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Report of Standing Committee on Research and Statistics (STACRES)[1]

Eighth Special Commission Meeting - January 1976

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REPORT OF STANDING COMMITTEE ON RESEARCH AND STATISTICS (STACRES)

Eighth Special Commission Meeting - January 1976

Chairman: A. W. May (Canada) Rapporteur: V. M. Hodder (ICNAF)

STACRES met at FAO, Rome, Italy, during 12-16 January 1976 to consider the Commission's request for : (a) a review of information concerning implementation of effort reduction in 1976 (Proposal (1) from the Seventh Special Commission Meeting, September 1975; Comm. Doc. 76/I/1 and Addenda); (b) a review of conservation measures for herring stocks in Subareas 4 and 5 and Statistical Area 6; and (c) a review of herring and mackerel size limits. Further meetings were held on 20 and 23 January 1976 to deal with "Other business" items and to give final approval to its report. Representatives were present from Canada, Cuba, Denmark, France, Federal Republic of Germany, German Democratic Republic, Japan, Poland, Portugal, Union of Soviet Socialist Republics, United Kingdom and United States of America, and observers from FAO and ICSEAF.

Ad hoc Working Groups on Fishing Effort Regulation (convened by Mr. A. T. Pinhorn) and Herring (convened by Dr. V. C. Anthony) were assigned the tasks of considering the above-mentioned items (a) and (b) respectively, and their reports, as approved by STACRES, are at Appendices I and II. Brief summaries of these reports, together with other matters considered by STACRES, are given below.

1. Groundfish Effort Regulation, Subareas 2 to 4 (App. I)

The major tasks of the Working Group were: (a) to review the base period data and the proposed numbers of fishing days for 1976, as submitted by member countries subsequent to the September 1975 Special Commission Meeting (Comm. Doc. 76/I/1 and Addenda); (b) to evaluate the effects of these revisions on the effort regulation and to determine the reduction in effort expected to be achieved by the effort regulation in 1976; and (c) to construct a revised table indentical in format to the illustrative table of Proposal (1) from the September 1975 Special Commission Meeting.

The Working Group provided some explanatory notes, additional to those contained in Comm. Doc. 76/I/1 and Addenda, for those countries which reported revisions and were represented at sessions of the Working Group. These notes further clarified the procedures used by the countries in revising the data, converting effort between tonnage/gear categories and transferring effort between areas.

Comparision of the total number of days fished in comparable units for all country/gear/tonnage categories and for all areas combined for 1972 with the proposed total number of fishing days for 1976 indicates that a decrease of about 23% is expected, the change ranging from -8% in Div. 3P to -36% in Div. 3M. For countries other than coastal states, the decrease in total effort for all areas between 1972 and 1976 is expected to be about 32%, the change ranging from -22% in Div. 4VWX to about -40% in Div. 3M, Div. 3LNO and Div. 3P. A similar comparison of effort expended in 1973 with proposed effort for 1976 indicates a decrease of 23% for all countries and areas combined, the change ranging from +13% in Div. 3M to -36% in Div. 4VWX. For countries other than coastal states, the decrease in total effort for all areas between 1973 and 1976 is expected to be about 33%, the change ranging from +3% in Div. 3M to -50% in Div. 4VWX (see Appendix I, Table 1). While the total amount of effort was about the same in 1972 and 1973, there was a general shift in fishing activity from the northern areas in 1972 to the southern areas in 1973. The revisions to 1973 effort data, as reported by some countries, resulted in an overall 8% increase in effort for all areas combined.

A table was constructed, identical in format to the illustrative table in Proposal (1) from the September 1975 Special Meeting, but using the revised base period data and the proposed numbers of fishing days for 1976, as submitted by member countries since the September 1975 Meeting (Comm. Doc. 76/I/1 and Addenda). All proposed revisions received up to 22 January 1976 have been incorporated into the table of fishing effort for 1976 (see Appendix I, Table 2).

Following a discussion of the definition of "days fished", it was concluded that a redefinition of the effort concept is undesirable from a scientific viewpoint, since it would disrupt the historical data on fishing effort, have the effect of rejecting an internationally-used definition, and create new uncertainties about the relationship of fishing effort to fishing mortality. It was pointed out that, if the effort concept "days fished" were redefined for regulatory purposes, adjustments would have to be made

both in the base period data and in the proposed fishing effort of each country for 1976.

The present list of species in the effort regulation proposal was considered to be ambiguous with reference to the definition of "other pelagics" and "sharks". It was concluded that, if the Commission wished to clarify this matter, the ICNAF List of Species should be used as the basis for clarification.

The question of excluding the fishery for roundnose grenadier from the effort regulation was discussed. From a biological point of view, with the present state of knowledge of the roundnose grenadier resource and its role in the ecosystem and since data for this species were included in the analyses of fishing effort data and the development of the data base, the exclusion of roundnose grenadier could not be recommended at this time. It was pointed out that, if the species were to be excluded for practical reasons, a smaller reduction in fishing effort would result, unless the total effort, as presently proposed for 1976, was reduced by the estimated amount of effort applicable to the roundnose grenadier fishery.

2. Herring Assessments (App. II)

The status of herring stocks under ICNAF's management regime was evaluated in accordance with the Commission's request when proposals for regulation in 1976 were deferred from the 1975 Annual Meeting. Because of new information on the inter-relationship of stocks in Subarea 4 (Res. Doc. 75/38), the assessment of the Subarea 4 stocks was undertaken for Div. 4V and Div. 4WX as separate management areas. Earlier assessments and previous conservation measures were based on managing the herring fishery in the northeastern part of Div. 4W together with the fishery in Div. 4V as a stock unit (i.e. Div. 4VW(a).

Provisional statistics for 1975 indicate that herring catches in the various management areas were as follows: 3,600 tons in Div. 4V for the first half of the 1975/76 season, 143,400 tons in Div. 4WX, 20,500 tons in Div. 5Y, and 143,300 tons in Div. 5Z and Stat. Area 6. Further details on catches in 1975 are given in Table 1 of the Report of the *ad hoc* Working Group on Herring (Appendix II). In all areas under management, the 1970 year-class continued, as in 1974, to make up the major proportion of the catches, and this situation is not expected to change appreciably in 1976.

Management advice on TACs (total allowable catches) from the various herring stocks in 1976, based on the most recent assessments, follows below. A summary of previous and proposed management regimes for herring in Subareas 4 and 5 and Stat. Area 6 is given in Table 1.

Table 1. Summary of previous and proposed management regimes for herring in Subareas 4 and 5 and Stat. Area 6.

Stock area	Nominal catches (000 tons) 1971	1972	1973	1974	1975	TACs (000 tons) 1973	1974	1975	1976[1]
Previous									
4VW(a)	72	32	30	44	31[2]	-	45	30[2]	-
4VW(a)	(seasonal - July to June)					-	-	45[3]	-
4XW(b) (adults)	70	75	91	89		90	90	90	-
Proposed									
4V	(seasonal - July to June)					-	-	-	11[4]
4WX (adults)	(calendar year)[5]				143	-	-	-	118[6]
5Y (adults)	39	43	16	18	20	25	25	16	4[7]
5Z+6	267	174	202	148	143	150	150	150	60[7]

[1] Proposed TACs for 1976.
[2] TAC pertains to January-June only.
[3] TAC pertains to July 1975-June 1976.
[4] TAC pertains to July 1976-June 1977.
[5] See footnote 1, page 5.
[6] Includes catch of 10,000 tons already taken in Div. 4W(a) in December 1975. An appropriate amount has to be deducted to allow for the inshore fishery.
[7] Proposed maximum TACs.

a) Herring in Division 4V

The advise for this stock remains unchanged from that recommended at the 1975 Annual Meeting, i.e. a TAC of 11,000 tons for the period from 1 July 1976 to 30 June 1977.

b) Herring in Divisions 4W and 4X

In developing advice for the conservation of herring in Div. 4WX, it was necessary to allow for the fact that the present management regime for Div. 4VW(a) involves a TAC for July 1975 to June 1976 of 45,000 tons, which is not partitioned between Div. 4V and Div. 4W(a). The TAC recommended for Div. 4WX is 118,000 tons for 1976. Since a catch of 34,000 tons is expected to be taken in Div. 4W(a) during January-June 1976[1], an amount of 84,000 tons is left to be taken in Div. 4XW(b) during January-December 1976 and in Div. 4W(a) during July-Decebmer 1976.

The stock size (age 4 and older) in Div. 4WX is expected to decline from 472,000 tons at the beginning of 1976 to 273,000 tons at the start of 1977. It was agreed that the stock size should not be allowed to decline below 250,000 tons. If the 1972 and 1973 year-classes are not substantially larger than presently estimated, a TAC of about 85,000 tons is implied for 1977.

c) Herring in Division 5Y

At the 1974 Annual Meeting (Proc. No. 20, App. II), the Commission agreed that the adult stock should be maintained at a minimum of 60,000 tons, and that the 1976 TAC would not be increased above that for 1975 unless the adult stock size at the end of 1975 had reached a level (110,000 tons) which would provide the MSY (maximum sustainable yield) by the end of 1976. The stock size (age 4 and older) is now calculated to be 58,000 tons at the beginning of 1976, in contrast to 64,000 tons estimated at the April 1975 Meeting of the Assessments Subcommittee (*Redbook* 1975, page 46)[2]. In order to maintain the adult stock size at the minimum level of 60,000 tons, a TAC of 4,000 tons or less is recommended for 1976, based on the assumption that the size of the recruiting 1973 year-class is about the same as the 1971 and 1972 year-classes (i.e. 64 million fish at age 3).

During the course of the Commission Meeting, STACRES was requested to examine the implication of assuming a higher level for the size of the 1973 year-class, as was done in assessing the stock in Div. 5Z and Stat. Area 6. This higher level for the 1973 year-class is based on the average of the sizes of the 1968 and 1972 year-classes at age 3 (i.e. 91 million fish). This procedure, when applied to the Div. 5Y stock, results in an adult stock size of 61,000 tons at the beginning of 1976 (about 3,000 tons higher than the level estimated by assuming the smaller size for the 1973 year-class). In order to maintain the adult stock size at the minimum level of 60,000 tons, a TAC of 7,000 tons could be taken in 1976 with fishing mortality ($F = 0.17$) less than one-half of the $F_{0.1}$ level. If 7,000 tons are taken in 1976 and if the assumption as to the lower level of the 1973 year-class is the more correct one, the stock size at the end of 1976 would be reduced to about 56,000 tons.

d) Herring in Division 5Z and Statistical Area 6

In this area, as in the others, the 1975 fishery was heavily dependent on the 1970 year-class. The 1971 and 1972 year-classes appear to be no better than the poorest observed in the fishery. The 1973 year-class also appears to be poor and, for assessment purposes, was taken to be in the range of 550-620 million fish at age 3.

At its Fourth Special Meeting in January 1974 (Proc. No. 7, App. II), the Commission agreed that an adult stock size of at least 225,000 tons be maintained to the beginning of 1977 and that the TAC could not be increased unless the adult stock size

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1 An estimated amount of 10,000 tons taken in December 1975 was considered to be 1976 catch for purposes of assessment and projected regulation, and this amount is included in the catch estimate of 34,000 tons. Since a similar situation will also pertain late in 1976, the Commission may wish to consider that the TAC in Div. 4WX apply for the period 1 November 1975 to 31 October 1976.

2 That assessment assumed that 15,000 tons (TAC of 16,000 tons minus 1,000 tons, representing the allocations for Federal Republic of Germany and German Democratic Republic which these countries agreed not to take) would be taken in 1975, and indicated that a TAC of 9,000 tons would maintain the adult stock at 60,000 tons at the start of 1977. Since the 1975 catch is now reported to be 20,500 tons, the projected 1976 catch must therefore be substantially lower than 9,000 tons.

at the end of 1975 had reached a level (500,000 tons) which would provide the MSY by the end of 1976. This level of stock size was not reached, and, in order to maintain the stock size at the minimum level of 225,000 tons, the TAC for 1976 should not exceed 60,000 tons, a value derived from using the higher of the two levels assumed as to the size of the 1973 year-class. Under these conditions, it is noted that a TAC lower than 60,000 tons would allow a slight increase in stock size, a first step in the Commission's goal of rebuilding the stock even at a low recruitment level.

e) Management Strategy of Stock Rebuilding

For the herring stocks in Div. 5Y and Div. 5Z plus Stat. Area 6, the Commission has adopted the goal of rebuilding stock sizes to levels capable of producing the maximum sustainable yield (and thus reducing the likelihood of recruitment failure). Such rebuilding can only be accomplished by harvesting less than the annual increase due to growth and recruitment. At current levels of stock size, the annual surplus depends almost entirely on the size of the recruiting year-class (age 3), which is composed partly of immature fish and which is presently being harvested at an age less than that giving the maximum yield-per-recruit.

To assess the long-term consequences of specific management options, several projections were made, assuming the recent poor levels of recruitment. For Div. 5Y, a TAC of 9,000 tons maintained for 1976-82 would result in continuing decline in stock size. For Div. 5Z and Stat. Area 6, a TAC of 60,000 tons for 1976-82 would allow the stock to rebuild slowly to only 58% of the desired level of 500,000 tons by 1982. However, if moderate to good recruitment of new year-classes were to occur, the stocks would increase very quickly; for example, given a TAC of 60,000 tons and recruitment equivalent to that provided by the 1970 year-class, the Georges Bank stock would increase to the 500,000-ton level within a single year.

3. Review of Herring and Mackerel Size Limits

a) Herring

a) At its January 1972 Special Meeting, the Commission introduced size limit regulations for the fisheries in Subarea 5 and part of Subarea 4 to the effect that a vessel may not take during a calendar year herring less than 9 inches (22.7 cm) in total length in an amount exceeding 10% by weight of all herring caught by the vessel during the year (Comm. Doc. 75/6, page 29). The regulation was amended at the January 1974 Special Meeting by adding a "25% by count" exemption to the already existing "10% by weight" exemption. A further amendment to the regulation was made at the June 1974 Annual Meeting to the effect that the period to which the exemption applied was reduced from an "annual basis" to a "per trip basis", where a trip was considered for the purpose of the regulation to be not more than 90 days on the fishing ground as determined from examination of the logbook.

STACRES noted that no new biological information was available that would indicate the need for a change in the minimum size limit.

b) Mackerel

At its April 1975 Meeting, the Assessments Subcommittee strongly recommended the implementation of a minimum size limit regulation of 25 cm total length for mackerel in Subareas 3 to 5 and Stat. Area 6, and this was endorsed by STACRES at its June 1975 Annual Meeting (*Redbook* 1975, pages 15 and 52). STACRES once again reemphasizes the need for such a minimum size limit regulation for the mackerel fishery in the ICNAF Area.

4. Other Business

a) Management of Greenland Fisheries for Cod

At its 1974 Annual Meeting, the Commission requested the Secretariat to point out to NEAFC (Northeast Atlantic Fisheries Commission) the problems involved in managing the cod fishery at West Greenland when the stocks migrate between West and East Greenland. The matter was considered by ICES at its 1975 Annual Meeting, and a meeting of the ICES Northwestern Working Group was scheduled for 8-12 March 1976 at Charlottenlund to (i) investigate the inter-relationship between cod at East and West Greenland and adjacent waters, and (ii) report separately on the state of the stocks of cod and haddock in Icelandic and adjacent waters. ICNAF was invited to participate in the discussion under item (i) above.

STACRES noted that several scientists from ICNAF Member Countries would be participating in the discussions of the Working Group, and nominated Mr. Sv. Aa. Horsted as the ICNAF representative to report to the April 1976 Meeting of the Assessments Subcommittee on progress and recommendations from the March 1976 Meeting of the ICES Working Group.

b) Reporting of Oceanographic Data to MEDS

STACRES took note of recommendations made at its June 1975 Annual Meeting regarding the designation of a national representative in each country who would be responsible for the submission of national oceanographic data to MEDS (Canadian Marine Environmental Data Service) within six months of its collection, so that MEDS can produce annual summaries of environmental conditions in the ICNAF Area (*Redbook* 1975, page 18). STACRES re-emphasized the necessity of having the names of the designated representatives and requested the Secretariat to bring the matter to the attention of member countries.

c) Meeting of Environmental Working Group

STACRES was informed that the Environmental Working Group (Mr. E. J. Sandeman, Convener) will meet at Szczecin, Poland, during the last week of April 1976 to continue discussion of its fisheries oceanographic program which was initiated at the 1974 Annual Meeting.

d) Workshop on Ageing Techniques

Mr. E.C. Lopez-Veiga presented a brief report on the Workshop which was held at Vigo, Spain, in October 1975. The studies on ageing of cod were completed and a report is being prepared for distribution prior to the April 1976 Meeting of the Assessments Subcommittee. However, the planned investigation of silver hake ageing techniques did not materialize, and it was strongly emphasized that these studies be carried out as soon as possible. STACRES accordingly

recommends

i) that a meeting of silver hake ageing experts from Canada, USSR and USA be held as soon as possible, preferably before or during the April 1976 Meeting of the Assessments Subcommittee but no later than May 1976, and

ii) that scientists of the three countries meet before the end of the present Commission Meeting to decide on the time and place for the silver hake Workshop, and inform the Secretariat.

5. Approval of Report and Adjournment

STACRES met on 20 January 1976 to give final approval to its Report, which was presented to the Commission by its Chairman (Dr. A. W. May) on the preceding day. A further brief session was held on 23 January 1976 to consider the Commission's request for additional information on herring in Div. 5Y. In adjourning this Special Meeting of STACRES, the Chairman expressed his appreciation for the facilities provided by the FAO Fisheries Department and thanked the participants for their cooperation and excellent work during the meetings of STACRES and its Working Groups.

APPENDIX I - REPORT OF *AD HOC* WORKING GROUP ON FISHING EFFORT REGULATION IN SUBAREAS 2 to 4.

Chairman: A. T. Pinhorn (Canada)

The *ad hoc* Working Group on Fishing Effort Regulation in Subareas 2 to 4 met during the week of 12-15 January 1976 at FAO, Rome, Italy, to evaluate the implications of the revisions to the basic fishing effort data and the 1976 allocated days fished, which have been reported to the Secretariat (Comm. Doc. 76/I/1 and Addenda) after the Seventh Special Commission Meeting in September 1975.

1. Terms of Reference

The Working Group was given the following terms of reference by STACRES:

a) To review the submissions by each country and to comment or provide further explanation of the revisions to the basic data and to the proposed fishing effort for 1976 where necessary.

b) To compare for each area the total number of fishing days proposed for 1976 by all countries combined with the revised 1972 and 1973 data on fishing effort.

c) To construct a table identical in format to the illustrative table at Attachment 2 of Proposal (1) for International Regulation of Fishing Effort for Groundfish in Subareas 2, 3 and 4 of the Convention Area, adopted at the September 1975 Special Commission Meeting, but using the revised base period data and proposed fishing effort data for 1976, as contained in Comm. Doc. 76/I/1 and Addenda or as revised at the meeting of the Working Group.

2. Review of Revised Basic Data and Changes in Proposed Allocation of Days Fished for 1972.

The Working Group reviewed the revised base period data and the proposed allocation of fishing effort for 1976, as submitted by member countries after the September 1975 Special Commission Meeting and summarized in Comm. Doc. 76/I/1 and Agenda. The following explanatory notes are additional to those contained in the document for those countries that were represented in the Working Group and for which additional explanation of revised data was necessary.

a) Bulgaria

The numbers of fishing days requested for 1976 in Subarea 2 and Div. 3K, in Div. 3LNO, and in Div. 4VWX (total of 380 days) are mainly additional to those allocated to Bulgaria at the September 1975 Special Commission Meeting (total of 21 days).

b) Japan

The revised numbers of fishing days submitted by Japan are identical to those allocated at the September 1975 Special Commission Meeting, except for increasing the number from 170 to 179 days fished for the 2000+ tonnage category in Div. 4VWX and decreasing the number from 18 to 9 days fished for the 1000-1999 tonnage category also in Div. 4VWX, because of an error found in 1973 statistics as previously reported to ICNAF.

c) Poland

The revised numbers of days fished, as reported in Comm. Doc. 76/I/1, contain fishing effort for both demersal and pelagic species. After discussion, the Working Group concluded that, since the fishing effort regulation is for groundfish, any effort directed at pelagic species should be excluded, as was the case for the effort data in the illustrative table of Proposal (1) from the September 1975 Special Commission Meeting. Consequently, an estimate of the fishing effort directed at pelagic species in each area was subtracted from the reported number of days fished. The Polish representative also indicated that previous statistics on days fished had been reported according to a definition used nationally, i.e. any days on which less than 8 hours of fishing took place were excluded. The previously reported days fished for

groundfish were therefore corrected to comply with the ICNAF definition of days fished, and this resulted in the revised data on days fished for 1973 shown in Table 2 for Poland. Removal of effort data for pelagic species resulted in revision of the base data (expressed in days fished according to the ICNAF definition) as follows:

Tonnage	Effort	2+3K	3LNO	3M	3P	4VWX
1000-1999	Total effort	-	-	-	-	78
	Pelagic effort	-	-	-	-	38
	Groundfish effort	-	-	-	-	40
2000-over	Total effort	2422	563	102	18	11
	Pelagic effort	53	17	9	1	-
	Groundfish effort	2369	546	93	17	11

d) Portugal

The data given for Portugal in Comm. Doc. 76/I/1 provides information on areas and tonnage/gear categories to which fishing effort had been transferred only and does not provide information on effort data remaining in other categories to which no effort was transferred or on conversion factors used for the transfers. Attention was also drawn to the fact that some errors were found in the Portuguese submission, in that some dory vessel effort remained after transfer and conversion; these have subsequently been taken into account and the data converted and included in other gear/tonnage categories. The details of the transfers, the conversion factors used and the number of fishing days requested for 1976 are fully described in Addenda II to Comm. Doc. 76/I/1.

e) USSR

Historically, the USSR has reported fishing effort by midwater trawls and bottom trawls as otter trawl effort, with no distinction between gears. The USSR statistical office traditionally associated bottom fish (groundfish) catches with bottom trawl effort and pelagic fish catches with midwater trawl effort. This was in error, as some groundfish are caught in midwater trawls and some pelagic fish in bottom trawls. Revision of the base period data for Subarea 2 and Div. 3K and for Div. 3LNO, correcting for these errors, results in the values for fishing effort by gear type shown in Table 2.

f) USA

Historically, the USA has reported fishing effort on the basis of a national rather than the ICNAF definition of days fished. As the national definition is essentially the number of hours, during which vessels are engaged in fishing operations, divided by 24, the actual number of calendar days on which fishing took place is substantially greater than the number of days reported in the ICNAF statistics. US effort data for 1972 and 1973 have been converted to days fished according to the ICNAF definition, on the basis of reanalysis of fishing logbook data for these years to determine the relationship between fishing effort in terms of the US national definition and days fished by the ICNAF definition. The converted numbers of days fished based on the ICNAF definition are given in Table 2.

g) Other Countries

Since not all countries were represented at the meetings of the Working Group during 12-15 January 1976, further minor revisions to Table 2 are to be expected during the course of the Commission Meeting (see Section 4 below).

3. Comparison of Proposed Fishing Effort for 1976 with Revised Effort for 1972[1] and 1973.

In order to determine the overall effect of the proposed reduction in fishing effort for groundfish in Subareas 2, 3 and 4 from the base years of 1972 and 1973

[1] The term "partially revised" is used in referring to 1972 base year data, as the revised numbers of days fished for some countries were not available and the reported numbers of days fished were used, whereas the revised effort data for 1973 were available for almost all countries.

to 1976, the following procedure was used. The revised fishing effort (days fished) for 1973 and the partially revised data for 1972, as well as the proposed numbers of days fished for 1976 in each tonnage/gear category for each country, were converted to standard Spanish 1000-1999 GRT otter trawl days fished for Subarea 2 plus Div. 3K, Div. 3LNO, Div. 3M, and Div. 3P, and to standard Canada(M) 150-499 GRT otter trawl days fished for Div. 4VWX, by using appropriate conversion factors based on relative catch rates in recent years. These standardized effort values were then totalled over all tonnage/gear categories for each area. In combining the total for all areas, the number of fishing days for Div. 4VWX, based on Canada(M) 150-499 GRT otter trawl standard, was converted to the Spanish 1000-1999 GRT otter trawl standard by using a conversion factor of 0.38 which is the average of conversion factors for the 1969-73 period. The results of the comparisons are given in Table 1.

Table 1. Percentage change in revised effort (days fished) relative to reported effort for 1973, and in the proposed effort for 1976 relative to the revised effort for 1973 and the partially revised effort for 1972.

	Percentage change in revised 1973 effort relative to reported effort for 1973		Percentage change in proposed 1976 effort relative to revised effort for 1973		Percentage change in proposed 1976 effort relative to partially revised 1972 effort	
Area	All countries	Excluding coastal states[1]	All countries	Excluding coastal states[1]	All countries	Excluding coastal states[1]
2+3K	+10	+11	-15	-18	-20	-23
3M	+ 1	+ 1	+13	+ 3	-36	-40
3LNO	+17	+24	-26	-39	-32	-41
3P	< 1	+ 1	-15	-32	- 8	-41
4VWX	< 1	< 1	-36	-50	-12	-22
Total	+ 8	+10	-23	-33	-23	-32

[1] Coastal states are considered to be Canada, France and USA.

Revisions to basic statistics for 1973, submitted by member countries after the September 1975 Special Commission Meeting, resulted in an increase in the total number of days fished by about 8% for all countries and areas combined when compared with the 1973 effort data available at that meeting. The change ranged from less than +1% in Div. 3P and Div. 4VWX to +17% in Div. 3LNO (Table 1).

Relative to the revised effort data for 1973, the number of fishing days proposed for 1976 under the effort regulation is expected to be 23% less for all countries and areas combined, the change ranging from +13% in Div. 3M to -36% in Div. 4VWX. When the data for coastal states are excluded from the analysis, the total fishing effort in 1976 for the remaining countries in all areas combined is expected to be 33% less than the 1973 level based on revised data, the change ranging from +3% in Div. 3M to -50% in Div. 4VWX.

Table 1 also indicates that, relative to the partially revised effort data for 1972, the 1976 fishing effort for all countries and areas combined is expected to decrease about 23%, the change ranging from -8% in Div. 3P to -36% in Div. 3M. When the data for coastal states are excluded, the total fishing effort in 1976 for the remaining countries in all areas combined is expected to be 32% less than the 1972 level, the change ranging from -22% in Div. 4VWX to -41% in Div. 3LNO and Div. 3P. The similarity of the overall percentage reductions from the 1972 and the 1973 levels of effort is because the total effort for both years is approximately the same, but in 1973 there was a general shift of fishing effort from the northern to the southern areas.

The conclusions drawn from Table 1 can only be considered as providing an approximate measure of the overall effect of the proposed reduction in fishing effort, considering the uncertainties in comparing different fleets fishing for different species, using overall conversion factors based on groundfish catch and effort statistics.

4. Revised Fishing Effort for the Base Period and Nationally Proposed Effort for 1976

Table 2 contains the revised effort data (in days fished) for the base years and the proposed fishing effort for 1976, based on information contained in Comm. Doc. 76/I/1 and Addenda including revisions made during meetings of the Working Group and further revisions reported to the Chairman of the Working Group up to 22 January 1976. This table is intended to replace the illustrative table of Proposal (1) for International Regulation of Fishing Effort for Groundfish in Subareas 2, 3 and 4 of the Convention Area, adopted at the Seventh Special Commission Meeting, Montreal, September 1975.

Table 2. **Fishing effort data for base period and proposed fishing effort for 1976. (This table is intended to replace the illustrative table of Prosposal (1) for International Regulation of Fishing Effort in Subareas 2, 3 and 4 of the Convention Area, adopted at the Seventh Special Commission Meeting, September 1975.**

Country	Base period	Vessel tonnage	Gear	Base data (days fished) for groundfish by area					Nationally proposed fishing days for 1976 by area[1]				
				2+3K	3LNO	3M	3P	4VWX	2+3K	3LNO	3M	3P	4VWX
Bulgaria	72-73	2000-over	OTB	-	19	-	-	-	80	80	-	-	220
		2000-over	OTM	2	-	-	-	-	-	-	-	-	-
Canada	72-73	150-499	OTB	-	1330	-	1436	5222	-	1600	-	2200	5100
		150-499	OTM	-	-	-	47	76	-	-	-	50	100
		150-499	LL	-	140	-	44	176	-	150	-	50	200
		500-999	OTB	63	5880	7	1053	2439	1200	7100	500	1500	2400
		500-999	OTM	11	2	4	103	102	-	-	-	100	100
Cuba	...	2000-over	OTB						250	450	225	-	810
Denmark	73	150-499	OTB	18	8	-	-	-	-	-	-	-	-
		150-499	LL	150	-	2115	-	-	540	-	1500	85	140
		500-999	OTB	311	76	-	-	303	306	83	100	75	125
		500-999	OTM	-	-	-	7	43	-	-	-	17	33
France	72-73	150-499	OTB	-	108	-	288	102	-	108	-	288	102
		1000-1999	OTB	411	269	105	109	492	411	269	105	109	492
FRG	73	1000-1999	OTB	243	13	6	-	-	123	6	3	-	-
		2000-over	OTB	1090	71	33	-	5	802	44	17	-	-
GDR	72	500-999	OTB	1120	65	-	2	199	682	38	-	-	-
		1000-1999	OTB	-	-	-	-	-	-	-	-	-	-
		1000-1999	OTM	-	-	-	-	-	-	-	-	-	-
		2000-over	OTB	165	3	-	-	-	234	30	-	-	-
		2000-over	OTM	-	-	-	-	-	-	-	-	-	-
Japan	73	1000-1999	OTB	-	1	-	1	18	-	1	-	1	18
		2000-over	OTB	-	78	-	31	179	-	78	-	31	179
Norway	73	150-499	OTB	89	-	-	-	-	-	-	-	-	-
		150-499	LL	252	33	93	243	112	300	135	288	304	250
		500-999	OTB	133	-	-	-	-	130	14	-	-	-
		500-999	LL	99	-	-	-	-	-	-	-	-	-
		1000-1999	OTB	73	-	-	-	-	-	-	-	-	-
Poland	73	1000-1999	OTB	-	-	-	-	40	-	-	-	-	-
		2000-over	OTB	2369	546	93	17	11	1535	300	80	-	-
Portugal	73	500-999	DV	-	200	-	116	7	-	-	-	-	-
		500-999	GN	-	359	-	-	-	-	483	-	8	2
		1000-1999	OTB	1778	1942	592	165	217	1496	1362	592	24	35
		1000-1999	DV	-	52	-	27	7	-	-	-	-	-
		1000-1999	GN	-	584	-	17	2	-	522	-	9	5
		2000-over	OTB	817	752	266	34	119	589	527	266	5	19
Romania	72-73	2000-over	OTB	175	33	10	2	-	80	80	25	35	-
Spain	72-73	150-499	PT	47	5240	13	1118	1459	215	2136	40	408	341
		500-999	PT	42	1852	8	237	740	183	1818	34	349	288
		1000-1999	OTB	245	386	233	128	257	558	302	82	105	116
		1000-1999	PT	3	291	-	57	120	22	202	14	43	33

Table 2. (continued)

Country	Base period	Vessel tonnage	Gear	Base data (days fished) for groundfish by area 2+3K	3LNO	3M	3P	4VWX	Nationally proposed fishing days for 1976 by area[1] 2+3K	3LNO	3M	3P	4VWX
USSR	72-73	150-499	OTB	-	1024	23	1902	53	-	563	23	172	53
		500-999	OTB	14	94	7	6	108	14	94	7	6	108
		1000-1999	OTB	-	-	-	-	-	-	-	-	-	-
		2000-over	OTB	4981	2863	1304	154	6827	3505	1051	736	154	3425
		2000-over	OTM	624	1203	-	-	-	343	662	-	-	-
UK	72	500-999	OTB	60	43	97	-	-	-	-	-	-	-
		1000-1999	OTB	653	504	642	-	85	616	246	370	-	-
USA	72-73	150-499	OTB	-	-	-	-	1617	-	-	-	-	1883
		150-499	OTM	-	-	-	-	-	-	-	-	-	81
Others				-	-	-	-	-	100	100	100	100	100

[1] Italy requested 250 fishing days in Subareas 2, 3 and 4 for 1976.

5. Definition of Days Fished

The effort concept "days fished", as used by ICNAF and many other international fisheries agencies, is defined as "the number of 24-hour periods, reckoned from midnight to midnight, during which any fishing took place". The Working Group considered it necessary to discuss the matter, as it was suggested in the submission of revised data by one country that "days fished" be redefined.

The Working Group concluded that, if the intention of the suggestion is that the Commission redefine the fishing day for the purpose of enforcement of the fishing effort regulation in Subareas 2 to 4 only, the matter could best be discussed in a committee other than STACRES. However, if the suggestion implied that "days fished" be redefined for purposes of reporting effort data to ICNAF for publication in the Statistical Bulletin, the implications of such a change would have to be considered more fully by STACRES prior to any change being made. It was pointed out that, if "days fished" were redefined for regulatory purposes, adjustments would have to be made in both the base period data and the proposed fishing effort in 1976 for each country, in order to maintain comparability between the two periods, and that it would not be possible for countries to make these adjustments at this meeting. Considered from a scientific viewpoint, the redefinition of "days fished" is undesirable, disrupting the historical data on fishing effort, rejecting an internationally-used definition, and creating new uncertainties concerning the relationship of fishing effort to fishing mortality.

The definition of "days fished" for groundfish for the purpose of regulation is a matter for STACREM and/or STACTIC to discuss. It was pointed out that the definition used in constructing the fishing effort tabulations for the base period is relevant to STACTIC's deliberations, as the use of a different definition will change the effectiveness of the regulation in limiting fishing mortality. In constructing the base period tabulations, fishing effort was considered to be the number of days fished for groundfish if more than 50% of the corresponding catch consisted of groundfish species, irrespective of the species which may have been sought.

6. Definition of Species Included in the Regulation

The species listed as exclusions in the effort regulation proposal, approved at the September 1975 Special Commission Meeting, were reviewed. It was concluded that the present list is ambiguous, particularly in relation to the definition of "other pelagics" and "sharks". It was pointed out that the fishing effort tabulations for the base years of 1972 and 1973 included all fishing effort by vessels greater than 150 GRT, except for herring, mackerel, capelin, and small quantities of effort for such pelagic species as tunas, swordfish, Atlantic saury and large sharks. By implication, the 1976 effort levels for regulation should apply to all finfish species other than those listed above, unless the Commission decides to include or exclude particular species, in which case the ICNAF List of

Species (in *Statistical Bulletin* Vol. 24) could be used to further clarify the issue. The regulation would then apply to all fishing effort for finfish species listed in the ICNAF List of Species under the categories Principal Groundfish, Flounders, Other Groundfish and Other Finfish (with the exception of capelin, porbeagle and other sharks); species listed in the groups Principal Pelagics and Other Pelagics would be excluded. The number of species excluded under this definition is larger than the number excluded in compiling the base period tabulations of fishing effort, but the species involved do not occur in fishable quantities in Subareas 2 to 4.

The Working Group discussed the implications of excluding the fishery for roundnose grenadier from the effort regulation. From the biological point of view, if a species is an integral part of the groundfish ecosystem, it should be included in the overall regulation of the system. It should be excluded only if it is found to belong to a completely separate ecosystem, it does not interact to any significant degree with the ecosystem being regulated, and it can be fished separately. In the case of roundnose grenadier, although the fishery is relatively distinct from the fishery for other species, the by-catch being only 15% in the directed fishery for roundnose grenadier by the German Democratic Republic and the species occurring at depths greater than for most other species, very little is known about the role it plays in the groundfish ecosystem. A 1974 assessment of the state of the stock in Subarea 2 and Div. 3K based on very limited data indicated that the portion of the stock being fished at the time was probably fully exploited but not over-exploited (Res. Doc. 74/6), and no new information has been presented since that time to indicate otherwise. Also, roundnose grenadier resources are thought to exist at depths greater than those presently fished, but no information was presented to indicate that fishing technology is presently available to exploit these resources.

The exclusion of fishing effort for roundnose grenadier from the effort regulation will result in a reduction in fishing effort in Subarea 2 and Div. 3K less than would otherwise be achieved. The reduction in total fishing effort in this area is expected to be about 15% in 1976 relative to 1973 (roundnose grenadier included), as indicated in Table 1 above. Previous general production model studies on cod, which represents the major portion of the groundfish resource in this area, indicate that a reduction considerably larger than 15% is necessary to reduce fishing effort on the stock from the 1972-73 level to the MSY level. Thus, the proposed reduction in fishing effort, even with roundnose grenadier included, may not be large enough to maximize production of the groundfish resource as a whole in this area. The Working Group therefore concluded that, from a biological viewpoint, with the present state of knowledge of the grenadier resource and its role in the ecosystem, it could not at this time recommend the exclusion of roundnose grenadier from the groundfish effort regulation, but that the problem could be further considered when a better understanding of the role of this species in the ecosystem is obtained.

From the practical point of view, the Commission may wish to exclude roundnose grenadier from the effort regulation for a particular country whose allocated effort is not sufficient for it to take its catch allocation, but it should at the same time bear in mind the biological uncertainties surrounding this species. Also, it should be noted that fishing effort for roundnose grenadier was included in the analysis of fishing effort data used in the groundfish general production model and in the development of the data base, both of which were important in deciding the necessity and magnitude of the effort regulation. The exclusion of the fishery for roundnose grenadier from the 1976 regulation at this time would result in a smaller reduction in fishing effort for 1976 relative to the base data, unless the total amount of effort as presently proposed for 1976 were reduced by the estimated amount that would be applied to the fishery for roundnose grenadier.

APPENDIX II - REPORT OF *AD HOC* WORKING GROUP ON HERRING

Chairman: V. C. Anthony (USA)

The *ad hoc* Working Group on Herring met during 12-15 January 1976 at FAO, Rome, Italy, to review the status of the herring stocks in Subareas 4 and 5 and Statistical Area 6 and to recommend TACs for 1976.

1. Fishery Trends

Preliminary herring catches by country and stock for 1975 are listed in Table 1. The catch from the Georges Bank stock in Div. 5Z and Stat. Area 6 was 143,000 tons in 1975, slightly less than the 1974 catch of 150,000 tons. The 1975 catch from the adult herring fishery of Div. 5Y was about 20,000 tons, compared with 18,000 tons in 1974. Catches from the 1974 and 1975 juvenile fisheies were 19,000 and 15,000 tons respectively. Catches from the Nova Scotia stock under management in Div. 4WX were 139,000 and 143,000 tons in 1974 and 1975 respectively. In addition, the catch of juveniles from the New Brunswick side of the Bay of Fundy in Div. 4X(b) (Fig. 1) was 33,000 tons in 1975 compared with 29,000 tons in 1974. In Div. 4V, the catch for the first half of the 1975/76 fishing season was 3,600 tons (TAC is based on July-June season). In all areas under quota regulation, the 1970 year-class continued, as in 1974, to make up the major proportion of the catches.

Table 1. Preliminary statistics of 1975 herring catches (metric tons) used in the January 1976 stock assessments.

Country	Catches by Stock area 4WX	5Y	5Z+6	1975 Total
Bulgaria	1	-	410	411
Canada	120,963 (33,389)[1] (3,079)[2]	3,431	-	124,394 (33,389)[1] (3,079)[2]
Cuba	-	-	600	600
France	-	90	2,850	2,940
FRG	1,343	-	23,230	24,573
GDR	-	-	30,800	30,800
Japan	-	-	1,874	1,874
Poland	-	71	38,400	38,471
Romania	-	-	2,000	2,000
USSR	21,060	_	38,600	59,660
USA	-	16,864 (15,132)[1]	4,492	21,356 (15,132)[1]
Totals	143,367 (33,389)[1] (3,079)[2]	20,456 (15,132)[1]	143,256	307,079 (48,521)[1] (3,079)[2]
Grand Total	179,835	35,588	143,256	358,679

[1] Catches in juvenile herring fisheries.
[2] Catches from local stocks.

2. Herring in Division 4V

No new information has become available since that presented to the 1975 Annual Meeting. Consequently, the recommendation for a TAC of 11,000 tons for the period 1 July 1976 to 30 June 1977 remains unchanged.

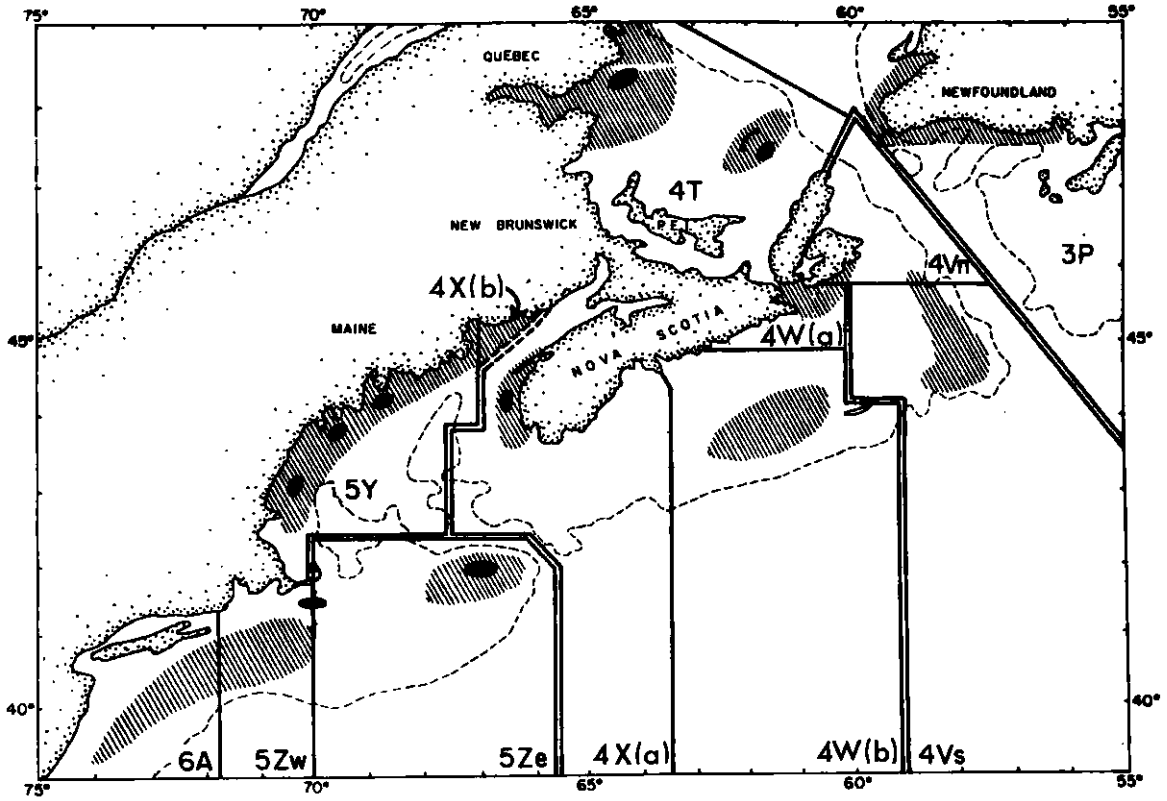


Fig. 1. Herring stock structure in Subareas 4 and 5 and Statistical Area 6. (Double lines indicate stock management areas; solid black areas indicate the general spawning grounds.)

3. Herring in Divisions 4W and 4X

The Assessments Subcommittee previously recommended that the fisheries in Div. 4W(a) and Div. 4XW(b) be combined (*Redbook* 1975, page 39), as a result of new information based on recent tagging experiments (Res. Doc. 75/38). Reconsideration of the 1976 TAC is, therefore, restricted to an analytical assessment of the stock in the two areas combined.

a) Catch Statistics and Age Composition

The total catch from the Div. 4WX fisheries in 1975 was about 179,800 tons, of which 143,400 tons was from the Div. 4WX stock, the remaining 36,400 tons having been taken in the New Brunswick juvenile fishery (Div. 4X(b)) and gillnet catches from local inshore stocks (Table 1). The 1970 year-class comprised 43% in numbers and 55% in weight of the catch from the Div. 4WX stock. Tables 2, 3 and 4 give statistics on removals, these being revisions of similar tables in Summ. Doc. 75/19 (Report of Herring Working Group, April 1975).

b) Year-class Size and Estimates of Fishing Mortality

The starting values of F used in the cohort analysis were set at 0.7 for the 1965 and earlier year-classes. Since the total effort in 1975 was only 77% of the 1974 effort level, it seemed reasonable that F in 1975 on the 1970 year-class would not exceed the level of F in 1974. Further, the continued dominance of the 1970 year-class in the catches and the associated catch per unit effort data indicated that the 1970 year-class was probably about 2.5 times the size of the 1966 year-class. Consequently, a starting F of 0.25 was set to obtain this level at age 1. It was assumed that the 1971 year-class did not experience a greater fishing mortality than the 1970 year-class in 1975, and thus F was set at 0.25. In 1975, the 1970 year-class comprised 86% of the catch of herring aged 5 and older, and, although fishing mortality

Table 2. Herring catches (numbers x 10^{-3}) by age-group in Div. 4XW(b) fisheries, 1974.

	Age (years)											
	1	2	3	4	5	6	7	8	9	10	11	Total
NB Weir	3,019	228,589	40,304	28,539	1,135	44	50	32	35	24	35	301,806
NB Purse seine	13,133	426,663	24,978	380	-	-	-	-	-	-	-	465,154
NB Total	16,152	655,252	65,282	28,919	1,135	44	50	32	35	24	35	766,960
NS Weir	-	65,176	3,848	21,246	1,207	315	117	60	87	39	46	92,141
NS Gillnet	-	-	241	12,797	2,107	1,388	845	315	639	282	315	18,929
NS Purse seine	-	50,291	17,163	343,590	20,547	4,976	1,973	477	1,302	467	559	441,345
NS Total	-	115,467	21,252	377,633	23,861	6,679	2,935	852	2,028	788	920	552,415
Canada Total	16,152	770,719	86,534	406,552	24,996	6,723	2,985	884	2,063	812	955	1,319,375
Other Countries	-	3	5,785	113,562	9,712	3,484	1,173	1,173	5,207	1,427	3,633	145,159
Div. 4XW(b) Total	16,152	770,722	92,319	520,114	34,708	10,207	4,158	2,057	7,270	2,239	4,588	1,464,534
Stock Total[1]	-	115,470	27,037	491,195	33,573	10,163	4,108	2,025	7,235	2,215	4,553	697,574

[1] Includes "NS Total" and "Other Countries" only.

Table 3. Monthly herring catches (metric tons) in Div. 4XW(b) fisheries, 1974.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
NB Weir	-	-	-	37	361	650	5,175	7,315	3,724	1,560	206	-	19,028
NB Purse seine	2,355	794	267	868	-	-	-	-	1,304	1,431	1,825	1,825	10,131
NB Total	2,355	794	267	905	361	650	5,175	7,315	5,028	2,991	2,031	1,287	29,159
NS Weir	-	-	-	-	1,813	1,818	1,276	584	697	248	-	-	6,436
NS Gillnet	-	-	1	21	80	1,071	760	1,024	1,276	51	1	-	4,285
NS Purse seine	-	-	-	-	592	15,146	35,933	23,708	1,193	287	-	-	76,859
NS Total	-	-	1	21	2,485	18,035	37,969	25,316	3,166	586	1	-	87,580
Canada Total	2,355	794	268	926	2,846	18,685	43,144	32,631	8,194	3,577	2,032	1,287	116,739
Other Countries	-	-	183	740	6,083	13,404	1,979	463	563	955	56	57	24,483
Div. 4XW(b) Total	2,355	794	451	1,666	8,929	32,089	45,123	33,094	8,757	4,532	2,088	1,344	141,222
Stock Total[1]	-	-	184	761	8,568	31,439	39,948	25,779	3,729	1,541	57	57	112,063

[1] Includes "NS Total" and "Other Countries" only.

Table 4. Calculated herring catches by age-group from Div. 4W(a) fisheries, 1969-75.

Age	1969	1970	1971	1972	1973	1974	1975
1	-	-	1,430	2,607	-	11	-
2	4,629	22,389	149,851	1,653	14,912	2,949	2,056
3	55,175	42,435	150,333	19,714	39,909	19,728	42,302
4	64,423	87,024	68,994	36,932	23,795	130,912	16,323
5	36,343	23,670	52,506	12,516	7,238	19,581	78,604
6	29,988	26,204	34,588	13,936	3,566	5,108	7,799
7	7,452	8,120	44,892	8,948	1,399	3,998	2,369
8	1,760	4,561	25,593	11,585	906	3,483	1,645
9	665	1,776	9,696	4,837	843	3,880	2,079
10	27	290	4,874	5,181	164	3,745	2,030
Total	200,462	216,469	542,757	117,909	92,732	193,395	155,207

increases with age, F should not be substantially higher on earlier year-classes that on the 1970 year-class in 1975; consequently, starting F's on the 1966-69 year-classes were set at 0.40. Regressions of total removals of age 2 fish and catch per unit effort of age 2 fish against calculated year-class size of 2-year-old fish plus additional juvenile catch data suggested that the sizes of the 1972 and 1973 year-classes at age 2 were higher than the conventional level of 750 X 10^6 fish. Starting values of F of 0.27 and 0.23 were set for the 1972 and 1973 year-classes respectively, in order to obtain year-class sizes of 1000 X 10^6 fish at age 2. The size of the 1974 year-class was set at the conventional level of 750 X 10^6 fish. The calculated fishing mortalities and year-class sizes at age from cohort analysis are given in Table 5.

c) Catch Predictions for 1976

In Div. 4WX, the fisheries occur in the early months of the year in Div. 4W(a) and in summer in 4XW(b). Consequently, the same mean weight-at-age values could not be used in the catch predictions for the two fisheries. Mean weight data for both areas were re-examined for the period 1969-75, and those used in the predictions are as follows:

Age	2	3	4	5	6	7	8	9	10
Div. 4W(a)	0.036	0.082	0.128	0.173	0.216	0.252	0.277	0.304	0.330
Div. 4XW(b)	0.042	0.113	0.175	0.218	0.259	0.298	0.332	0.364	0.392

The catch and stock size predictions (Table 6) are based on applying a given management strategy to the stock on an annual basis. Since the catches from Div. 4W(a) and Div. 4XW(b) were in about the same proportions in 1974 and 1975, the predicted removals at age (in numbers) on an annual basis were partitioned between the two fisheries. This was based on the average of the proportions of each year-class removed by each of the fisheries in 1974 and 1975 (e.g. the average of the proportion of the 1970 year-class removed in 1974 and 1975) for age 4 and older herring. The proportion used for removals of age 3 fish in Div. 4W(a) was set at 0.28, slightly less than for 4-year-olds. Since removals of age 2 fish in Div. 4W(a) are usually relatively low, the proportion was set at 0.02. The proportions used to partition the 1976 predicted catch between Div. 4W(a) and 4XW(b) are as follows:

Age	2	3	4	5	6	7	8	9	10
Div. 4W(a)	0.02	0.28	0.30	0.30	0.22	0.28	0.30	0.55	0.65
Div. 4XW(b)	0.98	0.72	0.70	0.70	0.78	0.72	0.70	0.45	0.35

Table 5. Herring in Div. 4WX: stock size, catch and fishing mortality by age-groups.

Year	Age (years) 2	3	4	5	6	7	8	9	10	Age 2 and older Number	Age 2 and older Weight	Age 4 and older Number	Age 4 and older Weight
Stock size (millions)										(10^{-6})	(000 t)	(10^{-6})	(000 t)
1966	1,443	1,802	645	822	215	54	20	2	-	5,003	634	1,758	371
1967	1,194	1,140	1,231	478	394	135	31	9	-	4,612	653	2,278	475
1968	2,365	939	871	792	292	179	58	21	7	5,524	687	2,220	484
1969	607	1,262	697	655	406	175	67	19	4	3,893	620	2,024	453
1970	807	434	689	466	399	241	93	36	10	3,175	527	1,934	445
1971	851	564	303	315	212	222	105	42	12	2,626	396	1,211	298
1972	5,874	551	267	143	135	104	94	44	17	7,229	504	804	197
1973	744	4,209	400	104	54	45	40	31	12	5,639	653	686	149
1974	997	584	2,913	230	53	20	19	16	8	4,840	702	3,259	594
1975	995	709	437	1,822	140	30	9	10	3	4,155	648	2,451	527
1976	750	651	446	279	1,162	77	17	5	5	3,392	577	1,991	472
Catch in numbers (millions)													
1966	45,678	270,055	56,063	308,471	44,916	15,006	7,716	1,689	215	749,809		434,076	
1967	43,234	68,671	238,403	109,786	159,205	57,936	4,497	409	296	682,437		570,532	
1968	746,145	78,899	64,045	267,965	70,183	87,767	31,258	15,277	5,635	1,367,174		542,130	
1969	70,178	380,232	116,375	152,093	101,434	56,111	20,597	6,859	2,816	906,695		456,285	
1970	106,193	57,254	275,563	186,746	115,348	102,208	37,407	19,204	7,590	907,513		744,066	
1971	161,088	215,236	116,010	135,406	77,124	97,474	46,442	19,275	9,435	877,490		501,166	
1972	663,740	57,061	126,446	70,400	72,539	50,198	50,483	26,009	13,223	113,099		409,298	
1973	27,601	589,092	107,908	35,535	26,269	19,886	17,682	19,749	9,585	853,307		236,614	
1974	118,419	45,865	662,107	53,118	15,271	8,106	5,508	11,115	5,960	885,469		721,185	
1975	185,975	152,730	87,975	366,772	42,085	8,966	2,766	3,133	2,661	853,063		514,358	
1976	5,650	36,420	86,604	67,840	321,228	21,324	4,498	1,397	1,444	546,405		504,335	
Fishing mortality												Mean F[1]	
1966	0.036	0.181	0.101	0.536	0.263	0.363	0.560	1.613	0.700			0.590	
1967	0.041	0.069	0.241	0.293	0.592	0.641	0.175	0.050	0.700			0.384	
1968	0.429	0.097	0.085	0.468	0.309	0.784	0.896	1.572	0.700			0.688	
1969	0.137	0.405	0.204	0.296	0.323	0.437	0.417	0.492	0.700			0.410	
1970	0.157	0.158	0.584	0.586	0.385	0.632	0.590	0.889	0.700			0.624	
1971	0.235	0.547	0.549	0.646	0.514	0.662	0.673	0.706	0.700			0.636	
1972	0.133	0.121	0.740	0.782	0.900	0.763	0.902	1.068	0.700			0.836	
1973	0.042	0.168	0.354	0.472	0.778	0.671	0.679	1.204	0.700			0.694	
1974	0.141	0.091	0.269	0.295	0.381	0.586	0.391	1.371	0.700			0.570	
1975	0.230	0.270	0.250	0.250	0.400	0.400	0.400	0.400	0.700			0.400	
1976	0.105	0.144	0.266	0.315	0.350	0.350	0.350	0.350	0.350			0.333	

[1] Mean F (for age 4 and over) unweighted.

The present conservation program involves a TAC of 45,000 tons for the period 1 July 1975 to 30 June 1976 in Div. 4VW(a), but this TAC is not partitioned between Div. 4V and Div. 4W(a). It is possible that 34,000 tons of the Canadian allocation in Div. 4VW(a) will be taken in Div. 4W(a) by 30 June 1976, since poor catches were experienced earlier in the 1975/76 fishing season in Div. 4V. Consequently, in setting the 1976 TAC for Div. 4WX, account must be taken of the expected catch in Div. 4W(a) during the first half of 1976. It was therefore assumed that 34,000 tons would be taken in Div. 4W(a) during January-June 1976 (about 10,000 tons were actually taken in December 1975, but, in the absence of information on length and age compositions, this amount was assumed to be 1976 catch for assessment purposes), and the estimated catch (in numbers) in Div. 4W(a) was adjusted to equal 34,000 tons. The predicted residual removals constitute the Div. 4XW(b) catch. The F-values were then calculated for each age-group for each area assuming that M = 0.1 for each area (Table 2).

Yield-per-recurit calculations, using Beverton-Holt equations, indicated that F_{max} = 0.7 and $F_{0.1}$ = 0.3 (Fig. 2). It appeared obvious that fishing at F_{max} would be extremely imprudent and that the fishery should be conducted at a level of F closer to $F_{0.1}$. Consequently, F = 0.35 was used for age 6 and older fish in 1976. The 1976 F-values used for ages 2 to 10 are based on partial recrutiment factors as follows:

Age	2	3	4	5	6	7	8	9	10
Partial recruitment	0.30	0.41	0.76	0.90	1.00	1.00	1.00	1.00	1.00
F in 1976	0.105	0.144	0.266	0.315	0.35	0.35	0.35	0.35	0.35

The catch prediction calculations indicate that the 1976 TAC should be 118,000 tons for the Div. 4WX stock. Assuming that 34,000 tons will be taken in Div. 4W(a) during January-June 1976, a catch of 84,000 tons is predicted for Div. 4XW(b) for January-December 1976 and for Div. 4W(a) during July-December 1976 (Table 6).

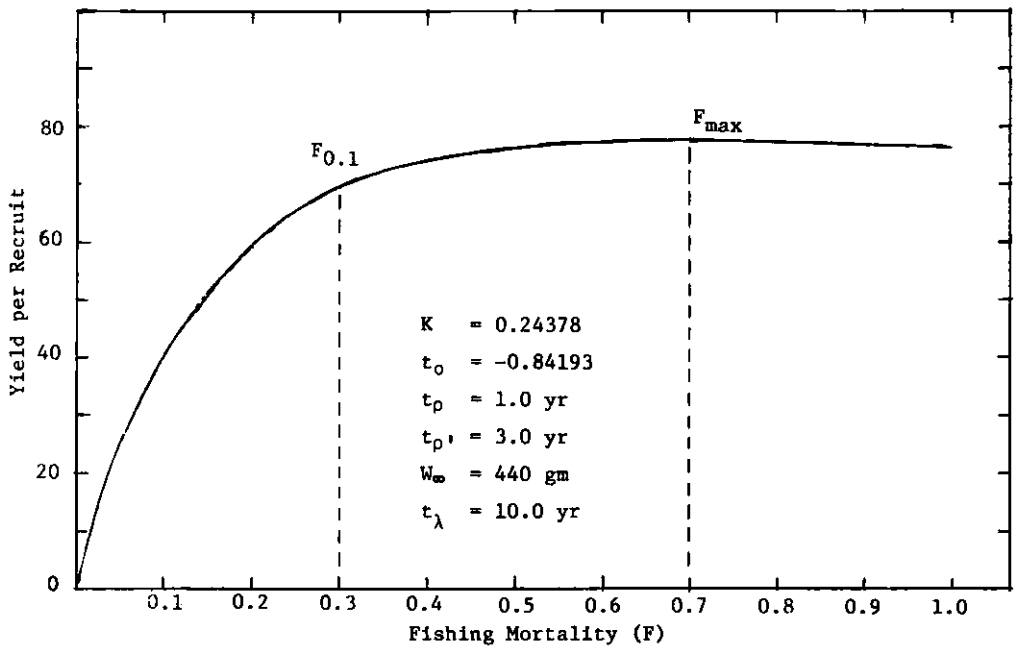


Fig. 2. Yield per recruit for herring in Div. 4X.

Table 6. Herring in Div. 4WX: catch projection for 1976 and stock size projection (age 2 and older) for 1977 for F = 0.35.

Age	Div. 4WX Stock size Jan 1976 (10^6)	Div. 4W(a) F	Div. 4W(a) Projected catch in Jan-Jun 1976 (10^6)	Div. 4W(a) Projected catch in Jan-Jun 1976 (000 t)	Div. 4WX Residual stock in Jul 1976 (10^6)	Div. 4XW(a) F	Div. 4XW(a) Projected catch in 1976 (10^6)	Div. 4XW(a) Projected catch in 1976 (000 t)	Div. 4WX Projected stock in Jan 1977 (10^6)	Div. 4WX Projected stock in Jan 1977 (000 t)
2	750	0.003	2	0.1	677	0.006	4	0.2	609	25.3
3	651	0.049	29	2.4	562	0.013	7	0.8	502	56.5
4	446	0.092	37	4.7	368	0.152	49	8.7	286	50.1
5	279	0.106	27	4.6	227	0.211	41	9.0	166	36.2
6	1,162	0.083	88	19.1	967	0.291	233	60.3	654	169.3
7	77	0.108	8	1.9	63	0.264	14	4.1	43	12.9
8	17	0.114	2	0.5	13	0.252	3	0.9	9	3.0
9	5	0.240	1	0.3	4	0.128	< 1	0.1	3	1.0
10	5	0.264	1	0.4	4	0.071	< 1	0.1	3	1.3
Total	3,392		195	34.0	2,885		352	84.2	2,275	354.6
								Total (age 4 and over)		272.8

It should be noted that the 1970 year-class has supported the fishery since 1972 and is predicted to constitute 67% of the catch by weight in 1976. Furthermore, the stock size (age 4 and older) will have declined by 42% from a level of 472,000 tons at the beginning of 1976 to 273,000 tons at the beginning of 1977. Although little is known about stock-recruitment relationships for herring and the minimum stock size necessary to ensure good recruitment, the Working Group agreed that, for the time being, the stock size (age 4 and older) should not be allowed to decline below 250,000 tons, which is 63% of the long-term average (1965-76) of 399,000 tons, the lowest stock size during the period being 149,000 tons in 1973 (Table 5). If the 1972 and 1973 year-classes are not substantially larger than presently estimated, the TAC for Div. 4WX would have to be reduced to about 85,000 tons in 1977, in order to maintain a stock size of 250,000 tons. Unless one or more good year-classes enter the fishery, subsequent TACs would have to be set at a relatively low level.

4. Herring in Division 5Y

a) Catch Statistics

The catch from the adult herring fishery in Div. 5Y (Jeffreys Ledge area) increased to 20,500 tons in 1975 (Table 1) from 18,000 tons in 1974. The Federal Republic of Germany and German Democratic Republic did not fish in the area in 1975, and catches by both Canada and Poland were less than in 1974. The USA catch increased to 16,900 tons from 10,200 tons in 1974. The catch from the juvenile herring fishery decreased to 15,000 tons in 1975 from 19,100 tons in 1974. Age 3 and older herring accounted for 33% (4,900 tons) of the 1975 catch from the juvenile fishery.

b) Fishing Mortality and Year-class Size

The fishing mortality on the various age-groups in 1975 and year-class abundance were estimated as follows:

(i) For the 1968 and earlier year-classes (age 7 and older), cohort analysis was applied to the catches using a starting F-value of 1.1 for 1975. This level of F roughly corresponds to that for the older age-groups in catches since 1970.

(ii) For the 1969 year-class (age 6), an F-value of 0.35 was assumed for 1975. This estimate is based on extrapolating a catch curve to 1978 (age 9) and applying starting F-values of 0.6, 1.0 and 1.4 to the projected 1978 catch by cohort analysis, giving estimates of F for 1975 of 0.31, 0.35 and 0.37.

Table 7. Herring in Div. 5Y: stock size, catch and fishing mortality by age-groups, 1967-76.

Year	Age (years) 2	3	4	5	6	7	8	9	10	10+	Age 3 and older Number	Age 3 and older Weight	Age 4 and older Number	Age 4 and older Weight
Stock size (millions)											(10^{-6})	(000 t)	(10^{-6})	(000 t)
1967	281	201	181	99	99	56	10	5	3	-	555	123	453	99
1968	329	230	165	146	92	86	48	10	5	3	785	126	555	98
1969	184	269	172	119	93	63	58	30	7	3	814	159	545	127
1970	147	149	185	136	88	56	36	36	19	4	597	148	448	130
1971	89	117	114	128	94	48	21	13	8	5	548	113	431	99
1972	675	72	75	72	74	44	16	3	2	1	359	75	287	66
1973	81	533[1]	44	28	23	22	11	4	1	-	666	95	133	31
1974	83	64[2]	420	31	13	7	6	3	2	-	546	99	482	91
1975	-	64[2]	39	287	19	6	3	2	1	1	422	86	358	79
1976	-	64[2]	36	16	182	11	2	1	-	-	312	65	248	58
Catch in numbers (thousands)											Age 2 and older		Age 3 and older	
1967	21	317	2,953	7,410	13,366	8,197	565	343	326	167	33,665	7,793	33,644	7,794
1968	564	17,734	17,467	29,458	29,280	27,974	18,387	3,166	2,412	1,960	148,402	31,264	147,838	31,230
1969	1,722	39,044	6,192	9,850	22,476	26,618	21,124	11,028	2,604	1,685	142,343	30,993	140,621	30,890
1970	3,419	9,327	26,370	18,350	26,835	26,943	23,344	27,993	13,774	2,666	179,021	40,095	175,602	39,564
1971	634	23,129	22,676	33,979	36,750	26,335	16,011	11,020	7,347	3,241	181,122	38,558	180,488	37,711
1972	21,243	16,992	37,487	39,758	42,449	27,493	9,347	1,434	1,311	761	199,375	42,169	177,032	41,216
1973	2,226	18,594	5,701	10,437	13,182	13,645	7,293	2,116	420	233	73,847	16,196	71,261	16,049
1974	3,979	14,950	62,821	7,224	5,094	3,568	2,991	1,436	801	348	103,212	17,774	99,233	17,543
1975	338	18,656	18,240	59,343	4,932	3,800	1,640	1,191	474	373	108,987	20,456	107,052	20,436
Fishing mortality														Mean F[3]
1967	-	0.002	0.018	0.078	0.15	0.16	0.06	0.07	0.11	-				0.066
1968	0.002	0.089	0.125	0.253	0.38	0.40	0.48	0.39	0.67	1.10				0.231
1969	0.010	0.170	0.041	0.096	0.31	0.55	0.46	0.46	0.50	1.10				0.215
1970	0.026	0.070	0.170	0.162	0.40	0.77	1.04	1.46	1.34	1.10				0.439
1971	0.008	0.250	0.250	0.350	0.56	0.93	1.82	2.03	2.01	1.10				0.526
1972	0.0354	0.300	0.800	0.930	1.01	1.17	1.08	0.84	1.54	1.10				0.832
1973	0.031	0.039	0.160	0.540	0.98	1.16	1.28	0.78	0.64	1.05				0.163
1974	0.055	0.299	0.181	0.300	0.56	0.79	0.88	0.99	0.79	1.10				0.233
1975	-	0.385	0.717	0.258	0.35	1.10	1.10	1.10	1.10	1.10				0.350

[1] Recruitment at age 3 assumed to be twice the size of the 1966 year-class at age 3 (*Redbook* 1974, page 110).
[2] Recruitment at age 3 assumed to be equal to the size of the 1969 year-class at age 3 as calculated in previous assessments.
[3] Average F's weighted over year-class by stock size in number.

(iii) The size of the 1970 year-class (age 5) was assumed at age 3 to be twice as large as the 1966 year-class at age 3 (i.e. 533 million fish). Catches of 18.6, 62.8 and 59.3 million fish from the 1970 year-class in 1973, 1974 and 1975 respectively (Table 7) produced F-values of 0.04, 0.18 and 0.26, resulting in an abundance of 182 million fish (44,000 tons) at the start of 1976.

(iv) The sizes of the 1971 and 1972 year-classes (ages 4 and 3 respectively in 1975) were assumed to be equal to the size of the 1969 year-class at age 3. The catches from these year-classes in 1975 did not indicate that a change in this assumption was necessary, and their abundance at the beginning of 1976 was estimated to be 16 and 36 million fish respectively.

c) Recruitment Level of 1973 Year-class

New information, available since the previous assessment in April 1975, on recruitment of the 1973 year-class in 1976 includes the results of a juvenile herring survey in the Gulf of Maine and catch statistics for the juvenile herring fishery in 1975. Both sets of data support the conclusion from the previous assessment that the size of this year-class is very small, being approximately the same as the 1971 and 1972 year-classes at age 3 (i.e. 64 million fish).

d) Adjustment in Mean Weights

Recent analysis of average weight data for herring in the Div. 5Y fishery for adults indicated that the mean weight of age 2 fish should be reduced from 87 gm, as used previously, to 60 gm and that for age 3 fish from 155 to 120 gm. The mean weights used for ages 4 to 11 herring are 180, 220, 240, 275, 300, 320, 340 and 360 gm.

e) The TAC Level for 1976.

The stock size (age 4 and older) at the beginning of 1976 was estimated in the previous assessment to be about 64,000 tons, under the assumption that the 1975 catch would be 15,000 tons. Since 20,500 tons were actually taken in 1975, the stock size at the start of 1976 is now estimated at 58,000 tons, compared with a spawning stock size of 79,000 tons at the beginning of 1975. Selection coefficients used in calculating the predicted catches for 1976 were obtained by averaging F-values for the years 1972 and 1973.

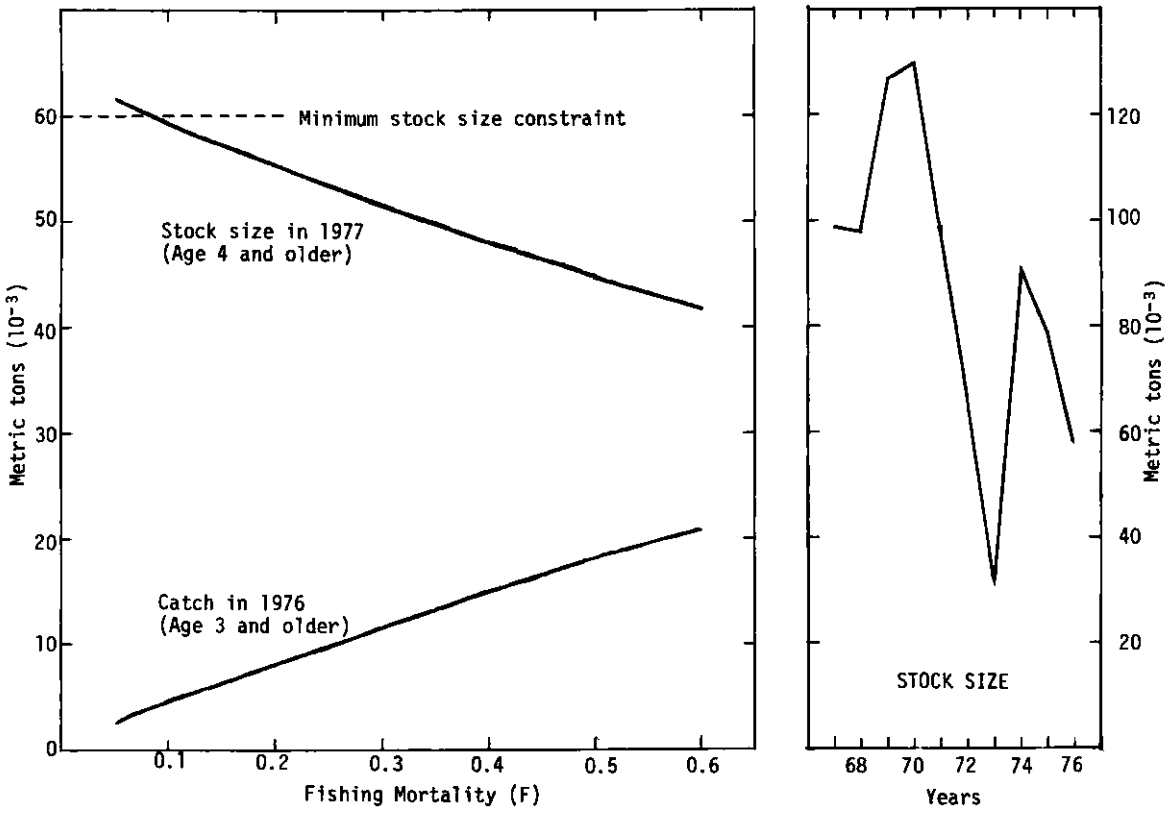
The projected stock sizes at the beginning of 1977, in relation to projected catches for a range of F-values, are given in Table 8 and Fig. 3. At its 1974 Annual Meeting (Proc. No. 20, App. II, page 240), the Commission agreed that the TAC for 1976 must be such that the adult stock size (age 4 and older) be maintained at a minimum of 60,000 tons at the start of 1977, and that the TAC in 1976 would not be increased above that for 1975 unless the adult stock size at the end of 1975 had reached the level (i.e. 110,000 tons) that would provide the maximum sustainable yield by the end of 1976. The 1975 TAC was set at 25,000 tons at the 1974 Annual Meeting, but it was adjusted to 16,000 tons at the November 1974 Special Commission Meeting. The desired adult stock size of 110,000 tons was not attained at the end of 1975, and, therefore the TAC cannot be increased in 1976. In order to maintain the minimum stock size of 60,000 tons, a catch of 3,500 tons may be taken in 1976 at an F-level of 0.08. A catch of 16,000 tons would require an F of 0.43 and result in a reduction in stock size to 47,000 tons. An F at the $F_{0.1}$ level of 0.38 would provide a catch of 14,500 tons, but the stock size at the end of 1976 would be reduced to 48,500 tons.

In view of the present state of the stock, the Working Group recommends that the TAC for 1976 be set at 4,000 tons or less, depending on the management strategy to rebuild the stock. Only by accepting such a TAC level can any increase in stock size be anticipated, in accord with the management objectives of the Commission.

Table 8. Herring in Div. 5Y: projected stock size in 1977 as a function of catch for a range of fishing mortalities in 1976, assuming that the recruiting year-class (1973) is equal to 63.5 million fish.

Stock size age 4 and older at start of 1975 (10^6)	(000t)	Catch age 3 and older in 1975 (000 t)	Stock size age 4 and older at start of 1976 (10^6)	(000 t)	F in 1976 (100%)	Predicted catch age 3 and older in 1976 (000 t)	Stock size age 4 and older at start of 1977 (000 t)
358	79	20.4	248	58	0.00	0.0	63.5
					0.08	3.5	60.0
					0.10	4.3	59.1
					0.20	8.2	55.0
					0.30	11.8	51.3
					0.40	15.2	47.8
					0.50	18.3	44.8
					0.60	21.2	41.7
					0.80	26.0	37.0

Fig. 3. Herring in Div. 5Y: projected catch in 1976 and resultant stock size in 1977 over a range of fishing mortalities, and the trend in stock size for 1967-76.



5. Herring in Division 5Z and Statistical Area 6

a) Catch Statistics

The catch of 143,000 tons in 1975 was slightly below the 150,000 tons reported for 1974. Most countries fished heaviest in the August-October period when 70% of the catch in weight was taken. Exceptions to this were the USSR, whose

catches were spread almost equally over the months of April to November, and the USA which fished mostly in January to March. The 1970 year-class continued to support the fishery, constituting 77% of the catch both in numbers and weight.

b) Indices of Abundance

Abundance indices were available for the commercial fisheries of Federal Republic of Germany and Poland for 1975. FRG vessels caught an average of 38 tons per day in 1975 compared with 40 tons per day in 1974. The catch per unit effort of Polish B-18 trawlers was 19 tons per day in September 1975 and 23 tons per day in October (preliminary data) compared with a value of 31.7 tons per day in 1974.

The average catch per tow in the USA autumn survey by *Albatross IV* in 1975 was 0.02 fish per tow, the lowest value in the 13 years of the survey. The average catch was 4.4 fish per tow for 1963-69, 0.8 fish per tow for 1970-72, and 0.09 fish per tow in 1973-75.

c) Estimation of Fishing Mortality in 1975

The fishing mortality on the various age-groups in 1975 were estimated as follows:

(i) For the 1971 and 1972 year-classes (ages 4 and 3), fishing mortality was estimated by starting with assumed recruitment of 550 million fish for each, the resulting F-values being 0.023 for age 3 and 0.23 for age 4. These values seemed to be rather low compared with those of previous years. However, since the fishery in 1975 was concentrated mainly on the 1970 year-class with the 1971 and 1972 year-classes accounting for only 13% of the total catch, these low F-values were considered to be realistic.

(ii) For the 1970 year-class (age 5), its size at age 3 was assumed to be equal to twice the size of the 1966 year-class (i.e. 3,202 million fish). Using this figure and the catches in 1973, 1974 and 1975 from the 1970 year-class, the F-value for age 5 in 1975 was estimated to be 1.03.

(iii) For herring older than age 5, fishing mortalities in the preceding years have always been higher than that for age 5 fish; therefore, F for fish older than age 5 was set at 1.10.

The F-values obtained by the above procedures were used to estimate the size of the stock at the beginning of 1976 as the starting points for the calculation of the catch in 1976 and the surviving stock for 1977 (Table 9).

d) Recruitment Level of the 1973 Year-class

New information on the size of the recruiting 1973 year-class in 1976 consisted of catch statistics from the juvenile herring fisheries in Subareas 4 and 5 and the results of the 1975 juvenile herring survey. These data indicated that the 1973 year-class was similar in size to those of 1971 and 1972.

e) Adjustment in Mean Weights

Mean weights used in the population prediction models for herring were examined on the basis of new sampling data. The weights used for ages 4 to 8+ fell within the range of the observed new data. However, the mean weight used previously for age 3 was appropriate only for the early autumn fishery. Examination of monthly catch statistics for 1975 indicated that 52% of the total catch in Subarea 5 and Stat. Area 6 was taken during the first half of the year. Consequently, the mean weight of age 3 herring was reduced from 155 gm used previously to 140 gm, which is the weighted mean of the averages from January-June and July-December samples.

Table 9. Herring in Div. 5Z and Stat. Area 6: stock size, catch and fishing mortality by age-groups, 1964-76.

	Age (years)								Age 3 and older		Age 4 and older	
	2	3	4	5	6	7	8	>8	Number	Weight	Number	Weight
Stock size (millions)									(10^6)	(000 t)	(10^6)	(000 t)
1965	2,272	1,517	2,241	2,277	282	101	22	-	6,440	1,219	4,923	1,006
1966	1,517	1,860	1,233	1,803	1,771	207	71	17	6,962	1,388	5,102	1,128
1967	1,755	1,242	1,511	978	1,316	1,197	119	46	6,409	1,357	5,167	1,184
1968	1,878	1,435	1,010	1,182	703	850	637	46	5,863	1,252	4,428	1,051
1969	-	1,536	1,128	762	664	364	304	217	4,975	1,010	3,439	795
1970	860	972	1,216	733	373	292	128	77	3,791	751	2,819	615
1971	764	693	683	588	355	195	155	58	2,727	554	2,034	457
1972	3,966	614	266	310	224	132	66	81	1,693	339	1,079	253
1973	678	3,222	471	118	60	40	17	13	3,941	597	719	146
1974	672	546	1,710	145	39	19	12	3	2,474	435	1,928	359
1975		550[1]	411	849	57	20	10	7	1,904	362	1,354	285
1976[2]			440	267	248	15	5	3			978	204
Catch in numbers (millions)												
1964	16.5	150.8	230.5	128.4	97.5	34.9	-	-	658.6	131.0		
1965	0.4	10.3	34.9	103.0	25.5	12.7	9.3	-	200.3	40.6		
1966	0.3	12.8	34.6	178.0	280.1	65.1	13.6	2.0	587.1	142.7		
1967	1.8	6.9	60.6	108.0	250.7	379.2	49.4	21.3	877.9	218.6		
1968	2.5	52.1	72.0	336.0	233.4	432.9	336.6	28.4	1493.9	373.4		
1969	-	45.5	210.8	277.1	278.1	188.5	190.5	133.3	1323.8	306.0		
1970	12.6	125.4	450.5	270.3	122.3	92.9	51.6	47.3	1172.9	247.0		
1971	12.9	332.5	275.5	284.6	175.8	103.9	50.4	35.7	1271.3	262.5		
1972	28.0	35.0	110.0	214.0	158.0	100.0	45.0	50.0	712.0	174.0		
1973	10.0	1026.0	266.0	64.0	33.0	23.0	12.0	8.0	1432.0	199.0		
1974	1.9	39.9	608.9	68.6	12.9	6.1	3.5	2.1	743.9	146.2		
1975	1.4	11.3	76.8	503.0	34.6	12.5	6.2	4.2	650.0	143.3		
Fishing mortality									Mean F[3]			
1965	0.001	0.008	0.02	0.05	0.11	0.15	-	-	0.034			
1966	0.001	0.008	0.03	0.12	0.19	0.43	0.24	-	0.102			
1967	0.001	0.006	0.05	0.13	0.24	0.43	0.68	(1.10)	0.175			
1968	0.002	0.041	0.08	0.38	0.46	0.83	0.88	(1.10)	0.372			
1969	-	0.033	0.23	0.52	0.62	0.85	1.18	(1.10)	0.359			
1970	0.016	0.154	0.53	0.52	0.45	0.43	0.59	(1.10)	0.407			
1971	0.019	0.756	0.59	0.77	0.79	0.89	0.45	(1.10)	0.698			
1972	0.008	0.065	0.61	1.45	1.51	1.82	1.42	(1.10)	0.792			
1973	0.016	0.432	0.98	0.91	0.94	1.00	1.43	(1.10)	0.528			
1974	0.003	0.084	0.50	0.74	0.45	0.44	0.38	(1.10)	0.420			
1975		0.023	0.23	1.03	1.10	1.10	1.10	(1.10)	0.560			

[1] Recruitment at age 3 assumed as in previous assessments (*Redbook* 1974, page 112).
[2] Stock size calculated from the relationship, $N_{i+1} = N_i e^{-Z_i}$.
[3] Mean F (for age 3 and older) weighted over year-classes by stock size in number.

f) The TAC Level for 1976

The assessment of the Georges Bank stock to determine the appropriate TAC for 1976 was made with the following assumptions:

(i) The size of the 1970 year-class at age 3 is equal to twice the size of the 1966 year-class as estimated in a previous assessment (*Redbook* 1974, page 44).

(ii) The sizes of the 1971 and 1972 year-classes at age 3 are equal to the size of the poorest year-class observed in the fishery (i.e. 1969 year-class) as indicated in a previous assessment (*Redbook* 1974, page 44).

(iii) The size of the 1973 year-class at age 3 is equal to the size of the two preceding year-classes (i.e. 550 million fish, which was chosen as a conventional level for poor year-classes). An alternative assessment was carried out, assuming that recruitment of the 1973 year-class at age 3 is equal to the poorest year-class observed in the fishery; this is approximately the average of the sizes of the 1968 and 1972 year-classes at age 3 (i.e. 620 million fish) and is close to the size of the 1969 year-class at age 3 (Table 9).

The results of the assessments are given in Table 10 and illustrated in Fig. 4A. At its January 1974 Special Meeting (Proc. No. 7, page 93), the Comcission agreed that the TAC for 1976 must be such as to maintain a stock size of at least 225,000 tons at the beginning of 1977, and that the TAC for 1976 can be increased only if the adult stock size at the end of 1975 had reached the level (i.e. at least 500,000 tons) that would provide the maximum sustainable yield by the end of 1976. This level of stock size was not achieved by the end of 1975 and the TAC (150,000 tons in 1975) cannot therefore be increased. If the size of the 1973 year-class at age 3 is assumed to be 550 million fish, a catch of 150,000 tons in 1976 would leave an adult stock size of 120,000 tons at the beginning of 1977, a value much below the minimum level of 225,000 tons. In order to prevent a decline in stock size below this minimum level by the end of 1976, the TAC for 1976 should not exceed 52,000 tons. Under the assumption that the size of the recruiting 1973 year-class is 620 million fish, the corresponding TAC would be 61,000 tons.

Table 10. Herring in Div. 5Z and Stat. Area 6: projected stock size in 1977 as a function of catch for a range of fishing mortalities for 1976, assuming the the recruiting year-class at age 3 equals 550 million fish[1].

Stock size age 4 and older at start of 1975		Catch age 3 and older in 1975	Stock size age 4 and older at start of 1976		F in 1976 (100%)	Predicted catch age 3 and older in 1976	Stock size age 4 and older at start of 1977
(10^6)	(000 t)	(000 t)	(10^6)	(000 t)		(000 t)	(000 t)
1,354	285	143	978	204	0.20	32	245
					0.38	57	219
					0.60	83	193
					0.80	103	172
					1.00	117	155
					1.50	150	120

[1] If recruitment is taken to be 620 million fish, the predicted catches remain unchanged and the stock size values increase by about 10,000 tons.

A TAC of 52,000 tons in 1976 implies a fishing mortality of 0.34 on fully recruited year-classes in that year, and the corresponding F for a TAC of 61,000 tons is 0.41. Both values are close to the $F_{0.1}$ level (Summ. Doc. 75/19, Fig. 6). A TAC between 50,000 and 60,000 tons would only keep the size of the stock at the low level of about 225,000 tons under the assumed recruitment levels. A substantial increase in stock size above this level can only occur if the size of the recruiting 1973 year-class is considerably larger than anticipated.

In view of the present low stock size, the Working Group recommends that the TAC for 1976 should not exceed 60,000 tons. A lower level of TAC would allow a slight increase in stock size toward the Commission's goal of rebuilding the stock even at a low recruitment level, e.g. a TAC of 40,000 tons would result in an increase in spawning stock size to about 240,000 tons (Fig. 4A). A lower level of TAC would also reduce the probability that the size of the 1976 and subsequent year-classes will be adversely affected by a reduced spawning stock. This aspect is particularly important, since the 1971 and 1972 year-classes were poor and the recruiting 1973 year-class also seems to be poor. These year-classes will probably contribute very little to the already reduced spawning stock (Fig. 4B).

6. Implications for a Management Strategy of Stock Rebuilding

The Commission has adopted the goal of rebuilding the stocks in Div. 5Y and in Div. 5Z and Stat. Area 6 to levels capable of producing the maximum sustainable yield (MSY). Maintaining the stock sizes at MSY levels is considered necessary in order to reduce the likelihood of recruitment failures which have resulted in collapses in most of the herring fisheries. Rebuilding the stocks can only be accomplished by harvesting at levels less than the yearly increases due to growth and recruitment. At present stock sizes the annual surplus depends al-

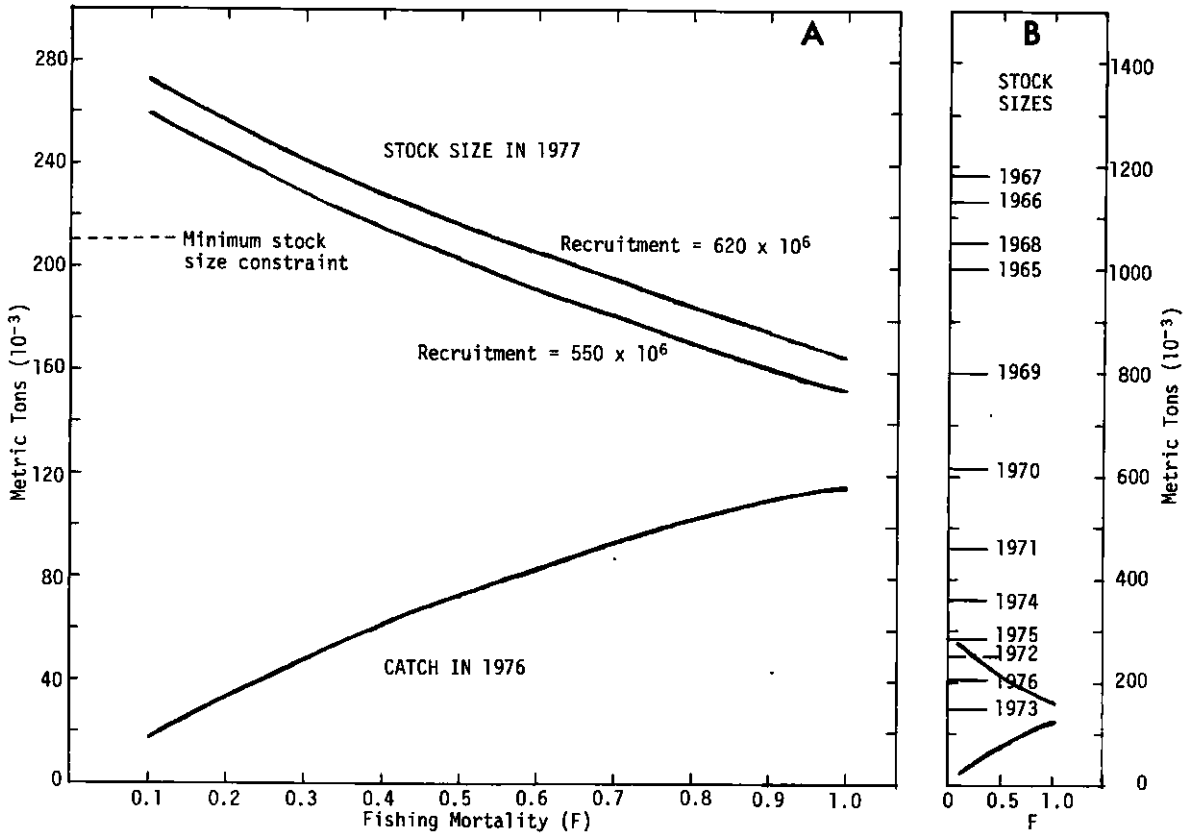


Fig. 4. Herring in Div. 5Z and Stat. Area 6: projected catch in 1976 and resultant stock sizes in 1977 over a range of fishing mortalities, assuming two levels of recruitment, and stock size levels for the period 1965-76.

most entirely on the size of the recruiting year-classes, but precise estimates of annual recrutiment are not possible at present. It is important to recognize that recruiting 3-year-old herring are not all mature and that the maximum yield-per-recruit lies between ages 4 and 5. Thus, estimates of recruitment which prove to be too low do not result in overall losses in yield but rather serve to increase the spawning stock size.

In order to examine the long-term consequences of specific management options, several projections were made, based on assessment data presented to the June 1975 Annual Meeting (Summ. Doc. 75/19). These projections are shown in Fig. 5 to 7 for Div. 5Y and in Fig. 8 and 9 for Div. 5Z plus Stat. Area 6.

The Div. 5Y stock was examined by applying over the period 1976-82 a constant TAC of 9,000 tons (giving a stock size of 60,000 tons in 1977) and constant annual recruitment of 64 million fish (about the level of the 1971 to 1973 year-classes at age 3) (Fig. 5). This strategy resulted in continued decline in stock size with no opportunity for rebuilding toward the desired level of 110,000 tons. Projections were also made, using constant recruitment of 64 million fish as before and three levels of fishing mortality (Fig. 6). Even at the low F-value of 0.1, the stock size showed a continuous decline after 1977. Since good year-classes occasionally occur in herring fisheries, a further simulation was done using a fixed mortality rate of $F_{0.1} = 0.38$ with a good year-class being recruited every fourth year (equal to the 1970 year-class) and low recruitment of 64 million fish for the other three years (Fig. 7). The result indicated that the catch would nearly stabilize at about 20,000 tons.

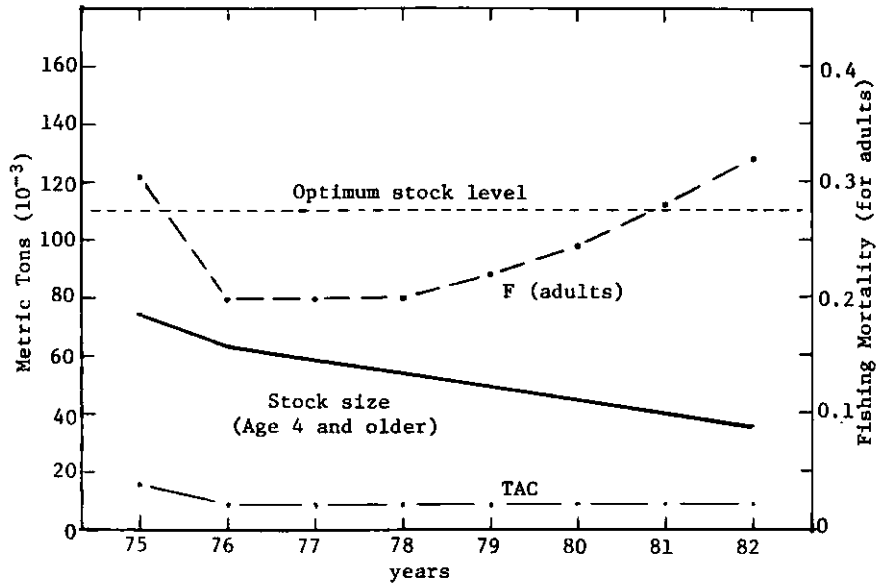


Fig. 5. Herring in Div. 5Y: simulated projection with constant recruitment of 64 million fish and TAC of 9,000 tons.

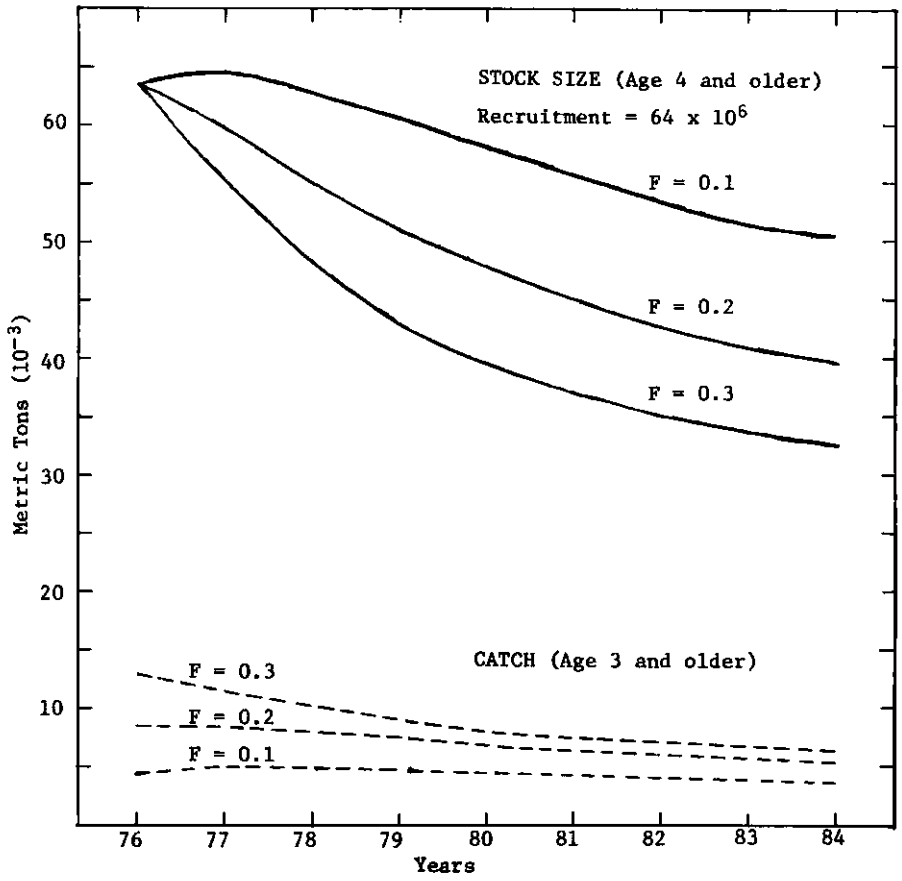


Fig. 6. Herring in Div. 5Y: simulation projections with constant recruitment and three levels of fishing mortality.

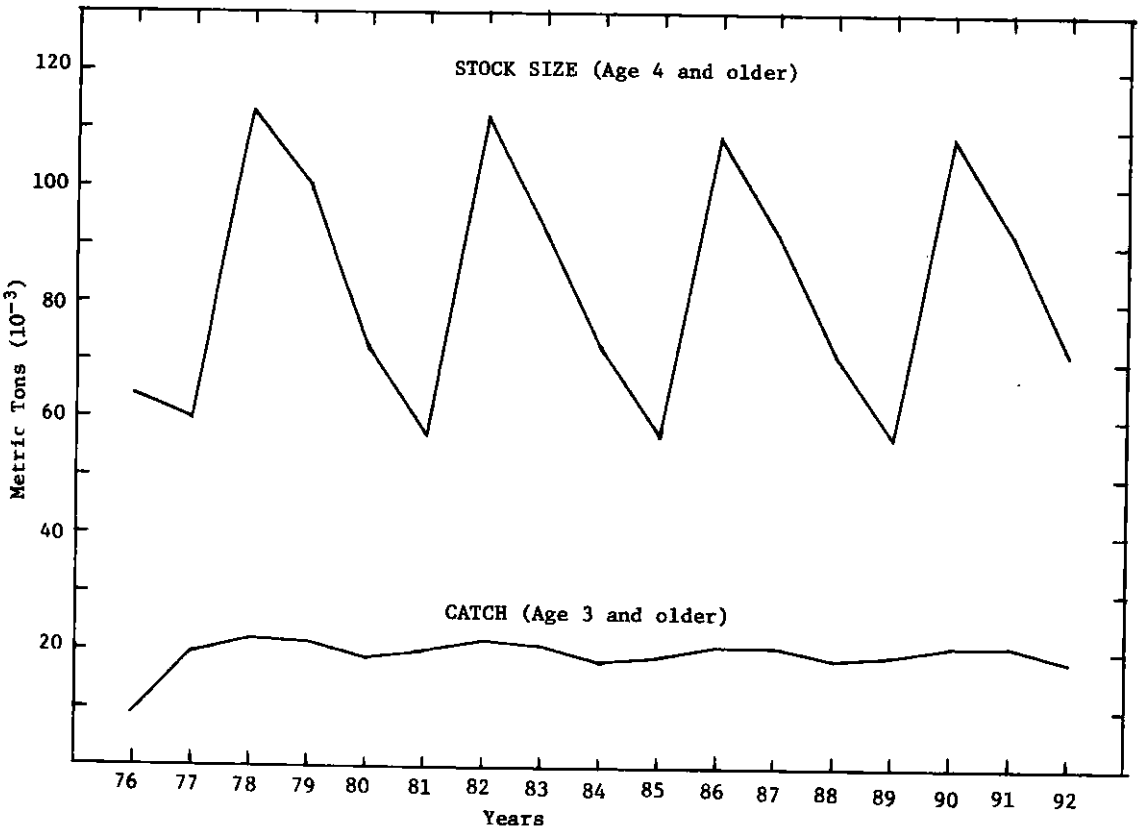


Fig. 7. Herring in Div. 5Y: simulated projections with fixed mortality at $F_{0.1}$, good recruitment (533 x 10^6 fish) every fourth year and poor recruitment (63.5 x 10^6) for the other years.

The stock size for Georges Bank was examined by applying for the period 1976-82 a constant TAC of 60,000 tons (giving a stock size of 225,000 tons in 1977) and constant annual recruitment of 550 million fish (the low level for recent year-classes) (Fig. 8). This strategy resulted in a continuous increase in stock size, but by 1982 the stock size would still be less than the 1975 level and be only 58% of the desired level of 500,000 tons. In order to provide for a faster rate of recovery, projections were made using constant annual recruitment, as before, of 550 million fish and a range of fishing mortalities; the resulting stock size and catch trends are shown in Fig. 9.

Under the strategy of maintaining a constant TAC for the Georges Bank stock, moderate recruitment of about 1,000 million fish (about one-third the size of the 1970 year-class) would increase the stock size to 300,000 tons or more in a single year. Good recruitment (equal to the 1970 year-class) would allow the stock size to reach the desired level of 500,000 tons within a single year. When the management objective is reached and the resulting recruitment has entered the fishery (time lag of 3 years), a TAC of 120,000 tons, corresponding to fishing at $F_{0.1}$, would maintain the stock size provided that annual recruitment is about 1,000 million fish (the average of the levels observed in the fishery during the past 11 years). If the stock size should exceed 1,000,000 tons, a condition that existed before 1970, then the TAC could be increased to a level greater than 120,000 tons and still allow for the maintenance of the desired stock level. Any decrease in stock size below the 500,000 tons level would, of course, require an appropriate reduction in the TAC.

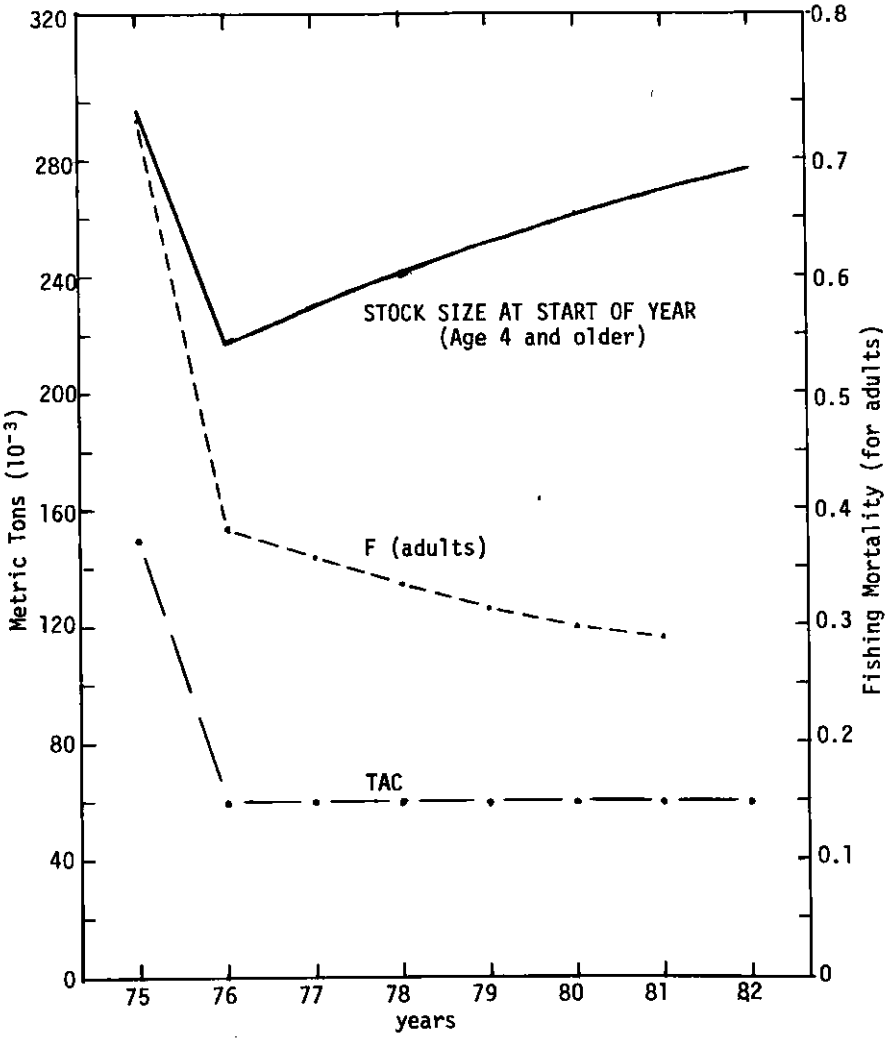


Fig. 8. Herring in Div. 5Z and Stat. Area 6: simulated projections with constant recruitment of 550 million fish and TAC of 60,000 tons.

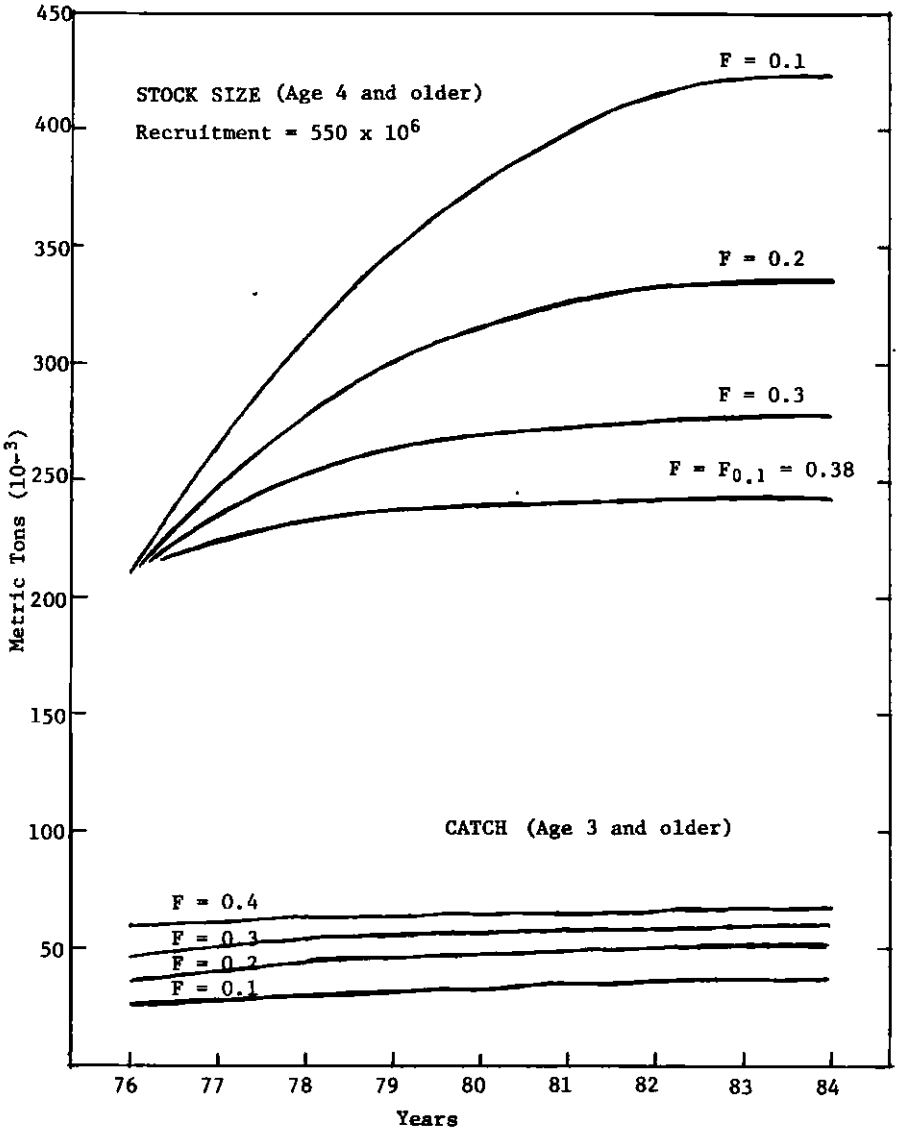


Fig. 9. Herring in Div. 5Z and Stat. Area 6: simulated projections for four levels of fishing mortality with recruitment constant at 550 million fish.