-group from the year of sampling. If opaque zones are counted, an age-group is defined as:
  - i) for spring spawners: the number of completed opaque zones prior to 1 January of the sampling year;
  - ii) for autumn spawners: the number of completed opaque zones prior to 1 January of the sampling year plus one (1).

If hyaline zones are counted, the age-group is defined as:

- i) for spring spawners: the number of completed hyaline zones prior to 1 January of the sampling year plus one (1);
- ii) for autumn spawners: the number of completed hyaline zones prior to 1 January of the sampling year including the nucleus as the first zone.

In addition it was recommended that, in reporting to ICNAF, countries should indicate whether opaque or hyaline zones were used.

## 3. Fishery Trends

Table 1 lists the provisional herring catches by country and area for 1973. The total 1973 catch was 474,000 tons, 86% of the 1972 catch of 547,000 tons and 49% of the peak 1969 catch of 965,000 tons. Catches in the Gulf of St. Lawrence - Newfoundland stocks (SA 3 and Div. 4RST) in 1973 were 78,000 tons compared to 119,000 tons in 1972. This 35% decline is very largely accounted for by much smaller catches in the winter fishery of the south coast of Newfoundland. Catches from the Banquereau stock (Div. 4VW(a)) declined from 38,000 tons in 1972 to 28,000 tons in 1973. A TAC for this stock in 1974 of 45,000 tons was set by the Commission at its 1973 Annual Meeting.

Three stocks were under quota regulation in 1973. Individual quota allocations and catches are listed by country in Table 2. These catches include all herring caught, by all fisheries and gears, both inside and outside the Convention Area.

The total catch in Div. 4X and Div. 4W (south of 44°52'N) was 135,000 tons. This includes a purse seine catch of 20,860 tons taken near Grand Manan Island (at the entrance to the Bay of Fundy) during the summer in a fishing area which extends into Div. 5Y. This area is almost contiguous with the area fished during the Nova Scotia summer fishery, and from sampling information it could be assumed that the Nova Scotia stock was being exploited. A detailed breakdown of catches by area, fishery and gear is given in the section dealing with the assessment of this stock (see below).

Catches in the Gulf of Maine (Div. 5Y) were 32,454 tons compared with 62,416 tons in 1972. In the Georges Bank area (Div. 5Z and SA 6) the 1973 catch at 201,645 tons was about 16% higher than in 1972.

In all areas under quota regulation in 1973, the 1970 year-class made up at least a substantial proportion of the catches. The 1971 year-class, on evidence presently available, is expected to be relatively small.

Table 1. Provisional herring catches (tons) by country and area (stock) in 1973.

| Country           | Nfld-Gulf of St. Lawrence |              | Banquereau   |             |                    | Nova Scotia and Bay of Fundy |                    |                    |                    | Gulf of Maine      | Georges Bank     |                   | Total        |               |
|-------------------|---------------------------|--------------|--------------|-------------|--------------------|------------------------------|--------------------|--------------------|--------------------|--------------------|------------------|-------------------|--------------|---------------|
|                   | SA 3                      | 4RST         | 4Vn          | 4Vs         | 4W(a) <sup>1</sup> | 4W(b) <sup>2</sup>           | 4X(a) <sup>3</sup> |                    | 4X(b) <sup>4</sup> | 5Y                 | 5Z               | SA 6              |              |               |
|                   |                           |              |              |             |                    |                              | >23 cm             | <23 cm             |                    |                    |                  |                   |              |               |
| Can(MQ)           | -                         | 34421        | 16800        | -           | 5542               | -                            | 48626 <sup>5</sup> | 11951 <sup>5</sup> | 29442 <sup>5</sup> | 12195 <sup>5</sup> | 4110             | 5086              | -            | 168173        |
| Can(N)            | 16015                     | 27218        | 3000         | -           | 1000               | -                            | -                  | -                  | -                  | -                  | -                | -                 | -            | 47233         |
| FRG               | -                         | -            | 557          | 675         | -                  | -                            | 228                | -                  | -                  | -                  | 690 <sup>6</sup> | 31006             | -            | 33156         |
| Japan             | -                         | -            | -            | 108         | -                  | 32                           | 1239               | -                  | -                  | -                  | -                | 1219              | 21           | 2619          |
| Poland            | -                         | -            | -            | -           | -                  | -                            | -                  | -                  | -                  | -                  | -                | 47071             | 2215         | 49286         |
| Romania           | -                         | -            | -            | -           | -                  | -                            | -                  | -                  | -                  | -                  | -                | 1300 <sup>7</sup> | -            | 1300          |
| USSR              | -                         | -            | -            | 73          | -                  | 13153                        | 17889              | -                  | -                  | -                  | -                | 42241             | 10067        | 83423         |
| USA               | -                         | -            | -            | -           | -                  | -                            | -                  | -                  | -                  | 22370              | -                | 4440              | 446          | 27256         |
| Oth. Mem.         | -                         | -            | -            | -           | -                  | -                            | -                  | -                  | -                  | -                  | -                | 3254              | 19           | 3273          |
| GDR               | -                         | -            | -            | -           | -                  | -                            | -                  | -                  | -                  | -                  | 5284             | 52257             | 1003         | 58544         |
| <b>Total</b>      | <b>16015</b>              | <b>61639</b> | <b>20357</b> | <b>856</b>  | <b>6542</b>        | <b>13185</b>                 | <b>67982</b>       | <b>11951</b>       | <b>29442</b>       | <b>12195</b>       | <b>32454</b>     | <b>187874</b>     | <b>13771</b> | <b>474263</b> |
| <b>1972 Total</b> | <b>52025</b>              | <b>66698</b> | <b>12388</b> | <b>2382</b> | <b>18002</b>       | <b>15503</b>                 |                    | <b>143771</b>      |                    |                    | <b>62416</b>     | <b>158549</b>     | <b>15642</b> | <b>547375</b> |

<sup>1</sup> Div. 4W north of 44°52'N.

<sup>2</sup> Div. 4W south of 44°52'N.

<sup>3</sup> Div. 4X offshore and Nova Scotia inshore.

<sup>4</sup> New Brunswick side of Bay of Fundy.

<sup>5</sup> Catch partitioned into adults and juveniles using yearly length frequencies from Res.Doc. 74/13 and conversion values from Res.Doc. 73/91.

<sup>6</sup> 191 tons transferred to Div. 5Z for assessment purposes.

<sup>7</sup> No catch reported; assumed to be 1973 quota allocation.

Table 2. Herring catches and quota allocations (tons) for 1973.

| Country          | 4XW(b)   |                | 5Y   |               | 5Z + 6             |                |
|------------------|--|----------------|--|---------------|--------------------|----------------|
|                  | Catch  | Quota          | Catch  | Quota         | Catch              | Quota          |
| Canada           | 78,068<br>(102,214) <sup>1</sup>               | 57,000         | 3,833<br>(4,110) <sup>1</sup>                | 4,000         | 5,086              | 5,050          |
| Fed.Rep. Germany | 228  | - <sup>2</sup> | 690  | 1,000         | 31,006             | 31,600         |
| Japan            | 1,271  | 1,350          | -  | -             | 1,240              | 1,200          |
| Poland           | -  | -              | -  | -             | 49,286             | 49,400         |
| Romania          | -  | -              | -  | -             | 1,300 <sup>3</sup> | 1,300          |
| USSR             | 31,042   | 31,050         | -  | -             | 52,308             | 48,200         |
| USA              | -  | -              | 16,234<br>(22,370) <sup>1</sup>              | 19,750        | 4,886              | 5,250          |
| Others - Bul.    | -  | -              | -  | -             | 878 <sup>4</sup>   | -              |
| - Fra.           | -  | 600            | -  | 250           | 2,395              | 8,000          |
| - GDR            | -  | -              | 5,284  | -             | 53,260             | -              |
| <b>Totals</b>    | <b>110,609</b><br><b>(134,755)<sup>1</sup></b> | <b>90,000</b>  | <b>26,041</b><br><b>(32,454)<sup>1</sup></b> | <b>25,000</b> | <b>201,645</b>     | <b>150,000</b> |

<sup>1</sup> Total catch including juveniles.

<sup>2</sup> No quota allocation; catch to be applied against quota allocation for "others".

<sup>3</sup> Catch data not available; assumed that quota was taken.

<sup>4</sup> Bulgarian data for Jan - Oct 1973.

4. Herring Assessments

a) Gulf of Maine (Div. 5Y)

Catch statistics. The total catch of herring in Div. 5Y by USA, Canada, Fed.Rep. Germany and German Dem.Rep. was 32,645 tons, 47% less than the amount caught in 1972. The catch by country, partitioned as adult and juvenile catches, are shown in Table 3.

Table 3. Catches in the Div. 5Y adult and juvenile herring fisheries in 1973.

| Country | Catches (tons)                    |                  | Total  |        |
|---------|-----------------------------------|------------------|--------|--------|
|         | Adult fishery                     | Juvenile fishery |        |        |
| USA     | - Ages 1-3                        | 1,124            | 15,110 | 16,234 |
|         | - Age 4 and older                 | 4,878            | 1,258  | 6,136  |
|         | Sub-total                         | 6,002            | 16,368 | 22,370 |
| Canada  | - Ages 1-3                        | 277              | -      | 277    |
|         | - Age 4 and older                 | 3,833            | -      | 3,833  |
|         | Sub-total                         | 4,110            | -      | 4,110  |
| FRG     | Age compositions not yet reported | 690              | -      | 690    |
| GDR     |                                   | 5,284            | -      | 5,284  |
| TOTAL   |                                   | 16,086           | 16,368 | 32,454 |

The catch in the adult herring fishery declined from 42,129 tons in 1972 to 16,085 tons in 1973 (this excludes 191 tons taken by the Fed.Rep. Germany in the southeast portion of Div. 5Y). There was some indication in 1973 that the unusual distribution of catches was due in part to changes in availability. All countries showed declines in catch, with the US catch of adults declining from 18,698 to 6,001 tons, the Canadian catch of adults from 11,637 to 4,110 tons, Fed.Rep. Germany catch from 2,936 to 690 tons and German Dem.Rep. catch from 8,898 to 5,284 tons; the Maine juvenile catch also declined from 19,513 tons in 1972 to 16,369 tons in 1973.

Year-class abundance and stock size. The catches in the Div. 5Y adult fishery (Table 4) show the continual decline in older fish and the great dependence of the fishery on the recruitment of the 1970 year-class. The good year-classes of 1960 to 1963 constituted 53%, 21%, 3% and 3% of the total catch (by weight) in the years 1970-73. The very poor year-classes of 1968 and 1969 constituted 2%, 13%, 23% and 42% of the total catch in the same years. The catch of the 1966 year-class (the strongest year-class between those of 1963 and 1970) declined from about 10,000 tons in 1972 to less than 4,000 tons in 1973. The size of the 1970 year-class is not known, but it appears large in the herring fisheries of Div. 5Z and 4X, and there has been some parallelism in year-class strength among the different fisheries. The catch of the 1970 year-class in the juvenile fishery at age 2 was about one-half of that of the 1966 year-class, although there are indications that the 1972 catch level may have been limited by plant capacities and not abundance.

Any large catch in 1974 must come substantially from the 1970 year-class, and the estimate of allowable catch in 1974 depends critically on the estimate of abundance of this year-class. The 1971 year-class appears to be poor, as judged from the catches of this year-class in the juvenile fishery in 1973. The age-2 herring catch of the 1971 year-class was larger than that of the 1969 year-class but less than that of the 1967 and 1968 year-classes.

Estimates of stock size in Div. 5Y for the years 1967-74 are given in Table 5. Following an accumulation of stock before 1968 from earlier strong year-classes, the adult (age 4 and older) stock size has steadily declined from 1968 to 1973. The estimated adult stock size (age 4 and older) at the beginning of 1973 was only 27% of that of 1967 and 1968. Under all three assumptions of recruitment in 1973 of the 1970 year-class, the 1974 stock size (age 4 and older) has increased (Table 5).



Table 4. Herring catches from the Div. 5Y adult fishery by age-group, 1967-73.

| Year              | Catch in numbers (000s) by age-group |       |       |       |       |       |       |       |       | Age 2 and older |               | Age 3 and older |               |
|-------------------|--------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-----------------|---------------|-----------------|---------------|
|                   | 2                                    | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 9+    | Number (000s)   | Weight (tons) | Number (000s)   | Weight (tons) |
| 1967              | 21                                   | 317   | 2953  | 7410  | 13366 | 8197  | 585   | 343   | 493   | 33644           | 7807          | 33665           | 7805          |
| 1968              | 564                                  | 17734 | 17467 | 29458 | 29280 | 27974 | 18387 | 3166  | 4372  | 148402          | 31900         | 147838          | 31851         |
| 1969              | 1722                                 | 39044 | 6192  | 9850  | 22476 | 26618 | 21124 | 11028 | 4289  | 142343          | 32406         | 140621          | 32256         |
| 1970              | 3417                                 | 9327  | 26370 | 18350 | 26835 | 26943 | 23344 | 27993 | 16440 | 179021          | 40187         | 175602          | 39890         |
| 1971              | 634                                  | 23129 | 22676 | 33979 | 36750 | 26335 | 16011 | 11020 | 10588 | 181122          | 38575         | 180488          | 38520         |
| 1972              | 21243                                | 16992 | 37487 | 39758 | 42449 | 27493 | 9347  | 1434  | 2072  | 199375          | 42169         | 178132          | 40321         |
| 1973 <sup>1</sup> | 1485                                 | 16559 | 6077  | 12923 | 15926 | 12631 | 6090  | 2113  | 1467  | 75271           | 15800         | 73786           | 15671         |

<sup>1</sup> The GDR catch in 1973 was not available when the calculations were made; a GDR catch of 5,000 tons was assumed with distribution over year-classes the same as for other countries.

Table 5. Stock sizes of adult herring in Div. 5Y, 1967-74.

| Year | Stock sizes (millions) at beginning of year by age-groups |     |     |                 |                 |                 |                 |                |                           | Age 3 and older |                           | Age 4 and older |  |
|------|---|-----|-----|-----------------|-----------------|-----------------|-----------------|----------------|---------------------------|-----------------|---------------------------|-----------------|--|
|      | 3   | 4   | 5   | 6               | 7               | 8               | 9               | 9+             | Number (10 <sup>6</sup> ) | Weight (000t)   | Number (10 <sup>6</sup> ) | Weight (000t)   |  |
| 1967 | 203   | 186 | 182 | 183             | 98              | 16              | 7               | 4              | 879                       | 184             | 676                       | 153             |  |
| 1968 | 239   | 166 | 147 | 135             | 124             | 64              | 11              | 7              | 893                       | 191             | 654                       | 154             |  |
| 1969 | 288   | 180 | 120 | 94              | 84              | 76              | 35              | 8              | 885                       | 186             | 597                       | 141             |  |
| 1970 | 192   | 200 | 142 | 89              | 56              | 45              | 43              | 22             | 798                       | 169             | 597                       | 139             |  |
| 1971 | 142   | 149 | 140 | 99              | 49              | 22              | 15              | 13             | 629                       | 133             | 487                       | 111             |  |
| 1972 | 591   | 96  | 102 | 84              | 48              | 16              | 3               | 4              | 412                       | 89              | 353                       | 80              |  |
| 1973 | 2882  | 26  | 45  | 48              | 31              | 15              | 5               | 3              | 461                       | 86              | 173                       | 42              |  |
|      | 4323  |     |     |                 |                 |                 |                 |                | 605                       | 109             |                           |                 |  |
|      | 575 <sup>4</sup>  |     |     |                 |                 |                 |                 |                | 748                       | 131             |                           |                 |  |
| 1974 | 59  | 221 | 330 | 16 <sup>5</sup> | 25 <sup>5</sup> | 25 <sup>5</sup> | 14 <sup>5</sup> | 7 <sup>5</sup> | 371                       | 73              | 312                       | 64              |  |
|      |   | 457 |     |                 |                 |                 |                 |                | 480                       | 92              | 421                       | 83              |  |
|      |   |     |     |                 |                 |                 |                 |                | 607                       | 115             | 548                       | 106             |  |

- <sup>1</sup> Assuming an F at age 2 in the juvenile fishery of 0.67 (the average over the 1966-68 year-classes).
- <sup>2</sup> Recruitment assumed to be equal to 1966 year-class at age 3.
- <sup>3</sup> Recruitment assumed to be 1.5 times 1966 year-class at age 3.
- <sup>4</sup> Recruitment assumed to be 2.0 times 1966 year-class at age 3.
- <sup>5</sup> From  $N_{i-1} - (F_i + 0.2)$  where i refers to the year-classes in 1973, and  $F_i$  from cohort analysis.

Estimates of F in 1973 to give 1974 stock size (age 5 and older). Catches of the 1966 and the 1963 year-classes in the Maine juvenile fisheries as 2-year-olds were very similar, and it was assumed that these two year-classes were of the same size. In the cohort analysis of the adult fishery, using 1972 as the base year, estimates of the size of the 1963 year-class in 1968 as 5-year-olds would be expected to be relatively unbiased by the assumed starting Fs. This estimate was therefore used to give the size of the 1966 year-class in 1971 as 5-year-olds. This size was equivalent to an F = 0.8 for this year-class in 1972, which gave 1972 Fs for other year-classes by using proportions from 1970 and 1971 Fs. These Fs were applied to 1972 stock size by age-group to give the 1973 stock size by age-group. The 1973 stock size and 1973 catch then gave estimates of fishing mortalities for 1973 (Table 6). These 1973 Fs were used to give year-class size in 1973 for age 4 and older fish and in 1974 for age 5 and older fish.

Table 6. Estimates of fishing mortality (F) in the Div. 5Y adult herring fishery from cohort analysis, assuming M = 0.2.

| Year | Fishing mortality (F) by age-group                             |                   |                   |                   |                   |                   |                   |                   | Average F <sup>1</sup> |               |
|------|--|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|------------------------|---------------|
|      | 3  | 4                 | 5                 | 6                 | 7                 | 8                 | 9                 | 9+                | Age 3 & older          | Age 4 & older |
| 1967 | -  | 0.04              | 0.10              | 0.19              | 0.22              | 0.10              | 0.12              | 0.36              | 0.10                   | 0.13          |
| 1968 | 0.09   | 0.12              | 0.25              | 0.27              | 0.29              | 0.38              | 0.37              | 1.07              | 0.24                   | 0.26          |
| 1969 | 0.16   | 0.04              | 0.10              | 0.31              | 0.43              | 0.37              | 0.42              | 0.80              | 0.21                   | 0.23          |
| 1970 | 0.06   | 0.16              | 0.15              | 0.40              | 0.75              | 0.87              | 1.27              | 1.63              | 0.35                   | 0.44          |
| 1971 | 0.20   | 0.18              | 0.31              | 0.53              | 0.91              | 1.69              | 1.58              | 1.87              | 0.46                   | 0.53          |
| 1972 | 0.42 <sup>2</sup>  | 0.56              | 0.56              | 0.80              | 0.97              | 1.00              | 0.65              | 0.67              | 0.66                   | 0.70          |
| 1973 | 0.065 <sup>3</sup><br>0.040 <sup>3</sup><br>0.030 <sup>3</sup> | 0.29 <sup>4</sup> | 0.38 <sup>4</sup> | 0.45 <sup>4</sup> | 0.59 <sup>4</sup> | 0.59 <sup>4</sup> | 0.65 <sup>4</sup> | 0.80 <sup>4</sup> | 0.21<br>0.16<br>0.13   | 0.45          |

<sup>1</sup> The average Fs are weighted over year-classes by stock size in numbers.

<sup>2</sup> From iteration of exploitation rate with N<sub>3</sub> determined from N<sub>2</sub>e<sup>-(0.67 + 0.20)</sup>, where 0.67 is F averaged over 1966-68 year-classes in juvenile fishery.

<sup>3</sup> From assumption of 3 levels of recruitment relative to the strength of the 1966 year-class at age 3.

<sup>4</sup> From iteration of exploitation rate where N<sub>1</sub> (for 1973) = N<sub>1-1</sub>e<sup>-Z</sup>i-1.

Recruitment in 1974 of 3- and 4-year-old fish. Three levels of year-class size for the 1970 year-class, as 3-year-olds in 1973, were assumed, viz. 1.0, 1.5, and 2.0 times the size of the 1966 year-class. Comparison of the 1973 catch for each of the three assumptions gave three estimates of F for this year-class in 1973 and three estimates of year-class size in 1974. Recruitment of the 1971 year-class in 1974 was equated to that of the 1969 year-class in 1972. This 1969 year-class was the weakest yet recorded in the fishery. For each estimate of 1970 year-class size (in each case coupled to the same estimate for the 1971 year-class), a range of fishing mortality was applied to the 1974 stock size to generate a range of catches in 1974 and stock sizes for 1975 (Table 7). Recruitment in 1975 was assumed to be slightly less (27,000 tons) than the average observed in the adult fishery since 1967 and the same 1974 Fs were applied in 1975 to give 1976 stock size.

TAC level. The Commission in 1973 agreed that the Div. 5Y catch in 1974 must result in the restoration of the adult stock to at least 60,000 tons by the end of 1974, and in any event, the TAC for 1974 cannot exceed that of 1973 unless the adult stock size at the end of 1973 has reached a level which will provide the maximum sustainable yield by the end of 1974 (Special Commission Meeting, January 1973, Proc. No. 3, App. II). The level of stock size to give the optimum level of recruitment is considered to be 100,000-120,000 tons. Unless the stock size is approximately 110,000 tons or greater at the beginning of 1974, the catch in 1974 must not exceed 25,000 tons. Under all of the present assumptions of recruitment in 1973, the stock size at the end of 1973 is less than 110,000 tons and the TAC for 1974 cannot therefore exceed 25,000 tons. As can be inferred from Table 7, for a stock size of at least 60,000 tons at the beginning of 1975, the 1974 catch would have to be less than 1,000 tons under Option A (1970 year-class equal to 1966 year-class), less than 18,000 tons under Option B (1970 year-class equal to 1.5 times the 1966 year-class), and less than 37,000 tons under Option C (1970 year-class equal to 2.0 times the 1966 year-class).

Table 7 and Fig. 1 show the consequence of maintaining a TAC of 25,000 tons in 1974. If it is

assumed that the 1970 year-class is 200% of the 1966 year-class, a catch of 25,000 tons should result in a stock size at the beginning of 1975 of 72,000 tons. If the 1970 year-class is 150% of the 1966 year-class, a catch of 25,000 tons in 1974 would result in a stock size of 55,000 tons at the beginning of 1975. If the 1970 year-class is the same size as the 1966 year-class, a catch of 25,000 tons in 1974 would result in a stock size of 37,000 tons.

Table 7. Resultant stock sizes (age 4 and older) as a function of catches (age 3 and older) for the Div. 5Y adult herring fishery, assuming three sizes of the 1970 year-class and a range of fishing mortality rates in 1974.

| 1970 yc<br>as % of<br>1966 yc | Stock size at<br>start of 1974 |        | F in<br>1974<br>(100%) | F on<br>1970<br>yc | Catch in<br>1974   |        | Stock<br>1975 <sup>1</sup><br>(000t) | Catch<br>1975<br>(000t) | Stock<br>1976 <sup>1</sup><br>(000t) |
|-------------------------------|--------------------------------|--------|------------------------|--------------------|--------------------|--------|--------------------------------------|-------------------------|--------------------------------------|
|                               | (10 <sup>b</sup> )             | (000t) |                        |                    | (10 <sup>b</sup> ) | (000t) |                                      |                         |                                      |
| 100%<br>(A)                   | 370                            | 64     | 0.2                    | 0.07               | 24.1               | 5.2    | 54.9 <sup>2</sup>                    | 6.2                     | 69.4                                 |
|                               |                                |        | 0.4                    | 0.14               | 46.2               | 9.9    | 50.7                                 | 10.9                    | 61.2                                 |
|                               |                                |        | 0.6                    | 0.21               | 66.5               | 14.2   | 46.8                                 | 14.3                    | 54.5                                 |
|                               |                                |        | 0.8                    | 0.28               | 85.0               | 18.1   | 43.3                                 | 16.9                    | 48.8                                 |
|                               |                                |        | 1.0                    | 0.35               | 102.1              | 21.7   | 40.2                                 | 18.8                    | 44.2                                 |
|                               |                                |        | 1.2                    | 0.42               | 117.8              | 25.0   | 37.3                                 | 20.1                    | 40.2                                 |
| 150%<br>(B)                   | 488                            | 85     | 0.2                    | 0.07               | 31.1               | 6.5    | 71.2                                 | 7.6                     | 84.4                                 |
|                               |                                |        | 0.4                    | 0.14               | 59.6               | 12.4   | 65.9                                 | 13.4                    | 74.1                                 |
|                               |                                |        | 0.6                    | 0.21               | 85.9               | 17.7   | 61.1 <sup>2</sup>                    | 17.7                    | 65.6                                 |
|                               |                                |        | 0.8                    | 0.28               | 110.1              | 22.7   | 56.7                                 | 20.9                    | 58.6                                 |
|                               |                                |        | 0.9                    | 0.32               | 121.5              | 25.0   | 55.0                                 | 21.9                    | 55.0                                 |
|                               |                                |        | 1.0                    | 0.35               | 132.4              | 27.2   | 52.6                                 | 22.2                    | 52.7                                 |
| 1.2                           | 0.42                           | 152.9  | 31.3                   | 49.0               | 24.8               | 47.7   |                                      |                         |                                      |
| 200%<br>(C)                   | 606                            | 106    | 0.2                    | 0.07               | 38.1               | 7.7    | 87.3                                 | 9.2                     | 99.1                                 |
|                               |                                |        | 0.4                    | 0.14               | 73.3               | 14.8   | 80.9                                 | 16.1                    | 86.7                                 |
|                               |                                |        | 0.6                    | 0.21               | 105.7              | 21.3   | 75.1                                 | 21.3                    | 76.4                                 |
|                               |                                |        | 0.7                    | 0.25               | 124.2              | 25.0   | 72.0                                 | 23.5                    | 71.0                                 |
|                               |                                |        | 0.8                    | 0.28               | 135.7              | 27.3   | 69.7                                 | 25.2                    | 67.8                                 |
|                               |                                |        | 1.0                    | 0.35               | 163.3              | 32.8   | 64.9 <sup>2</sup>                    | 28.0                    | 60.6                                 |

<sup>1</sup> Stock sizes pertain to beginning of year.

<sup>2</sup> For a stock size greater than 60,000 tons at the beginning of 1975, 1974 catches would have to be <1,000 tons under Option (A), <18,000 tons under Option (B) and <37,000 tons under Option (C).

Under all three assumptions about the size of the 1970 year-class, if future recruitment is slightly less than the average for the years 1967 to 1972 and the fishing mortality remains the same, the 1976 stock size will remain at about the same level relative to 1975. It should be pointed out that high precision should not be placed on the exact values in Table 7, as imprecise weight-at-age data and assumptions concerning the estimates of fishing mortalities will affect the precision of the stock size, even if the correct recruitment level were known.

Traditionally the fishery for adult herring in Div. 5Y has been based on fish of age 4 and older, caught mainly during the spawning season, while the juvenile fishery exploited mainly age 2 herring during the summer months. During the last two years, the adult fishery extended throughout the year, catching both age 2 and age 3 herring, while the increased use of the purse seine in the juvenile fishery has allowed increased catches of age 3 and older fish. If these fisheries are catching herring from the same stock, future assessments will require more specific consideration of the total catch of age 3 and older herring from both fisheries.

b) Georges Bank Stock (Div. 5Z and SA 6)

For the Georges Bank stock, recommendations as to total allowable catch (TAC) for 1974 have to take into account the need to restore stock size (age 4 and older) at beginning of 1975 to a level of at least 225,000 tons (Special Commission Meeting, January 1973, Proc. No. 3, App. I). Also the 1974 TAC cannot be increased beyond that of 1973 unless the stock size at the beginning of 1974 (age 4 and older) exceeds 500,000 tons.

Recalculation of stock size and fishing mortalities by age-group. The previous assessment for this stock (*Redbook* 1973, Part I, p. 39) was corrected to include the actual catches by German Dem.Rep. in 1972 (40,016 tons), using Polish and Fed.Rep. Germany age data to assess catches in numbers. New estimates of stock size, catch, and fishing mortality were thus obtained (Table 8) to replace those given in *Redbook* 1973, Part I (Table 9, p. 40). This resulted in estimates of 1973 stock sizes for fish older than 5 years that were less than the 1973 catch of these age-groups. It was assumed that mortality coefficients estimated for 1972 were correct but that in 1973 there had been a change in fishing pattern, resulting in higher mortality on younger fish, particularly the abundant 1970 year-class. For each age-group a predicted 1973 catch in numbers was estimated, assuming that 1972 mortality rates applied. These were compared with the actual 1973 catches to give a rough measure of the change of distribution of F among the age-groups. This procedure suggested that Fs for older age-groups were one-half, or slightly less, in 1973 compared to 1972, and allowed the calculation of Fs by age-groups. The levels of assumed Fs in 1974 were partitioned among age-groups in the same proportions. This then implies that recruitment of the 1970 year-class to the fishery was complete at age 3.

Table 8. Georges Bank herring stock (Div. 5Z + SA 6): stock size and catch (millions) and fishing mortality, 1967-74. (This is a revision of Table 9 in *Redbook* 1973, Part I, page 40.)

| Year  | Numbers (millions) by age-group |      |                   |                   |                  |                  |                 |                 |                 | Age 3 & older             |                     | Age 4 & older             |               |     |
|-------|---------------------------------|------|-------------------|-------------------|------------------|------------------|-----------------|-----------------|-----------------|---------------------------|---------------------|---------------------------|---------------|-----|
|       | 2                               | 3    | 4                 | 5                 | 6                | 7                | 8               | 9               | 9+              | Number (10 <sup>6</sup> ) | Weight (000t)       | Number (10 <sup>6</sup> ) | Weight (000t) |     |
| Stock | 1967 <sup>1</sup>               | 1201 | 1402              | 973               | 1302             | 1100             | 133             | 23              | 20              | 6154                      | 1322                | 4953                      | 1136          |     |
|       | 1968 <sup>1</sup>               | 1454 | 977               | 1093              | 699              | 839              | 557             | 64              | 13              | 5696                      | 1232                | 4242                      | 1007          |     |
|       | 1969 <sup>1</sup>               | 1627 | 1143              | 735               | 591              | 361              | 295             | 152             | 47              | 4951                      | 988                 | 3324                      | 736           |     |
|       | 1970 <sup>1</sup>               | 1012 | 1291              | 745               | 351              | 232              | 125             | 67              | 35              | 3858                      | 761                 | 2846                      | 604           |     |
|       | 1971 <sup>1</sup>               | 565  | 715               | 649               | 365              | 177              | 106             | 56              | 43              | 2676                      | 550                 | 2111                      | 462           |     |
|       | 1972 <sup>1</sup>               | 2010 | 559               | 239               | 333              | 238              | 142             | 53              | 41              | 33                        | 1638                | 339                       | 1079          | 253 |
|       | 1973                            |      | 1628 <sup>3</sup> |                   |                  |                  |                 |                 |                 |                           | 2459                | 433                       |               |     |
|       |                                 |      | 2440 <sup>3</sup> | 431 <sup>1</sup>  | 118 <sup>1</sup> | 119 <sup>1</sup> | 82 <sup>1</sup> | 45 <sup>1</sup> | 11 <sup>1</sup> | 25 <sup>1</sup>           | 3271                | 558                       | 831           | 180 |
|       |                                 |      | 3234 <sup>3</sup> |                   |                  |                  |                 |                 |                 |                           | 4065                | 681                       |               |     |
|       | 1974                            |      | 559 <sup>4</sup>  | 422 <sup>2</sup>  |                  |                  |                 |                 |                 |                           | 1285                | 243                       | 726           | 155 |
|       |                                 |      |                   | 1074 <sup>2</sup> | 118 <sup>2</sup> | 39 <sup>2</sup>  | 68 <sup>2</sup> | 47 <sup>2</sup> | 26 <sup>2</sup> | 6 <sup>2</sup>            | 1937                | 359                       | 1378          | 272 |
|       |                                 |      |                   | 1724 <sup>2</sup> |                  |                  |                 |                 |                 |                           | 2587                | 476                       | 2028          | 389 |
| Catch | 1967                            | 2    | 7                 | 61                | 108              | 251              | 379             | 49              | 11              | 10                        | 876                 | 219                       | 869           |     |
|       | 1968                            | 3    | 52                | 72                | 336              | 233              | 433             | 337             | 22              | 7                         | 1492                | 373                       | 1440          |     |
|       | 1969                            | -    | 46                | 210               | 277              | 278              | 189             | 191             | 110             | 24                        | 1325                | 306                       | 1279          |     |
|       | 1970                            | 13   | 125               | 451               | 270              | 122              | 93              | 52              | 30              | 18                        | 1161                | 247                       | 1048          |     |
|       | 1971                            | 13   | 333               | 276               | 285              | 176              | 104             | 50              | 14              | 22                        | 1260                | 263                       | 938           |     |
|       | 1972                            | 28   | 35                | 110               | 214              | 158              | 100             | 45              | 29              | 21                        | 712                 | 174                       | 677           |     |
|       | 1973                            | 10   | 1026              | 266               | 64               | 33               | 23              | 12              | 3               | 5                         | 1432                | 199                       | 415           |     |
| F     | 1967                            | -    | 0.01              | 0.05              | 0.13             | 0.24             | 0.48            | 0.53            | 0.74            | -                         | Mean F <sup>5</sup> |                           |               |     |
|       | 1968                            | -    | 0.04              | 0.08              | 0.41             | 0.46             | 0.85            | 1.10            | 0.46            | -                         | 0.18                |                           |               |     |
|       | 1969                            | -    | 0.03              | 0.23              | 0.54             | 0.74             | 0.86            | 1.25            | 1.61            | -                         | 0.40                |                           |               |     |
|       | 1970                            | -    | 0.15              | 0.49              | 0.51             | 0.48             | 0.58            | 0.60            | 0.63            | -                         | 0.42                |                           |               |     |
|       | 1971                            | -    | 1.05              | 0.56              | 0.66             | 0.76             | 1.04            | 0.75            | 0.33            | -                         | 0.41                |                           |               |     |
|       | 1972                            | 0.01 | 0.86              | 0.51              | 0.83             | 0.87             | 0.95            | 1.37            | 0.33            | -                         | 0.74                |                           |               |     |
|       | 1973                            | -    | 1.15              | 1.10              | 0.90             | 0.35             | 0.35            | 0.35            | 0.35            | -                         | 0.80                |                           |               |     |
|       |                                 |      | 0.62              |                   |                  |                  |                 |                 |                 |                           | 1.03                |                           |               |     |
|       |                                 |      | 0.43              |                   |                  |                  |                 |                 |                 |                           | 0.67                |                           |               |     |
|       |                                 |      |                   |                   |                  |                  |                 |                 |                 |                           | 0.51                |                           |               |     |

<sup>1</sup> Stock size calculated from  $\frac{CZ}{F(1-e^{-Z})}$ .

<sup>2</sup> Stock size calculated from  $N_{i+1} = N_i e^{-Z_i}$ .

<sup>3</sup> Assumed to be 100%, 150% and 200% of the 1966 year-class at age 3.

<sup>4</sup> Assumed to be same as for 1972.

<sup>5</sup> Average Fs weighted over year-classes by stock size in number.

Recruitment of the 1970 year-class. It was reported that the catch per unit effort of the Fed. Rep. Germany fleet in 1973 was the highest recorded and that the effort was widely distributed; it was estimated that the 1970 year-class was twice the size of the 1966 year-class. Polish and USSR catch per unit effort information also suggested that the 1970 year-class was very large, but no quantitative data were given. The 1973 US spring and autumn surveys indicated an abundance increase of 1.5. It was decided to carry out catch projections assuming three different levels of size for the 1970 year-class, i.e. 1.0, 1.5, and 2.0 relative to the 1966 year-class.

Fishing mortality rates for 1973. The 1973 fishing mortality rates are indicated in Table 8.

Quota levels. The 1974 catches and population sizes for 1975 were calculated for a range of 1974 Fs, which included a level equal to the corresponding 1973 F and, in addition, values less than and greater than this. The results are given in Table 9 and Figure 2. The following points can be made:

- i) The estimated stock size at the beginning of 1974 ranges from 155,000 tons to 389,000 tons for 1970 year-class size of 1.0 to 2.0 times that of 1966 year-class; the higher values are considerably less than the 500,000 ton level at which increase of the 1974 TAC relative to that of 1973 can be considered. It was agreed that the 1970 year-class was not large enough for the 1974 stock size to exceed 500,000 tons. Therefore the 1974 TAC should not exceed 150,000 tons.
- ii) If the 1970 year-class is the same size as the 1966 year-class, the 1975 stock size will not reach 225,000 tons even with a 1974 TAC of zero. However, it was agreed that the 1973 F value of 1.14 for 3-year-olds associated with this assumption as to the size of the 1970 year-class is too high and Option A (Table 9) is highly unlikely.

Table 9. Georges Bank herring stock (Div. 5Z + SA 6): 1975 stock size as a function of 1974 catch for three assumed levels of the 1970 year-class and for a range of fishing mortality rates in 1974.

| 1970 yc<br>as % of<br>1966 yc | 1974 stock size<br>at start of year |                  | F by age-group |      |      |      | Weighted<br>$\bar{F}$ | 1974 catch                   |                  | 1975 stock size<br>at start of year |                  |
|-------------------------------|-------------------------------------|------------------|----------------|------|------|------|-----------------------|------------------------------|------------------|-------------------------------------|------------------|
|                               | Number<br>(10 <sup>6</sup> )        | Weight<br>(000t) | 3              | 4    | 5    | 5+   |                       | Number<br>(10 <sup>6</sup> ) | Weight<br>(000t) | Number<br>(10 <sup>6</sup> )        | Weight<br>(000t) |
| 100%<br>(A)                   | 726                                 | 155              | 0.33           | 0.31 | 0.26 | 0.10 | 0.28                  | 286                          | 51               | 795                                 | 152              |
|                               |                                     |                  | 0.66           | 0.63 | 0.51 | 0.20 | 0.55                  | 501                          | 89               | 604                                 | 118              |
|                               |                                     |                  | 0.98           | 0.94 | 0.77 | 0.30 | 0.83                  | 662                          | 118              | 463                                 | 92               |
|                               |                                     |                  | 1.14           | 1.05 | 0.90 | 0.35 | 0.97                  | 726                          | 130              | 407                                 | 82               |
|                               |                                     |                  | 1.31           | 1.26 | 1.03 | 0.40 | 1.11                  | 783                          | 140              | 358                                 | 73               |
|                               |                                     |                  | 1.64           | 1.57 | 1.29 | 0.50 | 1.39                  | 876                          | 157              | 280                                 | 59               |
|                               |                                     |                  | 1.97           | 1.88 | 1.54 | 0.60 | 1.66                  | 946                          | 170              | 221                                 | 48               |
| 150%<br>(B)                   | 1378                                | 272              | 0.18           | 0.31 | 0.26 | 0.10 | 0.24                  | 387                          | 70               | 1231                                | 230              |
|                               |                                     |                  | 0.35           | 0.63 | 0.51 | 0.20 | 0.49                  | 685                          | 124              | 993                                 | 182              |
|                               |                                     |                  | 0.53           | 0.94 | 0.77 | 0.30 | 0.73                  | 916                          | 166              | 769                                 | 145              |
|                               |                                     |                  | 0.62           | 1.05 | 0.90 | 0.35 | 0.85                  | 1012                         | 184              | 686                                 | 130              |
|                               |                                     |                  | 0.71           | 1.26 | 1.03 | 0.40 | 0.92                  | 1096                         | 199              | 613                                 | 116              |
|                               |                                     |                  | 0.89           | 1.57 | 1.29 | 0.50 | 1.21                  | 1238                         | 225              | 491                                 | 94               |
| 200%<br>(C)                   | 2028                                | 389              | 0.12           | 0.31 | 0.26 | 0.10 | 0.25                  | 522                          | 95               | 1648                                | 304              |
|                               |                                     |                  | 0.25           | 0.63 | 0.51 | 0.20 | 0.49                  | 921                          | 168              | 1294                                | 239              |
|                               |                                     |                  | 0.37           | 0.94 | 0.77 | 0.30 | 0.74                  | 1228                         | 224              | 1024                                | 190              |
|                               |                                     |                  | 0.43           | 1.05 | 0.90 | 0.35 | 0.86                  | 1354                         | 247              | 914                                 | 170              |
|                               |                                     |                  | 0.49           | 1.26 | 1.03 | 0.40 | 0.98                  | 1465                         | 267              | 818                                 | 152              |
|                               |                                     |                  | 0.62           | 1.57 | 1.29 | 0.50 | 1.23                  | 1650                         | 301              | 660                                 | 123              |
|                               |                                     |                  | 0.74           | 1.88 | 1.54 | 0.60 | 1.47                  | 1705                         | 328              | 538                                 | 101              |
|                               |                                     |                  | 0.86           | 2.20 | 1.80 | 0.70 | 1.72                  | 1911                         | 349              | 442                                 | 83               |
| 0.98                          | 2.51                                | 2.06             | 0.80           | 1.97 | 2004 | 366  | 366                   | 69                           |                  |                                     |                  |
| 200%                          |                                     |                  | 0.20           | 0.52 | 0.42 | 0.17 | 0.41                  | 829                          | 150              | 1375                                | 255              |

It is not possible to determine with any certainty the size of the 1970 year-class on which the recommended TAC very largely depends. Some scientists considered Option C as realistic, with

the possibility that values even higher could have been assumed. Others maintained that the actual value probably lies between 1.50 and 2.00. If Option C is correct and the 1974 catch is 150,000 tons, the 1975 population size will be 255,000 tons, i.e. 30,000 tons more than the minimum stock size acceptable to the Commission.

c) Nova Scotia Stock (Div. 4XW(b))

Formal assessment of the Nova Scotia stock is made difficult because of the complexity of the fishery in that area. Because the same fishing areas in the Canadian fishery may contain juvenile, pre-spawning and spawning fish in proportions which vary from year to year and even from week to week within a fishing season, the problems of determining the numerical exploitation of individual year-classes are great. However recent analysis of the catch data (Res. Doc. 74/13) provides a better basis for future assessment.

Catch statistics. The total catch of herring in Div. 4XW(b) by Canada, Japan, USSR and Fed. Rep. Germany was about 135,000 tons. The Canadian catch amounted to 102,000 tons, of which about 38,000 tons were taken by fixed gear. The catch by gear, partitioned into components above and below 23 cm, is given in Table 10. The stock relationships are not well understood in Div. 4X, and it is assumed that fixed-gear catches and part of the purse-seine catches from New Brunswick are not from the same stock as that taken in Nova Scotia. However, the 20,860 tons of adult herring taken by purse seine were considered to be part of the Nova Scotia complex (see Res.Doc. 74/13). Therefore, for assessment purposes, the following components of the Canadian fishery were included: Nova Scotia purse-seine (and midwater trawl) catches; weir catches; the proportion of the gillnet catches in the area where the main stock is fished; as well as the Grand Manan purse-seine catches. Catch data for other countries involved in the fishery were incorporated for the period 1963-73.

Table 10. Herring catches in Div. 4XW(b) in 1973, partitioned into components above and below 23 cm.

| Country     | Gear        | Area  | Catch (tons) <sup>1</sup> |        |
|-------------|-------------|-------|---------------------------|--------|
|             |             |       | ≥23 cm                    | <23 cm |
| Canada      | Purse seine | 4X(a) | 36,209                    | 5,458  |
|             |             | 4X(b) | 20,860                    | 1,704  |
|             | Weir        | 4X(a) | 5,757                     | 6,493  |
|             |             | 4X(b) | 8,582                     | 10,491 |
|             | Gillnets    | 4X(a) | 5,715                     |        |
|             | Misc. gear  |       | 945                       |        |
| Sub-total   |             |       | 78,068                    | 24,146 |
| Japan       |             |       | 1,271                     |        |
| USSR        |             |       | 31,042                    |        |
| FRG         |             |       | 228                       |        |
| Sub-total   |             |       | 32,541                    |        |
| Grand Total |             |       | 110,609                   | 24,146 |

<sup>1</sup> The Canadian catch is also partitioned by gear based on yearly length frequencies, presented in Res.Doc. 74/13, and converted from percentage by length to percentage by weight taken from Res.Doc. 73/91. Catches by other countries are assumed to be >23 cm.

TAC levels. Numbers removed at age in the period 1965-73 are summarized in Table 11. For 1973 the USSR catch in Div. 4W was apportioned by USSR sampling data. Few length frequencies were available for the USSR Div. 4X catch, and thus it was apportioned using Canadian Nova Scotia purse-seine sampling data for June, July and August.

Table 11. Age composition of catches from the Div. 4XW(b) herring stock, 1965-73.

| Age<br>Year | Catch in numbers (000) by age |        |        |        |        |        |       |       |       |      | Total   |
|-------------|-------------------------------|--------|--------|--------|--------|--------|-------|-------|-------|------|---------|
|             | 1                             | 2      | 3      | 4      | 5      | 6      | 7     | 8     | 9     | 10   |         |
| 1965        | 30                            | 210828 | 26072  | 233081 | 49129  | 10721  | 1591  | 476   | 16    | 11   | 531955  |
| 1966        | 616                           | 45678  | 270055 | 56063  | 308471 | 44916  | 15006 | 7716  | 1689  | 215  | 750425  |
| 1967        | 4430                          | 43234  | 68671  | 238403 | 109786 | 159205 | 57936 | 4497  | 409   | -    | 686571  |
| 1968        | 13852                         | 746145 | 78899  | 64045  | 267965 | 70183  | 87767 | 31258 | 15277 | 5635 | 1381026 |
| 1969        | 5                             | 65549  | 325057 | 51952  | 115750 | 71446  | 48659 | 18837 | 6194  | 2789 | 706238  |
| 1970        | 448                           | 83808  | 14819  | 188539 | 163076 | 89144  | 93908 | 32846 | 13428 | 7300 | 691312  |
| 1971        | 4626                          | 11105  | 62611  | 46175  | 80192  | 41890  | 53092 | 21031 | 9732  | 4215 | 334669  |
| 1972        | 7732                          | 647970 | 35408  | 82118  | 56397  | 58906  | 43546 | 39860 | 23034 | 9315 | 1004286 |
| 1973        | 215                           | 27422  | 614700 | 137063 | 23449  | 21889  | 17655 | 14598 | 15955 | 6846 | 879792  |

It is apparent from these data that the fishery in 1973 was heavily dependent on the 1970 year-class, and this will also be true in 1974. Due to changes in the pattern of fishing in 1973 by both Canada and the USSR, no firm conclusion on the levels of F or the distribution of mortality among age-groups could be drawn. Thus it was not possible to base predictions of possible 1974 catch levels on a virtual population analysis. Rather, for ages 3 and 5 to 9, the mean ratio of catches at successive ages was used to estimate 1974 catches (Table 12), on the basis that mortality had, on the average, been close to the desirable level, as indicated by previous virtual population analysis which excluded 1973 catch data. Ratios for 2- and 10-year-olds were too variable to use this method. For age 2 fish, the 1974 estimated catch was taken as the equivalent of mean catches in average years (1966, 67, 69, 71, 73), giving an estimate of 1,500 tons. For 10-year-olds, the 1974 estimated catch was taken as equivalent to mean catches of 10-year-olds in 1968-73 (years for which ageing was considered to be sufficiently reliable), giving an estimate of 2,400 tons.

Table 12. Ratios used and calculations of the 1974 catch of age 3 and ages 5 and older, for the Div. 4XW(b) herring stock.

| Ratio of year n<br>to year n-1                    | Ratio of age n to age n-1 |         |        |        |        |        |
|---|---------------------------|---------|--------|--------|--------|--------|
|   | 3/2                       | 5/4     | 6/5    | 7/6    | 8/7    | 9/8    |
| 66/65   | 1.28                      | 1.32    | 0.91   | 1.40   | 4.85   | 3.55   |
| 67/66   | 1.50                      | 1.96    | 0.52   | 1.29   | 0.30   | 0.05   |
| 68/67   | 1.82                      | 1.12    | 0.64   | 0.55   | 0.54   | 3.40   |
| 69/68   | 0.44                      | 1.81    | 0.27   | 0.69   | 0.21   | 0.20   |
| 70/69   | 0.23                      | 3.14    | 0.77   | 1.31   | 0.68   | 0.93   |
| 71/70   | 0.75                      | 0.43    | 0.26   | 0.60   | 0.22   | 0.30   |
| 72/71   | 3.19                      | 1.22    | 0.73   | 1.04   | 0.75   | 1.10   |
| 73/72   | 0.95                      | 0.29    | 0.39   | 0.30   | 0.34   | 2.10   |
| Mean ratio  | 1.27                      | 1.41    | 0.56   | 0.90   | 0.43   | 1.45   |
| Age   | 3                         | 5       | 6      | 7      | 8      | 9      |
| No. at age <sub>N-1</sub>                         | 27,422                    | 137,063 | 23,449 | 21,889 | 17,655 | 14,598 |
| No. at age <sub>N</sub>                           | 34,826                    | 193,259 | 13,131 | 19,700 | 7,592  | 21,167 |
| Mean wt. (kg)                                     | 0.112                     | 0.223   | 0.268  | 0.294  | 0.331  | 0.357  |
| Estimated catch by<br>weight in 1974 <sup>1</sup> | 3,900                     | 43,096  | 3,519  | 5,791  | 2,512  | 7,556  |

<sup>1</sup> Total weight contributed by fish aged 3 and 5-9 in 1974 catch = 66,374 tons.

This method gives an estimate of the 1974 catch for all ages (excluding 4-year-olds of the 1970 year-class) of about 70,000 tons. However, there is considerable doubt as to the strength of the 1969 year-class on which this figure is strongly dependent. It is not possible at this time to determine whether the high estimated catch in 1973 of the 1969 year-class as age 4 gives a true estimate of the strength of that year-class, as the earlier history of the year-class in the fishery implied it was a very poor one.

As was done for other areas, three assumptions were made as to the strength of the 1970 year-class, i.e. 1.0, 1.5, 2.0 times the size of the 1966 year-class. The strength of the 1966 year-class was estimated to be 2.4 billion fish at age 1, using virtual population analysis. (There is a sufficient series of data for this year-class that the assumption of a terminal F value has little influence on the population estimate). Using a 1974 value of  $F = 0.50$ , giving a yield per recruit close to the maximum, the contribution of the 1970 year-class to 1974 catches is 21,000 tons (1.0 x 1966 year-class), 64,000 tons (1.5 x 1966 year-class) and 108,000 (2.0 x 1966 year-class).

The Commission has in the past applied the TAC only to adults in the purse seine - midwater trawl fishery, whereas these calculations refer to the entire stock. Estimated catches by other gears of at least 20,000 tons must be removed to make these estimates comparable with previous TAC levels. Thus, the three assumptions on the strength of the 1970 year-class give estimated total catches of 70,000 tons, 114,000 tons and 158,000 tons. However, uncertainties about the strength of the 1969 year-class which, from catches at ages 1-3 could be as small as one-third of that implied by the catches at age 4, suggest that these are upper estimates and that catches could be as much as 30,000 tons lower. Given the uncertainties in these estimates which bracket the 1973 TAC of 90,000 tons, the Working Group concluded that the TAC for 1974 should remain at 90,000 tons.

## 5. ICNAF Herring Research Requirements

### a) Tagging Experiment

Canada reported that a tagging experiment had been conducted in November and December 1973. Over 11,000 juvenile herring were tagged in the area around Grand Manan Island in the Bay of Fundy. External tags were used throughout. Recoveries are possible from SA 4 and 5 and should be sent to: Biological Station, St. Andrews, New Brunswick, Canada.

### b) Larval Surveys

It was agreed that continuation of the ICNAF Herring Larval Survey Program is desirable, since data can provide information on spawning stock size.

### c) Juvenile Surveys

It was agreed that the juvenile surveys should continue since the fishery is heavily dependent on incoming year-classes, for which few indices of abundance are at present available. For both larval and juvenile surveys, it was considered that the greatest importance was in providing information on future stock prospects but that preliminary estimates of mortality were also possible if both sets of data could be correlated. It was suggested that larval tows be incorporated in juvenile surveys carried out in the early months of the year. It was also recommended that STACRES organize the larval and juvenile surveys.

### d) Sampling and Statistics

In order to provide increasingly precise advice for management, an improvement in the quality of the data is necessary. Catch statistics and sampling data are essential for both adult and juvenile fisheries. Also, in order to calculate weight of the catch relative to numbers derived from present assessment techniques, mean weights-at-age by month are necessary, especially since the fishery is dependent on young fast-growing fish. Analysis would proceed much more quickly if numbers of fish caught at age by month were also supplied by each country. These data should be made available for the 1975 Mid-term Meeting.



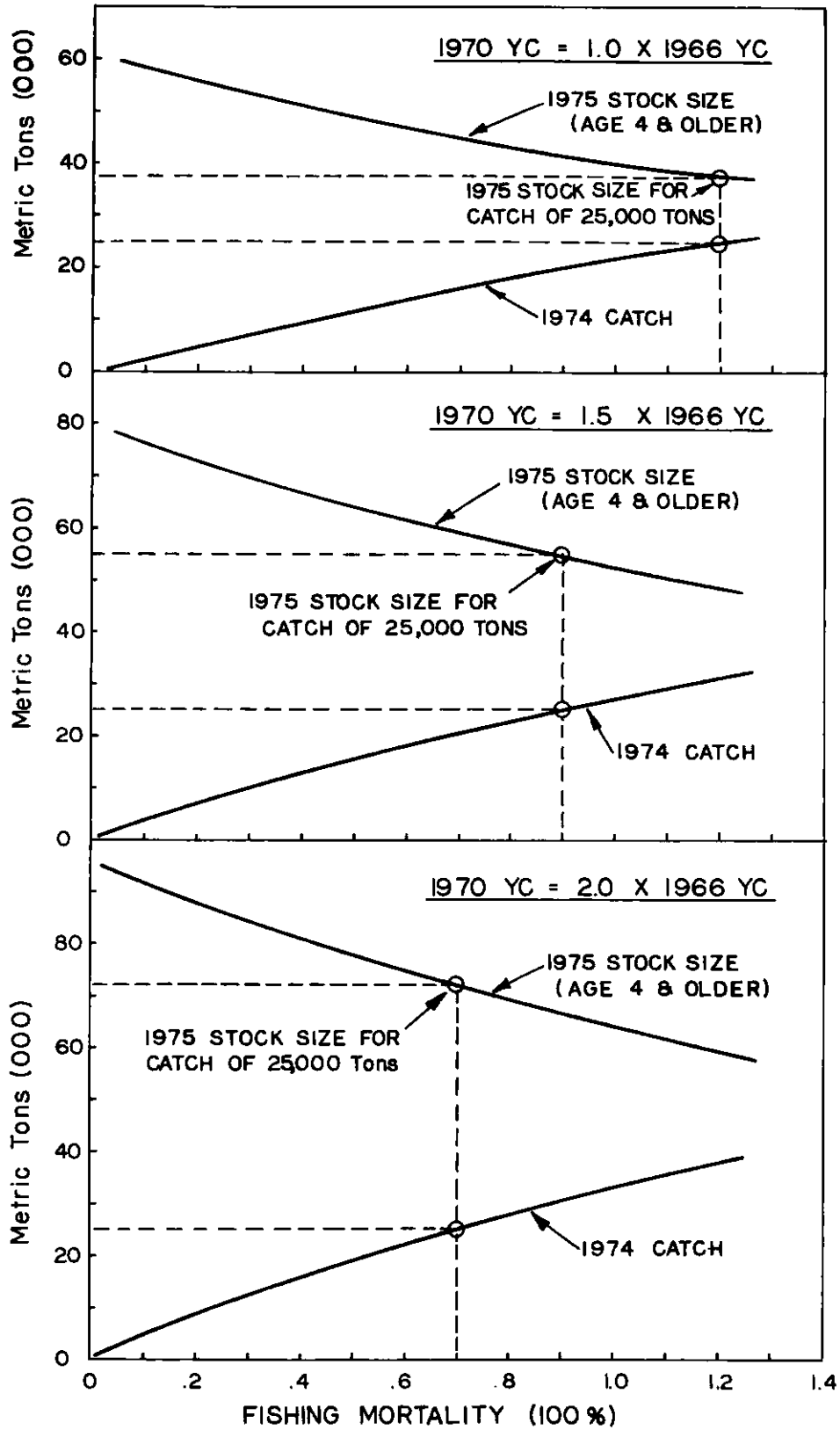


Fig. 1. Gulf of Maine (Div. 5Y) herring stock: 1975 stock size as a function of 1974 catch for a range of fishing mortalities and three assumptions about the 1970 year-class.

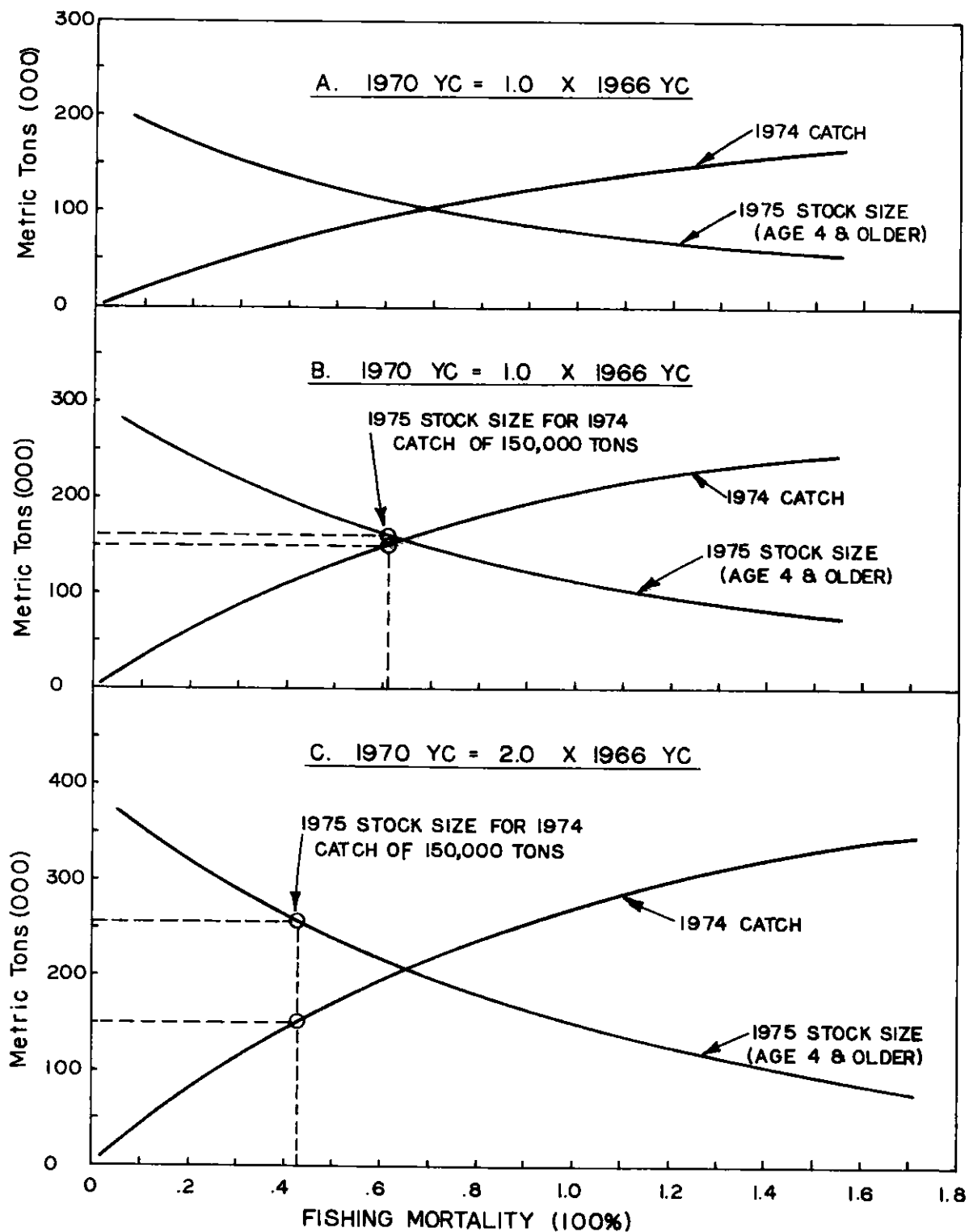


Fig. 2. Georges Bank (Div. 5Z + SA 6) herring stock: 1975 stock size as a function of 1974 catch for a range of fishing mortalities and three assumptions about the 1970 year-class.

APPENDIX II - REPORT OF SPECIAL WORKING GROUP ON ICNAF DATA BASE IMPROVEMENT

Acting Chairman: J. G. Pope

The Special Working Group on ICNAF Data Base Improvement met in several sessions during 15-18 January 1974 at FAO, Rome, Italy, with representatives present from 12 Member Countries and observers from FAO and the German Democratic Republic (Bulgaria, Iceland, Italy and Romania were not represented). In the absence of the Chairman, Mr R.C. Hennemuth (USA), Mr J.G. Pope (UK) was nominated to act as Chairman for this meeting.

1. The Special Working Group was established at the 1973 Annual Meeting to:
  - a) formulate a detailed general plan for the finer breakdown of catch and effort statistics in the ICNAF Area;
  - b) conduct a detailed study of the sampling methods used by member countries for estimating age-length compositions of catches, and document the sources and magnitude of sampling errors in past estimates of stock structure for major fisheries through analysis of past sampling; and
  - c) investigate the advantages as well as costs of an expanded central data processing unit in the Secretariat with respect to processing more refined data on catch and effort, as well as providing increased capability for analysis of commercial and research sampling data.

To make it possible for the Working Group to make specific recommendations to STACRES about the problems listed above, it is essential that further research work relevant to these topics be conducted and reported. Clearly, therefore, the primary objective of the Working Group at this meeting was to formulate the research work that was needed and to delegate this to member countries. The three following sections of this report are directed to this objective.

2. The Finer Breakdown of Catch and Effort Statistics

The general feeling of the Working Group was that there was a genuine need for a finer breakdown of catch and effort data. In particular, it was felt that a finer breakdown of such data would provide additional inputs into the assessments of the mixed fishery problem and would assist in the assessment of species with geographical ranges which did not correspond with the current reporting areas (e.g. red hake in Div. 5Z). It was also felt that a finer division of catch and effort data would help to refine measures of fishing effort.

It was noted that most countries currently collect data that would allow reporting of bi-weekly data on as fine a breakdown as 30-minute rectangles. It was clear, however, from the discussion that collecting catch and effort data in a breakdown as fine as this for all areas would involve everyone, particularly the ICNAF Secretariat, in a greatly increased workload. Consequently, it was decided to start with a pilot scheme on an experimental basis for one division. Div. 5Z was selected, for, in addition to supplying costing and logistic information for the Working Group, the data might well give valuable additional information for assessment of the red hake stocks in this area and for assessment of the mixed fishery problem. A protocol for the reporting of these data is given as Annex 1.

The results of this pilot study should enable the Working Group to advise the Commission on the probable cost and problems of increasing the data base of catch and effort statistics in all ICNAF Areas. It was stressed that this was an experiment to produce information and not a final recommendation. The reporting of this additional information for Div. 5Z was essentially additional to the usual data reporting and should in no circumstances be regarded as a substitute for the routine data submissions.

In order to formulate plans for analyses of these data, a task force, consisting of Dr B.E. Brown (USA), Dr F. Nagasaki (Japan), and Mr Ø. Ulltang (Norway), was requested to study and report on these problems. Their report is at Annex 2.

The scale of the proposed pilot study will require that the Secretariat have additional facilities. Without a clear indication of the quantity of the data that will be involved in the Georges Bank pilot study, it is not possible to project with any degree of precision the cost of such a study to the Commission. An indication of the work involved and the estimated needs are as follows:

|    |   |                     |            |
|----|---|---------------------|------------|
| a) | Preparation of data for key-punching                          | Clerk (3-4 mo)      | \$2,000.00 |
| b) | Key-punching and verifying                                    | Contract            | \$2,000.00 |
| c) | Programming   | Contract            | \$1,000.00 |
| d) | Computer costs (if work involves overtime for computer staff) |                     | \$1,000.00 |
| e) | Duplication of computer plots                                 |                     | 0          |
| f) | Space   | 200 ft <sup>2</sup> | 0          |

The provision of funds for the Secretariat to carry out items (a) to (e) above must be considered in conjunction with the provisions of space suitably located near the Secretariat offices, so that the data-processing can be closely supervised. The space problem is the most critical of those listed, and, unless provision is made for suitable space, the other points become redundant.

The Working Group therefore recommends that STACRES present these requirements to the Commission.

3. Age and Length Sampling

The Working Group agreed that there was a need to establish guidelines for all kinds of biological sampling and, where possible, to develop standard methodology for sampling length and age distributions and other biological characteristics of the stocks. It was decided that there was a real need first to improve the accuracy and precision of sampling for length and age, and the hope was expressed that the Working Group would be able to recommend specific levels of precision that could be regarded as satisfactory.

In order that the Working Group will be able to give specific advice rather than to merely voice the usual sampling platitudes, it was recommended that individual countries should conduct investigations of some of their sampling schemes and to submit these results prior to the 1974 Annual Meeting. It was felt that it would be valuable to coordinate the separate national work, and a sub-group of specialists (Mr Pope, Miss Brennan, Dr Rikhter, Mr Nikolaev, Mr Kröncke, Mr Gulland, Dr Popiel and Dr Brown) was set up to provide the Working Group with specific advice.

The proposals of this sub-group were:

- a) All member countries of ICNAF should produce a document, detailing their methods of sampling, and describing each major fishery in relation to the opportunities presented at sea and on shore for sampling catches and landings for length and age composition. A description should also be given of the current sampling program, including an outline of the costs (staff, etc.) involved. A suggested outline is:

- Population sampled
- Place sample taken
- Method of collection (including preservation)
- Size of sample and frequency of sampling
- Staffing and/or cost
- Reason for choice of method
- Possible drawbacks to method
- Constraints on sampling.

An example of the desired report is given as Annex 3. This information should be forwarded to the ICNAF Secretariat as soon as possible.

- b) In order that the merits of the various sampling schemes currently used may be investigated objectively, it was recommended that all members of ICNAF should, if at all possible, conduct investigations into the accuracy of their current sampling methods with the objective of identifying any biases present. These investigations, and any others previously made but unpublished, should be reported to the 1974 Annual Meeting as research documents.
- c) Since correct ageing is crucial to correct assessments, the Working Group

recommends

*i) that the Secretariat request national bibliographies of age validation studies already conducted on ICNAF stocks and advise on stocks where age reading was considered to be a problem; and*

*ii) that STACRES then consider the need for initiating suitable studies.*

- d) Member countries were nominated to conduct statistical studies of stocks as follows:

|              |                         |
|--------------|-------------------------|
| Cod, haddock | USA, Spain              |
| Flounders    | USA, Canada             |
| Redfish      | USSR, Canada            |
| Mackerel     | Poland, GDR             |
| Herring      | USSR, FRG, Poland       |
| Squid        | Japan                   |
| Silver hake  | USSR, UK (with US data) |

and are requested to adopt as a format for presentation where applicable:

- 1) the figures and tables of Res.Doc. 74/29 using the methods proposed by Miss J. Brennan; and
- ii) Fig. 1.10 of Gulland 1955 (Estimations of growth and mortality in commercial fish populations. *Fish. Invest.*, Lond., Ser. 2, 18(9)).

Advice on (i) may be obtained from Miss J. Brennan, Northeast Fisheries Center, NMFS, Woods Hole, Mass., USA, and on (ii) from J. Pope, Sea Fisheries Laboratory, Lowestoft, Suffolk, England.

Results should be reported as research documents for the 1974 Annual Meeting. Further useful references are given in Annex 4.

4. Expanded Central Data Base - Methods of Reporting and Processing

It was felt that an expanded central data-processing unit in the Secretariat might have considerable advantages in providing increased capability for analysis of commercial and research sampling data. However, the cost of such a unit would be impossible to define without results from the pilot study. The Working Group therefore decided to leave this question until these became available.

The Assistant Executive Secretary was requested to assess, before the 1974 Annual Meeting, the costs to the Commission of requiring the Secretariat to accommodate the reporting and processing of raw sampling data, assuming this was at the current level. The Working Group

recommends

*that individual countries inform the Assistant Executive Secretary of the approximate number of length and age samples they make in one year at present.*

5. The Working Group wishes to draw attention to the fact that sound advice to STACRES depends also on adequate biological sampling other than that giving age-length composition, as specified in the terms of reference; and the Working Group therefore

recommends

*that the terms of reference of the Working Group be expanded to include all aspects of biological sampling of catches.*

#### ANNEX 1 - PROTOCOL FOR THE REPORTING OF ADDITIONAL DATA FOR DIVISION 5Z

Reports should be made for the last 4 months of 1973, if at all possible, (to be reported by airmail to the Secretariat by 15 March 1974) and for the first 2 months of 1974 (to be brought to the 1974 Annual Meeting).

Reports should be made of the catch and effort by 30-minute rectangles (the Secretariat will circulate a chart showing the rectangles to be used as soon as possible) for each of the effort categories reported in STATLANT 21B or in more detail if this is available (e.g. discriminating between pelagic and bottom trawls). This information should be presented for each half month of the period - the first half of each month being defined as being from day 1 to day 15 and the second from day 16 to the end of the month. Effort data should be reported as currently requested, e.g. hours fished, days fished.

The species for which catch is to be detailed are cod, haddock, redfish, pollock, red hake, silver hake, yellowtail flounder, other flounders, squid, argentines, herring, mackerel, other fish.

Members are requested to complete a full breakdown of their statistics, but, if this is not possible, a stratified random sample of all vessel categories of at least 20% of their data should be analyzed. Information should be submitted to ICNAF on forms to be provided by the Secretariat.

#### ANNEX 2 - REPORT OF TASK FORCE ON ANALYSIS OF REFINED CATCH/EFFORT DATA

The following analyses are suggested to compare the 6-month refined time-area data with that currently being reported:

- a) Plots of catches of the requested categories and total catch by 30-minute squares by two-week period.
- b) Plots of effort by major gear and tonnage categories by 30-minute squares by two-week periods.
- c) Comparison of seasonal trends catch per unit effort for selected species calculated for the refined data and with the currently available data.
- d) Comparison of relative catchability coefficients between gear-tonnage classes calculated from the refined data and from the data currently available.

It is requested that the Secretariat be responsible for producing a computer file of the data and items (a) and (b), realizing that additional resources would be needed to do this. Items (c) and (d) should be done by scientists from the various countries (Japan will examine the squid data and USA will make a comparison of relative catchability coefficients using analysis of reviewed procedures). It is stressed that a significant amount of analysis must be available by the 1974 Annual Meeting. Therefore preliminary analyses on portions of the data should be reported to that Meeting. The Chairman of the Working Group will request other such studies by letter.

ANNEX 3 - EXAMPLE OF SAMPLING REPORT PROPOSED BY WORKING GROUP ON ICNAF DATA BASE IMPROVEMENT

Country - United States

Fishery - side trawlers making trips of about 14 days duration to Gulf of Maine, Georges Bank and Southern New England areas. Catches are landed at various New England ports.

Opportunities for Sampling - dockside sampling only. Sampling of discards is inadequate.

Current Sampling:

Population Sampled - yellowtail flounder landings from Georges Bank (Subdiv. 5Ze) by quarters.

Length Samples:

Place Sample Taken - dockside, at ports where the bulk of the species is landed.

Method of Collection - landings are sampled by market category and area in which catch was taken. A primary sampling unit consists of one 125 lb box of fish. The unit is separated into males and females and measured.

Size of Sample and Frequency of Collection - about 5 samples per month are taken, each consisting of about 100 fish.

Staffing and/or Cost - 5 port samplers.

Reason for Choice of Current Sampling Methods - with the logistic constraints listed below, the current scheme seems the most reasonable and direct such that unbiased estimates of percent at length can be made.

Drawbacks - the number of samples taken seems to be inadequate, although the number of fish measured per sample is adequate. Discards are not sampled.

Constraints - on-board sampling is not possible at present due to restrictions imposed by vessel captains, as well as lack of space on board for sampling and for sample storage.

Age Samples:

Place Sample Taken - dockside, at ports where the bulk of the species is landed.

Method of Collection - landings sampled for lengths (above) are subsampled for ageing, such that at least one fish is taken from each cm interval group by sex.

Size of Sample and Frequency of Collection - a total of 25 males and 25 females is typically collected for ageing from each sample taken for length measurements.

Staffing and/or Cost - 3 age readers, 5 port samplers.

Reason for Choice of Current Sampling Method - to get an unbiased estimate of percent of age at length (group).

Drawbacks - currently, both the numbers of samples taken and the number of fish per sample are inadequate to estimate the percent of age at length (group) precisely.

Constraints - the size of staff limits the workload (specifically ageing) that can be handled under specified time limits.

ANNEX 4 - SUGGESTED REFERENCES

- Bazigos, G. P. 1973. Deck Sampling: An Assessment of a Pilot Trawling Survey at Lake Malawi (*UNDP/SF/MLW. 16*), FAO, Rome, Italy.<sup>1</sup>
- Cochrane, W. G. 1963. Sampling Techniques. 2nd ed., John Wiley and Sons, Inc., New York, 413 p.
- Gulland, J. A. 1966. A Manual of Sampling and Statistical Methods for Fisheries Biology, Part 1: Sampling Methods. FAO, Rome, Italy.
- Pope, J. G. 1972. An Investigation of the Accuracy of Virtual Population Analysis Using Cohort Analysis. *Res. Bull. int. Comm. Northw. Atlant. Fish.*, No. 9, p. 65-74.
- Pope, J. G. and D. J. Garrod. 1973. A Contribution to the Discussion of the Effects of Error on the Action of Catch Quotas and Effort Quotas. *Annu. meet. int. Comm. Northw. Atlant. Fish 1973*, Res.Doc. No. 110, Serial No. 3074 (mimeographed).

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<sup>1</sup> A contribution to the discussion of the effects of errors in sampling; limited distribution to participants of the Special Working Group on ICNAF Data Base Improvement.



APPENDIX III - REPORT OF WORKING GROUP ON COORDINATED SURVEYS

Chairman: J. Messtorff

Rapporteurs: R. G. Halliday  
A. T. Pinhorn

The Coordinated Surveys Working Group met on 16-17 January 1974 at FAO, Rome, Italy, to consider various matters referred to it from STACRES. On the advice of the Chairman of STACRES, Dr A.W. May, the Group agreed to broaden the scope of its discussions to include all survey work, including hydro-acoustic surveys, on which a special session was held to discuss equipment and methodology.

1. Stratification Schemes for Groundfish Surveys

A revised stratification scheme for SA 2 and a proposed scheme for Div. 3K were presented by Dr Messtorff (Res.Doc. 74/4), who reported on the successful use of the stratified-random sampling design in these areas by Fed.Rep. Germany in 1973. It was noted that, in contrast, such a design was found impractical for use in SA 1.

Stratification schemes, which have been tested by use, are now available for almost all of SA 2 to 6, and it was suggested that these be brought together (including calculations of stratum sizes) for review and standardization at the Annual Meeting as a preliminary to production of a manual on methodology for groundfish surveys in the ICNAF Area. The Secretariat was requested to solicit information by Circular Letter and collate the material for presentation at the 1974 Annual Meeting. It was also proposed that the Secretariat produce working charts, showing the stratification schemes for all areas, and supply these to interested countries. It was thought that inclusion of the Baffin Island region in the stratification scheme would be useful, and countries with bathymetric charts of the area were requested to make these available at the 1974 Annual Meeting.

2. Review of Surveys Carried Out in 1973

Most countries indicated that the surveys scheduled for 1973, and summarized in a table in *Redbook* 1973, Part I, page 101, were carried out. However, details of surveys and results would not be available until the 1974 Annual Meeting.

3. Survey Plans and Coordination for 1974

Survey plans of most countries were not sufficiently firm for 1974 that a table setting out these plans could be produced as was done for 1973 at the 1973 Annual Meeting. However, most representatives could give general indications of their intentions, as follows:

Denmark will continue working selected trawling stations in SA 1 (20 hauls) and try to expand the number of stations in 1974.

Fed.Rep. Germany will, in 1974, repeat their surveys in SA 1 and 2 at levels similar to those of 1973. The young herring survey conducted in SA 5 and 6 in 1973 will also be repeated in 1974; this will be based on a stratified random sampling design and will include a comparison of catches between a bottom trawl, designed to catch pelagic species, and the standard bottom trawl used in USA surveys and also sampling with bongo nets for 1973 year-class herring.

German Dem.Rep. indicated that groundfish surveys would be conducted in SA 1, 2 and 3 from November 1974 to February 1975.

Canada hopes to conduct surveys at a level similar to that in 1973 and at similar times. In addition, a combined hydroacoustic and bottom trawling survey will be conducted on the Scotian Shelf between January and March, involving over 200 hauls if plans are successful.

USSR will conduct surveys in SA 2 and 3 in 1974 as in 1973, but no details were available. In SA 4, an October 1974 survey for silver hake in Emerald Basin will be conducted at a level similar to that in 1973 (20 hauls); the large-scale Scotian Shelf survey, which was not conducted in 1973, will be re-established in 1974, 120 trawl hauls being planned for August; in addition, a herring survey of 50 hauls is planned for Div. 4W-X in April. In SA 5 and 6 survey plans are the same for 1974 as for 1973, with the addition of a winter survey (February - March) for pelagics from Cape Hatteras to Georges Bank; this latter survey will include 120 hauls with a high opening bottom trawl, stations being chosen at random using the groundfish stratification scheme and will also include a hydro-acoustic survey.

France plans a survey in Div. 3P and Subdiv. 4Vn for cod during 15 January - 15 March and for scallops during 5-20 November. A herring survey will be conducted in Div. 5Z in September - October.

Poland will conduct a young herring and mackerel survey in SA 5 and 6 in March.

USA plans to conduct 1974 surveys at levels similar to those of 1973, but modified to include hydro-acoustic work in SA 4, 5 and 6. In addition, intensive surveys in shallow coastal waters will be conducted from the Bay of Fundy to Cape Hatteras in May. The USA is continuing to develop submarine surveys of resources of the continental slope mainly in SA 6, and in 1974 this will be done in July - August. Surface craft are also involved using techniques such as camera surveys. An invitation was extended for others to participate.

4. Hydro-acoustic Surveys

The potential importance of hydro-acoustic survey techniques for estimation of fish abundance was recognized and a special meeting of experts and interested biologists was held to discuss equipment and techniques following a presentation on methodology of hydro-acoustic equipment calibration by Mr J. Suomala (USA) (see Annex 1).

The Group concluded that the measurement of aquatic biomass by hydro-acoustic methods cannot, at this time, be considered to be a reliable information source for ICNAF deliberations and decisions. However, if properly developed and executed, hydro-acoustic experiments and subsequent surveys with properly calibrated equipment are performed, it is highly likely that additional information concerning the rate of change of pelagic fish abundance in the ICNAF Area may be obtained.

It was noted that cooperative arrangements have already been made for US, USSR and Polish research vessels to conduct hydro-acoustic experiments during the first half of 1974. Other countries are encouraged to participate in future arrangements of such experiments. US experts will prepare a manual for such proposed joint hydro-acoustic surveys.

5. Reporting of Survey Data (Res.Doc. 74/33, 34)

Summary information on the status of pre-recruit abundance estimates for the major species in SA 5 and 6 is given in Res.Doc. 74/33, and information on cost estimates for juvenile herring surveys at various levels of accuracy is presented in Res.Doc. 74/34.

The various procedures and techniques associated with the stratified-random groundfish surveys were discussed, and it was indicated that these originated from the experience of the US groundfish surveys over several years. They had been presented in various documents to previous ICNAF Meetings, and these together with previous discussions in the Working Group stimulated other countries to devise stratified-random schemes for the northern subareas. Dr Edwards (USA) indicated that all of the procedures and techniques used by the US scientists in their stratified-random surveys would be presented at the 1974 Annual Meeting as a single document, and the Working Group could then discuss the desirability and feasibility of including the material in the manual on surveys to be produced by the Secretariat as referred to in Section 1 above.

The Working Group discussed the desirability of obtaining data on the physical environment in time to be used in deliberations of STACRES. It was indicated that hydrographic observations at most trawling stations, as well as standard hydrographic sections, are carried out during surveys by some countries. It was further indicated that proposals will be forthcoming at the 1974 Annual Meeting concerning monitoring of the physical environment. The problem of procedures for handling such data was discussed. One suggestion was that a data bank might be established at the Secretariat. It was indicated that further discussion on this subject should take place at the next meeting of the Environmental Subcommittee.

The Chairman of STACRES suggested that the problem of coordinating all types of surveys should be discussed at the next meeting of the Steering and Publications Subcommittee.

6. Polish Government's Offer of the R/V Professor Siedlecki for Herring and Mackerel Research in Subarea 5 and Statistical Area 6

It was indicated that the R/V *Professor Siedlecki* would be available for a survey to provide biomass estimates of especially herring and mackerel in SA 5 and 6. The timing of the survey and the area to be covered were important considerations in planning the cruise. It was suggested that this might be part of a larger coordinated program involving other vessels. It was noted that, in addition to the Polish staff, there was accommodation for seven observers, and countries were invited to participate. In discussing the possibility of conducting herring and/or mackerel tagging with the Polish vessel, the type of gear used by the vessel was considered not suitable for taking these species in condition suitable for tagging.

7. Manual on ICNAF Groundfish Surveys

It was agreed that a comprehensive manual, setting out the methodology developed for quantitative

groundfish surveys in the ICNAF Area, would be most valuable in promoting standardization of techniques, now that stratification schemes are available for almost all of the fishing areas in SA 2 to 6. The presentation of data on survey methodology to the 1974 Annual Meeting, as requested in Section 1 above, will allow full consideration of data relevant to production of the manual. The Working Group therefore

recommends

*that a manual on ICNAF Coordinated Groundfish Surveys be produced subsequent to the 1974 Annual Meeting with format and content to be decided at that Meeting.*

8. Other Matters

It was agreed that sufficient time be available in the STACRES timetable for the 1974 Annual Meeting for the Working Group to deal with matters requiring further consideration at that time.

ANNEX 1 - SUMMARY OF US PRESENTATION ON AND PLANS FOR HYDRO-ACOUSTIC SURVEYS

Mr Suomala (USA) presented a report on the methodology of hydro-acoustic equipment calibration, a summary of which follows:

The estimation of the density of fish by hydro-acoustic methods in an aggregation is dependent upon the knowledge of a number of parameters. These parameters are given in the following simplified basic expression:

$$\hat{P} = \frac{R^2 e^{2\alpha R}}{I_0 K^2 \frac{\sigma}{4\pi} \frac{c^2}{2} \psi(\phi)} \bar{v}^2_{RMS}$$

- where: R - range to aggregation
- α - attenuation loss due to combined effects of scattering and absorption
- I<sub>0</sub> - acoustic source level
- K<sup>2</sup> - receiving voltage response
- σ - ratio of power scattered per unit solid angle to the incident intensity at target
- $\bar{v}^2_{RMS}$  - root mean squared value of randomly varying received voltage
- c - propagation velocity of sound
- ν - time interval of transmitted acoustic carrier frequency
- ψ(φ) - integrated transducer directivity function

All of the above terms, except σ, are measurable with high precision and reasonable accuracy to allow practical density estimations of fish targets. The value of σ for the pelagic species of current interests in those parts of the ICNAF Area monitored by the National Marine Fisheries Service, Woods Hole, is not known at this time, and scientifically acceptable values of density cannot be obtained. Accordingly, the parameter σ is to be combined with the density estimate,  $\hat{P}$ , as a lumped parameter in the initial hydro-acoustical measurement experiments to be conducted in 1974.

The National Marine Fisheries Service, Woods Hole, plans to make available basic hydro-acoustical calibration, echo signal and other electronic measurement and data-recording equipment for deployment on cooperating survey vessels in order to normalize specific differences in vessel hydro-acoustic equipment. This measurement equipment will be operated by US personnel during the sea operations.

The gathering and reduction of all data obtained during the experiment will be accomplished with the active participation of ICNAF scientists, and the results of this data reduction activity will be in accordance with scientifically and technologically acceptable methods and procedures.

The National Marine Fisheries Service, Woods Hole, will provide the following instrumentation and equipment to verify the various operational parameters of the hydro-acoustical and echo signal processing equipment on participating vessels:

- Tape recorder - Ampex FS1300
- Oscilloscope - Tektronix 545
- Camera - Type c12
- Comparator amplifier - type 1A7A and type W
- Counter - type 524L
- Hydrophone - type LC-32
- Digital computer - XDS 9300 and IBM 360/75
- Analog computer - Beckman 2200
- Miscellaneous voltmeters, oscillators, attenuators, megohmmeter, computer peripheral equipment and electronic calculators.

APPENDIX IV - STATEMENT IN RESPONSE TO STACRES QUESTIONS  
REGARDING ADVICE TO THE COMMISSION ON HERRING

STACRES asked two questions of the Commission (STACRES Report, Section I, Subsection 3):

- 1) Identification of components of the (herring) fisheries and hence catch quantities on which assessments should be based in order to be related to the TAC?
- 2) Identification of adult as opposed to juvenile (herring) fisheries?

The following brief explanation deals with both of these points. The TACs developed by the Herring Working Group in 1972, 1973 and 1974 applied to the following stock components:

- a) Div. 4WX. The adults caught in the Canadian purse seine fishery off southwestern Nova Scotia mainly in the summer and autumn. Adults caught by other nations offshore of the area fished by the Canadian fleet, including the overwintering concentrations found on the southern Scotian Shelf. (*Redbook* 1972, Part I, p. 43)
- b) Div. 5Y. The adults caught in "(the) substantial adult fishery....in the western portion of the Gulf of Maine....concentrated on Jeffreys Ledge, Stillwagen Bank and adjacent areas" - this area being distinct from that of the "traditional USA juvenile herring fishery....limited to the Maine coastline". (*Redbook* 1973, Part I, p. 48)
- c) Div. 5Z and Statistical Area 6. The adults caught in the Div. 5Z and SA 6 mobile fleet fisheries.

At the Special Meeting in Rome in January 1972, adult stock size was formally defined "as that of age 4 and older at the beginning of the calendar year" (*Redbook* 1973, Part I, p. 34).

There has been a change in the pattern of recruitment to the adult stage and adult fisheries. In earlier years few 3-year-old fish were caught. In 1973 much and even most of the catch in all fisheries was made up of 3-year-old fish. Recruitment of 3-year-old fish during the year (assumptions as to the size of which now largely determine advice as to TAC) can be dealt with separately (see, for instance, Fig. 1, p. 38, *Redbook* 1973, Part I).

Assessment, therefore, has continued to deal with adult fish, adjusting the details to take into account the biological changes in the stocks, i.e., earlier age at maturity.

Assessments for 1973 and 1974 have been based on the expected catch of adult herring. This includes 3-year-old herring expected to mature during the year, which for administrative reasons, to allow monitoring of catches in the Canadian purse seine fishery, are taken to be fish greater than 23 cm.

T. D. Iles, Chairman  
Herring Working Group

