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STANDING COMMITTEE ON RESEARCH AND STATISTICS

PROCEEDINGS
OF
SPECIAL MEETING SEPTEMBER 1975
SPECIAL MEETING JANUARY 1976
ANNUAL MEETING MAY-JUNE 1976

Dartmouth • Canada
August 1976

PREFACE

Redbook 1976 is issued in one volume and contains the Reports of the Standing Committee on Research and Statistics (STACRES) from Meetings held at Montreal, Canada, in September 1975, at FAO, Rome, Italy, in January 1976 and at Montreal, Canada, in May-June 1976. Also included for the first time are the Reports of Meetings of Scientific Advisers to Panels 1 to 5 held during the course of the 1976 Annual Meeting, and Meetings of Panel A (Seals) held in November and December 1975. Meetings of the Assessments and Biological Surveys Subcommittees were held at Dartmouth, Canada, in April 1976 and the reports of these meetings are appended to the STACRES Report of the 1976 Annual Meeting. The Third Meeting of the Environmental Working Group was held at Szczecin, Poland, in late April 1976 and its report is appended to the Report of the Environmental Subcommittee which met during the 1976 Annual Meeting.

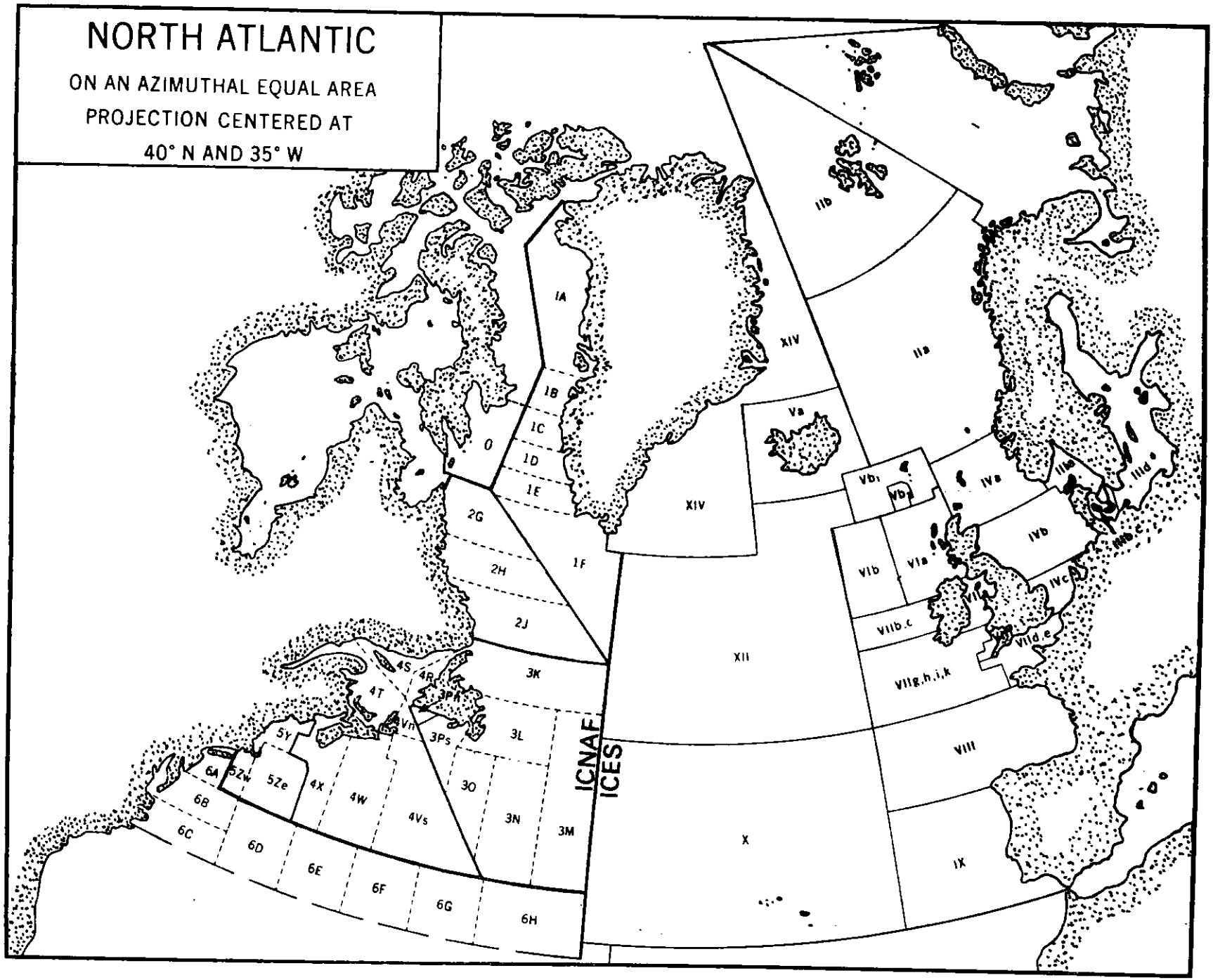
The STACRES Reports in Parts A, B and C of this volume correspond to Proceedings No. 1 of the Seventh Special Meeting of the Commission held in September 1975, of the Eighth Special Meeting held in January 1976 and of the 1976 Annual Meeting respectively. Part D contains the Reports of Meetings of Scientific Advisers to Panels, the inclusion of which was agreed by STACRES at the 1976 Annual Meeting (this volume, page 64). These reports were previously published as Appendices to the Reports of Meetings of Panels in the Proceedings of the Commission Meetings. Part E of this volume contains the agenda for Meetings of STACRES and Scientific Advisers to Panel A (Seals) held since the 1975 Annual Meeting, a list of STACRES recommendations, lists of Summary and Research Documents issued in the latter part of 1975 too late for inclusion in *Redbook* 1975, lists of Summary and Research documents presented to meetings held in 1976 up to and including the 1976 Annual Meeting, and a list of participants in scientific meetings of the Commission held during the year from July 1975 to June 1976.

13 August 1976

V. M. Hodder
Assistant Executive Secretary

CONTENTS

(A more detailed "Content" list is given on the pink page at the beginning of each section of this volume.)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4R
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6B
6C
6D
6E
6F
6G
6H
XIV
Va
Vb1
Vb2
IIb
IIa
IIIa
IIIb
IIIc
IIId
IVa
IVb
IVc
VIa
VIb
VIIa
VIIb,c
VIId,e
VIIg,h,i,k
VIII
IX
X
XII

PART A

REPORT OF STANDING COMMITTEE ON RESEARCH AND STATISTICS (STACRES)[1]

Seventh Special Commission Meeting - September 1975

CONTENTS

[1] Presented to the Seventh Special Commission Meeting as Proceedings No. 1.

A. REPORT OF STANDING COMMITTEE ON RESEARCH AND STATISTICS (STACRES)

Seventh Special Commission Meeting - September 1975

Chairman: A. W. May

Rapporteurs: B. B. Parrish
V. M. Hodder

Meetings of STACRES and its Assessment Subcommittee were held at Montreal, Canada, during 17-20 September 1975 to consider matters relative to fisheries management that were deferred from the 1975 Annual Meeting of the Commission. Representatives attended from Canada, Denmark, France, Federal Republic of Germany, Japan, Norway, Poland, Portugal, Spain, Union of Soviet Socialist Republics, United Kingdom and United States of America, and observers were present from Cuba and the International Council for the Exploration of the Sea (ICES).

The principal tasks at these meetings were to (a) consider the implications of possible alternative objectives for fisheries management; (b) review the status of certain cod and redfish stocks in Subareas 3 and 4, for which decisions on management in 1976 were deferred from the 1976 Annual Meeting of the Commission; (c) review the estimates of potential yield of the groundfish resources in Subareas 2 to 4; and (d) consider further the TAC for 1976 of finfish and squids in Subarea 5 and Statistical Area 6 (this item was added to the STACRES Agenda for discussion on account of its presence on the Commission's Agenda for the Seventh Special Meeting). The first item was considered within STACRES and the main points of the discussion are given in Section 1 below. The remaining items were referred to the Assessments Subcommittee, whose report (Appendix I) was discussed by STACRES in meetings held on 22 September 1975 and accepted with the observations given in Section 2 below. The "Remit to STACRES for Seventh Special Commission Meeting, September 1975" is at Appendix II.

1. Possible Alternative Objectives for Fisheries Management

The primary objective, to which the Commission's management measures have so far been directed, and the scientific advice given by STACRES, has been to achieve a fishing mortality rate (F) on the individual resources (or group of resources) exploited in the Convention Area, corresponding with maximizing the long-term catch (termed "maximum sustained catch"[1] in the text of the ICNAF Convention). The Commission has pursued this objective by the adoption of regulatory measures controlling the size (age) at which the fish recruit to the exploited stock (e.g. by mesh regulation) and/or their subsequent rate of exploitation by the fishery. The scientific advice related to this objective has been based on biological data for the individual fish stocks and on assessments of the relationships between catch and fishing mortality (fishing intensity) for them, using appropriate dynamic models describing their biological production processes. Implicit in this advice is that the timescale of full response to adjustments in exploitation rate is related to the number of years during which a year-class of fish contributes to the fishery.

As a consequence of differences in the nature of the dynamic models used for assessment, two measures of F (F_{max} and F_{MSY}) have been identified as reference points on which to base regulations for achieving the above management objective. F_{max} refers to the fishing mortality rate at which the average catch per recruit is at a maximum. It is a function of the growth and natural mortality processes within the fish stock and of the size (age) at which the fish enter the fishery, and it is therefore independent of changes in recruitment. F_{MSY}, on the other hand, refers to the fishing mortality rate at which the average long-term catch from the fish stock as a whole is highest and is therefore a function of the total production processes within the fish stock, including recruitment. Where the average level of recruitment does not change directly in response to changes in stock size, F_{max} and F_{MSY} will correspond. In the absence of detailed knowledge of the relationship between stock and recruitment for particular stocks exploited in the Convention Area, this correspondence has been assumed in the presentation of previous scientific advice on management action.

STACRES examined the principal features of the F_{max} reference point and identified the following as being of particular importance with regard to its adequacy as a basis for management actions:

a) The form of the relationship between catch per recruit and fishing mortality (F) differs markedly for the various fish stocks according to their growth and natural mortality characteristics. For some stocks, F_{max} occurs at a relatively high level of fishing mortality and it may not be clearly defined. Furthermore, its value for each stock is dependent upon the age and pattern of recruitment to the fishery. These features are illustrated in Fig. 1, showing the kinds of relationship between equilibrium yield per recruit and fishing mortality rate for different species exploited in the ICNAF Area.

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[1] It should be noted that the concept of maximum sustained catch (MSY) is difficult to define precisely and, in fact, cannot be estimated with any precision for many reasons. At best, it is a reference point or goal which the Commission tries to achieve, providing it is consistent with other goals, e.g. economic or social (see Paragraph 1, Article VIII Revised of ICNAF Convention).

b) Although F_{max} defines the fishing mortality rate at which the greatest catch will be obtained from each recruit entering the fishery by taking no account of the relationship between the size of the spawning stock and recruitment, it does not necessarily correspond with that giving the highest average catch (MSY) for the fish stock as a whole (although, as indicated above, it does so if average recruitment does not change with changes in stock size).

c) Because F_{max} takes no account of the stock and recruitment relationship, management measures based on this reference point do not guarantee the maintenance of spawning stock at a level that would ensure the maintenance of an optimum average level of recruitment.

d) The F_{max} level of fishing takes no account of possible economic objectives and factors.

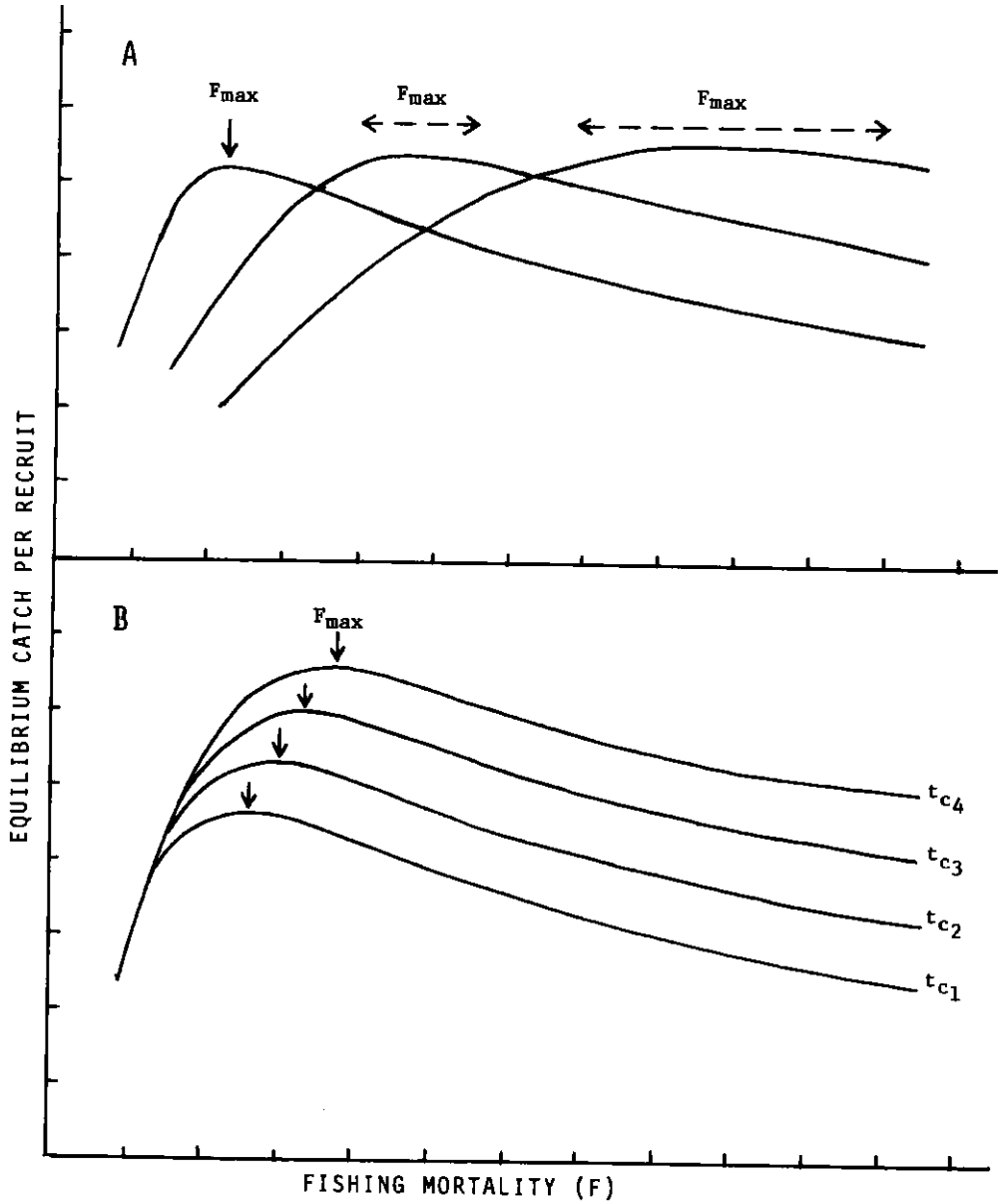

Fig. 1. Examples of equilibrium catch per recruit relationships: (A) for species having different growth and mortality characteristics, and (B) for a stock indicating the effect of different ages of recruitment to the fishery.

The above features indicate that the F_{max} reference point has potential limitations which have to be recognized and evaluated in the provision of scientific advice on management action. They are obviously greatest with respect to fish stocks for which the relationship between catch per recruit

and fishing mortality has no clearly defined maximum or, if present, it occurs at a relatively high value of fishing mortality rate. In these situations the setting of TACs for catch quota regulation at the F_{max} level may lead to severe reduction in the stock size, reduction in the number of age-groups in the exploited stock, large short-term changes in catch (and hence in the magnitude of the short-term changes which must be made in the TACs), and possible recruitment failures due to the generation of too low spawning stock sizes.

The principal element of the biological system governing the adequacy of F_{max} as a basis for management action is the recruitment process, both its variability due to environmental factors and especially the relationship between recruitment levels and spawning stock size. At present, little is known about the latter relationship, so that the evaluation has usually to be made on a generally qualitative basis using all available information on the size and composition of the stock and the observed variability in recruitment to it together with its relation to other components of the exploited ecosystem. However, the relationship is taken into account empirically in some assessment models.

STACRES considered that, in view of the possible large adverse consequences of setting the fishing mortality rate too high in cases where there is doubt about its adequacy, a more restrictive management system than that based on the F_{max} level of fishing mortality rate would be justified. In addition to appropriate measures for controlling the size (age) of recruitment to the fishery (e.g. through mesh regulation), the management system might comprise either, or a combination, of the following elements: (i) fixing the fishing mortality rate in the exploited phase at a level somewhat lower than F_{max}, and (ii) setting a target spawning stock size.

As pointed out previously (*Redbook* 1972, Part I, page 41), for fish stocks in which the relationship between catch per recruit and fishing mortality is a relatively flat-topped curve, a lower fishing mortality rate than F_{max} can be set which would result in only a small loss in average catch but would achieve a substantially higher average stock biomass, greater stock stability due to the presence of a larger number of age-groups in the exploited phase, higher average catch per unit effort, and increased economic efficiency.

The general consequences of adopting such an option (in terms of catch and catch per unit effort) are illustrated in Fig. 2. The average long-term loss in catch relative to the catch at F_{max} (F_{MSY}) is plotted against the average long-term increase in catch per unit effort, both in terms of catch and catch per recruit. The precise form of the relationships (Fig. 2) will, of course, be influenced by many factors. One possible reference for management action is the point on the curves where the slope is unity (i.e. where the rate of change of loss in catch equals the rate of change of gain in catch per unit effort). The actual catches and fishing efforts associated with any point on the curve will be different for different stocks. For example, the catch at F_{MSY} for redfish in Div. 3P is estimated at about 20,000 tons, but the point where the rate of change of loss in catch and the rate of change of gain in catch per unit effort is equal to unity corresponds to a catch of about 12,000 tons. As indicated above, the long-term stability of a fish stock may require a larger stock size (and lower catch) than that corresponding to F_{max} (F_{MSY}) to safeguard against recruitment variations. The implication of this was presented in a study of the cod stock in Subdiv. 4Vn (Jan-Apr) + Div. 4T (Res. Doc. 75/IX/140), where large increases in catch per unit effort would be achieved by regulating the fishery at a level below F_{max}(F_{MSY}) with only small losses in average catch.

The $F_{0.1}$ level, defined as the level at which the change in yield per recruit with respect to change in mortality rate is one-tenth of that of the fishery beginning on the virgin stock, has been specified as another possible reference point below F_{max}, since it is close to the economic optimum (*Redbook* 1972, Part I, page 41), but it does not have the unique merit in necessarily achieving the desired stability of stock size and recruitment. This level of F has already been used as a basis for advice to the Commission on the TACs for some stocks having relatively high values of F_{max}.

The establishment of a minimum spawning stock size constraint, as an element of the management objective, serves to minimize the risks of stock depletion and recruitment failure and hence should be, as far as possible, an integral part of the scientific evaluation leading to the advice on specific management measures. At present, however, owing to the lack of knowledge on stock and recruitment relationships, the precise value of the limiting stock size cannot be defined for most fish stocks and hence it must be gauged from historical data for each stock in question. Results of a theoretical study presented at this meeting (Res. Doc. 75/IX/134) suggest that, at least for some stocks, an equilibrium spawning stock biomass constraint at a biomass level about two-thirds of that of the virgin stock would provide an adequate biomass buffer for maintaining stock stability and resilience against depletion in the presence of large fluctuations in recruitment.

The risks inherent in a management system based on the exploitation of individual fish stocks at their F_{max} (F_{MSY}) levels are particularly large in fisheries on multi-species resources, in which the exploitation of each stock separately is not possible due to the presence of biological interactions.

In such situations, the objective of fishing each stock at the F_{max} level may lead to its depletion and a possible decrease in the long-term catch of the principal components of the commercial fisheries (although the total fish biomass available for exploitation may not decrease). The adoption of management measures, which maintain an adequate spawning biomass of the desired species, is particularly important in such cases. The second-tier quota system adopted for Subarea 5, and Stat. Area 6 was designed to provide such a safeguard.

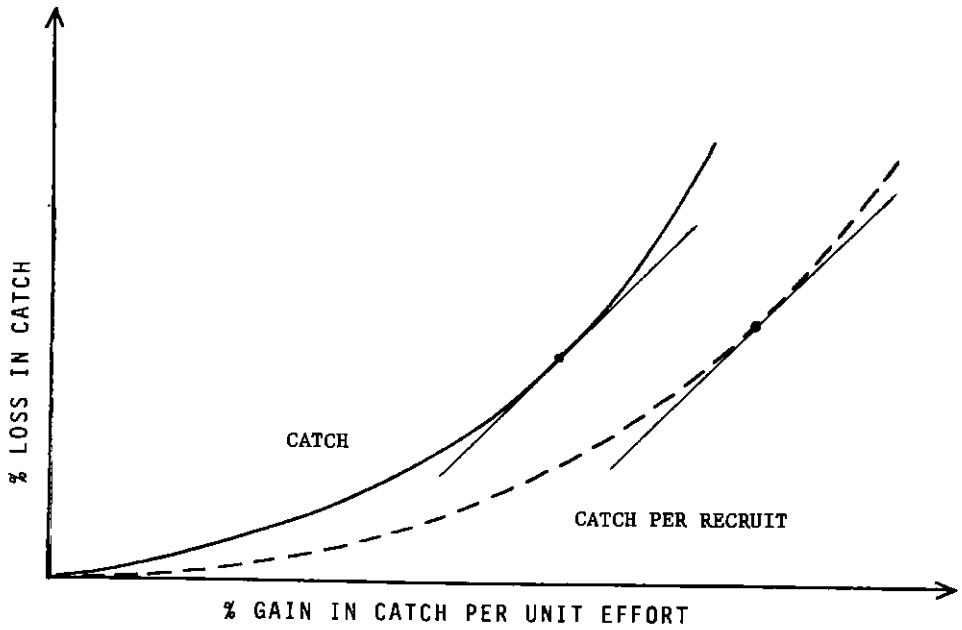

Fig. 2. Example of relationship between loss in average catch relative to that at F_{max} and gain in catch per unit effort.

2. Observations on Report of Assessments Subcommittee (Appendix I)

a) Status of Individual Stocks Deferred from 1975 Annual Meeting

STACRES accepted the conclusions of the Assessments Subcommittee with regard to the six stocks for which the Commission requested further advice on TACs for 1976. These, as set out in Table 1, include 1976 catches for various levels of fishing mortality (F), long term changes in catch and catch rate (stock size) relative to the long-term catch and catch rate for fishing at F_{max}, and the approximate periods of time before the stocks, if fished at the specified levels of F, will essentially reach equilibrium levels associated with those levels of F. However, STACRES considered that further amplification of the advice, regarding the sequence of changes to be expected from the initiation of a management policy in 1976 until the equilibrium condition is reached, would be of interest to the Commission.

All six stocks, listed in Table 1, have had a recent history of exploitation (although to a varying extent) at levels higher than F_{max}. Thus, stock sizes in 1976 are expected to be lower than equilibrium stock sizes associated with F_{max}. The long-term changes, indicated in Table 1, are contingent on F being maintained at the 1976 level for the indicated time period.

Fig. 3 illustrates the changes expected in catch and stock size (catch per unit effort) with time for a management policy of fishing at a constant level of F. If the Commission chooses to allow fishing at F_{max}, both the stock size and the catch would progressively increase with time to the equlibrium level associated with F_{max} (solid lines). If a lower value of F is chosen (say $F_{0.1}$), catch and stock size would again progressively increase with time to the equilibrium level associated with fishing at $F_{0.1}$ (dashed lines). In the latter case, however, the stock size would increase more rapidly than if fishing at F_{max} and reach an equilibrium at the higher stock size, and the catch would also increase but to a slightly lower equilibrium level. The time required, when fishing at $F_{0.1}$, for the stock size to reach the equilibrium level associated with F_{max} would be less than if fishing had occurred at F_{max} (t_1 in Fig. 3). The catch, if fishing at $F_{0.1}$, would also increase at a faster rate than if fishing at F_{max}, and the absolute difference between catches at $F_{0.1}$ and F_{max} would decrease with time. However, the equilibrium catch when fishing at levels of F below F_{max} will always be predicted to be lower than catches associated with F_{max}. It is important to reiterate that yield-per-recruit

calculations of this type are dependent on the assumptions of constant recruitment and constant age at entry to the fishery.

Table 1. Implications to long-term catch and catch per unit effort of alternate management options of fishing at or below F_{max} and the 1976 TACs associated with each one. (Average age at first capture and recruitment level of recent years are assumed in all of the predictions.)

Species	Stock area	Fishing mortality (F)	1976 TAC (tons)	Long-term change (%) relative to fishing at F_{max}		Time scale (years)	Long-term equilibrium catch (tons)
				Catch	Catch/effort		
Cod	3NO	0.25 (F_{max})	43,000	0	0	≈ 10	143,000
		0.20	35,000	-2	+15	≈ 10	
		0.15	27,000	-10	+42	≈ 10	
	3Ps	0.30 (F_{max})	48,000	0	0	≈ 6	59,000
		0.25	38,000	-2	+10	≈ 8	
		0.20	31,000	-8	+25	≈ 8	
		0.15	24,000	-20	+45	≈ 8	
	4VsW	0.35 (F_{max})	30,000	0	0	≈ 10	62,000
		0.20	18,000	-8	+50	≈ 10	
	4TVn[1]	0.40 (F_{max})	30,000	0	0	5-10	45,000
		0.35	25,000	-10	+50	5-10	
Redfish	3P	MSY level[2]	18,000	0	0	≈ 10	22,000
		80% MSY[2]	15,000	-5	+20	> 20	
		65% MSY[2]	12,000	-10	+35	> 20	
	4VWX	0.15 (F_{max})	20,000	0	0	> 20	32,000

[1] 4T(Jan-Dec)+4Vn(Jan-Apr).
[2] Fishing effort.

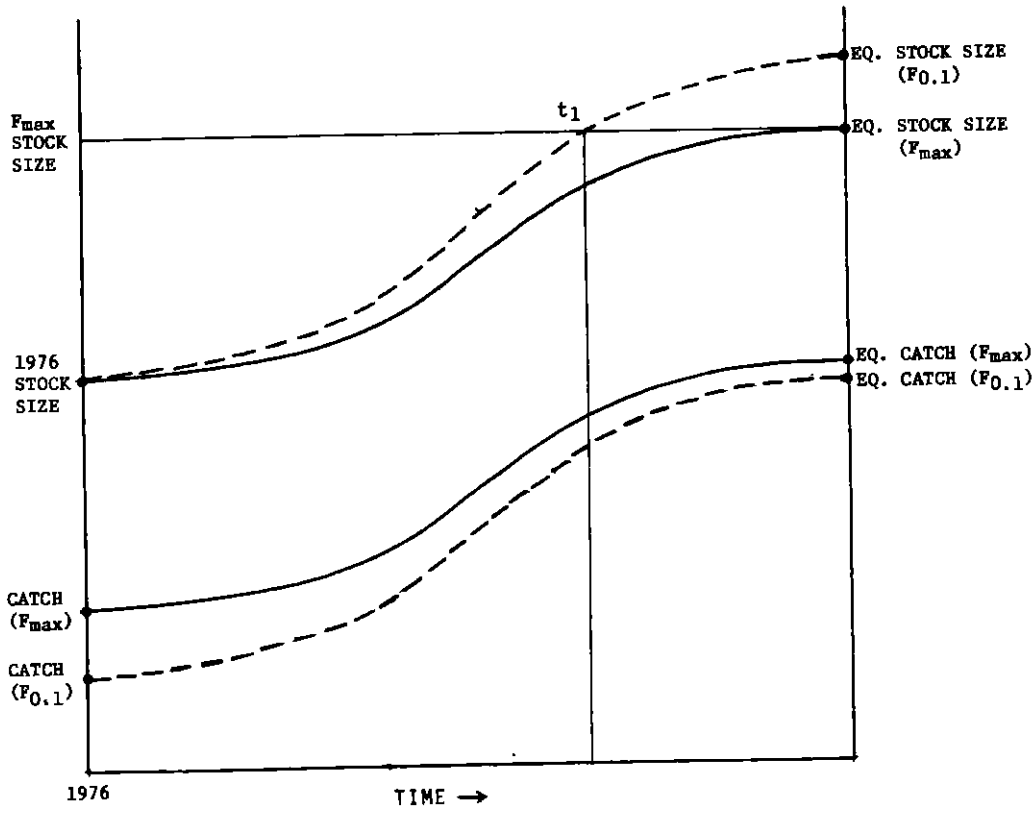

Fig. 3. Changes in stock size and catch with time given a policy of maintaining constant F. (Solid lines refer to fishing at F_{max} and dashed lines to fishing at $F_{0.1}$.)

b) The Overall Level of Fishing in Subareas 2 to 4

At its April 1975 Meeting, the Assessments Subcommittee discussed in some detail the effects of specific reductions in fishing mortality on the catch and stock size of various groundfish stocks in Subareas 2, 3 and 4 (*Redbook* 1975, pages 56-62) in relation to the proposals contained in Comm. Doc. 75/8. At the present meeting, STACRES concurred with the views of the Assessment Subcommittee that the analyses carried out at the April 1975 Meeting were still pertinent and that no further advice could usefully be given at this time. It was noted that the appropriateness of "days fished" as a basis for effort regulation had been discussed fully at earlier STACRES meetings, and, although "hours fished" is more closely related to fishing mortality, "days fished" or "days on ground" would be more practical for regulatory purposes ("days fished" is more closely related to F than "days on ground").

c) Further Consideration of Finfish and Squids Within The Second-tier Overall TAC for Subarea 5 and Statistical Area 6

In anticipation of the Commission's request for further advice on this matter (since it appears as an item on the Commission's Agenda for the Seventh Special Meeting), STACRES agreed to include this item on its Agenda and referred the matter to the Assessments Subcommittee for discussion. The Subcommittee's report on the subject (Appendix I, Section 3) was accepted by STACRES with the following observations:

i) STACRES noted that it had not previously recommended specifically that squids be included in the second-tier TAC but that its calculations of the second-tier TAC had been based on the inclusion of squids.

ii) Specific recommendations with respect to the species which should be included in the second-tier TAC were not made by STACRES for any other species.

iii) It is not yet possible to estimate the advantages or disadvantages that would be achieved by excluding one or another species from the second-tier TAC.

iv) The squid resources of both species (*Illex* and *Loligo*) have been maintained at a high level under the Commission's management regime of the past.

v) Discussion of the item (Further consideration of finfish and squid within the second-tier overall TAC in Subarea 5 and Statistical Area 6) was not as complete as would have been desirable, since not all member countries were represented by experts in this field (in some cases, the discussion of this item had not been anticipated).

3. Adjournment

The Chairman expressed his appreciation for the excellent work of the participants during this Special Meeting of STACRES and its Assessments Subcommittee and adjourned the final session at 2200 hours on 22 September 1975.

APPENDIX I. REPORT OF ASSESSMENTS SUBCOMMITTEE

Chairman: A. T. Pinhorn

The Subcommittee met at Montreal, Canada, during 18–20 September 1975 to consider matters referred to it by STACRES, namely (1) to review the status of certain stocks for which decisions on management in 1976 were deferred from the 1975 Annual Meeting of the Commission; (2) to consider the estimates of potential yield of groundfish resources in Subareas 2, 3 and 4; and (3) to consider further the 1976 TAC for finfish and squids in Subarea 5 and Stat. Area 6. Discussions on the first two points were based on the Commission's request for advice as outlined in "Remit to STACRES for Seventh Special Commission Meeting, September 1975" (see Appendix II). Consideration of the third point was requested by STACRES because the item appears on the Commission's Agenda for the Seventh Special Meeting.

1. Status of Individual Stocks Deferred from 1975 Annual Meeting

a) Cod in Divisions 3N and 3O

Because of a significant difference in age composition of catches between 1973 and 1974 (apparently caused by differences in age-reading techniques among the countries that submitted samples), a reassessment of this stock was not done at the April 1975 Meeting of the Subcommittee (*Redbook* 1975, page 29). Consequently it was recommended that the TAC for 1976 remain at the 1975 level of 85,000 tons. Since the 1974 fishing effort data were available at the present meeting, it was possible to estimate the fishing mortality (F) for 1974 from a correlation of earlier F-values with fishing effort. This resulted in an F considerably higher than that previously estimated for 1973 and reduced the influence of the suspected differences in age reading on the calculation of the TAC for 1976. A reassessment was therefore possible using 1974 age compositions.

No updating of the previous virtual population analysis using 1959–70 data was possible because of the lack of sampling data for 1971 and 1972. The Subcommittee reviewed the sampling data from the 1973 and 1974 commercial fisheries and examined the catch and effort data from Canadian, Spanish and USSR fisheries, together with catch-rate data from Canadian research vessel surveys. Catches in these divisions declined from a total of 126,000 tons in 1971 to 73,000 tons in 1974. The catch per unit effort in the Spanish pair trawl fishery showed a substantial decline during 1968–74. Abundance indices from research vessel surveys declined significantly between 1971 and 1974. On the basis of changes in the fishing effort of Spanish and USSR fisheries from the late 1960's to 1973 and on the basis of the correlation between total fishing effort and fishing mortalities in the 1960's, an F of 0.7 was estimated for 1974. If the 1975 catch is assumed to be about 75,000 tons, the fishing mortality in 1975 is estimated to be 0.6, a level well in excess of F_{max}. Future yields were estimated for a fishing mortality of 0.25 (F_{max}) and also for values of 0.2 and 0.15 under the assumptions that the 1975 catch would be about 75,000 tons and that recruitment would be about the average level observed in the 1960's.

The total biomass (4+ age-groups) at the beginning of 1975 was estimated to be 234,000 tons, about 60% of the average biomass of the 1960's. The Subcommittee concluded that, in order to safeguard future productivity, it is desirable to restore the total biomass at least to that earlier level as a first step. This could be achieved by 1977 by fishing at F_{max}, provided that the past level of average recruitment continues. Fishing at F_{max} in 1976 implies a catch of 43,000 tons, which is considerably less than that previously recommended. The implications of alternative management options for this cod stock are shown in Table 1.

b) Cod in Subdivision 3Ps

At its April 1975 Meeting, the Subcommittee concluded that fishing at F_{max} (0.3) in 1976 would yield a catch of about 55,000 tons, but, bearing in mind the desire to maintain TACs that had already been agreed for 1975 unless the changes were substantial, it recommended a TAC of 60,000 tons for 1976 (*Redbook* 1975, page 29). Re-examination of the data indicated that the 1974 age compositions, as previously used, over-estimated the 1974 reported catch. Upon making the necessary adjustments in the 1974 age composition of the catch and assuming that the 1975 TAC of 60,000 tons would be taken, the resulting calculation indicated that fishing at F_{max} (0.3) would in fact produce a yield of only 48,000 tons in 1976.

The Subcommittee reviewed the results of the virtual population analysis, which was updated using 1974 sampling data and assuming an F of 0.3 in 1974, and examined catch per unit effort data from the Spanish pair trawl fishery together with data from research vessel surveys. Catches from this stock declined from a peak level of 76,200 tons in 1970 to 46,000 tons in 1974. Estimates of fishing mortality during the 1959–73 period indicated that F was higher than 0.3 (F_{max}) up to 1971 and at about the F_{max} level since then. The catch per unit effort in the Spanish pair trawl fishery has declined steadily since 1968, although the results from Canadian

surveys in the area showed no obvious trend between 1972 and 1974.

The Subcommittee considered the current level of this resource in relation to its long-term potential. The biomass (4+ age-groups) in 1975 was estimated to be somewhst less than the average equilibrium biomass calculated when fishing at F_{max}, but was, however, slightly higher than the average biomass in the 1959-73 period. Since the 1975 level of biomass is at the lower limit of the range of biomass fluctuations that would have been expected during the 1960's if fishing had been consistently at F_{max}, the Subcommittee concluded that there was little evidence of severe reduction in this stock below the MSY level at the present time. Also, the estimate of spawning stock biomass for 1975 is at the upper limit of the range of spawning biomass observed throughout the 1960's and early 1970's but is lower than the estimate of the average long-term biomass when fishing at F_{max}. The higher biomass in 1975, compared with earlier years, may have resulted from the presence in the spawning stock of better-than-average year-classes. These were followed by the generally poorer-than-average year-classes of 1966-69, and this may, to some degree explain the decline in the catch per unit effort of Spanish pair trawlers since 1968, as sampling data indicate that in recent years the catchs of Spanish pair trawlers contained significant numbers of small cod.

A range of 1976 TACs associated with various levels of fishing mortality at or below F_{max} is given in Table 1, together with the implicstions of reduced TACs to long-term catch per unit effort and yield.

c) Cod in Subdvision 4Vn (Jan-Apr) and Division 4T (Res. Doc. 75/IX/140)

Nominal catches from the Gulf of St. Lawrence migrating cod stock were 48,700 tons in 1974, well below the TAC of 63,000 tons for that year. The 1975 TAC of 50,000 tons will generate a fishing mortality of 0.6. Cohort analysis and Canadian research vessel surveys indicate that F ranged between 0.4 and 0.6 during 1971-74 and that the spawning stock biomass ranged between 70,000 and 90,000 tons in 1973-75.

A system simulation based on the detailed biological structure of the stock was presented (Res. Doc. 75/IX/140). Two regions of spawning stock biomass promising high production were noted. Near the 150,000 ton level, the stock was best able to compensate for environmental fluctuation through the stabilizing density-dependent mechanisms of growth rates, egg production and predation of adults on juvenile cod. Stable yields of 40,000-45,000 tons may be anticipated at this level of spawning stock biomass. For spawning stock size of 90,000-100,000 tons, these stabilizing density-dependent factors are substantially weakened, since they have essentially reached their limiting values. Thus, an unbroken series of above-average year-classes, as predicted by the model, would result in slightly higher (about 10%) yields from this lower level of spawning stock size than from a spawning stock biomass of 150,000 tons. It was noted that, while heavily fished cod stocks have been observed to produce higher-than-average recruitment, large fluctuations in recruitment usually occurs. At the lower level of biomass, stability of catches and stock size depends entirely on stable, high levels of recruitment, and the entry of one or two relatively poor year-classes into the fishery would result in a rapid decline in spawning stock biomass below 50,000 tons and the need for severe corrective action. Stable high yields (within 10% of the maximum) would result from the higher biomass level of 150,000 tons, and the robustness of the stock to recruitment variations would increase, thus reducing substantially the need for rapid adjustments of the TAC.

The 1976 TAC of 45,000 tons, recommended at the April 1975 Meeting of the Subcommittee (*Redbook* 1975, page 34), represents a fishing mortality greater than 0.6, with the result that the current stock size would only be maintained or it may even decrease. A TAC of 30,000 tons for 1976 represents a level of F = 0.4 (previously estimated to be F_{max}), and this would allow the spawning stock to increase to the goal of 150,000 tons in 5-10 years, provided that recruitment was favourable during the period (Table 1). A TAC of 25,000 tons, representing an F of 0.35, would have the effect of reducing the dependence of the stock on favourable recruitment during the rebuilding process. The distribution of mortality between the winter fishery in Subdiv. 4Vn and the summer fishery in Div. 4T influences the total yield and the spawning stock biomass, with both tending to increase as the proportion of the annual fishing mortality in the winter fishery decreases.

d) Cod in Subdivision 4Vs and Division 4W (Res. Doc. 75/IX/136)

The status of this cod stock has been re-analyzed, taking into account some new information on the size and age composition of USSR and Spanish catches. Both the catch per unit effort of Spanish trawlers and cohort analysis indicate that a substantial decline in stock size occurred between the late 1960's and 1973. The mean age at recruitment to the fishery also declined from about age 4 in 1969-71 to age 3.5 in 1972-73.

Recent selection patterns (since 1969) indicate that F_{max} is in the range of 0.32-0.38, but the

fishing mortality has been above this level since at least 1969, the 1972-73 average being F = 0.80. Yield-per-recruit calculations indicate that a reduction in F (about 60%) to the F_{max} level would increase yield-per-recruit by about 10%. Substantial increases in yield-per-recruit are also predicted for increases in the mean selection age.

The 1975 TAC of 60,000 tons will generate fishing mortality in the range of 0.75-0.80. A reduction in F in 1976 to the F_{max} level of 0.35 (average value of recent selection patterns) implies a TAC of 30,000 tons. Maintenance of F_{max} and the present age-at-recruitment in the fishery would, in approximately 10 years, allow a predicted average catch of about 60,000 tons (Table 1). The present fishable stock size is approximately 50% of the average stock size corresponding to F_{max}. Lower values of F in 1976 obviously imply lower catches in 1976, but such a lower value, if maintained for up to 10 years, would result in the stock size rapidly approaching and even exceeding the average level of stock size corresponding to F_{max}. For example, fishing at $F_{0.1}$ = 0.20 in 1976 implies a 1976 catch of 18,000 tons, but, if this level of F were maintained for several years, the result would be a sustainable catch of 55,000 tons and a stock size 50% larger than that corresponding to F_{max} by about the mid-1980's.

e) Redfish in Division 3P (Res. Doc. 75/IX/137)

Nominal catches from this stock have been at a relatively high level in recent years, averaging about 31,000 tons during 1969-72. The catch declined from 27,500 tons in 1971 to 26,000 tons in 1972 and to 18,000 tons in 1973, but increased slightly to 22,000 tons in 1974, the year when quota regulation was first applied to this stock. The catch per unit effort of Canadian trawlers (151-500 GRT) has exhibited a steady decline from more than 0.9 tons per hour in 1965 to less than 0.5 tons per hour in 1974 and also in 1975, as indicated by preliminary data. The slight increase in catch from 1973 to 1974 was apparently attained by an increase in fishing effort from about 30,000 to 40,000 hours, the latter value being about the level of fishing effort in 1969 and 1971 when catches were considerably higher. This 50% increase in effort between 1973 and 1974 yielded only a 20% increase in catch. At the level of catch per unit effort experienced in 1974 and 1975 (0.5 tons per hour), the 1974 and 1975 TACs of 25,000 tons could only be attained with fishing effort about 30% in excess of that required to attain the MSY under equilibrium conditions.

Commercial catch per unit effort data indicate a high level of redfish abundance in this area during the second half of the 1960's with above-average recruitment to the fishery. Only about one-half as many redfish older than age 6 were caught in research surveys of the area in 1973, 1974 and 1975 as in a comparable survey in 1965 at the onset of the recent period of increased exploitation. The 1964-66 and adjacent year-classes, which have begun to enter the fishery in 1975 and upon which the fishery will become more dependent during 1976 and 1977, appear to be only one-half as abundant as those of the second half of the 1950's, which supported the fishery during 1965-74. The yield from these year-classes of the mid-1960's would therefore be expected to be substantially less than (perhaps only one-half) that supported by the earlier level of recruitment. It is possible that these year-classes may already have been exploited at an earlier age than is apparent from the limited sampling data available, if the observations on the sizes of redfish caught in other ICNAF divisions are indicative of the general trend toward the occurrence of relatively more small fish in the catches.

A further general production analysis of this stock, incorporating 1972-74 catch and effort data and using a range of moving averages (6, 8 and 10 years), as previously utilized to establish a range of MSY estimates for other redfish stocks, indicates that the MSY is in the range of about 20,000-23,000 tons as compared with an earlier estimate of 23,000 tons. On the basis of the revised MSY estimate and preliminary indications that the catch per unit effort in 1975 will be at about the same level as in 1974, it would appear that a TAC of 18,000 tons, instead of 20,000 tons as indicated by an earlier analysis, would maintain fishing effort at the MSY level in 1976. Fishing at a level less than that corresponding to the MSY level of fishing effort would result in some immediate loss in yield but would lead to long-term improvement in the catch per unit effort (Table 1). Because of the late age at maturity and the slow growth rate of redfish, benefits from improved catch per unit effort would only be realized in the long-term.

f) Redfish in Divisions 4V, 4W and 4X (Res. Doc. 75/IX/135)

The Scotian Shelf stock of redfish has been exploited since the mid-1930's, with catches during the initial period of exploitation reaching a high of 77,000 tons in 1949. A second substantial peak occurred in 1971 with a catch of 62,000 tons. Subsequently, catches have declined by about 10,000 tons per year to a level of 33,000 tons by 1974.

Commercial catch rates and length frequency data indicate that stock abundance increased in the early 1970's, thus attracting increased fishing effort. A production model using US catch and effort data suggests that both effort and yield declined from 1971 to the level corresponding approximately to the predicted long-term maximum yield by 1974.

At the present age of recruitment to the fishery (age 6), the maximum yield-per-recruit is attained at F of about 0.11-0.16. Mortality estimates for the fishery in 1971-74 are F = 0.30, approximately twice that which maximized yield-per-recruit. Substantial increases in yield-per-recruit are predicted for increases in age at recruitment to the fishery. Yield-per-recruit calculations imply that a 1976 TAC of 20,000 tons would reduce exploitation to a level which approximately maximizes the long-term yield (Table 1). Available information is too incomplete to support analyses demonstrating the implications of alternative management options.

Table 1. Implications to long-term catch and catch per unit effort of alternate management options of fishing at or below F_{max} and the 1976 TACs associated with each one. (Average age at first capture and recruitment level of recent years are assumed in all of the predictions.)

Species	Stock area	Fishing mortality (F)	1976 TAC (tons)	Long-term change (%) relative to fishing at F_{max}		Time scale (years)	Long-term equilibrium catch (tons)
				Catch	Catch/effort		
Cod	3NO	0.25 (F_{max})	43,000	0	0	≈ 10	143,000
		0.20	35,000	-2	+15	≈ 10	
		0.15	27,000	-10	+42	≈ 10	
	3Ps	0.30 (F_{max})	48,000	0	0	≈ 6	59,000
		0.25	38,000	-2	+10	≈ 8	
		0.20	31,000	-8	+25	≈ 8	
		0.15	24,000	-20	+45	≈ 8	
	4VsW	0.35 (F_{max})	30,000	0	0	≈ 10	62,000
		0.20	18,000	-8	+50	≈ 10	
	4TVn[1]	0.40 (F_{max})	30,000	0	0	5-10	45,000
		0.35	25,000	-10	+50	5-10	
Redfish	3P	MSY level[2]	18,000	0	0	≈ 10	22,000
		80% MSY[2]	15,000	-5	+20	> 20	
		65% MSY[2]	12,000	-10	+35	> 20	
	4VWX	0.15 (F_{max})	20,000	0	0	> 20	32,000

[1] 4T(Jan-Dec)+4Vn(Jan-Apr).
[2] Fishing effort.

2. Review of Potential Yield of the Groundfish Resources in Subareas 2 to 4 in Comparison with Estimates Based on Individual Resources

The Subcommittee noted that a discussion on this matter had taken place at its April 1975 Meeting (*Redbook* 1975, page 56-62). Further consideration at the present meeting indicated that, in view of the uncertainties associated with estimating MSY catch and effort from general production models, particularly Schaefer models (Res. Doc. 75/1X/125, 126, 127), little new evidence could be added to that given earlier (based on general production models) with regard to the need for the overall regulation of the groundfish resources in Subareas 2 to 4. It was pointed out, however, that the fishing mortalities for a number of key stocks, for which 1976 TACs are being considered at the present meeting, are higher than had been previously estimated. Also, it was noted that a number of stocks have shown signs of stress over the past five years (e.g. cod, flatfishes and redfish in Subareas 2 and 3, and cod, haddock, redfish and flatfishes in Div. 4VWX). The application of the Schaefer model to cod and redfish separately in Subarea 2 and Div. 3K (Res. Doc. 75/IX/126) indicates that cod has been fished beyond the MSY level in the 1970's, thus supporting the conclusion from a Schaefer model analysis of the resource as a whole, since cod represents the major portion of the groundfish resource in this area. It was noted that, although the regulation of individual resources has attempted to control the fishing mortality at the F_{max} level since 1973 for those stocks for which TACs were in effect in 1973, the 1976 TACs, as recommended at the April 1975 Meeting of the Subcommittee, for those same stocks add up to 1.3 million tons as compared with 2.1 million tons for 1973. Thus, if the regulation of these stocks in 1973 had effectively controlled the resource at the MSY level, some response might have been evident in 1975, but instead a continued decline is apparent.

If the overall level of exploitation were to have any biological implication, it would be that continued fishing beyond the MSY level might lead to reduction in future recruitment. Although there are some stocks for which the current recruitment levels are low (e.g. cod in Div 2J+3KL), clear trends in recruitment, which could have resulted from heavy exploitation, cannot be clearly demonstrated generally. The Subcommittee indicated the need for investigation of indices for evaluating the status of stocks from the viewpoint of production/biomass ratios and biomass/recruit relationships.

3. Further Consideration of Finfish and Squids Within the Second-tier Overall TAC for Subarea 5 and Statistical Area 6

At its Special October 1973 Meeting, the Commission established a TAC regulation for the catch of finfish (excluding menhaden, billfishes, tunas and large sharks other than dogfish) and squids in Subarea 5 and Statistical Area 6. Specified TACs were determined for application in 1974 and 1975, and the 1976 TAC was to be decided at the 1975 Annual Meeting such that it would ensure the restoration of the stocks to a level which would provide the MSY. At its April 1975 Meeting (*Redbook* 1975, page 54), the Subcommittee reviewed all available data pertaining to the determination of the TAC for 1976 to achieve this objective and presented the Commission with a range of values, each associated with a projected time schedule (years) required for the total biomass of finfish and squids to rebuild to the long-term MSY level. At its June 1975 Annual Meeting, the Commission agreed to a second-tier TAC of 650,000 tons for 1976, excluding squids.

The Subcommittee, at the present meeting, reviewed the previous discussions on this subject together with any available new data. The original advice to the Commission by the Subcommittee included squids in the TAC for several reasons. The squids are an integral part of the total community structure, and the significance of this is further supported by new data on the collective feeding habits of the finfish and squid community which shows major overlaps in the existing predator-prey relationships (Res. Doc. 75/IX/130). Furthermore, the second-tier system was intended to include mixed fisheries implications as well as biological considerations. Observations, made by ICNAF inspectors under the Commission's Scheme of Joint Enforcement, have shown that unreported by-catch in the squid fisheries may be substantial, indicating that significant fisheries interactions also exist. Consequently, the Subcommittee agreed that there was no reason to revise its original advice to the Commission.

The Subcommittee then reviewed the table of second-tier TAC options, considered at its April 1975 Meeting (*Redbook* 1975, page 56), and also an extended table of options which was presented to the June 1975 Annual Meeting of Scientific Advisers to Panel 5 for consideration (Res. Doc. 75/117). This latter table (see below) included estimates of the relative probability that recovery of the biomass toward the MSY level would begin in 1976.

TAC (000 tons)	Years to MSY	Probability	Probability (%) relative to that at 650,000 tons
800	13	0.59	74
750	11	0.67	84
650	7	0.80	100
550	5	0.90	113
450	4	0.95	119
350	3	0.98	123

These probabilities can be used to express the relative chance for the start of recovery of the biomass at various TACs. For example, given an exact probability at 650,000 tons, the setting of the TAC at 750,000 tons would reduce the probability to 84% relative to that for 650,000 tons, and setting the TAC at 550,000 tons would increase the probability to 113%.

At its April 1975 Meeting, the Subcommittee considered 650,000 tons to be a realistic minimum level for the second-tier TAC in 1976 in order to correct for the by-catch problem. This value was based on the assumption that the sum of the 1976 TACs for the individual resources in Subarea 5 and Statistical Area 6 would be about 825,000 tons. Further discussion of individual species TACs based on new data took place at the June 1975 Meeting of the Subcommittee without any recommended changes. Taking account of the TACs set by the Commission at its June 1975 Annual Meeting, allowing for one-third of the 1976 TAC for pollock in Div. 4VWX + Subarea 5 to be taken in Subarea 5 and assuming the 1976 herring TACs to be as recommended at its April 1975 Meeting, thus altering the previously summed TAC total to 816,000 tons, the Subcommittee at the present meeting considered it necessary to re-evaluate the resulting reduction required from the summed TACs to arrive at the appropriate second-tier TAC for 1976. The magnitude of the estimated decline in overall biomass in Subarea 5 and Statistical Area 6 was reconfirmed by new data (Res. Doc. 75/IX/139), and further analysis (Res. Doc. 75/IX/132) indicates that the expected catch in 1976 would be 574,000 tons, if the area were fished at MSY effort. The sum of the individual TACs, based on those agreed by the Commission at its June 1975 Annual Meeting, is 747,000 tons, excluding herring whose TACs for 1976 are to be decided at a Special Meeting of the Commission in January 1976. Since the revised sum of the TACs for 1976 is about 9,000 tons less than that assumed at its April 1975 Meeting, the Subcommittee considered that the second-tier TAC for 1976 should also be less than the previously advised TAC of 650,000 tons in order to achieve the same objective.

APPENDIX II. REMIT TO STACRES FOR SEVENTH SPECIAL COMMISSION MEETING, SEPTEMBER 1975

1. The Commission requests further advice on TACs for 1976 for the following stocks for which TACs were not agreed at the June 1975 Annual Meeting: (i) cod in Div. 3NO; (ii) cod in Subdiv 3Ps; (iii) cod in Subdiv. 4Vn(Jan-Apr) + Div. 4T; (iv) cod in Subdiv. 4Vs + Div. 4W; (v) redfish in Div. 3P; and (vi) redfish in Div. 4VWX. In particular, STACRES is requested to specify possible objectives that might be considered by the Commission, the long-term stock sizes and catches associated with these objectives, and the TACs required to achieve them over specified periods of time.

   In framing its advice, STACRES should

   a) review the present size of the named stocks and longer-term potential when exploited at the level of fishing mortality associated with the maximum sustainable yield per recruit;

   b) redefine the influence of variations in recruitment on estimates of maximum sustainable yield (MSY); and

   c) re-examine the potential effects of a range of levels of exploitation lower than that associated with the MSY, with a view to promoting greater stability of stock sizes and catches, and specify (i) their implications to stock size, (ii) the time scale of changes they imply, and (iii) stock constraints that would assist in attaining an appropriate management objective.

2. STACRES should also review estimates of the potential yield of the groundfish resources of Subareas 2 to 4 in comparison with estimates based on individual resources.

PART B

REPORT OF STANDING COMMITTEE ON RESEARCH AND STATISTICS (STACRES)[1]

Eighth Special Commission Meeting - January 1976

CONTENTS

[1] Presented to the Eighth Special Commission Meeting as Proceedings No. 1.

B. REPORT OF STANDING COMMITTEE ON RESEARCH AND STATISTICS (STACRES)

Eighth Special Commission Meeting - January 1976

Chairman: A. W. May Rapporteur: V. M. Hodder

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 identical 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.

Comparison 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 sbift 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 developement 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)					TACs (000 tons)			
	1971	1972	1973	1974	1975	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)				143	-	-	-	118[5]
5Y (adults)	39	43	16	18	20	25	25	16	4[6]
5Z+6	267	174	202	148	143	150	150	150	60[6]

[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] 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.
[6] Proposed maximum TACs.

a) Herring in Division 4V

The advice 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-December 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 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.

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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.

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 a 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

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 re-emphasizes 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 (1)

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

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 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 Addenda. 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 fisbing 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) Portugal

The data given for Portugal in Comm. Doc. 76/I/1 provide 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.

d) Poland

The revised numbers of days fiahed, 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, ss 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

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 re-analysis 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 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.

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).

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.

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.

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.

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.

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 meet-

Table 2. Fishing effort data for base period and proposed fishing effort for 1976. (This table is intended to replace the illustrative table of Proposal (1) for International Regulation of Fishing Effort in Subareas 2, 3 and 4 of the Convention Area, adoped 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
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.

ing. 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 numbers 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 round 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

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, in accordance with the request of STACRES.

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 fisheries 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.

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 experi-

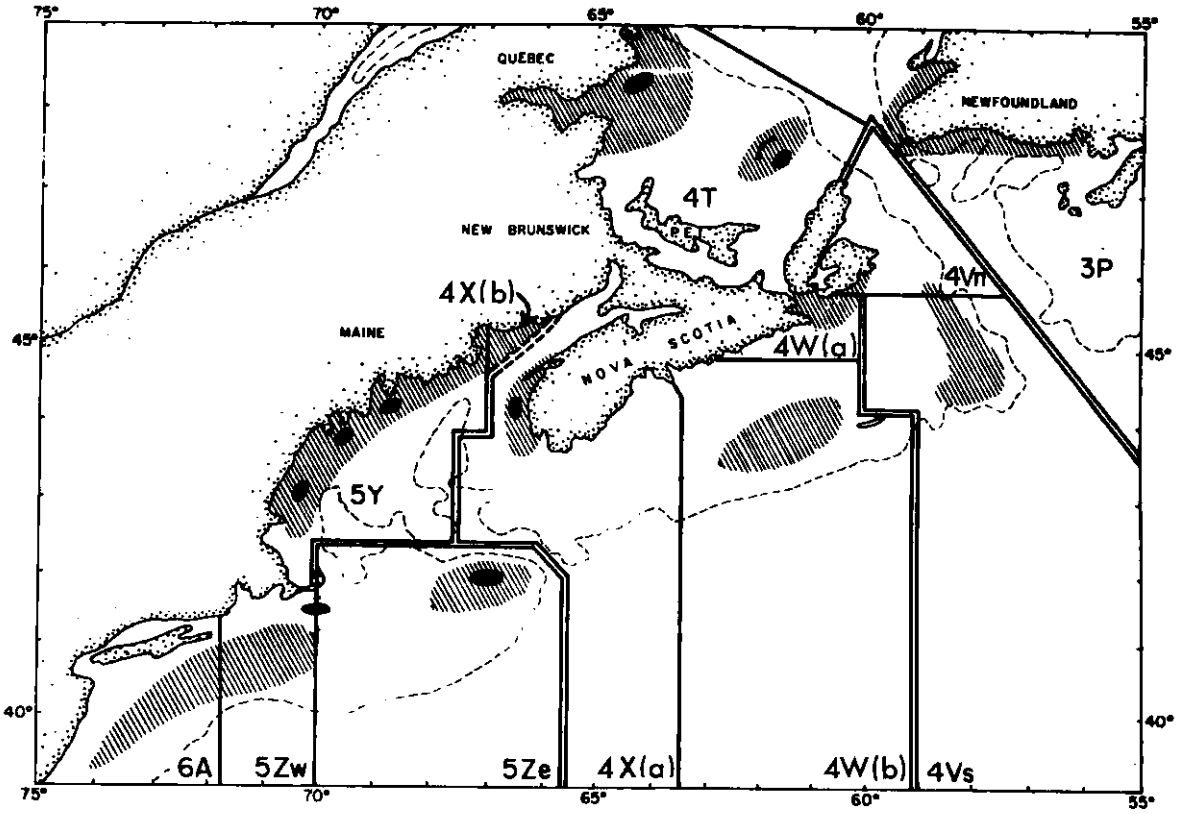

Fig. 1. Herring stock structure in Subareas 4 and 5 and Statistical Area 6. (Double lines indicate stock management areas; solid black areas indicate the general spawning grounds.)

ments (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 were taken 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 age 5 and older herring, and, although fishing mortality increases with age, F should not be substantially higher on earlier year-classes than 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 750×10^6 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 1000×10^6 fish at age 2. The size of the 1974 year-class was set at the conventional level of 750×10^6 fish. The calculated fishing mortalities and year-class sizes at age from cohort analysis are given in Table 5.

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	1,3D2	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	4D6,552	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

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 0.2. The proportions used to partition the 1976 predicted catch betwen 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

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. 4W(a) and Div. 4V. 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 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-recruit 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

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.

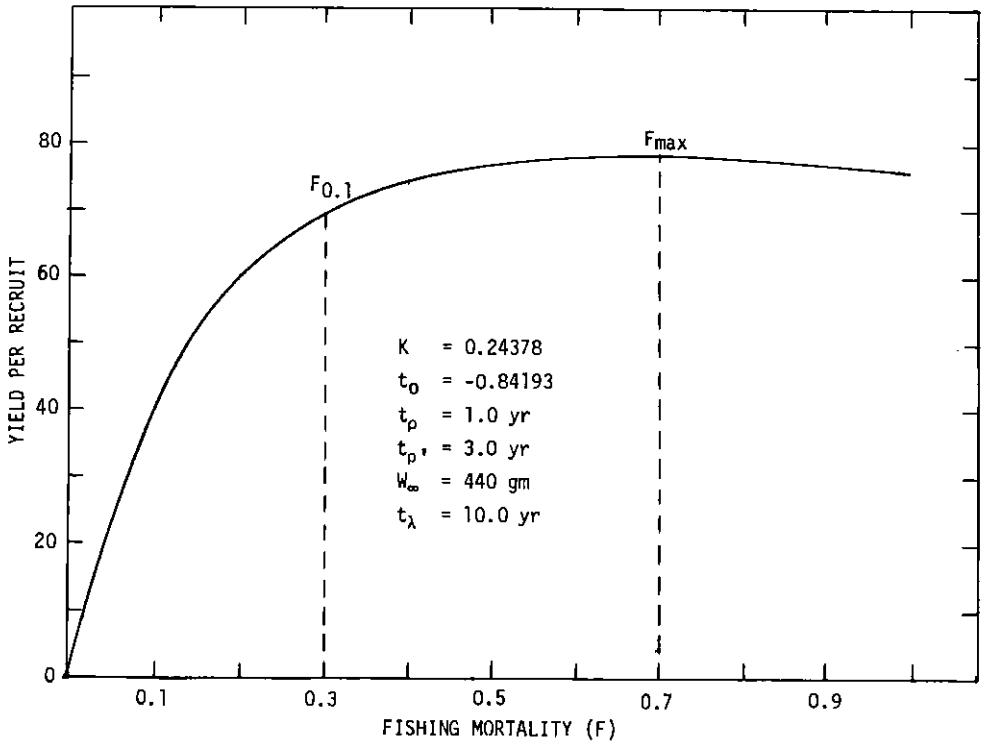

Fig. 2. Yield per recruit for herring in Div. 4X.

was used for age 6 and older fish in 1976. The 1976 F-values used for ages 2 to 10 are based on partial recruitment 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).

Table 6. Herring in Div. 4VWX: catch projection for 1976 and stock size projection (age 2 and older) for 1977 at 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(b) F	Div. 4XW(b) Projected catch in 1976 (10^6)	Div. 4XW(b) 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

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.

(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 aasumed 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 berring 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.

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.

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

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		Catch (age 3 and older) in 1975	Stock size (age 4 and older) at start of 1976		F in 1976	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)	(100%)	(000 t)	(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

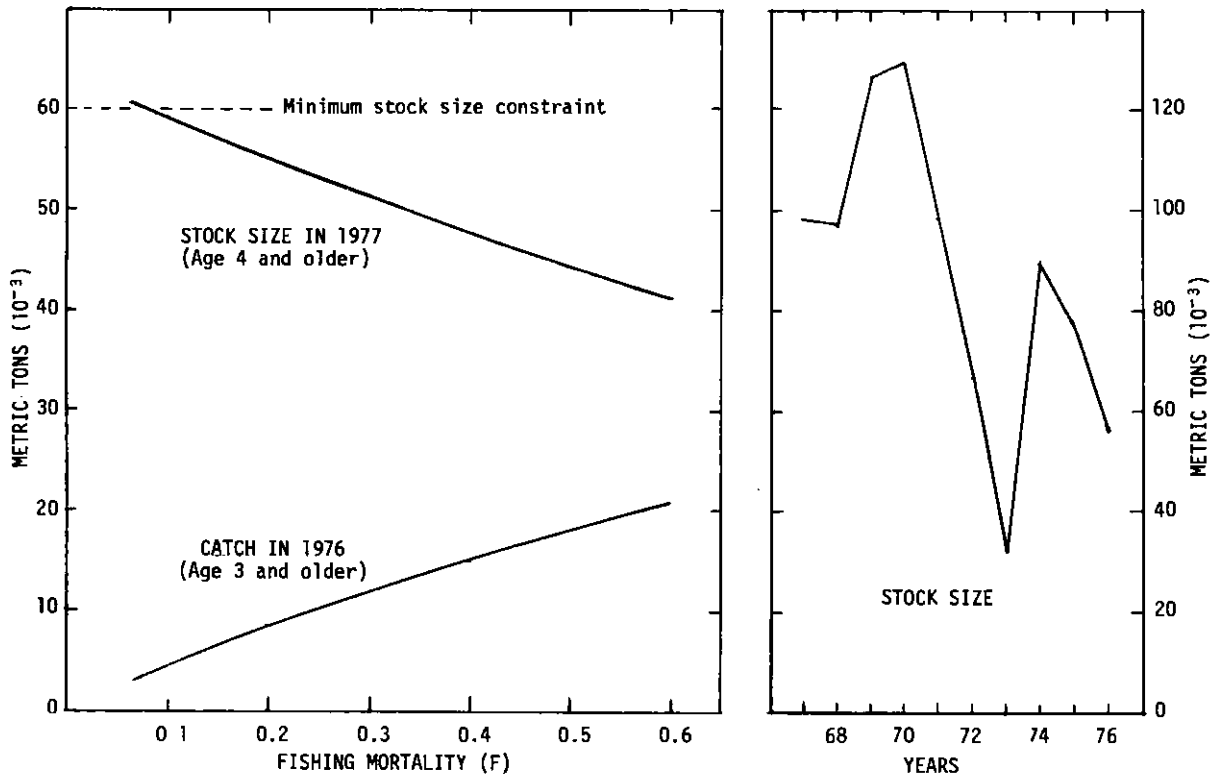

Fig. 3. Herring in Div. 5Y: projected catch in 1976 and resultant stock size in 1977 over a range of fishing mortalities, and the trend in stock size for 1967-76.

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.

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 spresd 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 availsble 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) Eatimation 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 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.

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).

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.

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 Commission 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 that the recruiting year-class at age 3 equals 550 million fish[1].

Stock size (age 4 and older) at start of 1975 (10^6)	(000 t)	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)
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.

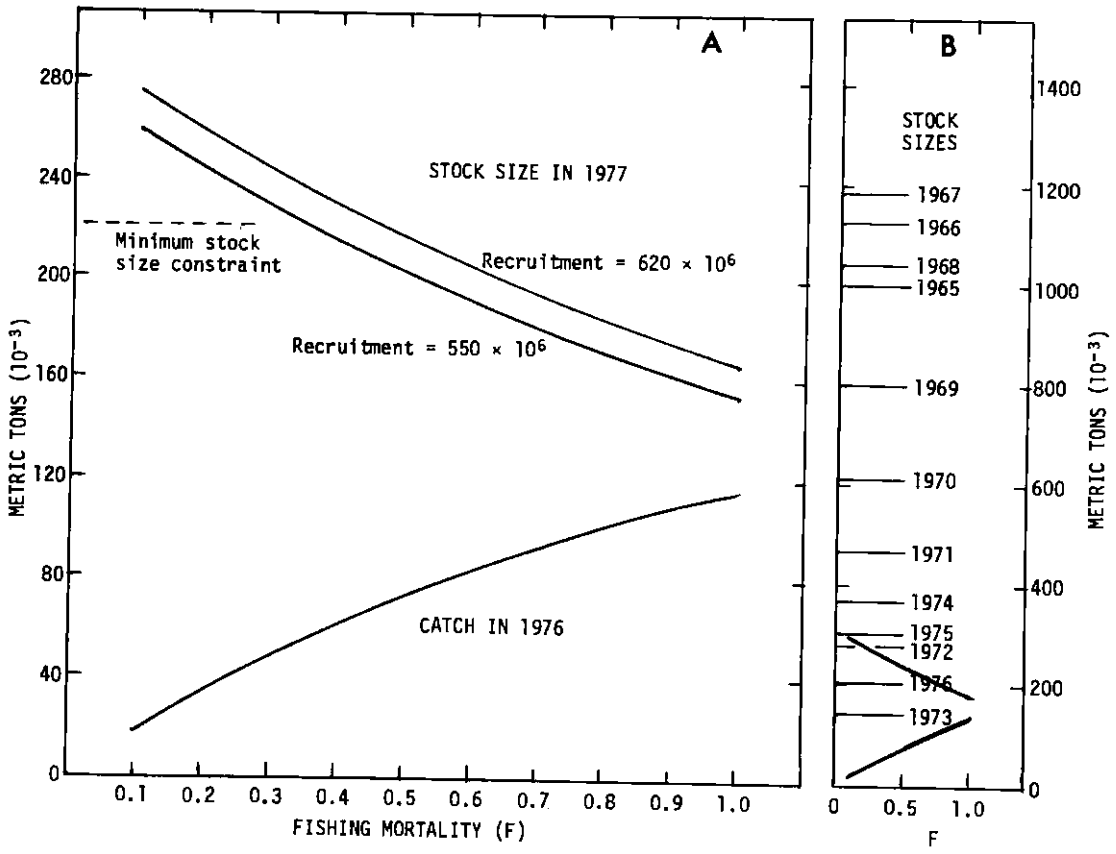

Fig. 4. Herring in Div. 5Z and Stat. Area 6: projected catch in 1976 and resultant stock sizes in 1977 over a range of fishing mortalities, assuming two levels of recruitment and the stock size levels for the period 1965-76.

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 almost entirely on the size of the recruiting year-classes, but precise estimates of annual recruitment 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.

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.

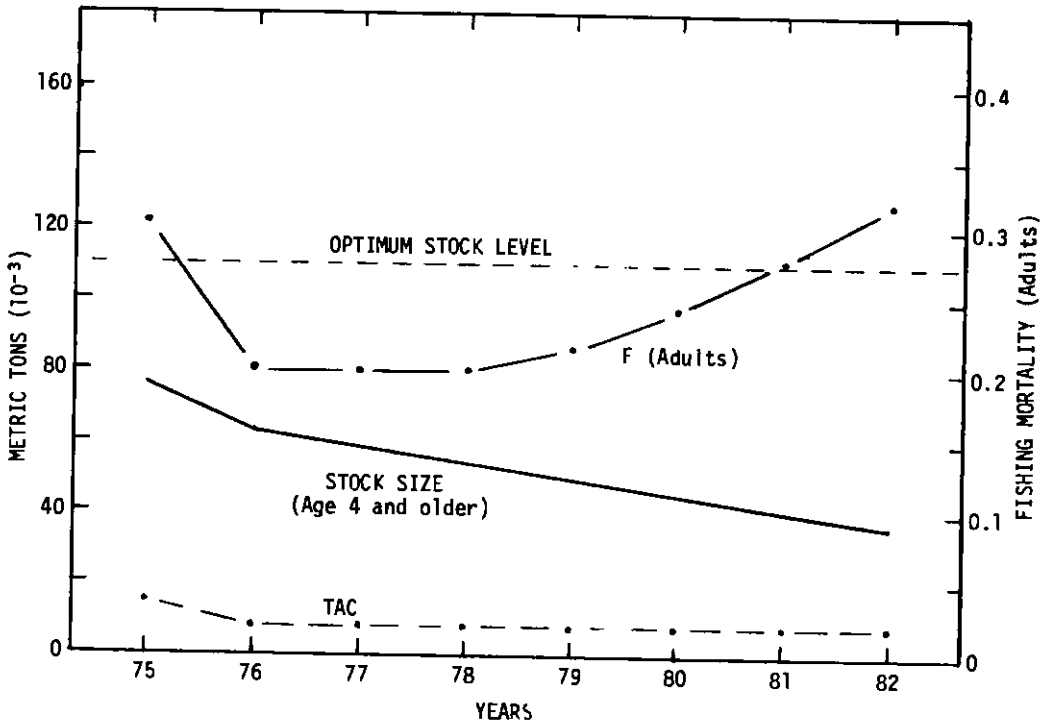

Fig. 5. Herring in Div. 5Y: simulated projection with recruitment of 64 million fish and TAC of 9,000 tons.

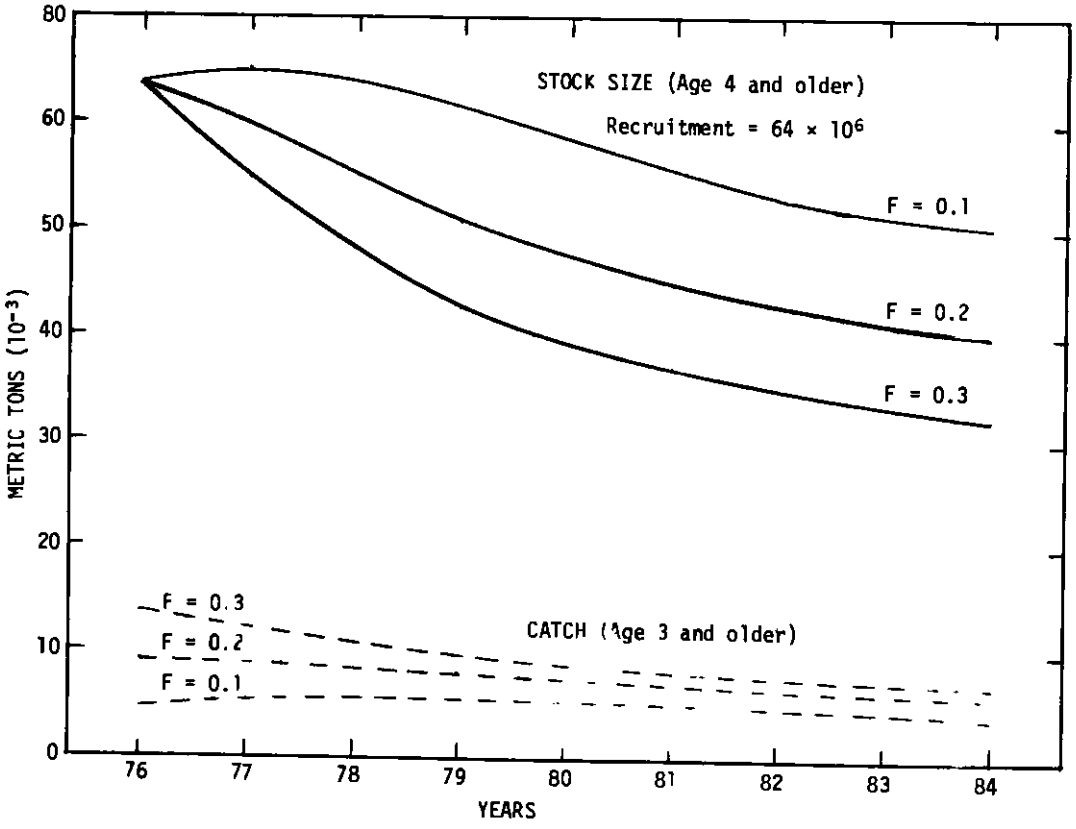

Fig. 6. Herring in Div. 5Y: simulation projections with constant recruitment and three levels of fishing mortality.

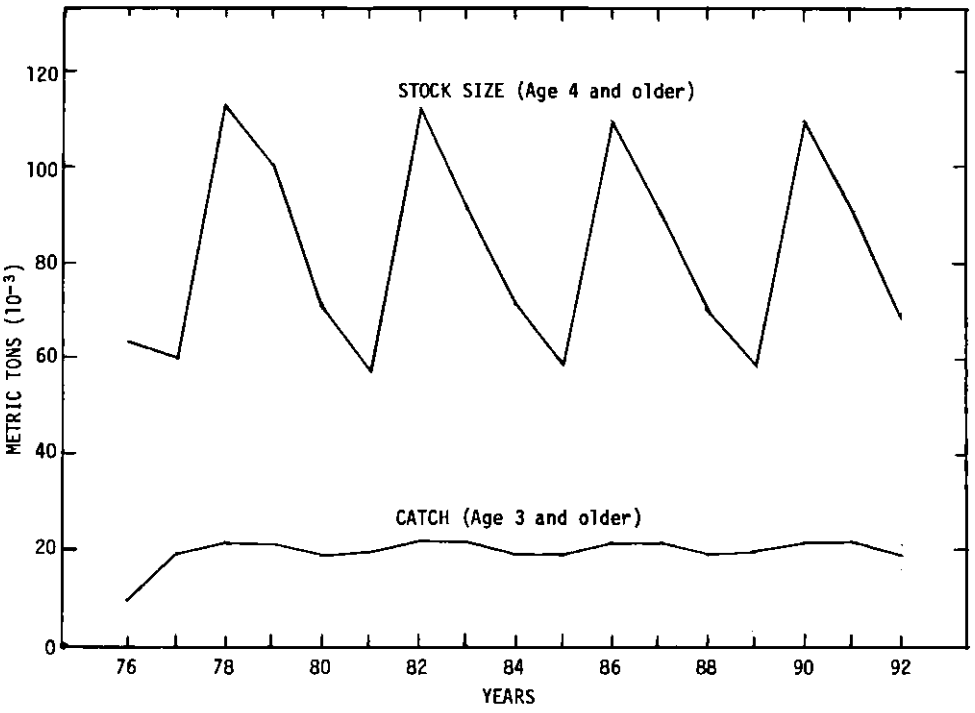

Fig. 7. Herring in Div. 5Y: simulated projections with fixed mortality at $F_{0.1}$, good recruitment (533×10^6 fish) every fourth year and poor recruitment (63.5×10^6) for the other years.

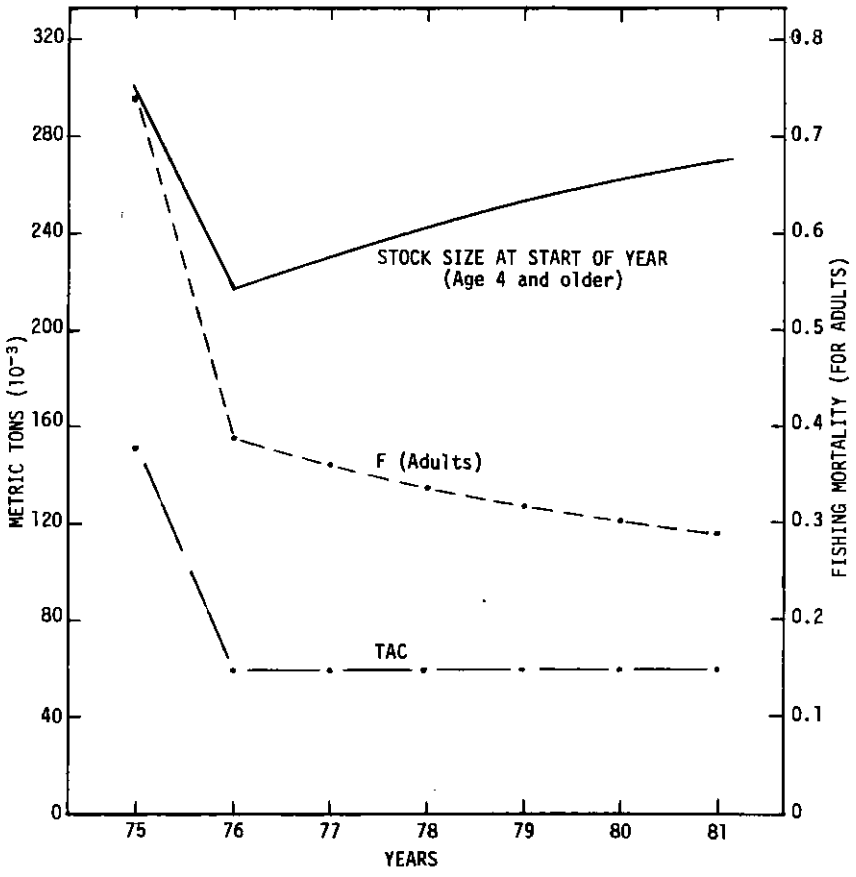

Fig. 8. Herring in Div. 5Z and Stat. Area 6: simulated projections with constant recruitment of 550 million fish and TAC of 60,000 tons.

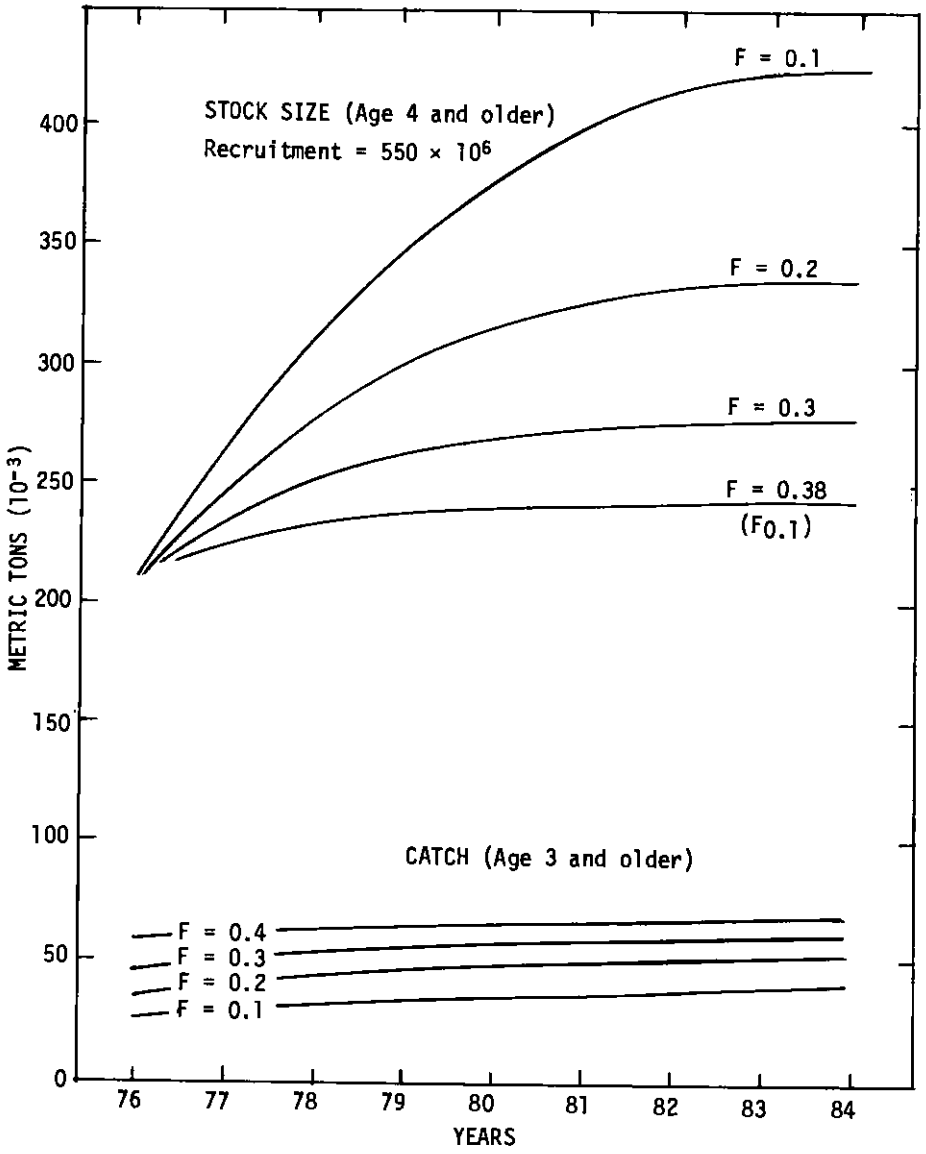

Fig. 9. Herring in Div. 5Z and Stat. Area 6: simulated projections for four levels of fishing mortality with recruitment constant at 550 million fish.

PART C

REPORT OF STANDING COMMITTEE ON RESEARCH AND STATISTICS (STACRES)[1]

Annual Meeting - May-June 1976

CONTENTS

[1] Presented to the 1976 Annual Meeting as Proceedings No. 1 (Serial No. 3949).

C. REPORT OF STANDING COMMITTEE ON RESEARCH AND STATISTICS (STACRES)

Annual Meeting - May-June 1976

Chairman: A. W. May Rapporteur: V. M. Hodder

Meetings of STACRES and its Subcommittees and Working Groups were held at Montreal, Canada, during 31 May-3 June and on 21 June 1976. Representatives were present from all member countries except Iceland, Italy and Romania, and observers attended from the Food and Agriculture Organization of the United Nations (FAO), the International Council for the Exploration of the Sea (ICES), and the International Commission for the Southeast Atlantic Fisheries (ICSEAF).

These meetings were preceded on 31 March-10 April 1976 by meetings of the Assessments and Biological Surveys Subcommittees at Dartmouth, Canada, and on 26-30 April 1976 by a meeting of the Environmental Working Group at Szczecin, Poland. A workshop on the ageing of cod was held at Vigo, Spain, on 20-25 October 1975 (Summ. Doc. 76/VI/13) and discussions on the ageing of silver hake took place at a workshop held at Dartmouth, Canada, during 1-3 April 1976 (Summ. Doc. 76/VI/21). Since the 1975 Annual Meeting, STACRES also met during the Seventh Special Meeting at Montreal, Canada, in September 1975 (Part A, this volume) and during the Eighth Special Meeting at FAO, Rome, Italy, in January 1976 (Part B, this volume).

The reports of the various Subcommittees and Working Groups, as adopted by STACRES at this Annual Meeting, are given in Appendix I (Assessments), Appendix II (Biological Surveys), Appendix III (Statistics and Sampling), Appendix IV (Fishing Effort Studies), Appendix V (Environmental), Appendix VI (Herring Tagging Program), Appendix VII (Mackerel) and Appendix VIII (Steering and Publications). Brief summaries of these reports, together with other matters considered by STACRES, are given below. The STACRES agenda, list of recommendations, lists of summary and research documents and lists of meeting participants are given in Part E of this volume.

I. ASSESSMENTS (APP. I)

1. Fishery Trends

In 1975 the total nominal catch of all species in the Northwest Atlantic (Subareas 1 to 5 and Statistical Areas 0 and 6) was 3.8 million tons, a decline from 4.0 million tons in 1974 and 4.45 million tons in 1973. Substantial declines occurred in the fisheries for cod in Subareas 2-4 and for mackerel and "other pelagics" in the southern part of the ICNAF Area. Substantial increases in catch were recorded for shrimp in Subarea 1, capelin in Subareas 2 and 3 and "other fish" in Subarea 5. Considering the catches of all species by subarea, increases were recorded for Subareas 1 and 2, and decreases for Subareas 3-5 and Statistical Area 6. Details of nominal catches for 1975 are given in Summ. Doc. 76/VI/35 (Rev.) and a summary of catches in 1974 and 1975 is presented in Table 1 of the Report of the Assessments Subcommittee (Appendix I).

2. Stock Assessments

The Assessments Subcommittee met at ICNAF Headquarters in April 1976 to review the assessments for all stocks for which TACs (total allowable catches) are in effect or proposed. Advice was put forward on catch levels for 1977. In the past, such advice has generally taken the form of recommendations for TACs aimed at controlling the fishing mortality at F_{max} or F_{MSY}, in order to maximize yield per recruit or total yield from the fisheries. Following previous discussion of management objectives at the September 1975 Meeting (Part A, this volume), the Subcommittee decided that its advice on TACs for 1977 should be based on management objectives different from those associated with F_{max} or F_{MSY}. Several reasons for managing stocks at a level of fishing mortality less than that giving F_{max} or F_{MSY} were pointed out:

a) Errors associated with TACs can be large, and losses from over-exploiting a stock are likely to be much greater than any losses due to under-exploitation.

b) Fishing at higher levels of fishing mortality reduces the number of age-groups in the stock with the result that the fisheries (and the calculated TACs) are heavily dependent on recruiting age-groups. This increases the probability of error in the TACs.

c) Although it may be too early to fully assess the effects of regulations in recent years based on F_{max}, it is evident in many cases that the stocks are continuing to decline.

A single management objective to cover all stocks was not proposed, but it was decided that advice on TACs for 1977 would in general be recommended with the aim of achieving $F_{0.1}$ rather than F_{max},

or to control fishing effort at a level less than that associated with F_{MSY}. In cases where the objective is to rebuild the spawning biomass, the TAC is not necessarily associated with $F_{0.1}$ or any other specific level of fishing mortality.

Advice on TAC levels for 1977 is summarized in the last column of Table 1. As a consequence of calculating TACs associated with levels of fishing less than those giving F_{max} or F_{MSY}, and because of continued stock declines in a number of cases, the recommended TACs for 1977 are generally less than those recommended for 1976. In several cases where there is concern that the spawning biomass may be too low, the recommended TAC is zero. In these cases, if the zero TAC is accepted, it is important that direct surveys to estimate stock abundance be carried out.

The nominal catch figures for 1975 (Table 1) are based on statistics compiled for the 1976 Annual Meeting (Summ. Doc. 76/VI/35). These figures may differ slightly from those used by the Assessments Subcommittee, based on advance preliminary statistics compiled for the April 1976 Meeting of the Subcommittee.

Table 1. Nominal catches (1971-75) and TACs (1973-77) by species and stock area, with TACs recommended by the Assessments Subcommittee at its April 1976 Meeting in parentheses.

Species	Stock area	Nominal catches (000 tons)					TACs (000 tons)[1]				
		1971	1972	1973	1974	1975[2]	1973	1974	1975	1976	1977
Cod	1	121	111	63	48	48	-	107.0	60.0	45.1	(0.0)
	2GH	13	14	+	4	7	-	20.0	20.0	20.0	(20.0)
	2J+3KL	432	458	355	373	288	665.5	656.7	554.0	300.0	(160.0)
	3M	34	58	23	25	22	-	40.0	40.0	40.0	(25.0)
	3NO	126	103	80	73	44	103.5	101.1	87.7	43.0	(30.0)
	3Ps	64	44	53	47	35	70.5	70.0	62.4	47.5	(32.0)
	4Vn(Jan-Apr)+4T	57	68	51	49	39	-	63.0	50.0	30.0	(0.0)[21]
	4Vn(May-Dec)	11	9	6	6	4	-	10.0	10.0	10.0	(3.5)
	4VsW	54	62	54	44	32	60.5	60.0	60.0	30.0	(7.0)
	4X(offshore)[3]	9	7	7	6	7	-	-	5.0	4.0	(4.0)
	5Y	8	7	6	8	9	10.0	10.0	10.0	8.0	(3.2)
	5Z	28	25	29	27	24	35.0	35.0	35.0	35.0	(15.0)
Haddock	4VW	13	5	4	2	2	4.0	0.0	0.0	2.0[4]	(0.0)
	4X	18	13	13	13	18	9.0	0.0	15.0	15.0	(0.0)
	5	12	7	6	5	7	6.0	0.0	6.0[4]	6.0[4]	(0.0)
Redfish	2+3K	19	20	39	30	26	-	30.0	30.0	30.0	(30.0)
	3M	8	42	22	35	16	-	40.0	16.0	16.0	(16.0)
	3LN	34	29	33	22	18	-	28.0	20.0	20.0	(16.0)
	3O	20	16	9	13	15	-	16.0	16.0	16.0	(16.0)
	3P	28	26	18	22	28	-	25.0	25.0	18.0	(18.0)
	4VWX	62	50	40	27	28	-	40.0	30.0	20.0	(20.0)
	5	20	19	17	10	11	30.0	30.0	25.0	17.0	(9.0)
Silver hake	4VWX	129	114	299	96	116	-	100.0	120.0	100.0	(63.0)[22]
	5Y	8	7	9	5	9	10.0	10.0	15.0	10.0	(5.0)
	5Ze	72	78	62	66	63	80.0	80.0	80.0	50.0	(70.0)
	5Zw+6	28	35	65	58	42	80.0	80.0	80.0	43.0	(50.0)
Red hake	5Ze	9	39	25	10	15	-	20.0[5]	20.0[5]	26.0	(16.0)
	5Zw+6	31	36	41	24	13	40.0[5]	50.0[5]	45.0[5]	16.0	(28.0)
Pollock	4VWX	12	20	30	25	25	50.0[6]	55.0	55.0	55.0	(20.0)
	5	14	13	13	12	14					
A. plaice	2+3K	5	9	5	6	6	-	10.5	8.0	8.0	(8.0)
	3M	1	1	1	2	2	-	2.0	2.0	2.0	(2.0)
	3LNO	68	59	53	46	43	60.5	60.0	60.0	47.0	(47.0)
	3Ps	7	7	15	7	4	-	11.0	11.0	8.0	(6.0)
Witch	2J+3KL	16	17	24	16	12	-	22.0	17.0	17.0	(17.0)
	3NO	15	9	7	8	6	-	10.0	10.0	10.0	(10.0)
	3Ps	2	2	3	2	1	-	3.0	3.0	3.0	(3.0)
Yellowtail	3LNO	37	39	33	24	23	50.0	40.0	35.0	9.0	(12.0)
	5(E69°)	31	39	31	25	14	16.0	16.0	16.0	16.0	(7.0)
	5(W69°)+6					6	10.0[7]	10.0[7]	4.0	4.0	(0.0)
G. halibut	0+1	4	14	10	14	25	-	-	-	20.0	(20.0)
	2+3KL	25	30	29	27	29	-	40.0	40.0	30.0	(30.0)
A. plaice, witch and yellowtail	4VWX	34	23	28	25	22	-	32.0	32.0	28.0	(28.0)
Flounders (except yellowtail)	5+6	28	24	22	21	27	25.0	25.0	25.0	20.0	(20.0)

Table 1. (Continued)

Species	Stock area	Nominal catches (000 tons) 1971	1972	1973	1974	1975[2]	TACs (000 tons)[1] 1973	1974	1975	1976	1977
R. grenadier	0+1	8	8	5	12	5	-	-	10.0	13.5	(8.0)
	2+3	75	24	18	28	27	-	32.0	32.0	32.0	(35.0)
Herring(Option 1)	4V(Jul-Jun)[8]	13	19	17	20	7[9]	-	-	-	(11.0)[23]	(11.0)[23]
	4WX(total)	(146)	(177)	(140)	(173)	(184)					
	4WX(adults)	113	109	97	125	132	-	-	-	(92.5)[24]	(109.0)[25]
(Option 2)	4VW(a)	72	32	30	44	33	-	45.0	30.0[10]		
	4VW(a)(Jul-Jun)[8]	...	...	...	...	20[9]	-	-	45.0[11]	36.0[11]	(33.5)[26]
	4XW(b)(total)	(114)	(160)	(135)	(141)	(145)					
	4XW(b)(adults)	70	75	91	97	95	90.0	90.0	90.0	(89.2)[27]	(84.0)
	5Y(total)	(51)	(62)	(32)	(37)	(37)					
	5Y(adults)	39	43	16	18	21	25.0	25.0	16.0	7.0	(0.0)
	5Z+6	267	174	202	150	146	150.0	150.0	150.0	60.0	(50.0)
Mackerel	3+4	24	22	38	45	36	-	55.0[12]	70.0	56.0	(0.0)[28]
	5+6	349	387	381	295	251	450.0	304.0	285.0	254.0	
Argentine	4VWX	7	6	1	17	15	-	25.0	25.0	25.0	(20.0)
Capelin	2+3K	+	46	136	127	199	-	110.0[13]	160.0[14]	160.0[14]	(300.0)[29]
	3L	1	1	4	58	34			45.0	45.0	
	3NO	1	21	127	101	128	-	148.0[13]	126.0[15]	126.0[15]	(200.0)[29]
	3Ps	1	3	1	2	2			9.0	9.0	
Other finfish[16]	5+6	159	172	157	132	116	-	150.0	150.0	150.0	(150.0)[30]
Shrimp	1	9	10	13	18	38	-	-	-	-	(26.0)[31]
Squid-*Illex*	3+4	9	2	10	+	18	-	-	25.0	25.0[17]	(25.0)
	5+6									30.0	(30.0)
		25	49	59	56	47[18]	-	71.0[19]	71.0[19]		
Squid-*Loligo*	5+6									44.0	(44.0)
Overall 2nd tier[20]	5+6	1,140	1,171	1,159	942	854	-	923.9	850.0	650.0	(500.0)

1 TACs include quantities estimated to be taken outside the Convention Area.
2 Provisional statistics compiled for the 1976 Annual Meeting from STATLANT 21A reports.
3 That part of Div. 4X south and east of straight lines joining the coordinates in the order listed: 44°20'N, 63°20'W; 43°00'N, 65°40'W; 43°00'N, 67°40'W.
4 TACs for by-catch with no directed fishery.
5 TACs pertain to 5Z(E69°) and 5Z(W69°)+6 for 1973 to 1975.
6 TAC pertains to 4X+5 only.
7 TACs pertain to 5(W69°) only for 1973 and 1974.
8 Catches and TACs pertain to fishing season July to June (e.g. 1973 = 1973/74 season).
9 Catches for Jul-Dec 1975 only.
10 TAC pertains to Jan-Jun 1975 only.
11 TACs pertain to fishing seasons 1975/76 and 1976/77 respectively.
12 TAC pertains to 4VWX only.
13 In addition, countries without specific allocations may each take up to 10,000 tons from these stocks, no more than 5,000 tons of which may be taken in Div. 3LNOPs.
14 In addition, countries without specific allocations may each take up to 10,000 tons.
15 In addition, countries without specific allocations may each take up to 5,000 tons in Div. 3LNOPs, but no more than 5,000 tons in aggregate from Div. 3L and no more than 1,000 tons in aggregate from Subdiv. 3Ps.
16 Excludes all TAC species and also menhaden, billfishes, tunas and large sharks (except dogfish).
17 In addition, countries without specific allocations may each take up to 3,000 tons.
18 Catches not yet available from all countries by *Illex* and *Loligo* separately.
19 TACs pertain to *Illex* and *Loligo* combined.
20 Includes squids and all finfish species, except menhaden, billfishes, tunas and large sharks other than dogfish.

Footnotes relevant to TACs recommended at the April 1976 Meeting of Assessments Subcommittee

21 Recommended TAC is subject to management strategy for 4Vn winter fishery and 4T summer fishery, as indicated in Section VI. 2(a).
22 Recommended TAC not agreed to by scientists from Cuba, GDR and USSR.
23 Recommended TAC for fishing seasons 1976/77 and 1977/78 respectively.
24 Recommended TAC for the period 1 Apr-31 Oct 1976.
25 Recommended TAC for fishing season 1 Nov 1976 to 31 Oct 1977.
26 Recommended TAC for fishing season 1 Jul 1977 to 30 Jun 1978.
27 This TAC is now recommended for 1976, although 81,000 tons was provisionally agreed by the Commission at the January 1976 Special Meeting (see Section VI. 2(ℓ)).
28 TAC is subject to reassessment at the 1976 Annual Meeting (see Section VII. 2(p)).
29 Not more than 50,000 tons should be taken in Div. 3L nor more than 10,000 tons in Subdiv. 3Ps.
30 Within this recommended TAC, advisory TACs are proposed for the following species: 25,000 tons of argentine, 40,000 tons of dogfish, 18,000 tons of butterfish, and 10,000 tons (including inshore fishery) of river herrings (*Alosa pseudoharengus* and *A. aestivalis*).
31 Recommended TAC pertains to offshore fishing grounds (in the Convention Area).

3. Further Discussions of Assessments at Annual Meeting

Additional material pertaining to the assessment of a number of stocks was presented at the Annual Meeting. Further discussion of the assessment for mackerel stocks was taken in STACRES (see Section IX of this report and also Appendix VII). New data for other stocks were referred to the appropriate groups of scientific advisers to the various Panels. Discussions on the overall second-tier TAC in Subarea 5 and Stat. Area 6 were not completed at the April 1976 Meeting of the Assessments Subcommittee, although it was agreed that 500,000 tons should be used as an upper reference point, and this subject was referred to the Scientific Advisers to Panel 5 for further advice. Thus it is important that the recommended TACs for 1977, listed in Table 1, be considered in the light of further discussions by Scientific Advisers to Panels, which in some cases may result in modification of the recommendations.

4. Fishery Statistics and Biological Sampling

The importance of accurate statistical reporting was emphasized, since any inaccuracy in this respect will result in errors in assessment and in recommended TACs. Again in 1975, as in previous years, no sampling data were available for a number of stocks and the data available for some others were so scanty that they could not be used in assessments. Since the accuracy of assessment advice is directly related to the adequacy of the data base, STACRES once agsin urges member countries to provide their scientists with the resources to improve their capability to provide good advice and, in particular, to improve their sampling efficiency.

5. Overall Groundfish Fishing Effort in Subareas 2 to 4

The overall decline in catch rates in the 1970's has not reflected any beneficial effects of TAC regulations. The reductions in TACa recommended for 1977 indicate that no increase in fishing effort can be recommended. Although the effects of fishing the stocks at $F_{0.1}$ in 1977 would not have a significant effect on catch rates in that year, it could be expected to result in observable increases in catch rates in 1978 and subsequent years. The level of fishing effort in each management area in relation to the fishing mortality it would generate has not yet been accurately determined, and hence it remains to be demonstrated whether further adjustments in effort would be required to achieve $F_{0.1}$. The benefits of increasing catches and catch rates to be anticipated after 1977 would not be a rationale for increasing total fishing effort since these higher catches will be attainable without an increase in effort.

II. BIOLOGICAL SURVEYS (APP. II)

1. Survey Activities and Plans

Total survey activity in 1975 was of about the same scale as in 1974 with most of the surveys concentrated in the southern part of the ICNAF Area. Plans for the remainder of 1976 and early 1977, including coordinated surveys for larval herring during the sutumn and winter, were drawn up. Consideration of a means to assign priorities for survey programs is underway. STACRES endorsed the continued development of coordinated survey activity and the suggestion of the Subcommittee that special attention should be given to survey designs for clustered fish species (e.g. mackerel). It was noted that a preliminary draft of the ICNAF Manual on Groundfish Surveys is expected to be available early next year.

2. Reporting and Processing of Survey Data

A proposed set of standard forms for reporting survey data to the Secretariat was developed. In order to assess the feasibility of processing these data within the Secretariat, a pilot project approach was agreed.

3. Hydroacoustic Surveys

Considerable attention was given to the potential, as well as to the current limitations, of hydroacoustic techniques as an adjunct to conventional surveys for abundance estimation. It was noted that these techniques are now being used by a number of countries.

III. STATISTICS AND SAMPLING (APP. III)

1. Statistical Activities and Publications

The late reporting of data continues to affect the timely production of statistical publications, particularly the Statistical Bulletin, and STACRES endorses the Subcommittee's request that member countries adhere to the 30 June deadline for the submission of detailed catch and effort statistics

for the preceding year. STACRES also noted that advance statistics for the April Meeting of the Assessments Subcommittee were very incomplete. Information on discards continues to be very inadequate, but improvement is hoped for as a result of the Commission's requirement for recording statistics on discards in fishing logbooks. In general, there has been little improvement in the quality and promptness of statistical reporting to the Commission.

The ability of the Secretariat to process statistical information has been significantly improved by additions to the staff of a biostatistician and a statistical clerk and by the installation of an in-house computer terminal.

STACRES noted that provision has now been made on STATLANT 21B Forms for the reporting of catch and effort statistics by 30' × 30' unit areas and twice-monthly time periods. This finer breakdown will necessitate the reporting of catches in a smaller unit than the metric ton, and STACRES accordingly

recommends (2)

that for statistics reported by 30' × 30' unit areas and twice-monthly time periods the weight unit be the "kilogram", pending consideration of this matter at the next session of the CWP.

The 1974 List of Fishing Vessels was issued recently, following which countries were requested to provide revised lists for 1975. These revised lists were not complete at the time of the Annual Meeting, and STACRES concluded that for research purposes it was not in fact necessary to prepare a partial list specially for the Annual Meeting, although STACTIC's possible interest in this matter should be taken into consideration.

STACRES was informed that the Ninth Session of the CWP will be held at the Secretariat Office, Dartmouth, Canada, in the latter part of 1977, and accordingly

recommends (3)

that Canada be requested to nominate a representative to participate on behalf of ICNAF at the next session, in addition to the Assistant Executive Secretary and the Chairman of the Statistics and Sampling Subcommittee.

2. Sampling Activities

Serious deficiencies in the level of sampling activity continue to exist. In 1974, the minimum sampling requirement was met for less than 60% of the TAC stocks with respect to length data and for less than 50% with respect to age data. For five stocks no sampling data were available. The lack of improvement in quantity and quality of sampling is thus very discouraging, and member countries are again urged to participate fully in the ICNAF Sampling Program. STACRES endorsed the suggestion of the Subcommittee that an exchange of sampling manuals, which have been developed by various countries, be undertaken through the Secretariat.

Following the analysis of data from a special sampling project, it was agreed that there are definite advantages in the processing of sampling data by the Secretariat, as opposed to processing by individual countries, and STACRES

recommends (4)

i) that the establishment of an adequate base of sampling data at the Secretariat be implemented as soon as possible, in order to provide the basic information required for scientific studies; and

ii) that a small group of consultants be nominated, together with the Secretariat, to specify the requirements and costs of implementing such a detailed data base, including methods of processing, in order that the subcommittees and working groups may be provided with the tabulations and data analyses as required to carry out their tasks.

IV. FISHING EFFORT STUDIES (APP. IV)

1. Several analyses of data from the Div. 5Z Pilot Study were reviewed. Use of a new "learning index" suggested that sharp increases in efficiency occurred for the larger vessels (>1800 GRT) of USSR, German Democratic Republic and Poland since these vessels began fishing in Subarea 5 and Stat. Area 6, but that similar increases were not apparent for smaller vessels of these and other countries. Studies of variation in daily catch per unit effort lead to the implication that attempts to achieve reduction in fishing mortality by reducing the number of days fished could in theory be nullified by increasing the number of hours fished per day. Analysis of data on fishing power indicated that the calculation of fishing effort to correspond to a desired level of fishing mortality would require

the fine-scale reporting of catch and effort data.

2. STACRES endorsed the suggestion of the Working Group that it would not meet again on a routine basis unless there were specific projects or requirements.

V. ENVIRONMENTAL (APP. V)

1. Environmental Working Group

This group met at Szczecin, Poland, in April 1976 to review progress and plan for further research relative to the two special cooperative studies in the Gulf of Maine-Georges Bank area and on Flemish Cap. STACRES noted that progress on studies in the former area is satisfactory and that a very active coordinated program is underway. Progress has been slower in the Flemish Cap study and a greater commitment to this study is desirable. It was agreed that greater progress would be achieved if a meeting of appropriate scientists could be arranged. STACRES therefore

recommends (5)

that Dr. Konstantinov be asked to convene a meeting of a small group of scientists (including the Chairman of the Subcommittee and Dr. Wolford), who might be directly concerned with a coordinated international experiment on Flemish Cap, to further examine the data base, to appraise the suitability of Flemish Cap as an area worthy of a special study and, if the outcome of the appraisal is favourable, to develop a preliminary proposal for consideration by the Subcommittee at its meeting in 1977.

2. Standardization of Oceanographic Sections and Stations

Following discussions of this matter during the past several years, STACRES

recommends (6)

that the sections and stations listed in Circular Letter 76/25, after minor editorial amendments, and those listed in Res. Doc. 76/VI/37 Corrigendum be adopted as standard ICNAF oceanographic stations.

It was proposed that a complete and fully amended list of standard ICNAF sections with individual station positions and approximate depths be assembled by Mr. Sandeman and circulated to ICNAF member countries by the Secretariat.

3. Plankton Sorting Centre

STACRES welcomed a report that the Plankton Sorting and Identification Centre at Szczecin, Poland, developed jointly by Poland and USA, is now well established and actively engaged in ICNAF work.

4. Other Matters

A review of environmental conditions in the ICNAF Area in 1975 is contained in Appendix V of this report. A brief review was presented of a new USA program of monitoring the effects of large Gulf Stream eddies using a combination of satellite technology and ships. It was noted that several research vessels from ICNAF member countries participated in this activity earlier this year.

VI. GEAR AND SELECTIVITY

1. Trawl Materials and Mesh Size Sampling, 1975

STACRES was informed that returns for 1975 had been received from 11 member countries. Further reports are expected for 1975, and STACRES agreed that the Secretariat issue a summary of all available data as soon as possible after the Annual Meeting.

2. Mesh Selection Studies (Res. Doc. 76/VI/63)

STACRES noted that the results of mesh studies on European hake, *Merluccius merluccius*, in the Spanish fisheries off Galicia gave selection factors for that species of 2.8 for polyethylene, 3.5 for polypropylene and 3.7 for polyamide netting.

3. Mesh Size in the Silver Hake Fishery in Divisions 4VWX

The only mesh selection information available for silver hake is that of Jensen and Hennemuth (ICNAF

Research Bulletin No. 5, 1966), which shows a selection factor of 5.1 for *Merluccius bilinearis* in nylon nets. The experiments were conducted in Subarea 5. In an earlier discussion of the appropriate mesh size for the silver hake fishery in Subarea 5, a mesh size of 55 mm (nylon) was recommended by the Assessments Subcommittee to give a 50% selection length at age 3 of 27.8 cm (ICNAF *Redbook* 1972, Part I). Recent analyses of size at age and growth rate of silver hake in Div. 4VWX (Res. Doc. 75/104, 76/VI/59) and of yield-per-recruit data give results different from those on which the 1972 recommendation was based. These data imply that, at present fishing mortality rates, yield-per-recruit is maximized at a mean selection age (t_c) of 30 months (birthday 1 July), which is equivalent to a mean selection length (ℓ_c) of 30 cm. Using the mesh selection factor of 5.1, as before, gives an estimate of 60 mm (nylon) as the mesh size required to maximize yield-per-recruit. This would minimize the catches of juveniles and allow a substantial proportion of the stock to spawn at least once.

There is, however, substantial disagreement regarding the correct method of ageing silver hake and hence in determining their size at age and growth rate (Summ. Doc. 76/VI/21). Consequently, it cannot be resolved whether the appropriate mesh size is 55 mm or 60 mm (nylon). Concern was expressed at the large differential between the selection factors for silver hake and European hake and whether the factor for silver hake was an over-estimate. This matter could not be resolved, but it was concluded that 55 mm (nylon) was a minimum estimate of the desirable mesh size.

VII. AGEING TECHNIQUES AND VALIDATION STUDIES

1. Report of Ageing Workshop on Cod (Summ. Doc. 76/VI/13 and Addendum)

The report of the Workshop, held at Vigo, Spain, during 20-25 October 1975, indicated a number of serious problems related to the interpretation of otoliths, the most important being (i) the determination of the first annulus, (ii) the presence of splits and checks which often make the interpretation of annuli difficult, (iii) the interpretation of annuli in the edge of the otolith for older fish, (iv) the effects of cutting the otoliths off-centre, and (v) the recognition of peculiarities in otoliths from specific areas. The Workshop recommended that STACRES request further studies on these problems and that another workshop be organized to study the problems in a specific area and to establish a set of guidelines for otolith interpretation.

STACRES noted that some further analysis of the data might be possible in relation to the distribution of age determinations by fish size and suggested that the Secretariat might carry out such further analyses as might be considered appropriate. It was generally agreed that a workshop, consisting of a small group of ageing experts (with Mr. R. Wells as Convener), be held in January 1977 at the Biological Ststion, St. John's, Newfoundland, to focus its attention on age determination of cod in Div. 2J, 3K and 3L with a view to resolving some of the difficulties and to preparing a set of objective guidelines for the interpretation of otoliths.

2. Report of Ageing Workshop on Silver Hake (Summ. Doc. 76/VI/21)

This Workshop was held at Dartmouth, Canada, during 1-3 April 1976. The studies and discussions by the group in the limited time available formed the basis for more extensive studies proposed for a workshop to take place at Woods Hole, USA, in the autumn of 1976. The need for studies on red hake ageing problems was emphasized and STACRES agreed that the workshop should consider both silver and red hakes. It was further agreed that member countries be urged to ensure that experts (actually engaged in age reading for these species) participate in the workshop. The timing and arrangements for the workshop will be determined in collaboration with scientists at the Woods Hole Laboratory, and countries will be informed by Circular Letter from the Secretariat.

3. Review of Papers on Validation Studies

STACRES noted that no papers on this subject were available for consideration at this meeting and urges that such studies should be pursued and reported as research papers when data are available. In view of the difficulties associated with the ageing of cod and the hakes, the importance of continuing studies on these species, as well as initiating similar studies for other Northwest Atlantic fish species was strongly emphasized. STACRES noted the paper on age determination of roundnose grenadier (Res. Doc. 76/VI/28) and welcomed this study as a significant contribution to our knowledge of this species.

4. Need for Further Workshops or Otolith Exchange Programs

As noted above, STACRES agreed to add the study of red hake ageing to those already planned for silver hake at a workshop to be held later in 1976. STACRES encouraged the bilateral and/or multilateral exchange of ageing material for other species between Research Institutes with a view to identifying any age determination problems.

VIII. INTERNATIONAL HERRING TAGGING PROGRAM (APP. VI)

1. The management of herring fisheries in the southern part of the ICNAF Area has been conducted separately on stocks in Div. 4XW(b), Div. 5Y, and Div. 5Z + Stat. Area 6. Recent tagging results indicate that a significant mixture of herring from the three spawning areas may occur at various times of the year. Declines in stock size accentuate the need to determine the extent of intermixing so that this can be taken into account in the management of the fisheries. Additional knowledge of the relations between the juvenile stocks and the adult stocks to which they recruit is also necessary. STACRES concluded that additional herring tagging experiments should be carried out with the participation of countries involved in the herring fisheries. A detailed plan for such experiments is contained in Appendix VI, and Dr. W. T. Stobo was nominated to coordinate the tagging activities.

In order to undertake the new tagging experiments later in 1976, it was considered necessary to obtain the tags as soon as possible and also advantageous to purchase the tags as a single order from a single agency. STACRES accordingly

recommends (7)

i) that a quantity of 100,000 tags be purchased by the Secretariat for distribution to countries participating in the program, and

ii) that those countries which have an interest in the tagging program contribute to the cost of obtaining the tags (estimated to cost about $18,000).

STACRES noted that a substantially reduced TAC for herring in 1977 would likely have an effect on the research plans outlined in Appendix VI for the international tagging experiment in late 1976 and in 1977. It was agreed that the "seeding" experiments, planned for the latter part of 1976 to test the efficiency of recovery on fishing vessels, should be continued, and that the plans for a large-scale tagging program in 1977 might have to be readjusted by the coordinator, following correspondence with participating countries.

IX. MACKEREL ASSESSMENT (APP. VII)

1. Conclusions from the April 1976 Meeting

At the April 1976 Meeting of the Assessments Subcommittee, it was concluded from the data available at that time that a zero TAC for 1977 was indicated for the mackerel stocks in the ICNAF Area (Subareas 3 to 5 and Stat. Area 6). This opinion was not shared by scientists of German Democratic Republic, Poland and USSR, who had reservations about the results from survey indices of abundance and who considered that the estimates of the parameters used in the assessment were incorrect. Further analysis of the mackerel data was deferred for review at the 1976 Annual Meeting.

2. Further Consideration of Mackerel at the Annual Meeting

Further analysis of the available mackerel data is presented in detail in Appendix VII, and, although extensive discussions were held within STACRES, it was not possible to reconcile the differences of opinion on appropriate values for (i) the 1975 fishing mortality on age-groups 3 and older, (ii) the partial recruitment of age 2 fish in 1975, and (iii) the sizes of the 1975 and 1976 year-classes. Differences of opinion also continue to exist on the predicted 1976 catch composition.

It was possible to bring the divergent opinions together to the point where one group of scientists could agree that fishing at $F_{0.1}$ in 1977 would generate a catch of as much as 55,000 tons, while another group of scientists could agree that fishing at $F_{0.1}$ would generate a catch of as little as 115,000 tons. In other words, the implied TAC for $F_{0.1}$ would be 55,000 tons or less on the one hand and 115,000 tons or more on the other.

It was agreed that it would be desirable to rebuild the spawning biomass of mackerel to a level in the range of 500,000 to 1,000,000 tons (from an estimated level possibly between 162,000 and 349,000 tons at the beginning of 1977). There was no agreement on the rate at which such rebuilding needed to occur or on the TAC necessary in 1977 to attain this objective.

It should finally be noted that the ranges of options presented for the various parameters (see Appendix VII) represent in each case the extreme values which would be acceptable to the various scientists expressing different viewpoints. Thus it is not agreed that the actual values of the various parameters would likely be within these ranges. The consequence is, from the range of individual scientific opinion on the recommended TAC level for 1977, that it ranges from zero to 250,000 tons.

At the request of the Chairman of Joint Panels 3, 4 and 5, the Assessments Subcommittee met briefly on 18 June to consider whether sufficient new information could be made available to merit reconsideration of the status of the mackerel stocks at a meeting late in 1976. The Subcommittee agreed that such a meeting would be useful and specified the data requirements and timetable for this meeting (see Appendix I, page 111).

X. COLLABORATION WITH OTHER ORGANIZATIONS

1. Mr. B. Parrish (UK) reported that the editing of the contributions to the Report of the Joint ICES/ICNAF Salmon Tagging Experiment is at an advanced stage and it is hoped that the report, to be published as a volume of the ICES *Rapports et Procès Verbaux*, will be ready for publication in the near future.

2. STACRES was informed that the contributions to the ICES/FAO/ICNAF Symposium on Acoustic Methods in Fisheries Research, held at Bergen, Norway, in June 1973, are probably now at the printers and should be published as a volume of ICES *Rapports et Procès Verbaux* during the present year.

3. Dr. A. Schumacher (ICNAF Observer to ICES) reported on the ICES Annual Meeting held at Montreal, Canada, in October 1975, noting that the Secretariat had extracted from the ICES Report a number of resolutions pertinent to ICNAF matters (Summ. Doc. 76/VI/26). STACRES noted the usefulness of the information in this document and suggested that the Secretariat forward a copy of the STACRES Report to ICES prior to its Annual Meeting pointing out the relevant matters that ICES should bring to the attention of its committees, and that ICES be requested to reciprocate following its Annual Meeting. Noting that ICES is planning to hold a symposium on the biological basis of pelagic fish stock management in the North Atlantic in 1978 but that plans have not yet been finalized, STACRES agreed to consider the extent of its participation in the symposium at the 1977 Annual Meeting when detailed plans should be available.

4. Dr. B. Draganik (Assistant Executive Secretary of ICSEAF) expressed his appreciation for the invitation to attend the scientific meetings of STACRES and for the assistance of the ICNAF Secretariat in the preparation of an automated data-processing system for ICSEAF. He indicated that ICNAF's experience in research and statistical activities is greatly relied upon by ICSEAF scientists, and that a scheme of exchanging ageing material was already in progress with plans for a workshop later. He requested that ICSEAF be kept informed of plans for such ICNAF workshops in case that some ICSEAF scientists might wish to attend.

5. STACRES was informed that the Ninth Session of the CWP is planned for late summer or autumn of 1977 at ICNAF Headquarters in Dartmouth, Canada. Noting that ICNAF was represented on the CWP by USA for the last two sessions, STACRES agreed that Canada be requested to nominate a representative for the next CWP session.

XI. STEERING AND PUBLICATIONS (APP. VIII)

1. Status of Subcommittees and Working Groups

STACRES concurred with the Subcommittee's suggestion that the Working Group on Fishing Effort Studies and the Working Group on Environmental Studies should be discontinued, noting that further studies on these matters could be undertaken by the relevant subcommittees.

2. Future Status of STACRES

In the light of the stated intentions by Canada and USA to extend coastal state jurisdiction for fisheries management, STACRES concurred with the views of the Subcommittee on the need for continued international cooperation in regard to the STATLANT system of statistical reporting, the implementation of the ICNAF data base for fisheries statistical and biological data, and the coordination of research activities. It was further noted that STACRES could serve as the forum for discussions on general problems of fisheries science and management in the Northwest Atlantic.

3. Review of Publications

STACRES noted that the Secretariat had implemented the publication guidelines for the Research Bulletin and Selected Papers series. However, it was pointed out that the increased workload of the Secretariat had delayed the compilation of the index of ICNAF documents. Noting the importance of completing this project as soon as possible, it was suggested that the Secretariat should consider the use of contingency funds to obtain help in the editing of research papers for publication.

The 1976 research papers were reviewed and selections made for possible publication in the Selected Papers series.

In view of the increased participation of scientific advisers in reviewing assessment data for advice to panels at the Annual Meeting, STACRES agreed that the Reports of Scientific Advisers should be published in Redbook so that the reports of all scientific meetings will be contained in the same volume.

4. Status of Fisheries and Research Carried Out

STACRES noted the request of Panel 5 for advice on whether it was necessary to continue the preparation of summary documents on the status of fisheries and research carried out. It was pointed out that these reports form the basis for a section in the Commission's Annual Report. The need for the hasty preparation of these reports for presentation to the Annual Meeting was questioned, as all of the relevant material is usually reviewed by the various subcommittees and working groups. It was finally agreed that summary reports for inclusion in the Annual Report could best be prepared after the Annual Meeting, with the Secretariat assuming responsibility for preparing the sections on the state of the fisheries and the Chairmen of Scientific Advisers for summaries of research activities conducted during the preceding year.

5. Review of Research Papers in STACRES

STACRES noted that most of the research documents had been reviewed by the various subcommittees and working groups except for the following papers which were reviewed in STACRES.

a) Res. Doc. 76/VI/89. This paper presents some results of studies on salmon taken in June and July 1975 near St. Pierre and Miquelon. In particular, length and age data for the samples are given together with information on gear selectivity, environmental conditions and food contents of stomachs.

b) Res. Doc. 76/VI/96. This paper presents a method for giving a precise and quick iterative solution for fishing mortality, if the stock size at the start of the year, the catch in numbers during the year and the natural mortality rate are known. This allows the calculation of stock size projections by specifying quota levels rather than fishing mortality rates.

c) Res. Doc. 76/VI/112. This paper presents information on the species composition of by-catches in the specialized fishery by USSR for roundnose grenadier. Except in Div. 2J, where the by-catch was 29% consisting mainly of redfish and Greenland halibut, the by-catches in other areas were all less than 8% with Greenland halibut making up the major part of this figure.

XII. FUTURE SCIENTIFIC MEETINGS

1. STACRES noted the possible need for one or more meetings later in 1976 to further consider matters deferred to Special Commission Meetings, but considered that these could only be arranged after the Commission's decision to hold such meetings is made known.

2. STACRES noted that plans are now being made to hold a workshop on ageing of silver hake and red hake at Woods Hole, USA, in October 1976 and a further workshop on ageing cod at St. John's, Canada, in January 1977. It was also noted that the Scientific Advisers to Panel A (Seals) will meet in Copenhagen, Denmark, on 11-12 October 1976 immediately following the scientific meetings of ICES.

3. STACRES agreed that the Assessments Subcommittee should meet for 10 days in the last half of April 1977 at ICNAF Headquarters in Dartmouth, Canada, the meeting to be scheduled to avoid any overlap with the meeting of the ICES Liaison Committee.

4. STACRES agreed to meet, together with its Subcommittees, during the week preceding the 1977 Annual Meeting of the Commission.

XIII. OFFICERS FOR 1976/77

1. Chairman of STACRES and its Subcommittees were elected (or re-elected) as follows:

STACRES	- Dr. M. D. Grosslein, USA (elected)
Assessments Subcommittee	- Mr. A. T. Pinhorn, Canada (re-elected)
Statistics and Sampling Subcommittee	- Dr. J. Messtorff, FRG (elected)
Environmental Subcommittee	- Mr. E. J. Sandeman, Canada (elected)
Biological Surveys Subcommittee	- Dr. W. Doubleday, Canada (elected)

2. Members of the Steering and Publications Subcommittee were confirmed as follows:

Canada	- Dr. A. W. May
Denmark, Fed. Rep. Germany, UK	- Mr. B. B. Parrish (UK)
Cuba, France, Portugal, Spain	- Mr. R. H. Letaconnoux (France)
Iceland, Italy, Japan, Norway	- Mr. Ø. Ulltang (Norway)
Bulgaria, German Dem. Rep., Poland, Romania, USSR	- Dr. V. A. Rikhter (USSR)
USA	- Mr. R. C. Hennemuth
Ex officio Chairman	- Chairman of STACRES

XIV. APPRECIATION

1. The Chairman of STACRES expressed his appreciation for the excellent work of all scientists who participated in the numerous meetings of STACRES and its Subcommittees and Working Groups during his term of office and also to the Secretariat for its technical support.

2. STACRES expressed its thanks to the outgoing Chairman, who so ably chaired more than the usual number of STACRES meetings during the past three years.

APPENDIX I. REPORT OF ASSESSMENTS SUBCOMMITTEE

Chairman: A. T. Pinhorn

The Assessments Subcommittee met at Dartmouth, Canada, during 31 March-10 April 1976 to review the state of the marine resources in the ICNAF Area, to recommend TAC levels for 1977, and to advise on the scientific aspects of certain proposals which the Commission will consider at its Annual Meeting in June 1976. Representatives attended from all member countries except Bulgaria, Iceland, Italy and Portugal. The review of TAC levels was carried out in working groups of the Subcommittee as follows: groundfish stocks in Subareas 1, 2 and 3, including Stat. Area 0 (Sv. Aa. Horsted, Convener); groundfish stocks in Subareas 4 and 5, including Stat. Area 6 (R. C. Hennemuth, Convener); and pelagic fish stocks (capelin, herring and mackerel) throughout the ICNAF Area (Ø. Ulltang, Convener). The various sections of this report are set out to correspond as far as possible with the way in which they will be considered by the various Panels and their Scientific Advisers.

The Subcommittee also met during the STACRES Meeting at Montreal, Canada, to review trends in the fisheries in 1975. A further meeting was held on 18 June 1976 at the request of the Chairman of Joint Panels 3, 4 and 5 to consider whether sufficient new information could be made available to warrant holding a meeting later in 1976 to review the status of the mackerel stocks and to specify the data requirements if such a meeting was considered to be useful. The report of this latter meeting is included under "Mackerel" in Section VII. 2(p) of this Appendix.

I. INTRODUCTORY REMARKS

In the past, the Subcommittee has generally recommended TACs (total allowable catches) which were aimed at controlling the fishing mortality at F_{max}, thus maximizing yield per recruit, or at F_{MSY}, thus maximizing total yield. A full discussion on possible alternative management objectives other than those associated with F_{max} and F_{MSY} and their implications to the management of fish stocks is contained in the Report of STACRES to the Seventh Special Commission Meeting in September 1975 (Part A, this volume). Similar discussions have taken place in other fora, such as the ICES Report of the *ad hoc* Meeting on the Provision of Advice on the Biological Basis for Fisheries Management (C.M.1976/Gen:3) and the FAO Advisory Committee on Marine Resources Research (FAO Fisheries Report No. 142, Suppl. 1). The Subcommittee therefore considered that a general discussion of this subject was not necessary at the present meeting.

The Subcommittee did, however, consider it necessary to decide whether its advice at this meeting should be on the same basis as used previously in recommending TACs or whether in fact it should recommend TACs for 1977 with management objectives different from those associated with F_{max} or F_{MSY}. Several reasons for managing stocks at a level of fishing mortality less than F_{max} or F_{MSY} were pointed out. The errors associated with TACs are certainly very large and the inherent losses of over-exploiting a stock (including possible loss of the stock) are likely to be much greater than any losses due to under-exploiting a stock. Also, fishing at higher levels of fishing mortsility reduces the number of age-groups in the stock and causes the fishery, and hence the calculated TACs, to be heavily dependent on recruiting age-groups, thus rendering the calculation of TACs more difficult and more prone to serious error. The objective in recent years has been generally one of mansging at F_{max}, and, although it may be too early to fully assess the effects of these regulations, it is apparent in many cases that the stocks are continuing to decline. The Subcommittee therefore decided that, although a single management objective could not be recommended to cover all stocks because the objective may vary from stock to stock, TACs for 1977 should generally be recommended with the aim of achieving $F_{0.1}$ rather than F_{max}, but that the consequences of different levels of F on total stock biomass, spawning stock biomass, relative age compositions, etc., should be examined. Thus, in general, the TACs recommended for 1977 for many of the stocks are those which will control the fishing mortality at a level less than F_{max}, in most cases at $F_{0.1}$, or those which will control fishing effort at a level less than that associated with F_{MSY}. In other cases, of course, the aim is to rebuild spawning biomass, and the TAC is not necessarily associated with $F_{0.1}$ or any other specified level of fishing mortality but is aimed at rebuilding the spawning stock at an appropriate rate.

In addition to recommending TACs for 1977, STACRES was requested to examine, for as many groundfish stocks as possible in Subareas 2, 3 and 4, a range of TACs lower than that associated with the maximum sustainable yield, and to indicate the long-term implications regarding stock size, the time scale of the changes and the long-term yield or any other measures that STACRES might consider desirable (Comm. Doc. 76/VI/22). This has been done for as many stocks as possible in the ICNAF Area, and various management options are presented for those species. For those stocks, for which it was not possible to provide the detailed advice requested, the Subcommittee wishes to draw attention to the conclusions of STACRES at the September 1975 Special Commission Meeting (Part A, this volume) that from general production models, although the regulation of stocks at MSY levels results in a biomass of about one-half of that of the virgin stock, a biomass constraint at a level of two-thirds of that of the virgin stock would provide an adequate biomass buffer for maintaining stock stability and resilience against depletion in the presence of large fluctuations in recruitment.

II. GENERAL FISHERY TRENDS

Statistics of nominal catches of all species taken in the Northwest Atlantic were not available at the time of the Subcommittee Meeting in April 1976, as the request for advance statistics for assessment purposes was confined to species stocks under present or prospective catch quota regulation. However, provisional nominal catches for 1975, as compiled from STATLANT 21A submissions, were available at the Annual Meeting in June 1976, and these are summarized by subarea in Table 1, together with comparable figures for 1974. It should be noted that the catch figures used in the "Species Review" sections throughout this report, based on preliminary advance statistics provided prior to the April 1976 Meeting, may differ slightly from the data listed in Table 1 and also from catch figures mentioned in the "Fishery Trends" sections, these latter figures having been prepared at the Annual Meeting for insertion in the report.

The total nominal catch of all finfish and invertebrates declined from 4.0 million tons in 1974 to 3.8 million tons in 1975, after having declined from 4.45 million tons in 1973. About 85% of this decline from 1974 to 1975 occurred in the cod catches in Subareas 2, 3 and 4. Significant declines also occurred in mackerel catches and in "other pelagic" catches (mainly menhaden), while significant increases occurred in capelin catches in Subareas 2 and 3 and in "other fish" catches in Subarea 5. The total catch of Atlantic salmon in 1975 was 4,288 tons (4,169 tons in 1974), comprising 2,045 tons from the West Greenland fishery (Subarea 1) and 2,243 tons from Canadian home-waters (Subareas 2 to 4). Catches of other species were generally similar to, but in total slightly below, those of 1974. The most significant changes of individual species by subarea are outlined under "Fishery Trends" at the beginning of Sections IV to VII of this report.

Table 1. Nominal catches (000 tons) in 1974 and 1975[1]. (The symbol + indicates less than 500 tons.)

Species	SA 0		SA 1		SA 2		SA 3		SA 4		SA 5		SA 6		Total	
	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975
Cod	+	+	48	48	125	89	410	314	172	145	34	33	1	1	790	630
Haddock	-	-	+	-	+	-	2	2	16	20	5	7	+	-	23	29
Redfish	+	+	3	9	7	15	116	88	96	94	10	11	+	+	232	216
Silver hake	-	-	-	-	-	-	+	3	96	116	118	87	12	27	226	233
Red hake	-	-	-	-	-	-	-	1	3	3	21	18	12	11	36	33
Pollock	-	-	+	+	+	+	1	+	26	25	12	14	+	+	39	39
Flounders	1	2	16	26	21	15	120	110	48	45	37	36	10	10	253	244
Roundnose grenadier	3	+	10	5	6	12	23	16	-	-	-	+	-	-	42	33
Other groundfish	-	+	10	11	4	2	12	16	40	40	20	16	13	10	99	95
Herring	-	-	+	+	+	1	18	24	228	238	174	178	13	5	433	446
Mackerel	-	-	-	-	-	-	2	4	43	32	152	167	143	84	340	287
Other pelagics	-	-	+	+	-	-	-	-	2	1	49	34	222	182	273	217
Argentine	-	-	-	-	-	-	1	+	17	15	20	1	-	+	38	16
Capelin	-	-	3	1	85	145	202	220	+	+	-	-	-	-	290	366
Other fish	-	-	3	3	7	8	23	21	48	43	23	41	36	36	140	152
Squids	-	-	-	-	+	-	+	4	+	14	29	17	26	30	56	65
Shrimps	-	-	18	38	-	+	+	+	4	5	8	5	1	+	31	48
Other invertebrates	-	-	-	-	-	+	4	3	32	29	92	117	509	467	637	617
All species[2]	4	2	111	141	255	287	934	826	871	865	804	782	998	863	3978	3766

[1] Nominal catches for 1975 are based on STATLANT 21A reports compiled for the 1976 Annual Meeting.
[2] Except seaweeds.

III. SUMMARY OF RECENT CATCHES AND TACs

Tables containing summaries of recent catches and TACs for the various stocks under regulation in 1976 and for which regulation is proposed for 1977 are given in the following sections which deal with the stock assessments. In almost all cases the TACs recommended for 1977 are based on the assumption that the TACs agreed by the Commission for 1976 will be taken, as the Subcommittee cannot prejudge countries' in-

tentions in this regard.

A complete listing of recent catches and TACs by species and stock area is presented in Table 1 of the STACRES Report (this volume, page 56). The provisional nominal catches for 1975 listed in that table are based on statistics compiled for the Annual Meeting and those may differ slightly from the catches for 1975 listed in the tables of this report, the latter having been compiled from preliminary statistics submitted prior to the Meeting of the Assessments Subcommittee in April 1976.

IV. STATISTICAL AREA 0 AND SUBAREA 1

1. Fishery Trends

The total nominal catch of all species from Stat. Area 0 decreased from 3,600 tons in 1974 to 2,200 tons in 1975. The 1975 catch consisted of 1,600 tons of Greenland halibut and 200 tons of roundnose grenadier while catches of these species in 1974 were 900 tons and 2,700 tons respectively. In addition, about 300 tons of cod were reported in 1975.

In Subarea 1 the total nominal catch of all species increased from 111,000 tons in 1974 to 141,000 tons in 1975, mainly due to a sharp increase in the catches of Greenland halibut (13,000 to 23,000 tons) and northern deepwater prawn or shrimp (*Pandulus borealis*) (18,000 to 38,000 tons). Spain and USSR reported substantial catches of shrimp from Subarea 1 for the first time in 1975. While the cod catch showed no further decline from 1974 to 1975, there was a marked increase in the catch of redfish (3,300 to 8,900 tons) and a decline in the catch of roundnose grenadier (9,700 to 4,700 tons). The catch of salmon was 2,045 tons, slightly greater than the 1974 catch of 1,960 tons; in the offshore drift gillnet fishery the catches were 260 tons by Denmark (F), 381 tons by Denmark (M) and 217 tons by Norway, while 1,187 tons were taken by Greenland-based vessels using set gillnets inshore and drift gillnets offshore.

2. Species Review

Table 2 contains a summary of recent catches and TACs, including those recommended for 1977, for stocks under consideration for management in Statistical Area 0 and Subarea 1. The TACs listed include quantities, if any, estimated to be taken outside the Convention Area.

Table 2. Statistical Area 0 and Subarea 1: summary of nominal catches (1971-75) and TACs (1973-77) by species and stock area. (Nominal catches for 1975 are based on advance provisional statistics for April 1976 assessments, and TACs in parentheses are those recommended by the Assessments Subcommittee.)

Species	Stock area	Nominal catches (000 tons)					TACs (000 tons)				
		1971	1972	1973	1974	1975	1973	1974	1975	1976	1977
Cod	1	121	111	63	48	46	-	107.0	60.0	45.1	(0.0)
G. halibut	0+1	4	14	10	14	26	-	-	-	20.0	(20.0)
R. grenadier	0+1	8	8	5	12	5	-	-	10.0	13.5	(8.0)
Shrimp	1	9	10	13	18	39	-	-	-	-	(26.0)[1]

[1] Recommended TAC pertains to offshore fishing grounds in Convention Area.

a) Cod in Subarea 1 (Res. Doc. 76/VI/17; Summ. Doc. 76/VI/7)

Provisional statistics for 1975 indicate that the nominal catch of cod was slightly less than the very low 1974 level of 48,000 tons. The 1975 catch (46,000 tons) is 76% of the TAC of 60,000 tons adopted by the Commission for that year, but is about the same as the 1976 TAC of 45,100 tons. Analysis of effort trends, country by country, indicates that by 1974 the overall effort had dropped to one-third of the 1968 level. Catch-per-unit-effort figures for the same span of years indicate that stock abundance has also decreased to about one-third of the 1968 level. The analyses indicate an instantaneous fishing mortality in 1974-75 of about 0.35, which is slightly below the $F_{0.1}$ level previously estimated to be about 0.40.

In 1974 the important 1968 year-class accounted for about 50% of the nominal catch by number as well as by weight. In 1975 the proportion of this year-class in the total catch dropped to about 35% by number and about 40% by weight. The size of this year-class seems to have been somewhat

over-estimated in previous analyses or that it is disappearing more rapidly from the Subarea than was expected, probably due to spawning migration to East Greenland where the year-class accounted for about 50% of the 1975 catch by number. The year-class forms the most important part of the spawning stock, which has shown some temporary improvement, compared to the low 1973 level predicted in the 1975 assessment of this stock.

If the TAC for 1976 is fully utilized, the spawning stock size will inevitably decrease somewhat, due to the poor 1969 and 1970 year-classes. However, recruitment prospects for some of the later year-classes, especially that of 1973, are better than for the very poor 1969 and 1970 year-classes. The 1975 year-class also seems to be relatively stronger than the poor year-classes around 1970 and is expected to contribute to improving the stock condition in due time, but the Commission should not yet take this into any account as the statement is based only on larval occurrence and temperature observations.

The likely improvement in recruitment over the next few years may be the result of improved environmental conditions, but the Subcommittee stresses the importance of regulating the fishery so that a higher stock size is maintained than would likely be the case in an unregulated fishery. It is therefore strongly advised that the likely improvement of stock recruitment in 1977 not be used to raise the 1977 catch level with a resulting high mortality on the new recruits, but that the catch level be as low as possible to allow for as many of these new recruits as possible to contribute to future spawning stock size, thereby increasing the possibility of rebuilding the stock. In order to harvest the 1973 year-class properly, the exploitation of these age 4 fish in 1977 should be kept to a minimum so as to allow the individual fish to grow to a better commercial size before more intensive exploitation starts. There is, therefore, every reason to keep the 1977 catch level as low as possible. The Subcommittee consequently recommends that the 1977 TAC be set at zero.

Table 3 illustrates the various levels of spawning biomass by 1978 and 1979 that will result from various levels of fishing in 1977 and 1978 respectively. If the TAC for 1976 is fully taken, the spawning biomass will be about 130,000 tons in Subarea 1 at the beginning of 1977. In order to maintain this level of spawning stock at the beginning of 1978, the 1977 catch level should be about 31,000 tons. A catch lower than this will lead to further improvement of spawning stock size, whereas a catch above 31,000 tons will reduce spawning biomass to a further low level by 1978, although some improvement will occur thereafter when the 1973 year-class enters the spawning stock in 1979.

Table 3. Predicted catches (tons) of Subarea 1 cod in 1977 and 1978 for various levels of exploitation, and resultant spawning biomass at the beginning of 1978 and 1979. (TAC of 45,000 tons for 1976 is assumed to be fully utilized.)

F in 1977-78	Spawning biomass 1 Jan 1977	Catch 1977	Spawning biomass 1 Jan 1978	Catch 1978	Spawning biomass 1 Jan 1979
0	130,000	0	160,000	0	270,000
0.24	130,000	31,000	131,000	37,000	200,000
0.35(1976)	130,000	44,000	120,000	44,000	175,000
0.40($F_{0.1}$)	130,000	50,000	115,000	48,000	155,000

Maintenance of the present level of F(0.35) would lead to catches of about 44,000 tons in 1977 and 1978 and a spawning stock biomass of about 120,000 tons at the beginning of 1978 and about 175,000 tons at the start of 1979. Fishing at the $F_{0.1}$ level (0.40) in 1977 should lead to a catch of about 50,000 tons but would reduce the spawning biomass to about 115,000 tons by 1978. Close to 50% of the predicted catches for 1977 and somewhat more than 50% of the spawning biomass by 1978 would consist of cod of the 1971-75 year-classes, i.e. those year-classes for which estimation of recruitment has been used in doing the analysis.

In its last two reports to the Commission, the Subcommittee has pointed out that the matter of managing the Subarea 1 cod fisheries, so as to take possible stock-recruitment relationships into account, also involves regulation of the fisheries off East Greenland. The question of the inter-relationship between cod stocks at Iceland and at Greenland has recently been discussed in the ICES North-Western Working Group, whose provisional report (Summ. Doc. 76/VI/7) was discussed by the Subcommittee. The report confirms both the emigration of part of the mature cod from West Greenland to East Greenland and Iceland and the dependency of the West Greenland cod on spawning off southeast Greenland and probably also more northeastward between East Greenland and Iceland. The Subcommittee endorses the statement by the ICES Working Group that, from a

biological viewpoint, the cod stock in Div. 1E and 1F may be considered to be just as much related to cod off East Greenland as to cod in Div. 1A to 1D.

The two North Atlantic fisheries commissions may, therefore, wish to consider ways to include the cod stock off East Greenland in the regulation of the Greenland cod stocks. The Subcommittee noted that the ICES Working Group had given no special advice on management of the East Greenland cod. However, analyses presented to the Subcommittee (Res. Doc. 76/VI/17), using the same data for catch by age-groups off East Greenland as was considered by the ICES Working Group but with revised F-values (and assuming that recruitment to East Greenland is equal to recruitment to Div. 1E and 1F), suggest that a catch for the Greenland area as a whole (ICNAF Subarea 1 + ICES Subarea XIV) would be about 25% greater than that at West Greenland for the same level of F at East and West Greenland. Thus, for a 1977 catch of 31,000 tons at West Greenland, a catch of 8,000 tons would apply for East Greenland. This figure of 8,000 tons is about 1,400 tons above the 1974 catch of cod off East Greenland and also somewhat above the provisionally reported catch in 1975, but it is less than one-third of the high catches in 1970-72, when the average annual yield was about 26,000 tons.

Should the Commission wish to consider a breakdown of the total Greenland area for management purposes, it would be appropriate to consider Div. 1A-1D separately from Div. 1E-1F and East Greenland combined. In that case, about 75% of an adopted TAC for Subarea 1 could be allocated to Div. 1A-1D and the remainder of the Subarea 1 TAC added to whatever TAC might be set for East Greenland (estimated to be about 25% of the Subarea 1 TAC), thus constituting a TAC for the region Div. 1E-1F + ICES Subarea XIV.

b) Greenland halibut in Statistical Area 0 and Subarea 1

Nominal catches from these areas increased from 10,000 tons in 1973 to 14,000 tons in 1974 and to nearly 26,000 tons in 1975, the last figure being based on provisional statistics reported to the present meeting and on information in the USSR Research Report (Summ. Doc. 76/VI/20). In 1975, the Subcommittee considered 20,000 tons to be an appropriate level as a precautionary TAC for 1976. At the present meeting, the Subcommittee, while expressing the need for caution because of a possible by-catch problem in connection with the shrimp fishery in Subarea 1, recommends that the TAC for 1977 remain at 20,000 tons.

c) Roundnose grenadier in Statistical Area 0 and Subarea 1 (Res. Doc. 76/VI/27, 28); Summ. Doc. 76/VI/18, 20)

Nominal catches of grenadier in these areas ranged from 5,000 to 12,000 tons during the 1967-75 period, the average annual catch being about 6,000 tons. The provisional 1975 catch was 5,000 tons, a decrease from the 1974 catch of 12,000 tons. New data were reported by German Democratic Republic and USSR (Summ. Doc. 76/VI/18,20).

Previously it was not possible to calculate the stock size because of the lack of data on the age composition of catches. Two new methods of age determination are described in Res. Doc. 76/IV/28, and the GDR samples for the years 1973 and 1974, together with length samples for previous years, were used in the stock assessment given in Res. Doc. 76/VI/27. Stock size and fishing mortality were calculated by cohort analysis, based on age-groups as well as length-groups. Two options for M were used, 0.1 and 0.2, between which the actual value is likely to be found.

The results indicate that the fishing mortalities and catches of the more recent years are in the range of the calculated $F_{0.1}$ (0.3 and 0.5), and the sustainable yields are calculated to be 7,400 tons for M = 0.1 and 9,800 tons for M = 0.2. The Subcommittee accordingly recommends a TAC of 8,000 tons for 1977.

d) Shrimp in Subarea 1 (Comm. Doc. 76/VI/20; Summ. Doc. 76/VI/19; Res. Doc. 76/VI/15, 16, 50)

Shrimp (*Pandalus borealis*) is known to occur along most of the West Greenland coast both offshore and inshore. It is fished mainly in depths below 150 m, with most shrimp fishing grounds having a depth of 250-500 m. Most of the offshore grounds occur in Div. 1A-1C. Disko Bay is by far the most important inshore ground, with catches accounting for about 70-80% of the inshore catches.

The species has protandric hermaphrodism, i.e. it starts its mature life period as male but, as it grows further, a change of the gonads occurs and the animal remains female for the rest of its life. The growth rate in Greenland waters is very slow compared to more southern regions of the area of distribution. The change from male to female occurs at an age of 4-5 years. The females are oviferous from spawning in July-August until hatching in April-May, and their growth rate is thereby so slow that it is difficult to distinguish older age-groups from each other in length frequency diagrams. However, the major part of the catches consist of age-groups 4 and older

(i.e. females) but also of some 3-year-old males.

At least some of the observed fluctuations in abundance on individual grounds have been shown to be connected with environmental changes, indicating that considerable migration, including passive transportation with the currents, occurs regularly. The species is found mainly in the deeper and warmer water masses originating from the Irminger current. After hatching the larvae are found in the plankton and can be carried over long distances. The stock on one ground may, therefore, well get a considerable part of its recruits from larvae hatched on another ground. The stock in the Disko Bay area is thus thought to be rather dependent on stocks to the south and to the west of the bay, and there are some indications that, besides the larval drift, inflow of adult shrimp to Disko Bay and other inshore grounds occurs more or less regularly.

Greenland has gradually built up a shrimp fishery and the industry is based mainly on inshore grounds from Nanortalik (Div. 1F) to Disko Bay (Div. 1A), with the latter area accounting for 70-80% of the Greenlanders' catches. There was some fishing in the late 1930's at Holsteinsborg (Div. 1B), but the development of the Greenland shrimp fishery started about 1950. By 1970 the total catch of the Greenlanders had reached a level of 8,400 tons annually, and it has been further increased to a level of about 10,000 tons in 1974-75 (Table 4). The existence of offshore grounds has been known for several years, and mapping and research sampling on them started in the early 1960's. Apart from some occasional fishing by Greenlanders on grounds close to the shore, the offshore grounds were, however, not fished (for shrimps) before 1969 when Faroese vessels started a fishery. Norway has participated since 1972, and in the last year or two Spain and USSR have also participated in the fishery. Also, some of the larger Greenland vessels are now fishing mainly offshore. The development of the fishery is shown in Table 4 together with the Greenlanders' fishery. No discarding occurs in the Greenlanders' fishery but some may occur in the offshore fisheries.

Table 4. Annual nominal catches of shrimp from West Greenland, 1970-75. (Figures for 1975 are provisional; the Spanish catch is a rough estimate as given in Res. Doc. 76/VI/50; the catch for Denmark (M) is at present a rough estimate; the USSR catch is taken from Summ. Doc. 76/VI/20, reported as "other shellfish".)

	1970	1971	1972	1973	1974	1975
Greenland	8,429	8,941	7,368	8,135	10,243	9,885
Faroes	130	496	755	1,371	2,023	5,300
Denmark(M)	-	-	-	196	308	1,000
Norway	-	-	1,409	2,940	5,616	8,678
Spain	-	-	-	-	?	8,500
USSR	-	-	-	-	-	6,033
Total Offshore	130	496	2,164	4,507	7,947+	29,511
Grand Total	8,559	9,437	9,532	12,642	18,190+	39,396

Compared to other North Atlantic areas where shrimp fishing is taking place, Subarea 1 now accounts for by far the largest catch, followed by the Gulf of Maine. In 1975 the Greenland catch was more than three times the highest catch ever achieved in the Gulf of Maine (12,766 tons taken by the USA in 1969) where the USA catch by 1974 had decreased to 8,000 tons with a further decrease in 1975 and 1976. The 1975 catch at Greenland is of the same magnitude as the USA catch in Alaska for 1970 and about 60% of the highest USA catch recorded there (65,000 tons in 1973).

Noting the rapid development of the offshore fishery in 1975 and the Danish proposal to regulate the fishery (Comm. Doc. 76/VI/20), the Subcommittee agreed that the fishery should be regulated and therefore discussed some analyses carried out to estimate the stock size. An analysis, based on some Faroese vessels' catch and effort in 1975 (Res. Doc. 76/VI/15) and the present knowledge of the extension of the grounds, indicated that the stock size on the offshore grounds is 80,000-90,000 tons. A similar analysis for some of the Spanish trawlers (Res. Doc. 76/VI/50) and some special areas gave results for these areas, which were similar to the Faroese data for the same areas. The stock size in question refers only to those age-groups in the stock which are recruited to the fishery. Most of the factors involved in the analyses will tend to underestimate the stock size. However, it is a basic assumption that the catch per unit effort of the vessels, for which data are included in the analyses, do apply also to other parts of the areas considered rather than just to those grounds actually fished. These analyses together with the catch figures indicate that about one-third of the recruited stock was removed by the fishery in 1975. It should be noted that offshore fishing in 1975 took place on a nearly virgin

stock with several accumulated year-classes of adult shrimp. In the absence of a better knowledge of natural and fishing mortality, stock-recruitment relationship, and year-class fluctuations, the Subcommittee considers that the maintenance of a catch level like that in 1975 is too risky and could lead to depletion of the (female) stock below that required to ensure a steady reasonably high catch level.

Another analysis (Res. Doc. 76/VI/16), aimed at supplying a proposal for a precautionary quota, should the Commission wish so, was discussed by the Subcommittee. One of the basic assumptions in this analysis is that the recent catch level in the Disko Bay area (about 8,000 tons) is close to the long-term MSY level for this area. The area of Disko Bay is about 8,000 km^2, including grounds not actually fished but regarded as supply areas. The other basic assumption is that the yield per unit area (i.e. 1 ton per km^2 per year) applies also to the offshore fishing grounds and their supply areas, if any. However, for areas adjacent to Disko Bay (west and southwest of the bay), the yield figure used in the analysis was reduced to 0.5 tons per km^2, thereby taking into account the likely importance of these areas for the recruitment to Disko Bay, including the possible intrusion of adult shrimp from these areas to the bay. If the basic assumptions hold, then the analysis indicates that a probable MSY level for the offshore grounds as a whole is about 26,000 tons annually. It should be stressed that this figure applies to the total catch including possible discards.

The basic assumption that the recent catch level in the Disko Bay area represents the MSY level was considered. In the absence of proper information on long-term trends in catch per effort, the Subcommittee was not able to make an analysis of this question. It was noted, however, that gear improvement has taken place and that fishermen report that they have to switch more frequently than formerly between grounds to maintain their daily catch rate. It was also shown that the stock density on the offshore grounds in Div. 1C-1E is not as high as in Div. 1B (Res. Doc. 76/VI/15, Table 2). Thus the long-term catch level per unit area for these southern grounds probably cannot be taken to be as high as for Disko Bay area. It was also noted that there might be a relationship between the present high stock density of shrimp and the rather low level of the cod stock, since the cod is known to be one of the important predators on shrimp. After considering all of the available data, the Subcommittee recommends that the Commission limit shrimp fishing in Subarea 1 so that the total catch on offshore grounds (Convention Area) should in any case not exceed 26,000 tons annually, including all discards.

The Subcommittee discussed the biological aspects of the desirability of breaking a possible overall TAC down by areas (ICNAF divisions or specific fishing grounds). Quite clearly, if the possible TAC is not broken down, overfishing may occur locally and could be critical if it occurred in areas important for recruitment. If the Commission wishes to consider a breakdown of an overall TAC, the Subcommittee advises that, in addition to the caution mentioned for the areas close to Disko Bay, attention should be placed on the stock-recruitment relationship in connection with the likely drift of larvae northwards. It would thus seem advisable to have a relatively light exploitation rate of stocks in Div. 1E-1D and southern part of Div. 1C. Stock density on these grounds seems to be less than one-half of that in Div. 1B (Res. Doc. 76/VI/15, Table 2) so that the MSY level here may be overestimated by applying the Disko Bay unit to these areas. On the other hand, apart from the possible precaution to be taken for areas supplying recruitment to the Disko Bay, grounds in the northernmost part of the subarea may be more heavily fished. This would apply specifically to grounds so far to the north that there is a possibility that larvae from these stocks are lost through drift to unfavourable environments.

In connection with a discussion of a break-down of a possible TAC the Commission may wish to consider an effort regulation combined with or instead of a TAC. The Subcommittee did not discuss this matter in any detail due to the lack of adequate data for most gear/vessel categories.

The Subcommittee discussed the desirability of a mesh size regulation. Data available suggest that the most proper mesh size in the trawl codend is 22 mm knot to knot (approximately 44 mm stretched mesh) (Res. Doc. 76/VI/16). Such a mesh size would diminish catch of small shrimp of age-group 3 and would not reduce catch of larger shrimp to any great extent compared to catches obtained by smaller mesh sizes.

It was also pointed out that special nursery grounds may exist, especially in more shallow water than the actual grounds fished, but no such specific areas can at present be described.

The Subcommittee stresses that information on catch and effort in the shrimp fisheries should be recorded through the adopted STATLANT reporting system in the form applicable to ICNAF. The Subcommittee further urges countries participating in the fishery to supply all relevant information on by-catches and discards, and that samples of catches and landings be taken and reported to ICNAF.

V. SUBAREAS 2 AND 3

1. Fishery Trends

The provisional nominal catch of all species in Subarea 2 in 1975 was 287,000 tons, approximately 30,000 tons greater than in 1974 and 128,000 tons greater than the low level of 1973 (159,000 tons). The higher total production was mainly attributable to increases in the catches of redfish, roundnose grenadier and capelin. The cod catch, on the other hand, declined from 125,000 tons in 1974 to 89,000 tons in 1975.

In Subarea 3 the total nominal catch of all species decreased from 934,000 tons in 1974 to 826,000 tons in 1975. This was due principally to a marked decrease in the cod catch, which declined by almost 100,000 tons to 314,000 tons in 1975. This decline was most marked in the northern divisions (3K and 3L) and the cod catch as a whole in Subarea 3 was substantially less than the sum of the 1975 TACs for cod in this area. The redfish catch (88,000 tons) was also lower than in 1974 (116,000 tons), in conformity with the lower TACs set for 1975. However, in Div. 3P the redfish catch of 28,000 tons was slightly greater than the TAC (25,000 tons). The catches of other species subject to quota regulations in the Subarea were similar to those of 1974, and in all cases they were less than the TACs, although the capelin catch of 220,000 tons was the highest since the fishery for this species commenced in the early 1970's.

2. Species Review

Table 5 contains a summary of recent catches and TACs, including those recommended for 1977, for stocks under consideration for management in Subareas 2 and 3. The TACs listed include quantities, if any, estimated to be taken outside the Convention Area.

a) Cod in Divisions 2G and 2H

Catches of cod in this area declined from an average of 70,000 tons in the period 1965-69 to 10,000 tons in the period 1970-74. Part of this decline may be attributed to severe ice conditions during the latter period. The provisional catch in 1975 was about 6,000 tons. An analytical assessment of this stock, presented in 1973, showed the catch corresponding to F_{max} assuming average recruitment to be in the order of 40,000 tons. Because of the very large catches in the late 1960's, the older fish had been severely depleted. In addition, the younger year-classes were apparently poor. For these reasons, a TAC of 20,000 tons was adopted by the Commission for 1974, 1975 and 1976 to allow the stock to rebuild. Since 1973, data have not been sufficient to allow an updating of the assessment. Sampling data (length and age compositions) and catch rates are urgently needed to properly assess this stock.

Although catch rates of FRG trawlers showed an improvement in 1974-75 over the low levels of 1971-73, it was not possible to determine whether the increase was due to increased abundance or to changes in fisbing pattern and availability. In view of the uncertainties in determining the status of this stock, the Subcommittee recommends that the TAC for 1977 remain at the level of 20,000 tons.

b) Cod in Divisions 2J, 3K and 3L (Res. Doc. 76/VI/53; Summ. Doc. 76/VI/17, 18, 20)

Average annual catches of cod in this area declined from about 650,000 tons in the period 1965-69 to about 425,000 tons in 1970-74. The provisional catch in 1975 was about 280,000 tons. Catch rates for GDR and FRG fisheries in 1975 tend to show a decline in abundance in comparison with those for 1974. The bottom trawl survey conducted by USSR shows a decline in the number of cod per hour trawling in Div. 3K and 3L from 72 fish in 1974 to 53 fish in 1975.

Age composition data for 1975 indicate that the catches consisted of older fish than in 1974, with the 1967 and 1968 year-classes predominating. The USSR young fish survey shows the 1970, 1971 and 1972 year-classes to be poor. However, the FRG groundfish survey, conducted later in the year, indicates that the 1972 year-clasa is stronger than those of 1970 and 1971.

Estimates of recruitment were derived from a consideration of the results of the USSR young fish surveys. It was noted that the correlation between values of year-class strength derived from the young fish surveys and values for these year-classes from the virtual population analysis is not good, indicating that the recruitment estimates are subject to a great deal of variation.

Weight-at-age data were reviewed and considered appropriate for use for the stock as a whole.

A virtual population analysis and catch projections based on the results of this analysis were considered, assuming that the TAC for 1976 will be caught and using recruitment values derived as described above. A catch at F_{max} of 260,000 tons in 1977 would result in a spawning stock

size of about 600,000 tons at the end of the year, compared to a level of 1.2 million tons for the 1969-72 period. In view of the current low level of stock size and the very poor recruitment of year-classes younger than that of 1969, concern was expressed that the spawning stock may now be at a level which would result in wide fluctuations in recruitment and, consequently, a series of years of poor recruitment might well be the result. At the level of $F_{0.1}$=0.2, the yield in 1977 would amount to about 160,000 tons. Continued fishing at this level, assuming average recruitment over the period 1970-74, would result in catch and spawning biomass levels (000 tons) as follows:

	1977	1980	1983	1986
Spawning biomass at start of year	680	930	1,200	1,400
Catch	160	250	300	325

Table 5. Subareas 2 and 3: summary of nominal catches (1971-75) and TACs (1973-77) by species and stock area. (Nominal catches for 1975 are based on advance provisional statistics for April 1976 assessments, and TACs in parentheses are those recommended by the Assessments Subcommittee.)

Species	Stock area	Nominal catches (000 tons) 1971	1972	1973	1974	1975	TACs (000 tons) 1973	1974	1975	1976	1977
Cod	2GH	13	14	+	4	6	-	20.0	20.0	20.0	(20.0)
	2J+3KL	432	458	355	373	277	665.5	656.7	554.0	300.0	(160.0)
	3M	34	58	23	25	23	-	40.0	40.0	40.0	(25.0)
	3NO	126	103	80	73	45	103.5	101.1	87.7	43.0	(30.0)
	3Ps	64	44	53	47	36	70.5	70.0	62.4	47.5	(32.0)
Redfish	2+3K	19	20	39	30	23	-	30.0	30.0	30.0	(30.0)
	3M	8	42	22	35	16	-	40.0	16.0	16.0	(16.0)
	3LN	34	29	33	22	17	-	28.0	20.0	20.0	(16.0)
	30	20	16	9	13	14	-	16.0	16.0	16.0	(16.0)
	3P	28	26	18	22	28	-	25.0	25.0	18.0	(18.0)
A. plaice	2+3K	5	9	5	6	6	-	10.5	8.0	8.0	(8.0)
	3M	1	1	1	2	2	-	2.0	2.0	2.0	(2.0)
	3LNO	68	59	53	46	43	60.5	60.0	60.0	47.0	(47.0)
	3Ps	7	7	15	7	4	-	11.0	11.0	8.0	(6.0)
Witch	2J+3KL	16	17	24	16	13	-	22.0	17.0	17.0	(17.0)
	3NO	15	9	7	8	6	-	10.0	10.0	10.0	(10.0)
	3Ps	2	2	3	2	1	-	3.0	3.0	3.0	(3.0)
Yellowtail	3LNO	37	39	33	24	23	50.0	40.0	35.0	9.0	(12.0)
G. halibut	2+3KL	25	30	29	27	28	-	40.0	40.0	30.0	(30.0)
R. grenadier	2+3	75	24	18	28	28	-	32.0	32.0	32.0	(35.0)
Capelin	2+3K	+	46	136	127	189	-	110+[1]	160+[2]	160+[2]	(300.0)
	3L	1	1	4	58	30			45+	45+	
	3NO	1	21	127	101	122	-	148+[1]	126+[3]	126+[3]	(200.0)[4]
	3Ps	1	3	1	2	2			9+	9+	
Mackerel	3+4	24	22	38	45	37	-	55.0[5]	70.0	56.0	(0.0)[6]
	5+6	349	387	381	295	246	450.0	304.0	285.0	254.0	
Squid-*Illex*	3+4	9	2	10	+	17	-	-	25.0	25.0[7]	(25.0)

[1] Countries without specific allocations may each take up to 10,000 tons from the stocks, no more than 5,000 tons of which may be taken in Div. 3LNOPs.
[2] Countries without specific allocations may each take up to 10,000 tons.
[3] Countries without specific allocations may each take up to 5,000 tons in Div. 3LNOPs, but no more than 5,000 tons in aggregate from Div. 3L and no more than 1,000 tons in aggregate from Subdiv. 3Ps.
[4] No more than 50,000 tons of which should be taken in Div. 3L and no more than 10,000 tons in Subdiv. 3Ps.
[5] TAC pertains to Div. 4VWX only.
[6] Recommended TAC subject to re-assessment at 1976 Annual Meeting (see Section VII, 2(p)).
[7] Countries without specific allocations may eacb take up to 3,000 tons.

Fishing at $F_{0.1}$ in 1977, the spawning stock at the end of the year would not be reduced below the level at the start of the year, whereas fishing at F_{max} during 1977 would result in a spawning stock at the end of the year about 12% lower than that at the beginning of the year. In view of the poor recruitment in recent years and the low level of spawning stock size, and considering that the 1972 year-class may be moderately strong, the Subcommittee considered that a reduced catch in 1977 was appropriate to preserve the spawning stock and to allow the incoming year-classes to contribute more fully to the fishery. The Subcommittee therefore recommends that the TAC in 1977 be set at 160,000 tons, the yield corresponding to fishing at $F_{0.1}$.

c) Cod in Division 3M (Res. Doc. 76/VI/33, 53; Summ. Doc. 76/VI/20)

Catches of cod in this area declined from an average of about 42,000 tons in the period 1965-69 to about 33,000 tons in 1970-74. The catches in 1973, 1974 and 1975 were each in the order of 25,000 tons. An analytical assessment presented in 1973 indicated that the average long-term yield is about 40,000 tons annually. This estimate is confirmed by a general production model assessment presented at this meeting, which indicates that, following the high fishing activity in 1972, the stock was in a somewhat depressed condition.

Sampling data have been exceedingly scanty over the past few years, and no updating of the analytical assessment has been possible. Length frequencies for the fourth quarter of 1975, submitted by Portugal and United Kingdom, show that catches were composed predominantly of cod smaller than 50 cm. Sampling data, submitted by Canada, indicate that catches in June by commercial pair trawlers were composed of larger cod (mean length at 60 cm) and also that a considerable increase in growth rate may have occurred over the past few years. USSR surveys in the area demonstrate wide fluctuations in recruitment but a remarkably strong 1973 year-class is indicated. Catch rate data indicate a downward trend in stock abundance since 1963, but there was some improvement in 1974. This improvement may well continue in the immediate future as the strong 1973 year-class enters the fishery.

The Commission has adopted a TAC of 40,000 tons for this stock since 1974. The decline in catch rate, the fact that catches in the last 3 years have been considerably below 40,000 tons, and the evidence showing that the stock is now composed mainly of smaller and younger cod suggest that the stock at present is not in a condition to support the continued fishery at the MSY level. A TAC at a lower level would provide the opportunity for the younger fish, including the apparently strong 1973 year-class, to grow and contribute greater catches over a longer period of time. The Subcommittee considered that the TAC for 1976 was rather high and accordingly recommends that the TAC for 1977 be set at 25,000 tons, corresponding to the level of catches in the last three years.

d) Cod in Divisions 3N and 3O (Summ. Doc. 76/VI/8, 20)

Nominal catches of cod in this area have shown a sharp decline from a high of 227,000 tons in 1967 to 73,000 tons in 1974. Provisional statistics for 1975 indicate a further decline to 45,000 tons. The 1975 catch represents a shortfall of 43,000 tons on the 1975 TAC of 87,700 tons.

Due to the paucity of sampling data, it was impossible to construct satisfactory estimates of catch-at-age in 1975. Only two length and age frequency samples were available, and to use these to convert the catches of all countries to numbers caught by age-groups might well result in serious biases. It was possible to make an assessment using 1974 catch-at-age data (Summ. Doc. 76/VI/8), but, due to the depleted state of the older age-groups, the catches predicted for 1977 were based largely on assumptions about the sizes of the incoming year-classes. This is clearly an unsatisfactory basis for predicting TACs.

Catch rates of Spanish pair trawlers showed a substantial decline during 1968-74. On the basis of changes in Spanish and USSR fishing effort between the late 1960's and 1973 and in the correlation between fishing effort and fishing mortality in the 1960's, a fishing mortality of 0.7 (well in excess of F_{max} at 0.25) was estimated for 1974. Comparable catch rate data are not yet available for 1975. USSR trawl surveys (Summ. Doc. 76/VI/20) and Canadian surveys in the area suggest that the stock in 1975 was at a low level of abundance similar to that in 1974. If this is the case, the decline in catch between 1974 and 1975 is due to a decrease in fishing effort, and the F-value applicable to the 1975 fishery is about 0.5. At the September 1975 Special Commission Meeting, the total biomass of cod (age 4 and older) at the beginning of 1975 was estimated to be about 234,000 tons, or about 60% of the average biomass in the 1960's. The Subcommittee affirms its conclusions of that meeting that, in order to safeguard future productivity, it is desirable to restore the total biomass to at least the earlier level.

At the September 1975 Special Commission Meeting, the Subcommittee recommended a TAC of 43,000 tons for 1976. Insufficient data are available at the present time to provide an adequate re-

assessment of this stock, and no particular figure could be determined for the yield in 1977. The Subcommittee noted that the TACs adopted by the Commission for 1973 and 1974 were well above those recommended by STACRES and that the adopted TACs were not fully utilized. The shortfalls in catch with respect to the TACs in 1973, 1974 and 1975 were 24,000, 28,000 and 43,000 tons respectively. In view of the lack of sampling data for this stock and in such cases where the stock is known to be depressed, a substantial reduction in TAC is in order so that the stock can be protected. The Subcommittee therefore recommends that the TAC be reduced 25% below the 1976 TAC (43,000 tons) and be set at 30,000 tons for 1977. This level of catch is consistent with the calculation that it was possible to make for this stock with the very limited data available.

e) Cod in Subdivision 3Ps

Nominal catches of cod in this area declined from 53,000 tons in 1973 to 46,700 tons in 1974, and provisional statistics for 1975 indicate a further decline to 36,000 tons.

At its April 1975 Meeting, the Subcommittee concluded that fishing at F_{max} (0.3) in 1976 would yield a catch of 55,000 tons, but, since this figure was not substantially different from the TAC of the previous year, a TAC of 60,000 tons was recommended for 1976. At the September 1975 Special Commission Meeting, a re-examination of the data considered at the April 1975 Meeting together with additional information indicated a catch of 47,500 tons for 1976 by fishing at F_{max}, the TAC subsequently adopted by the Commission.

An updating of the virtual population analysis, using the 1975 provisional catch of 36,000 tons, indicated a catch for 1977 of 45,000 tons at F_{max} = 0.3. Continued fishing at F_{max} under average recruitment conditions would result in an improvement in biomass from about 220,000 tons in 1977 to about 260,000 tons in 1986. Fishing at $F_{0.1}$ (0.2) in 1977 would provide a catch of 32,000 tons, but with continued fishing at this level, again assuming average recruitment, there would be a substantial increase in biomass to 325,000 tons by 1986. A catch of 45,000 tons at F_{max} in 1977 would result in a spawning stock size of about 160,000 tons at the beginning of 1978 compared to the average level of 140,000 tons during 1969-72. Assuming average recruitment and continued fishing at F_{max}, the spawning biomass would reach a level of about 170,000 tons by 1984. Fishing at the $F_{0.1}$ level in 1977 would result in a spawning biomass of about 175,000 tons at the beginning of 1978, and continued fisbing at that level, assuming average recruitment, would lead to a spawning stock size of about 225,000 tons by 1984.

The Subcommittee noted that about one-third of the catch by weight in 1977 would depend on year-classes for which only average recruitment estimates were used in the analysis. In view of this uncertainty, the Subcommittee considers it prudent to fish at a level lower than F_{max} and therefore recommends that the TAC for 1977 be set at 32,000 tons, the yield corresponding to fishing at $F_{0.1}$ using the assumed average recruitment values.

f) Redfish in Subarea 2 and Division 3K

Previous general production analysea indicated that this stock can sustain catches of 40,000-45,000 tons per year under equilibrium conditions, but the stock has been in a depressed condition in recent years. Catches in relation to fishing effort during 1966-74 were below the equilibrium curve. Catches increased from 20,000 tons in 1972 to 39,000 tons in 1973, the largest catch since 1965, but subsequently declined to 30,000 tons in 1974 and to 23,000 tons in 1975 under quota regulation. The increased catch in 1973 resulted from increased effort directed toward the stock in response to improvement in catch per unit effort. Effort declined from 2,300 standard days fished (days fished by 2000+ GRT trawlers) in 1973 to 1,840 days in 1974. Catch per standard day fished was 16.4 tons in 1974 compared with 16.8 tons in 1973, both of which were above the 1971-72 level but only slightly better than the 13.2-15.0 tons per day during 1967-70. Commercial length frequency data indicate that catches in 1975 contained a higher proportion (in numbers) of 22-30 cm fish than during 1972-74. However, there was a marked absence of younger age-groups (fish less than 20 cm) in 1974 and 1975 research surveys by Federal Republic of Germany, uaing amall-meshed liners in the survey trawl.

The TACs for 1974-76 were limited to 30,000 tons in order to permit the stock to rebuild from the depressed level of the late 1960's and early 1970's. Since redfish is a slow-growing, long-lived species, the Subcommittee recommends that the TAC for 1977 be maintained at 30,000 tons to take advantage of somewhat improved recruitment, which began to enter the fishery in 1975, to permit rebuilding of the stock. This level of catch is expected to control the fishing mortality below F_{MSY}.

g) Redfish in Division 3M

Maximum sustainable yield estimates of 13,000-17,000 tons were derived previously from a general

production study of this stock. A previous yield-per-recruit analysis indicated an $F_{0.1}$ level of 0.2-0.3 and suggested that the average level of fishing mortality during 1963-73, when catches averaged 13,600 tons, may have been at or greater than $F_{0.1}$ for the average recruitment levels during that period. Because of the lack of data on the age composition of the commercial catches during 1974-75, it has not been possible to update this assessment. However, it was noted that the estimated level of fishing mortality during 1972-73 of 0.8-1.0, with an average catch of 33,000 tons, was considerably beyond the $F_{0.1}$ level. The catch declined from 43,000 tons in 1972 (almost five times the average 1963-71 level of 8,500 tons) to 22,000 tons in 1973, increased to 35,000 tons in 1974 and declined to 16,000 tons in 1975 under quota regulation. The catch per standard day fished by 150-499 GRT otter trawlers increased substantially from 3.4 tons in 1969 to 7.8 tons in 1972 and subsequently declined to 6.6 tons in 1973 and 5.5 tons in 1974. For the first time, substantial quantities of redfish (about 13,000 tons) were reported taken by midwater trawl in 1974. USSR vessels (2000+ GRT) reported midwater trawl catch rates of 33 tons per day fished in 1974. According to information noted at the January 1976 Special Commission Meeting, significant quantities of redfish may have been taken by midwater trawl in both Div. 3M and Div. 3LN during 1972 and 1973 but reported as caught by otter trawl without distinction between bottom and midwater fishing. Canadian vessels of 500-999 GRT, on the basis of limited midwater trawling for redfish in Div. 3M during 1975, reported catch rates of 16.6 tons per day fished.

The available evidence indicates that catches of the magnitude of those taken during 1972-74 could not be sustained without risking stock depletion. Because it is not possible to specify the level of catch in 1977 corresponding to $F_{0.1}$ or alternative levels of fishing mortality, the Subcommittee recommends that the TAC for 1977 remain at 16,000 tons, approximately the level of the estimated maximum sustainable yield.

h) Redfish in Divisions 3L and 3N

The 1973 redfish catch from this area was 33,000 tons, approximately the same as the 1971-72 average of 32,000 tons but in excess of the estimated MSY level of 20,000 tons, derived previously from a general production analysis of effort data from the redfish fishery in Div. 3N and extrapolated to include Div. 3L. The 1974 and 1975 catches under quota regulation at TACs of 28,000 and 20,000 tons respectively were substantially lower at 22,000 and 17,000 tons. For the first time in 1974 significant quantities (8,100 tons) were reported taken by midwater trawl, chiefly in Div. 3L. Because of the apparent lack of a direct bottom trawl fishery for redfish in 1974, it has not been possible to update the general production assessment, upon which the earlier MSY estimate was based. Bottom trawl catch rates had been relatively stable during 1966-73 with a slight increase during 1972-73. Canadian vessels of 500-999 GRT, based on limited midwater fishing for redfish in Div. 3L during 1975, reported midwater trawl catch rates of 15.9 tons per day fished.

No commercial length or age data were available for this stock during 1967-74, despite the increased catchea of 1971-73. However, some sampling data were available for 1975 midwater trawl catches. These indicated that the redfish caught by midwater trawl were of a considerably larger size (36-40 cm for males and bimodal for females at 30-34 cm and 40-46 cm with the larger-sized fish predominating) than those normally taken by bottom trawl. The Subcommittee noted the possibility that this new midwater fishery may be exploiting the oceanic pelagic redfish instead of the North American shelf redfish which are fished traditionally by bottom trawl. The predominance of very large redfish in 1975 midwater trawl catches could be due to fishing the coastal fringe of the oceanic redfish which occur pelagically between North America and West Greenland and which are much faster-growing, attaining a considerably larger size than the North American redfish. If the same species or stock fished previously by bottom trawl primarily in Div. 3N is now being taken by midwater trawl, the occurrence of these very large fish at high catch rates would suggest that this stock has not been subjected to a high rate of exploitation in recent years.

An examination of catches in relation to fishing effort, calculated from catches and bottom trawl catch rates during 1971-73, indicated that fishing effort during those years was beyond the F_{MSY} level. In view of the uncertainty about the level of fishing effort directed toward redfish in this area during 1974-75 and assuming that the same stock complex is being fished by midwater trawl as by bottom trawl, the Subcommittee recommends a TAC of 16,000 tons for 1977 to reduce effort below the F_{MSY} level in order to compensate for the fact that fishing effort was beyond the F_{MSY} level during 1971-73. Priority should be given to stock-species identification studies for redfish in this area in order to resolve the uncertainties that have arisen as a result of the recent development of a midwater fishery.

i) Redfish in Division 3O

Catches from this stock declined from approximately 20,000 tons in 1971 to 16,000 tons in 1972 and 9,000 tons in 1973, but subsequently increased to 13,000 tons in 1974 and 14,500 tons in 1975

under quota regulation. Catch per standard hour fished has increased significantly from 0.7 tons in 1971 to 1.2 tons in 1974. The decline in catch during 1972 and 1973 apparently resulted from decreased fishing effort rather than decreased abundance, since the upward trend in catch per unit effort indicates an increase in abundance or availability during 1971-74.

No commercial length or age data have been available for this stock since 1968. The upward trend in commercial catch per unit effort suggests that this stock may have been experiencing good recruitment in recent years. In view of the lack of adequate data to permit a more detailed assessment of this stock, the Subcommittee recommends that the 1977 TAC for this stock remain at 16,000 tons.

j) Redfish in Division 3P

Nominal catches from this stock were at a relatively high level during 1969-72, averaging about 31,000 tons. The catch declined from 27,500 tons in 1971 to 26,000 tons in 1972 and 18,000 tons in 1973. There was an increase to 22,000 tons in 1974, when a TAC of 25,000 tons was first applied to this stock. The provisional 1975 catch of 28,000 tons was in excess of the TAC of 25,000 tons. The catch per unit effort of Canadian bottom trawlers (150-499 GRT), which had exhibited a steady decline from more than 0.9 tons per hour in 1965 to 0.5 tons per hour in 1974, levelled off at 0.5 tons per hour in 1975. The catch rates of Canadian midwater trawlers (500-999 GRT) declined from 1.48 tons per hour in 1973 to 0.92 tons per hour in 1975. The increase in catch from 18,000 tons in 1973 to 23,000 tons in 1974 and 28,000 tons in 1975 was accomplished only through substantial increases in fishing effort, beyond that required to attain the MSY under equilibrium conditions.

Commercial catch rate data indicated a high level of redfish abundance in this area during the mid-to-late 1960's with above-average recruitment to the fishery. Only about one-half as many redfish older than age 6 were caught in research surveys of the area in 1973, 1974 and 1975 as in a comparable survey in 1965 at the onset of the recent period of increased exploitation. These moderately good year-classes (1964-66), which are expected to enter the fishery over the next several years, appear to be only one-half as abundant as those of the mid-to-late 1950's, which supported the fishery during 1965-75. The yield from these year-classes of 1964-66 would therefore be expected to be substantially less than that supported by the earlier level of recruitment. Canadian commercial age composition data for 1975 indicate a shift to exploitation of slightly older fish in 1975, possibly due to some shift in fishing activity from Subdiv. 3Pn to 3Ps. The year-classes of the mid-1960's are not yet contributing as significantly to the fishery as expected, but they were present to a very limited extent in bottom trawl catches in 1975.

On the basis of revised estimates of MSY (20,000-23,000 tons) and preliminary indications that the catch per unit effort in 1975 would be at about the same level as in 1974, the Subcommittee at the September 1975 Special Commission Meeting concluded that a TAC of 18,000 tons would maintain fishing effort at the MSY level in 1976. Estimates of fishing mortality from commercial age composition data during 1973-75 indicate that fishing mortality during that period, when catches averaged 22,500 tons, was at the $F_{0.1}$ level. Because catch per unit effort apparently stabilized in 1975, similar considerations suggest that a TAC of 18,000 tons would maintain fishing effort at the MSY level in 1977. In view of some uncertainty about the degree of dependence to be expected in 1977 upon the mid-1960's year-classes and about the relative strength of these recruiting year-classes, it is not possible to specify the level of catch in 1977 corresponding to $F_{0.1}$ and alternative levels of fishing mortality. Therefore, the Subcommittee recommends that the TAC for 1977 be 18,000 tons, the same level of TAC as adopted for 1976.

k) American plaice in Subarea 2 and Division 3K

Nominal catches since 1973 have averaged about 5,500 tons annually, with a provisional catch of 5,700 tons for 1975. TACS of 8,000 tons for 1975 and 1976 were set by the Commission at the 1974 and 1975 Annual Meetings, aimed at managing the stock at the $F_{0.1}$ level of fishing mortality (0.45 for males and 0.30 for females). This fishery is to a large extent a by-catch fishery, but it is of considerable importance to the Canadian inshore gillnet fishermen, whose catches have declined somewhat in recent years, attributable in part to adverse ice conditions. No new data for this stock were available at this time, so the Subcommittee recommends that the TAC for 1977 remain at 8,000 tons.

ℓ) American plaice in Division 3M

Nominal catches for this stock were 504 tons in 1973, 1,928 tons in 1974 and approximately 1,700 tons in 1975. Based on average catch statistics, the Subcommittee again recommends that the TAC for 1977 be maintained at the 1976 level of 2,000 tons.

m) American plaice in Divisions 3L, 3N and 3O

Nominal catches from this stock have declined from 94,000 tons in 1967 to 68,000 tons in 1971 and to 46,000 tons in 1974. Provisional statistics indicate a catch of 43,400 tons in 1975. The TAC for the years 1973 to 1975 was set at 60,000 tons annually and this was expected to regulate the fishery at $F_{0.1}$ (0.50 for males and 0.45 for females). However, an updated assessment presented at the April 1975 Meeting of the Subcommittee indicated a fairly major reduction in stock abundance, especially in the Div. 3L segment of the stock area, and the Subcommittee recommended a reduction in the TAC for 1976 to 47,000 tons, which was calculated on the basis of 35,000 tons for Div. 3LN and an estimate of 12,000 tons for Div. 3O.

Catch rates have declined in recent years, but data for 1975 from commercial trawlers in Div. 3LN indicate that stock abundance has stabilized somewhat and data from research surveys indicate a slightly upward trend compared with the level in 1974. On the basis of the virtual population analysis presented at the present meeting, the Subcommittee recommends that the TAC for 1977 remain at 47,000 tons, corresponding to fishing at $F_{0.1}$, calculated on the basis of 37,000 tons for Div. 3LN and 10,000 tons for Div. 3O. The latter value for Div. 3O is slightly lower than that estimated for 1976 because of a decrease in catch rate in this division in 1975.

Some indication of the condition of the stock is given in the following table, with reference to the relative size of the spawning biomass of females in Div. 3L and 3N, using average recruitment values for 1971-73. Females are 50% mature at age 10.5 years in Div. 3L and at age 8.5 years in Div. 3N. No information was available to calculate comparable values for Div. 3O. The associated F-values for fully recruited age-groups are given in parenthesis.

	Spawning biomass of females (000 tons)						
Div.	1965-70	1973	1974	1975	1976	1977	1981
3L	120 (0.57)	55 (1.20)	51 (0.41)	63 (0.50)	73 (0.45)	80 (0.45)	90 (0.45)
3N	78 (0.40)	90 (0.90)	63 (0.40)	65 (0.60)	71 (0.45)	78 (0.45)	100 (0.45)

These trends in spawning biomass indicate that, if recruitment remains at the average level, the present regime of managing the fishery at $F_{0.1}$ (0.45 for females) should restore the stock to a higher level of abundance than is the case at present.

n) American plaice in Subdivision 3Ps

Except in 1973, when 15,000 tons were taken, nominal catches from this stock for 1971-74 averaged about 7,000 tons annually. Provisional statistics for 1975 indicate a catch of 4,200 tons. To a large extent this is a by-catch fishery with cod being the species sought. On the basis of an assessment in 1975, the previous TAC of 11,000 tons was reduced to 8,000 tons for 1976, in order to regulate the catch at $F_{0.1}$ (0.35 for males and 0.20 for females). The average annual catch of 5,500 tons for 1974-75 generated a fishing mortality of $F_{0.1}$. The Subcommittee therefore recommends that the TAC for 1977 be set at 6,000 tons in order to maintain the fishing mortality at $F_{0.1}$.

o) Witch flounder in Divisions 2J, 3K and 3L

Nominal catches from this stock declined from 24,000 tons in 1973 to 16,000 tons in 1974, and provisional statistics indicate a further decline to about 12,500 tons in 1975. This fishery is to a large extent a by-catch fishery, but it is of considerable importance to the Canadian inshore fishermen, whose catches in recent years have been somewhat reduced due to local ice conditions, especially in Div. 3K. On the basis of a yield-per-recruit assessment presented at the 1974 Annual Meeting, a TAC of 17,000 tons was recommended which would regulate the fishery at $F_{0.1}$ (0.30 for males and 0.25 for females). Since no new data are available at present, the Subcommittee recommends that the TAC for 1977 remain at 17,000 tons.

p) Witch flounder in Divisions 3N and 3O

Recent nominal catches have ranged from 15,000 tons in 1971 to 8,000 tons in 1974, and provisional statistics indicate a further decline to 6,000 tons in 1975. This is mainly a by-catch fishery associated with the cod and American plaice fisheries. A TAC of 10,000 tons was recommended for 1976 based on a yield-per-recruit assessment presented in 1975, indicating that fishing at $F_{0.1}$ (0.45 for males and 0.40 for females) would allow this yield. In the absence of any new information, the Subcommittee recommends that the TAC for 1977 remain at 10,000 tons.

q) Witch flounder in Subdivision 3Ps (Res. Doc. 76/VI/39)

Nominal catches have remained at the level of 2,000-3,000 tons in 1971-74 but declined to 1,400 tons in 1975. This is primarily a by-catch fishery. A yield-per-recruit assessment presented at the present meeting indicates a yield of 3,000 tons by fishing at $F_{0.1}$ (0.25 for males and 0.20 for females). The Subcommittee accordingly recommends a TAC of 3,000 tons for 1977.

r) Yellowtail flounder in Divisions 3L, 3N and 3O (Res. Doc. 76/VI/67)

Nominal catches from this stock increased from extremely low levels in 1964-65 to a maximum of 39,000 tons in 1972, and subsequently declined to 24,000 tons in 1974. Provisional statistics indicate that about 23,000 tons were taken in 1975. TACs for the years 1973 to 1975 were established at 50,000, 40,000 and 35,000 tons respectively. An assessment presented in 1975 indicated that fishing mortality was extremely high and that the expected levels of recruitment were not being realized. Indications of a decline in stock abundance came from both research surveys and catch rate data for the Canadian fishery, with the latter showing a decline of 30% between 1973 and 1974. The Subcommittee at its 1975 Meeting accordingly recommended a TAC of 10,000 tons for 1976, a yield slightly greater than the TAC of 9,000 tons subsequently established by the Commission.

A major difficulty in assessing this stock is due to the fact that the fishery is composed almost entirely of 6 age-groups (5-10 years). Thus there is a high dependence on the recruiting year-class at age 5 in making catch projections for 1977 based on stock size in 1974. At present the method of determining the strength of the recruiting year-classes is very crude and results in approximate values only, and thus the catch projected for 1977 is based almost entirely on approximate recruitment values. In view of this problem, the Subcommittee decided to present a range of predicted catches, based on the average recruitment of age 5 fish in 1971-73 (84 million fish) as a value for 1974 and a range of recruitment values for 1975 to 1977.

Recruitment at age 5 (10^6 fish)	Catch in 1976 at F=0.50 (tons)	Catch in 1977 at F=0.55 (tons)
80	10,539	15,450
70	9,753	13,741
60	8,962	12,034
50	8,170	10,327

It should be noted that the removal of 23,000 tons in 1975 was achieved at an apparent high fishing mortality, well above the $F_{0.1}$ level (0.55). In spite of this, there were general indications that the stock size in 1975 was beginning to stabilize, with catch rate data from the commercial fishery and research surveys being similar to those recorded for 1974. The Subcommittee had some difficulty in advising on an appropriate TAC for 1977, because of doubt concerning the recruitment for 1975, 1976 and 1977, but considered that a recruitment level of 60 million fish would be appropriate. Accordingly, the Subcommittee recommends a TAC of 12,000 tons for 1977.

s) Greenland halibut in Subarea 2 and Divisions 3K and 3L

Nominal catches for this stock have remained relatively stable since 1972 at about 28,000 tons, and the provisional catch for 1975 is at the same level. An assessment presented in 1975 indicated that not more than 30,000 tons should be removed in 1976 if the stock is to be exploited at $F_{0.1}$ (0.6 for males and 0.2 for females). Although some new information indicates that the present level of fishing mortality may be slightly above $F_{0.1}$, fairly good recruitment prospects are indicated in Canadian and Federal Republic of Germany research surveys. Consequently, the Subcommittee recommends that the TAC for 1977 remain at 30,000 tons.

t) Roundnose grenadier in Subareas 2 and 3 (Res. Doc. 76/VI/27, 28; Summ. Doc. 76/VI/18, 20)

Nominal catches decreased from 75,000 tons in 1971 to 18,000 tons in 1973 but increased to 28,000 tons in 1974. Provisional statistics indicated a catch of about 28,000 tons in 1975. New data were reported by German Democratic Republic and USSR (Summ. Doc. 76/VI/18, 20). Methods of age determination and stock size calculation were the same as described for Stat. Area 0 and Subarea 1 (Res. Doc. 76/VI/27, 28). The assessment indicates that catches in the last two years were slightly below the sustainable yield (31,800 tons) at $F_{0.1}$ (0.2) for M = 0.1. For M = 0.2, the sustainable yield at $F_{0.1}$ (0.4) is 40,800 tons. Accordingly, the Subcommittee recommends a slight increase in the TAC (32,000 tons in 1976) to 35,000 tons in 1977.

u) Capelin in Subareas 2 and 3 (Res. Doc. 76/VI/9, 20, 23, 51, 54, 62)

Provisional statistics indicate a nominal catch of 343,000 tons from these stocks in 1975 compared with 288,000 tons in 1974 and 265,000 tons in 1973. Additional biological data on food and feeding (Res. Doc. 76/VI/20), age distributions (Res. Doc. 76/VI/62), commercial catch characteristics in 1975 (Res. Doc. 76/VI/9,23) and biomass estimates from acoustic surveys (Res. Doc. 76/VI/51,54) were presented at this meeting. The acoustic surveys, conducted in Div. 3N in June 1975 and in Div.2J and 3K in October 1975, indicated biomass levels in the order of 1,000,000 tons in each area. These estimates are comparable with previous ones from acoustic surveys.

At the January 1975 Special Commission Meeting, STACRES recommended increasing the TAC for Subareas 2 and 3 from 250,000 tons in 1974 to a maximum of 500,000 tons per year for the three-year period 1975-77, during which time the capelin resources and their major predators would be monitored to determine the effects of this TAC on their critical population parameters (recruitment, growth and mortality). It was also recommended that the TAC be divided into 300,000 tons for Subarea 2 and Div. 3K and 200,000 tons for Div.3LNOPs, with no more than 10,000 tons to be taken in Subdiv. 3Ps and no more than 50,000 tons in Div. 3L. At the 1975 Annual Meeting, STACRES recommended the continuation of the conservation measures adopted at the January 1975 Meeting. New data presented at the present meeting did not warrant any modification to the previous advice, and the Subcommittee accordingly recommends the same conservation measures for 1977 as previously recommended for 1976.

The Subcommittee noted that it will be necessary at its 1977 Meeting to thoroughly review the data accrued over the three-year period in order to advise the Commission on the TAC for 1978. The Subcommittee therefore

recommends (8)

i) that countries involved in the capelin fishery collect and analyze the appropriate data for presentation to the 1977 Meeting of the Assessments Subcommittee, and

ii) that the Scientific Advisers to Panels 2 and 3 discuss at the 1976 Annual Meeting what types of data are now available and what are necessary to be collected before the 1977 Meeting of the Subcommittee.

v) Mackerel in Subareas 3 and 4

The status of the mackerel fishery in Subareas 3 and 4 is considered in conjunction with the overall assessment of the stocks in Subareas 3 to 6 (see under Mackerel in Section VII, 2(p)).

w) Squid-*Illex* in Subareas 2 to 4

The assessment of *Illex* in Subareas 2 to 4 is considered together with the stock component in Subareas 5 and 6 (see under Squid-*Illex* in Section VII, 2(r)).

VI. SUBAREA 4

1. Fishery Trends

The provisional nominal catch of finfish species from Subarea 4 in 1975 was 817,000 tons, 2% below the 1974 total of 835,000 tons. The catch of invertebrates increased to 48,000 tons, 33% more than the 1974 level of 36,000 tons. The harvest of seaweeds declined to 40,000 tons from 66,000 tons in 1974. The overall catch of all species thus declined from 937,000 tons in 1974 to 905,000 tons in 1975.

The total catch of cod decreased by 27,000 tons from 172,000 tons in 1974 to 145,000 tons in 1975, the declines occurring in almost equal quantities in the Div. 4TVn and 4VsW stocks, partly due to catch quota restrictions on fishing by Denmark, Portugal and Spain. American plaice catches declined by 6,000 tons from 28,000 tons in 1974 to 22,000 tons in 1975, due to reduced Canadian catches mainly in Div. 4S and to reduced USSR catches on the Scotian Shelf, the latter attributable to catch quota restrictions. Mackerel catches declined by 11,000 tons to 32,000 tons in 1975. Reduced USSR catches were apparently due to catch quota restrictions, but the lower Canadian catch was due to reduced availability of mackerel to inshore gears, particularly in Div. 4T. The alewife catch declined by 12,000 tons to 6,000 tons in 1975 due to declines in both the Canadian and USSR catches. Searobins were again reported as being caught on the Scotian Shelf in 1975, although this species is not thought to occur in this area; the reported catch of 3,000 tons is substantially lower than the 9,000 tons reported in 1974.

Increases were recorded for a number of species in 1975. The silver hake catch in Div. 4VWX increased by 20,000 tons to 116,000 tons in 1975 due to an incease in the 1975 TAC of 20,000 tons over the TAC

in 1974. The catch of anglers increased by 6,000 tons to 18,000 tons in 1975 and the catch of skates increased by 9,000 tons to 19,000 tons. The herring catch in Div. 4X increased by 12,000 tons to 147,000 tons, with increases recorded for both Canadian and USSR catches. The total herring catch in Subarea 4 increased by 10,000 tons to 238,000 tons in 1975. Squid catches increased to 14,000 tons from 400 tons in 1974 due to the initiation of a USSR fishery. Changes in catch levels for other species were relatively small (less than 5,000 tons). The influence of catch quota regulations in catches make many of the changes in catch levels difficult to interpret.

2. Species Review

Table 6 contains a summary of recent catches and TACs, including those recommended for 1977, for stocks under consideration for management in Subarea 4. The TACs listed include quantities, if any, estimated to be taken outside the Convention Area.

Table 6. Subarea 4: summary of nominal catches (1971-75) and TACs (1973-77) by species and stock area. (Nominal catches for 1975 are based on advance provisional statistics for April 1976 assessments, and TACs in parentheses are those recommended by the Assessments Subcommittee.)

Species	Stock area	Nominal catches (000 tons)					TACs (000 tons)				
		1971	1972	1973	1974	1975	1973	1974	1975	1976	1977
Cod	4Vn(Jan-Apr)+4T	57	68	51	49	39	-	63.0	50.0	30.0	(0.0)[1]
	4Vn(May-Dec)	11	9	6	6	4	-	10.0	10.0	10.0	(3.5)
	4VsW	54	62	54	44	31	60.5	60.0	60.0	30.0	(7.0)
	4X(offshore)[2]	9	7	7	6	7	-	-	5.0	4.0	(4.0)
Haddock	4VW	13	5	4	2	2	4.0	0.0	0.0	2.0[3]	(0.0)
	4X	18	13	13	13	18	9.0	0.0	15.0	15.0	(0.0)
Redfish	4VWX	62	50	40	27	28	-	40.0	30.0	20.0	(20.0)
Silver hake	4VWX	129	114	299	96	112	-	100.0	120.0	100.0	(63.0)[4]
Pollock	4VWX	12	20	30	25	25	50.0[5]	55.0	55.0	55.0	(20.0)
	5	14	13	13	12	13					
Flounders	4VWX	34	23	28	25	22	-	32.0	32.0	28.0	(28.0)
Herring (Opt.1)	4V(Jul-Jun)	13	19	17	20	7[6]	-	-	-	(11.0)[7]	(11.0)[7]
	4WX(total)	(146)	(177)	(140)	(173)	(184)					
	4WX(adults)	113	109	97	125	132	-	-	-	(92.5)[8]	(109.0)[9]
(Opt.2)	4VW(a)	72	32	30	44	33	-	45.0	30.0[10]		
	4VW(a)(Jul-Jun)	...	...	...	...	20[6]	-	-	45.0[11]	36.0[11]	(33.5)[11]
	4XW(b)(total)	(114)	(160)	(135)	(141)	(145)					
	4XW(b)(adults)	70	75	91	97	95	90.0	90.0	90.0	(89.2)[12]	(84.0)
Mackerel	3+4	24	22	38	45	37	-	55.0[13]	70.0	56.0	(0.0)[14]
	5+6	349	387	381	295	246	450.0	304.0	285.0	254.0	
Argentine	4VWX	7	6	1	17	15	-	25.0	25.0	25.0	(20.0)
Squid-*Illex*	3+4	9	2	10	+	17	-	-	25.0	25.0[15]	(25.0)

[1] Recommended TAC subject to management strategy for 4Vn winter fishery and 4T summer fishery (see Section VI, 2(a)).
[2] That part of Div. 4X south and east of straight lines joining 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] TAC for by-catch with no directed fishery.
[4] Recommended TAC not agreed to by scientists from Cuba, GDR and USSR.
[5] TAC pertains to 4X+5 only.
[6] Catches pertain to the period Jul-Dec 1975 only.
[7] Recommended TACs for fishing seasons Jul 1976-Jun 1977 and Jul 1977-Jun 1978 respectively.
[8] Recommended TAC for the period 1 Apr-31 Oct 1976.
[9] Recommended TAC for the fishing season 1 Nov 1976-31 Oct 1977.
[10] TAC pertains to Jan-Jun 1975 only.
[11] TACs for fishing seasons Jul 1975-Jun 1976, Jul 1976-Jun 1977 and Jul 1977-Jun 1978 respectively.
[12] TAC now recommended for 1976, although 81,000 tons was provisionally agreed by the Commission at its Jan. 1976 Special Meeting.
[13] TAC pertains to 4VWX only.
[14] TAC subject to re-assessment at 1976 Annual Meeting (see Section VII, 2(p)).
[15] Countries without specific allocations may each take up to 3,000 tons.

a) Cod in Subdivision 4Vn(Jan-Apr) and Division 4T

Nominal catches from this southern Gulf of St. Lawrence stock have fluctuated but they show a declining trend from 66,300 tons in 1962 to a provisional figure of 39,000 tons in 1975, considerably below the TAC of 50,000 tons. The spawning stock biomass dropped to an all time low level of 83,000 tons. The TAC for 1976 was reduced to 30,000 tons, which is expected to generate an F of 0.35 and allow for the spawning stock to rebuild to a desired level of 150,000 tons (ICNAF Sel. Pap. No. 1: 171-193). The system simulation presented in 1975 was used as the basis for the assessment, but new analyses have elucidated the positive relationship between spawning stock production and the catch of pelagic eggs, coupled with the effects of temperature on egg mortality. Also a positive relationship was found between the numbers of eggs and the numbers of larvae. Previously it had been hypothesized that an additional predator was necessary to describe the variations in year-class size, not accounted for by cannibalism of older cod (age 4 and older) on the juvenile cod as they become demersal. Evidence was presented that this additional predator is mackerel which feed on cod larvae. It was concluded that the management of the cod stock through regulation of exploitation may only be partially successful in achieving the objective.

Catch projections were presented using the latest partial recruitment values which are more indicative of the winter fishery, since this fishery is presently taking about two-thirds of the catch from this stock. The average value of recruitment predicted for the size of the 1973 year-class at age 2 from juvenile surveys is 76 million fish, and recruitment of about 60 million fish is implied by the egg and larvae models for the 1974 and 1975 year-classes. For a catch of 32,000 tons in 1977 at $F_{0.1} = 0.35$, assuming that the 1976 TAC of 30,000 tons is taken, the spawning stock will initially decline to 72,000 tons in 1976 and then increase to 80,000 tons in 1977 (Table 7), still slightly below the level of 83,000 tons in 1975.

When the lower fiducial limit of recruitment from the abundance of age 2 cod in juvenile surveys is considered, and all of the other parameters remain constant, the spawning stock biomass continues to decline to 66,000 tons in 1977 with a catch of 26,000 tons at F = 0.35 predicted for that year (Table 8). This level of spawning stock biomass is critically low, and TACs of 10,000 tons at F = 0.11 and 15,000 tons at F = 0.17 were considered for 1977. A TAC of 10,000 tons is required to maintain the spawning stock at a level equivalent to that in 1975. In view of poor recruitment prospects and the uncertainty associated with egg and larval models, the Subcommittee advises extreme caution in setting the TAC for 1977, especially if the winter fishery is permitted to continue.

Table 7. Stock size and catch projections for southern Gulf of St. Lawrence cod stock, assuming average recruitment. (Figures for stock size and catch by age are numbers of fish $\times 10^{-3}$.)

Age (yr)	Weight (kg)	Partial recruitment	1975		1976		1977	
			Stock size	Catch	Stock size	Catch	Stock size	Catch
2	0.18	0.00	76,574	0	59,000	0	60,000	0
3	0.45	0.19	34,095	2,450	62,694	3,736	48,305	2,817
4	0.75	1.00	29.925	9,621	25,704	7,045	47,958	12,911
5	1.19	1.00	18,423	5,923	15,872	4,350	14,718	3,962
6	1.78	1.00	7,102	2,283	9,771	2,678	9,088	2,447
7	2.30	1.00	9,589	3,083	3,767	1,032	5,595	1,506
8	2.62	1.00	3,778	1,215	5,086	1,394	2,157	580
9	2.99	1.00	3,122	1,004	2,004	549	2,912	784
10	3.63	1.00	2,230	717	1,656	453	1,147	309
11	4.23	1.00	1,726	555	1,183	324	948	255
12	6.75	1.00	342	110	916	251	677	182
13	9.26	1.00	142	46	181	50	524	141
14	6.44	1.00	121	39	75	21	104	28
15	6.55	1.00	7	3	64	18	43	12
Fishing mortality (F)			0.434		0.358		0.350	
Catch (tons)			39,085		30,000		32,347	
Stock biomass (age 3+) (tons)			133,484		131,528		137,171	
Spawning biomass (age 4+) after the winter fishery (tons)			82,699		72,321		80,803	

Table 8. Stock size and catch projections for souther Gulf of St. Lawrence cod stock, assuming low recruitment. (Figures for stock size and catch by age are numbers of fish × 10^{-3}.)

Age (Yr)	Weight (kg)	Partial recruits	1975		1976		1977		1977	
			Stock size	Catch	Stock size	Catch	Stock size	Catch	Stock Size[1]	Stock size[2]
2	0.18	0.00	32,796	0	59,000	0	60,000	0	60,000	60,000
3	0.45	0.19	34,095	2,450	26,851	1,662	48,305	2,820	48,305	48,305
4	0.75	1.00	29,925	9,620	25,704	7,278	20,485	5,515	21,287	21,529
5	1.19	1 00	18,423	5,923	15,872	4,494	14,511	3,907	17,761	18,852
6	1.78	1.00	7,102	2,283	9,771	2,767	8,960	2,412	10,967	11,641
7	2.30	1.00	9,589	3,083	3,767	1,067	5,516	1,485	6,752	7,166
8	2.62	1.00	3,778	1,215	5,086	1,440	2,127	573	2,603	2,763
9	2.99	1.00	3,122	1,004	2,004	567	2,871	773	3,514	3,730
10	3.63	1.00	2,230	717	1,656	469	1,131	305	1,384	1,469
11	4.23	1.00	1,726	555	1,183	335	935	252	1,144	1,215
12	6.75	1.00	342	110	916	259	668	180	817	868
13	9.26	1.00	142	47	181	51	517	139	632	672
14	6.44	1.00	121	39	75	21	102	28	125	133
15	6.55	1.00	7	2	64	18	43	12	51	55
Fishing mortality (F)			0.434		0.372		0.350		0.170	0.110
Catch (tons)			39,085		30,000		26,499		15,000	10,000
Stock biomass (age 3+) (tons)			133,484		115,399		115,457		129,368	139,683
Spawning biomass (age 4+) after the winter fishery (tons)			82,699		72,321		65,603		75,342	82,561

[1] Alternate estimate for 1977 catch of 15,000 tons.
[2] Alternate estimate for 1977 catch of 10,000 tons.

Table 9. Stock size and catch projections for southern Gulf of St. Lawrence cod, assuming low recruitment in 1975 and moderate recruitment in 1976 and 1977. (Figures for stock size and catch by age are numbers of fish × 10^{-3}.)

Age (Yr)	Weight (kg)	Partial recruits	1975		1976		1977		1977
			Stock size	Catch	Stock size	Catch	Stock size	Catch	Catch
2	0.18	0.05	32,796	662	59,000	974	60,000	1,077	541
3	0.45	0.12	34,095	1,626	26,254	1,028	47,425	2,016	1,020
4	0.75	0.58	29,925	6,258	26,447	4,619	20,567	3,875	2,045
5	1.19	0.88	18,423	5,496	18,872	4,753	17,495	4,733	2,566
6	1.78	1.00	7,102	2,350	10,151	2,847	11,181	3,363	1,842
7	2.30	1.00	9,589	3,173	3,708	1,040	9,755	1,731	948
8	2.62	1.00	3,778	1,250	5,006	1,404	2,102	632	346
9	2.99	1.00	3,122	1,033	1,972	553	2,838	854	468
10	3.63	1.00	2,230	738	1,630	457	1,118	336	184
11	4.23	1.00	1,726	571	1,164	327	924	278	152
12	6.75	1.00	342	113	901	253	660	199	109
13	9.26	1.00	142	47	179	50	511	154	84
14	6.44	1.00	121	40	74	21	101	30	17
15	6.55	1.00	7	2	63	18	42	13	7
Fishing mortality (F)			0.450		0.368		0.400		0.200
Catch (tons)			39,085		30,000		31,329		17,016
Stock biomass (age 3+) (tons			139,565		112,081		131,996		
Spawning biomass (age 4+) after the winter fishery (tons)			82,698		71,187		77,459		

The winter fishery in Subdiv. 4Vn has taken an increasing proportion of the catch from about 30% in the 1960's to 63% in 1975. It is in this fishery that the greater proportion of immature fish (ages 3, 4 and 5) are caught. In 1975, about 66% of the catch from the winter fishery consisted of fish less than age 6, with only 40% of the catch being mature individuals. In contrast, tbe

catch from the summer fishery in Div. 4T comprised 53% of fish less than age 6. This difference is due to the different partial recruitments in the two fisheries. If a catch of 30,000 tons were taken in Div. 4T only, the resultant spawning stock size would be equivalent to that which would allow a catch of only 10,000 tons from Div. 4T and Subdiv. 4Vn combined, given the present pattern of fishing (Table 9). The Subcommittee therefore considers it imperative that the catch of immature fish be severely reduced, requiring measures to further regulate the winter fishery in Subdiv. 4Vn. If such action is not taken, the Subcommittee must recommend a zero TAC for 1977 to ensure an increase in spawning stock size. If this problem can be resolved for 1977, a catch of 30,000 tons can be taken from the stock without reducing the spawning stock size below its present level. Theoretically, a continuum of options exists between zero and a TAC of 30,000 tons, when the proportion of the catch taken in Subdiv. 4Vn is varied from 63% to zero.

Potentially, other options are available, such as changing the mesh size regulation to avoid the catching of immature fish and perhaps allow a TAC up to 30,000 tons. However, the appropriate mesh size cannot be advised at this time, nor can the difficulties in enforcing a larger mesh size regulation be envisaged for such a small area as Subdiv. 4Vn and over such a short period of the year. Another alternative would be to establish closed areas where there are potential concentrations of immature fish. The problem of managing this stock is a difficult one with many options requiring further detailed simulation studies of the fishery. The results of these will be available for consideration at the 1976 Annual Meeting. The effects of certain options are illustrated in Table 10. It must be pointed out that fishing at $F_{max} = 0.45$ or at $F_{0.1} = 0.40$ are not considered options to be followed for this fishery, since the management strategy must be aimed at rebuilding the spawning stock.

Table 10. Cod in Div. 4T and Subdiv. 4Vn (spring): implications of alternative management options on long-term catch and the 1977 TACs associated with each option.

	Fishing mortality	1977 TAC (tons)	Comments on management objectives and options
Partial recruitment as at present	0.00	0	Increase stock by 9%
	0.10	10,000	Maintain 1975 stock
	0.35	26,500	Decrease stock by 20%
Partial recruitment as in summery fishery	0.00	0	Increase stock by 14%
	0.20	16,000	Increase stock by 10%
	0.40 ($F_{0.1}$)	30,000	Maintain 1975 stock

b) Cod in Subdivision 4Vn (May-Dec)

Nominal catches in this area during the summer and autumn fishery were 7,000 tons in 1973 and 6,000 tons in 1974. Provisional statistics indicate that the catch in 1975 was about 4,400 tons, the lowest recorded for the area in recent years. Catches during May to December are partly based on local stocks, which historically have provided for approximately one half of the total cod catch. In addition, the offshore catches are based partly on cod which belong to the Div. 4T stock, these being early arrivals to or late departures from the over-wintering area in Subdiv. 4Vn (mainly between January and April), and partly on cod belonging to the Div. 4VsW stock which migrate northward and spend the summer in Subdiv. 4Vn.

Catches in both the offshore and inshore fisheries have declined substantially in recent yesrs, indicating that stock abundance may have declined as well. Considering the serious condition of the adjacent stocks (in Div. 4VsW and in Div. 4Vn (Jan-Apr) + 4T), essentially no catch should be taken from them in Subdiv. 4Vn during the May-December period. The TAC for this area was initially set slightly above recent catches in order to prevent any large increase in fishing from occurring on one or the other stock component in the area. With the recent declines both in catch and stock abundance, the equivalent TAC is now 5,000 tons. However, to be relatively certain that no increase in exploitation rate will occur in 1977, the TAC should be reduced below the 1975 catch. The Subcommittee accordingly recommends a TAC of 3,500 tons for 1977 in order to achieve this objective.

c) Cod in Subdivision 4Vs and Division 4W (Res. Doc. 76/VI/46)

Nominal catches from this stock averaged 60,000 tons during 1960-74. However, catches have declined since 1972 to 54,000 tons in 1973, 44,000 tons in 1974 and to 30,000 tons in 1975 (provisional data). TACs of 60,500, 60,000 and 60,000 tons were adopted for the years 1973 to 1975, and the TAC for 1976 is 30,000 tons. Catch rates of Spanish pair trawlers (150-499 GRT) declined

steadily from 2.38 tons per hour in 1968 to 0.51 in 1974. Analysis of age compositions of commercial catches indicated that the stock biomass declined from about 250,000 tons in the late 1960's to about 100,000 tons in 1975.

Since 1971, fishing mortality rates have exceeded F_{max} = 0.35. However, the observed levels of fishing mortality were not sufficient to explain the rapid decline in stock size in recent years, the major cause being the recruitment to the fishery of the poor 1971 to 1973 year-classes. In view of the large silver hake fishery conducted in this area with small-meshed trawls during the period when the cod stocks declined, the Subcommittee examined the consequences of relatively small by-catches of young cod (ages 1 and 2) in the silver hake fishery on the subsequent recruitment of cod. It was estimated that by-catches of about 4,000 tons annually, equally divided between ages 1 and 2 fish, explained the reduced recruitment of cod observed in recent years, and that by-catches of 10,000 tons of age 1 fish could virtually eliminate the cod stock.

The 1976 TAC of 30,000 tons corresponds to a fishing mortality of 0.8-0.9. Fishing at F_{max} = 0.35 in 1977 would give a catch of 12,500 tons, while fishing at $F_{0.1}$ = 0.2 would yield 7,500 tons. The rebuilding of the stock is contingent on recruitment at higher levels than have been experienced in the 1970's. Table 11 shows how the stock might be expected to recover from a biomass of 90,000 tons in 1976 in five years, with recruitment of 75 million fish at age 1 and various combinations of by-catches at ages 1 and 2. With no by-catch, recovery to 200,000 tons (desired stock size) in five years is possible, even when fishing at F_{max} = 0.35. With by catches of 10,000 tons, recovery of the stock size to 200,000 tons is not possible.

In view of the extremely serious consequences of relatively small by-catches of ages 1 and 2 fish, it is a matter of prime importance to reliably determine the magnitude of such by-catches and whether they are indeed the primary cause of declines in recruitment to this stock. Assuming a moderate by-catch of 4,000 tons, fishing at $F_{0.1}$ = 0.2 in 1977 would produce a catch of 7,000 tons and provide for increasing the spawning stock. The Subcommittee therefore recommends that the TAC for 1977 be set at 7,000 tons as the best option. The Subcommittee further notes that, if by-catches can be reduced by 1977, the TAC could be increased in subsequent years and still achieve the same objective.

Table 11. Cod in Div. 4VsW: five-year projections showing the effect of by-catches of ages 1 and 2 cod on catch in the directed fishery and on stock size for various levels of fishing mortality.

Assumed by-catches by age (tons)			Projected catches and biomass (tons) for F levels in directed fishery[1]			
Age 1	Age 2		F=0.00	F=0.10	F=0.20	F=0.35
0	0	Catch 1st year (1977)		4,396		14,050
		Catch 5th year		18,230		37,110
		Biomass 5th year		305,662		203,160
2,000	2,000	Catch 1st year (1977)		3,929	7,000	12,510
		Catch 5th year		13,340	18,000	26,650
		Biomass 5th year		224,260	200,000	148,974
5,000	5,000	Catch 1st year (1977)	0	3,223		
		Catch 5th year	0	5,950		
		Biomass 5th year	135,757	95,734		
4,000	0	Catch 1st year (1977)		3,741		11,890
		Catch 5th year		11,370		22,450
		Biomass 5th year		188,466		124,136
10,000	0	Catch 1st year (1977)	0			
		Catch 5th year	0			
		Biomass 5th year	0			

[1] $F_{0.1}$ = 0.2 and F_{max} = 0.35.

d) Cod in Division 4X (offshore)

Nominal catches from this offshore stock declined from 9,000 tons in 1971 to 6,000 tons in 1974. Since the TAC does not apply to the whole of Div. 4X, provisional statistics were not available

in sufficient detail to determine the 1975 offshore catch with accuracy. However, in order to advise the Commission on the status of this stock, the 1975 catch is estimated at 6,700 tons. Most of the cod taken in Div. 4X come from relatively sedentary inshore stocks which are not regulated by the Commission. Cod on the offshore banks appear to be a separate stock and do not intermix with the inshore stocks to any significant degree. The TAC was set at 5,000 tons for 1975 and 4,000 tons for 1976.

Research surveys indicate that 1972 and 1973 year-classes are weak, probably only half as strong as the recent average year-class size, i.e. 3.5 million fish at age 2. Fishing at an estimated F = 0.65 in 1975, catch projections indicate that the TAC set for 1976 (4,000 tons) will generate an F = 0.30 and allow an increase in stock size. Yield-per-recruit calculations indicate that F_{max} = 0.35 and $F_{0.1}$ = 0.25. Projections for 1977 at these F levels indicate catches of 5,500 and 4,000 tons respectively with further increases in stock size over the 1974 level in both cases.

At present the stock is depressed due to growth overfishing. If subjected to fishing at $F_{0.1}$ (0.25), the stock could be expected to yield at least 9,500 tons and be maintained at a level over 39,000 tons at recent recruitment levels. If subjected to fishing at F_{max}(0.35), the equivalent values are 10,000 tons for the catch and 30,000 tons for the stock size. However, the stock size in 1975 is only 12,000 tons, but, if fishing at $F_{0.1}$ is adopted as the management policy, the stock size will recover to 20,000 tons in 1977. Given the uncertainties about 1975 catches and the accelerated rate of recovery of the stock if fished at $F_{0.1}$, the Subcommittee recommends that the TAC for 1977 be maintained at the 1976 level of 4,000 tons.

e) Haddock in Divisions 4V and 4W (Res. Doc. 76/VI/26)

Provisional statistics indicate that the nominal catch in 1975 was about 1,800 tons, down slightly from 2,300 tons in 1974. Research surveys show a slight improvement in stock size in 1975 due to the appearance of a moderately-sized 1974 year-class. However, variation among years in survey results is such that a single observation, as in the case of the 1974 year-class, is not particularly reliable. On the basis of present information, it appears this year-class is of comparable strength to an average, or slightly less than average, year-class by the standard of those which occurred in the 1950's and early 1960's.

Stock biomass is still at a very low level, possibly 15,000-20,000 tons in the last few years, for a stock which was capable of sustaining catches over 25,000 tons in the 1950's and early 1960's. Should the 1974 year-class prove to be larger than others in the past several years, it should not be harvested but should be allowed to contribute to the spawning stock. The Subcommittee therefore recommends a zero TAC for 1977 and that every effort be made to minimize removals in fisheries directed at other species. A TAC of 2,000 tons was set for 1976 to allow for by-catch. Should the 1974 year-class be stronger than other recent year-class, by-catches will likely increase in 1976 and 1977, if present fishing patterns are maintained. However, it is recommended that the 2,000-ton TAC for by-catch not be increased, and that member countries make additional efforts to reduce by-catch rates in order to prevent catches from exceeding the present level.

f) Haddock in Division 4X (Res. Doc. 76/VI/60)

Provisional statistics indicate a nominal catch of 18,300 tons in 1975. The 1969, 1971 and 1972 year-classes all made significant contributions to the catch and the 1973 year-class also contributed fairly substantially in terms of numbers but less so in weight. Whereas the size of the poor 1964 to 1968 year-classes ranged from 7 million to 15 million fish at age 2, the 1969 year-class contained 22 million fish at this age. This was followed by the poorest year-class on record (4 million fish). However, the 1971 year-class contained 38 million fish at age 2. Abundance estimates of juvenile haddock from research surveys agree well with estimates of year-class size at age 2 from cohort analysis, and, on the basis of these surveys, the strengths of year-classes at age 2 subsequent to that of 1971 were estimated and used in the catch projections:

Year-class	1972	1973	1974	1975
Size (millions)	22	10	17	(20)

The present regulations require that there be no directed fishery for haddock, but allowance is made for unavoidable by-catch of 15,000 tons. The maintenance of this regime for 1977 (and for 1978) will result in some decline in spawning stock in each year. Spawning stock was at a minimum of 31,000 tons in 1974, but improved recruitment from the 1971 and 1972 year-classes resulted in increases to 44,500 and 47,500 tons in 1975 and 1976 respectively. However, the poorer 1973 and 1974 year-classes will result in a decline in spawning stock to 39,000 tons by 1978, if the catch remains at 15,000 tons. Spawning biomass in the early 1960's, when the stock was providing stable yields, was in the order of 80,000 tons, and the objective of the present management is

the rebuilding of the spawning stock to at least this level. Since the stock size will not increase toward this level in 1977, the Subcommittee advises that the present management policy be maintained, i.e. that no directed fishery for haddock be allowed in 1977. The Subcommittee accordingly recommends a zero TAC for 1977 and that removals be kept at the lowest possible level.

g) Redfish in Divisions 4V, 4W and 4X (Res. Doc. 76/VI/25)

Provisional statistics indicate a nominal catch of 28,100 tons in 1975, down slightly from 32,800 tons in 1974, and slightly below the 1975 TAC of 30,000 tons. Catch rates of Canadian and USA trawlers declined further in 1975 as they have in each year since 1971. It is apparent from length frequency data that a good year-class entered the fishery in 1970-71 resulting in a substantial increase in catch rate and total catch. While catches declined after 1971, fishing mortality during 1971-74 was about 0.30, substantially above F_{max}(0.18). Research surveya in 1974 gave indications of improved recruitment about to enter the fishery, but these potential recruits did not show up strongly in 1975 surveys. Substantial catches of these small 13-21 cm fish were made by USSR in 1975. While these fish will probably contribute to USSR catches again in both 1976 and 1977 and may begin contributing to USA catches in 1977, they will probalby not contribute significantly to the Canadian catches until 1978 due to the preference in the Canadian fishery for larger fish.

On the basis of yield-per-recruit calculationa and the assumption that the stock size in 1977 will be comparable to the average of thoae for 1971-74 due to increased recruitment, fishing at F_{max} in 1977 would produce a yield of 28,000 tons, while fishing at $F_{0.1}$(0.10) would give a catch of 16,000 tons. General production analyses suggest that the catch in 1977 would be about 26,000 tons if fishing is conducted at F_{MSY}. Given the uncertainties about recruitment and the fact that recruiting year-classes are being fished as small fish, the Subcommittee recommends that the TAC for 1977 be reduced to 20,000 tona, again pointing out that the harvesting of redfish less than 20 cm results in a significant loss in yield per recruit.

h) Silver hake in Divisions 4V, 4W and 4X (Rea. Doc. 76/VI/57, 59; Summ. Doc. 76/VI/21)

Provisional catches in 1975 were 112,000 tons, slightly below the TAC of 120,000 tons. A total of 108,000 tons was taken by USSR and small quantities were reported by Bulgaria, Cuba, FRG, Japan and USA. One of the major problems in assessing this stock is disagreement about ageing. A workshop on ageing was held during the present meeting to try to clarify this issue (Summ. Doc. 76/VI/21). The USSR ageing expert was not able to attend and time was limited, but some progress was made towards agreement. The method of ageing, developed by USA, was studied and adopted as the agreed technique for further study. It was indicated that age determination using whole otoliths had a probable bias toward the older age-groups, but further study is required. However, ageing studies by USA and length frequency analysis by Canada did provide similar results for age-groups 1 and 2.

Stock assessments and catch projections for 1977 were provided by Canada and USSR. The USSR assessment estimated catches of 124,000 to 229,000 tons for F_{opt} = 0.7 and M = 0.5 and 0.8 respectively. The Canadian assessment estimated the 1977 catch at 63,000 tons for F_{max} =0.7 and M = 0.4. The differences are due primarily to the different estimates assumed for the strengths of the 1973 to 1975 year-classes, values used for the age composition of catches, and growth rates. These differences could not be resolved. However, the Subcommittee noted that:

i) the Canadian virtual population analysis was more consistent with the probable age composition, i.e. a higher proportion of younger fish;

ii) the value of F_{opt} = 0.7 estimated by USSR was based on the assumption that catches of fish less than 30 cm would be negligible, when in fact more than 40% of the 1975 catch by number was composed of smaller fish;

iii) the standard yield per recruit at M = 0.4 indicates F_{max} = 0.7 and $F_{0.1}$ = 0.35, but fishing in recent years have been at levels much higher than F = 0.7, so that the choice of F = 0.7 is a maximum option;

iv) the stock abundance in 1975 had decreased from that in 1974; and

v) the estimated catch in 1977 would be very dependent on the 1974 year-class, and, assuming a moderate size, would result in much less severe consequences in the event of an error than otherwise.

With the exception of scientists from Cuba, German Democtatic Republic and USSR, the members of the Subcommittee agreed that the evidence available indicates that the TAC for 1977 should be recommended at 63,000 tons, which corresponds to fishing at F_{max} = 0.7.

The scientists from Cuba, German Democratic Republic and USSR disagreed with this advice. Abundance indices from USSR trawling surveys indicate that the 1974 year-class is very abundant and that the 1972 and 1973 year-classes are of average abundance, but preliminary data show that the 1975 year-class is poor. According to the estimates of USSR scientists, mortality rates of M = 0.5 and F_{opt} = 0.7 should be applied to this particular stock, and they consider it possible to recommend a TAC for 1977 at the level of 100,000-120,000 tons. The estimates provided indicate that the silver hake stock in this case would be maintained at the level of 1975 (380,000 tons in 1976 and 408,000 tons in 1977). Also, in the opinion of USSR scientists, comparison of age determination methods used by USSR and USA indicated that some ageing data were difficult to explain from a biological viewpoint (Summ. Doc. 76/VI/21). Therefore, data obtained from the actual age reading by USSR experts for many years appeared to be more accurate for virtual population stock assessment.

The Subcommittee noted that an agreed data base of catch age compositions was necessary and

recommends (9)

i) that the ageing problems be resolved and age compositions of catches be recalculated during this year, and

ii) that the relationship between pre-recruit survey indices and subsequent stock size of year-classes be determined.

i) Pollock in Divisions 4V, 4W, 4X and Subarea 5 (Res. Doc. 76/VI/47 and Addendum)

At the September 1975 Special Commission Meeting, STACRES was requested to provide for assessing the pollock in Subarea 4 and in Subarea 5 separately. The Subcommittee at the present meeting thoroughly reviewed the available information on this question and concluded that the assumption of a single major stock in Subareas 4 and 5 was still valid and that, therefore, the assessment had to be done for the stock area as a whole. The presence of local spawning stocks in Subarea 4 would provide some biological basis for allocating the TAC to the different areas, since harvesting the entire TAC from one area might have adverse stock implications. There is, however, no scientific basis as to what percentage should be used in proportioning the TAC to the two separate areas.

The nominal catch of pollock was maintained at about 40,000 tons from 1960 to 1964 but decreased to 23,000 tons in 1970 and increased again to nearly 40,000 tons in 1975. A preliminary assessment was presented at this meeting. Estimates of fishing mortality from both research survey and commercial data indicate that F has increased beyond the level of F_{max} = 0.4 (M = 0.2) in the most recent years (since 1973). USA autumn bottom trawl surveys have indicated a declining trend in abundance in the 1970's, and the Canadian index, which had been increasing, dropped sharply in 1975. The surveys indicate that the 1972-74 year-classes are weaker than those of 1968, 1969 and 1971 and that recruitment prospects for 1977 are less favourable than during 1968-73. If it is assumed that fishing mortality in 1975 was at F = 0.5, then the stock size was about 121,200 tons. Assuming a modest decline in stock size at 100,000 tons for 1977, a catch of 30,000 tons would result from fishing at F_{max} = 0.40 and a catch of 20,000 tons would result from fishing at $F_{0.1}$ = 0.24. No information is available on the effects of these catches on stock size, but fishing at F_{max} in 1977 would probably result in a lower stock size in 1978 than in 1975. The Subcommittee therefore recommends a TAC of 20,000 tons for 1977.

j) American plaice, witch and yellowtail in Divisions 4V, 4W and 4X

The provisional nominal catches of these species were 21,700 tons in 1975, somewhat below the TAC of 32,000 tons. Canadian commercial catch rates showed a small increase to 86 kg per hour fished in 1975, following a consistent decline from 151 kg per hour in 1965 to 76 kg per hour in 1974. Biomass estimates from research surveys also indicate that some small increase in stock size may have occurred.

The TAC was reduced to 28,000 tons for 1976, because of observed over-exploitation of American plaice in Div. 4W and substantial declines in the yellowtail stocks. The possibility of a small increase in abundance in 1975 does not significantly change the previous conclusions on the status of the stocks, and the Subcommittee recommends that the TAC for 1977 be maintained at 28,000 tons.

k) Herring in Division 4V (*Redbook* 1975, page 39; Res. Doc. 76/VI/22; Section B this volume)

The fishery in this area is managed on a seasonal basis in conjunction with that in Div. 4W(a). At the 1975 Annual Meeting, STACRES recommended that the fishery in Div. 4W(a) be combined with that in Div. 4XW(b) for management, leaving the fishery in Div. 4V to be managed separately on a seasonal basis (July of one year to June of the next). This recommendation was reiterated by STACRES at its January 1976 Meeting and again by this Subcommittee at the present meeting.

During the 1971/72 to 1974/75 seasons, nominal catches averaged about 17,000 tons. Provisional statistics indicate that about 7,000 tons were taken in the last half of 1975. The Canadian fishery in this area (which recently comprised over 90% of the total catch) is now completed for the 1975/76 season with a catch of 5,500 tons. This catch represents a 69% decline from the 1974/75 season, and catch rates also declined. However, weather conditions severely hampered all fishing activity in Div. 4V during the season and fishing effort, both as the number of nights fished and as hours fished each night, was substantially reduced. Consequently, the additional data are insufficient to warrant changing the previous STACRES recommendation (*Redbook* 1975, page 39; Section B, this volume) for a TAC of 11,000 tons for 1976/77, or revise this recommendation of 11,000 tons for 1977/78.

ℓ) Herring in Divisions 4W and 4X (*Redbook* 1975, page 39; Res. Doc. 76/VI/21, 45; Section B, this volume)

STACRES at the January 1976 Special Commission Meeting reiterated its earlier recommendation (*Redbook* 1975, page 39) that the fisheries in Div. 4W(a) and 4XW(b) be combined for management purposes. Reconsideration of the 1976 TAC and consideration of the 1977 TAC is, therefore, restricted to an analytical assessment of the combined areas. New information since the January 1976 Special Meeting include an analysis of data from the Canadian 1975/76 winter fishery in Div. 4W(a), revisions to historical data and 1975 catch data in Div. 4XW(b), and re-evaluation of the size of the 1973 year-class (Res. Doc. 76/VI/45). Since the fiahery commences in November in Div. 4W(a), the assessment is based on a fishing season from 1 November of one year to 31 October of the next. This change necessitated a recalculation of catch at age in numbers, as the previous assessment was based on calculations for the calendar year. Fig. 1 shows the approximate periods of fishing for Canadian (CDN) and distant water fleets (DWF).

The size of the 1972 year-class was set at 1 billion fish (1.0×10^9) at age 2, as had been agreed at the January 1976 Special Meeting. The size of the 1973 year-class was revised from 1 billion fish at age 2 to 1.5 billion fish. This revision appears to be justified, as the F-values calculated from cohort analysis using 1 billion fish at age 2 were abnormally high (0.31), compared with a mean F of 0.19 for the 1966-72 year-classes at age 2, considering the history and present nature of the fishery (Res. Doc. 76/IV/45). Also, the catches of the 1973 year-class in 1975 in the Bay of Fundy weir fishery suggest that this year-class is better than previously assumed. The calculated stock sizes, catches and fishing mortalities are given in Table 12.

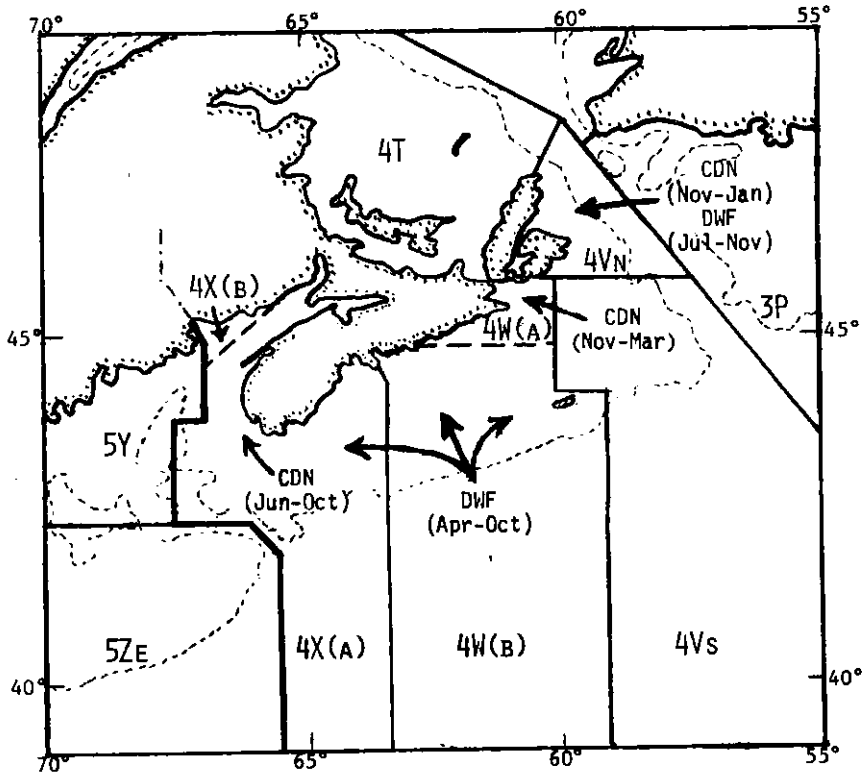

Fig. 1. Map showing the approximate times of fishing for herring in Div. 4VWX by Canadian (CDN) and distant water fleets (DWF). (For illuatrative purposes only.)

Table 12. Herring in Div. 4WX: stock sizes, catches and fishing mortalities, 1966-77.

Year[1]	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	1,458	2,123	664	831	217	54	20	2	<1	5,369	678	1,788	377
1967	1,206	1,155	1,494	490	401	137	32	9	<1	4,924	708	2,563	527
1968	2,381	944	883	1,007	302	184	60	22	7	5,790	744	2,465	538
1969	610	1,269	701	664	576	182	69	20	4	4,095	672	2,216	503
1970	810	436	692	467	401	242	94	36	10	3,188	530	1,942	447
1971	897	566	305	313	211	222	105	42	12	2,673	399	1,210	297
1972	5,907	604	290	147	138	104	94	44	17	7,345	520	834	203
1973	753	4,236	428	104	55	46	40	31	12	5,705	665	716	155
1974	1,000	590	2,942	255	53	22	20	17	7	4,906	715	3,316	606
1975	1,512	712	442	1,851	160	30	11	12	4	4,734	685	2,510	541
1976	750	1,020	441	282	1,180	88	16	6	6	3,789	627	2,019	480
1977	750	553	723	277	168	681	51	9	2	3,184	545	1,912	454
Catch in numbers (millions)													
1966	43.6	270.1	58.6	308.8	45.5	14.0	7.7	1.7	.2	750.1		436.4	
1967	47.9	68.4	238.4	109.8	159.2	57.9	4.5	.4	.3	686.9		570.6	
1968	751.7	79.9	65.1	274.5	72.8	90.6	32.0	15.4	5.7	1,387.8		556.2	
1969	70.4	383.8	117.5	158.1	254.0	60.5	22.0	7.2	3.0	1,076.4		622.3	
1970	107.3	57.4	279.8	189.4	116.9	103.1	38.1	19.4	9.4	919.0		754.3	
1971	144.2	191.6	113.3	131.0	76.0	97.6	46.5	19.5	9.4	829.2		493.4	
1972	663.4	73.7	147.8	72.1	74.2	50.6	50.9	26.1	13.3	1,172.2		435.1	
1973	29.7	582.0	105.9	34.8	25.8	19.5	17.4	19.5	9.5	844.1		232.5	
1974	118.3	45.6	616.1	53.2	15.3	8.1	5.3	11.0	5.8	878.6		714.7	
1975	241.3	157.7	88.9	372.6	48.2	9.0	3.2	3.5	2.9	927.2		528.2	
1976	64.5	122.5	93.3	68.7	307.5	23.5	4.4	2.9	1.7	689.0		502.0	
Fishing mortality										Mean F^2(2+)		Mean F^2(4+)	
1966	0.034	0.152	0.103	0.529	0.263	0.336	0.558	1.613	0.700	0.181		0.334	
1967	0.045	0.068	0.194	0.284	0.578	0.631	0.171	0.050	0.700	0.180		0.294	
1968	0.429	0.098	0.085	0.358	0.310	0.786	0.898	1.518	0.700	0.325		0.311	
1969	0.136	0.407	0.205	0.305	0.667	0.459	0.439	0.509	0.700	0.356		0.387	
1970	0.158	0.157	0.592	0.594	0.389	0.636	0.594	0.894	0.700	0.404		0.562	
1971	0.195	0.469	0.529	0.620	0.507	0.664	0.673	0.707	0.700	0.434		0.594	
1972	0.133	0.145	0.829	0.781	0.900	0.770	0.917	1.074	0.700	0.215		0.845	
1973	0.045	0.165	0.320	0.464	0.727	0.635	0.667	1.217	0.700	0.186		0.457	
1974	0.140	0.089	0.263	0.262	0.380	0.529	0.349	1.309	0.700	0.224		0.273	
1975	0.193	0.279	0.250	0.250	0.400	0.400	0.400	0.400	0.700	0.243		0.263	
1976	0.105	0.144	0.266	0.315	0.350	0.350	0.350	0.764	0.350	0.234		0.328	

[1] Year refers to November-October fishing season, (i.e. 1966 = 1 November 1965 to 31 October 1966).
[2] Weighted by stock size.

i) Catch prediction for 1975/76 (Nov-Oct)

The catches in the fishery in Div. 4W(a) during November 1975 to March 1976 were analyzed (Res. Doc. 76/VI/21) and these data were used to calculate F-values for that sector of the 1976 fishery. M = 0.1 was assumed and the stock size calculated as on 1 May 1976. Since the management strategy for the Div. 4WX fishery in 1976 is to fish at F = 0.35, the F-values for the 6-month period (May-Oct 1976) were obtained by subtracting the F-values for the Div. 4W(a) winter fishery in 1975/76 from the annual F. However, an annual F higher than 0.35 had to be used for the 1967 year-class because of the high F-value calculated for the Div. 4W(a) fishery. M = 0.1 was again used for this sector of the fishery.

The catch prediction indicates that the TAC in Div. 4WX for the period 1 April-31 October 1976 should be set at 92,500 tons (Table 13). This figure includes an estimate of 15,000 tons for inshore gear catches, which is greater than the estimate from the previous assessment due to the increased estimate of recruitment. The TAC of 92,500 tons for April-October 1976 corresponds to a total TAC for the 1975/76 season (1 November 1975 to 31 October 1976) of 129,600 tons, of which 37,100 tons have already been taken up to 31 March 1976 in Div. 4W(a).

The Commission had previously agreed to a 1975/76 TAC of 45,000 tons for Div. 4VW(a). Since not all countries have reported taking their 1975/76 allocations in Div. 4VW(a), and since effort has recently been concentrated in Div. 4W(a), up to 3,300 tons could still be taken in 4W(a) up to 30 June 1976. Therefore, if the Commission wishes to consider a 1976 TAC for only Div. 4XW(b) as previously, it should be set at 89,200 tons, corresponding to fishing at F = 0.35. This TAC includes an estimate of 15,000 tons for inshore gear catches. The increase in TAC from that recommended at the Janusry 1976 Special Meeting is due largely to the revised estimate for the 1973 year-class (a catch of 83,700 tons would result from the previous estimate of the 1973 year-class). A TAC of 81,000 tons for 1976, as provisionally agreed by the Commission at its January 1976 Special Meeting would regulate the fishery at $F_{0.1}$ = 0.30.

Table 13. Herring in Div. 4WX: catch projections for 1975/76 and stock size projections for 1976/77 with F = 0.35. (Assessment refers to fishing season from 1 November to 31 October.)

Age	Div. 4WX Stock size 1 Nov 1975	F	Div. 4W(a) Catch for period Nov 75 to Apr 76		Div. 4WX Residual stock in May 1976	F	Div. 4WX Projected catch May to Oct 1976		Div. 4WX Residual stock on 1 Nov 1976	
	(millions)		*(millions)*	*(000 t)*	*(millions)*		*(millions)*	*(000 t)*	*(millions)*	*(000 t)*
2	750	<0.001	0.1	-	678.5	0.105	64.4	2.7	552.8	23.2
3[1]	1,020	0.050	47.5	3.6	878.2	0.094	75.0	8.5	723.3	81.7
	(602)	(0.087)	(47.5)	(3.6)	(499.5)	(0.057)	(26.3)	(3.0)	(426.9)	(48.2)
4	441	0.116	46.1	6.1	355.4	0.150	47.2	8.3	276.8	48.4
5	282	0.130	32.7	6.3	223.7	0.185	36.0	7.8	168.2	36.7
6	1,180	0.067	72.7	16.2	998.9	0.283	234.8	60.8	681.1	176.4
7	88	0.145	11.3	2.9	68.9	0.205	12.2	3.6	50.8	15.1
8	16	0.200	2.8	0.9	12.1	0.150	1.6	0.5	9.4	3.1
9	6	0.609	2.5	0.8	2.8	0.155	0.4	0.1	2.2	0.9
10	6	0.191	1.0	0.3	4.7	0.159	0.7	0.3	3.6	1.4
Totals				37.1 (37.1)				92.5 (87.0)		387.1 (353.6)

[1] The two sets of figures refer to the two assumptions as to the size of the 1973 year-class: the set in parentheses are based on aasuming 1 billion fish at age 2, as used in the January 1976 assesement; the set used in the present aasesament are based on assuming 1.5 billion fish at age 2.

ii) Catch prediction for 1976/77 (Nov-Oct)

Assuming that the catch of 129,600 tons is taken in Div. 4WX during the 1975/76 season and that the 1973 year-class size at age 2 is about 1.5 billion fish, the stock size at the beginning of the 1976/77 season (1 November 1976) will be 454,000 tons (age 4 and older fish). Yield-per-recruit calculations indicate that $F_{0.1}$ is about 0.30. Using this management strategy and setting the 1975 year-class size at the conventional level of 750 million fish at age 2, a TAC of 109,000 tons is predicted for Div. 4WX for the 1976/77 season (1 November 1976-31 October 1977) (Table 14).

If the Commission wishes to manage these fisheries as previously, i.e. for Div. 4XW(b) on a calendar year basis, the recommended TAC for 1977 in Div. 4XW(b) is 84,000 tons, which includes an estimated 15,000 tons expected to be taken by inshore gears.

Table 14. Herring in Div. 4WX: catch projection for 1976/77 season (1 November to 31 October) at three levels of fishing mortality ($F_{0.1}$ = 0.30)

Age	Stock size 1 Nov 1976	Projected catch for fishing season Nov 1976 to Oct 1977 F = 0.35		F = 0.30		F = 0.25	
	(millions)	*(millions)*	*(000 t)*	*(millions)*	*(000 t)*	*(millions)*	*(000 t)*
2	750.0	67.9	2.9	58.6	2.5	49.2	2.1
3	522.8	67.1	7.6	58.1	6.6	48.9	5.5
4[1]	723.3	153.8	26.9	134.2	23.5	113.8	19.9
	(426.9)	(90.9)	(15.9)	(79.2)	(13.9)	(67.2)	(11.8)
5	276.8	68.1	14.9	59.6	13.0	50.7	11.1
6	168.2	45.3	11.7	39.7	10.3	33.9	8.8
7	681.1	183.3	54.6	160.8	47.9	137.1	40.9
8	50.8	13.7	4.5	12.0	4.0	10.2	3.4
9	9.4	2.5	0.9	2.2	0.8	1.9	0.7
10	2.2	0.6	0.2	0.5	0.2	0.4	0.2
Totals			124.2		108.7		92.5
			(113.2)		(99.1)		(84.3)
Residual stock biomass (age 4 and older) in 1977			337.5		351.4		365.9
			(304.9)		(317.6)		(330.8)
Stock biomass (age 4 and older) on 1 Nov 1977			382.5		398.6		415.4
			(342.0)		(356.5)		(371.6)

[1] The two sets of figures refer to two assumptions as to the size of the 1973 year-class: the figures in parentheses are based on assuming 1 billion fish at age 2, and the other set is based on assuming 1.5 billion fish at age 2 as used in the present assessment.

iii) Catch prediction for 1977/78 (Nov-Oct)

In order to arrive at the TAC for Div. 4VW(a) in 1977/78, it was necessary to predict the 1977/78 catch for Div. 4WX and then apportion it between Div. 4W(a) and 4XW(b). The predicted TAC for Div. 4WX for the 1977/78 season, using $F_{0.1}$ = 0.30 and setting the size of the 1976 year-class at the conventional level of 750 million fish at age 2, is 98,000 tons (Table 15).

Table 15. Herring in Div. 4WX: catch projection for 1977/78 season (1 November to 31 October) at three levels of fishing mortality ($F_{0.1}$ = 0.30).

Age	F = 0.35 Stock size 1 Nov 1977	F = 0.35 Projected catch for 1977/78		F = 0.30 Stock size 1 Nov 1977	F = 0.30 Projected catch for 1977/78		F = 0.25 Stock size 1 Nov 1977	F = 0.25 Projected catch for 1977/78	
	(millions)	*(millions)*	*(000 t)*	*(millions)*	*(millions)*	*(000 t)*	*(millions)*	*(millions)*	*(000 t)*
2	750.0	67.9	2.9	750.0	58.6	2.5	750.0	49.2	2.1
3	552.8	67.1	7.6	561.2	59.0	6.7	569.7	50.4	5.7
4	392.1	83.4	14.6	400.2	74.2	13.0	408.5	64.3	11.2
5[1]	453.9	111.7	24.4	471.5	101.6	22.0	489.7	89.8	19.6
	(267.9)	(66.0)	(14.4)	(278.3)	(59.9)	(13.1)	(289.1)	(53.0)	(11.6)
6	165.4	44.5	11.5	173.0	40.8	10.6	180.9	36.4	9.4
7	97.0	26.1	7.8	102.0	24.1	7.2	107.2	21.6	6.4
8	392.9	105.8	35.1	413.1	97.5	32.4	434.3	87.4	29.0
9	29.3	7.9	2.9	30.8	7.3	2.6	32.4	6.5	2.4
10	5.4	1.5	0.6	5.7	1.4	0.5	6.0	1.2	0.5
Total			107.3			97.6			86.3
			(97.3)			(88.5)			(78.3)
Residual stock biomass (age 4 and older) in 1978			293.8			316.3			340.9
			(269.5)			(290.0)			(312.3)
Stobk biomass (age 4 and older) on 1 Nov 1978			328.7			354.6			382.9
			(299.9)			(323.3)			(348.9)

[1] The two sets of figures refer to two assumptions as to the size of the 1973 year-class: the figures in parentheses are based on assuming 1 billion fish at age 2, and the other set is based on assuming 1.5 billion fish at age 2 as used in the present assessment.

iv) Management considerations

The Commission has set TACs for management areas that differ from those now recommended by STACRES. Consequently TACs have been set for Div. 4VW(a) in the 1975/76 and 1976/77 seasons and for Div. 4XW(b) in 1976. STACRES considered and recommended at the June 1975 Annual Meeting and again at the January 1976 Special Meeting that the management areas be changed to conform with those based on improved knowledge of the stock relationships. The Subcommittee again reiterates the need for the change and strongly recommends that the Commission set TACs for the management areas 4V and 4WX as indicated below:

Div. 4V (1 Jul-30 Jun)		Div. 4WX (1 Nov-31 Oct)	
Season	TAC	Season	TAC
1975/76	15,000[1]	1975/76	(92,500)[2,3]
1976/77	11,000[1]	1976/77	109,000[3]
1977/78	11,000		

[1] From STACRES recommendations (*Redbook* 1975, page 39).
[2] For remainder of 1975/76 season (1 April to 31 October 1976); includes 3,300 tons allocated but not yet reported as caught within the 1975/76 TAC for Div. 4VW(a).
[3] If the Commission wishes to manage the fishery on a calendar year basis, the comparable TACs for 1976 and 1977 are 96,500 tons and 109,000 tons respectively.

If the Commission decides to continue managing the fisheries in Div. 4VWX as previously (i.e. Div. 4VW(a) and Div. 4XW(b)), the TACs are projected as follows:

Div. 4VW(a) (1 Jul-30 Jun)				Div. 4XW(b)[5]	
Season	4V	4W(a)	TAC	Year	TAC
1975/76	15,000[1]	30,000[1]	45,000[2]	1976	89,200[6]
1976/77	11,000[1]	25,000[1]	36,000[2]	1977	84,000[6,7]
1977/78	11,000[3]	22,500[4]	33,500		

[1] From STACRES recommendations (*Redbook* 1975, page 39).
[2] Already agreed by the Commission and allocated.
[3] Recommended at the present meeting.
[4] Catch in 4W(a) decreased proportionately to decrease in catch for 4WX (from 109,000 tons to 98,000 tons).
[5] Although the assessment period is 1 Nov-31 Oct, the catch is normally taken during Apr-Oct period, so that the TAC can be assumed as a calendar year TAC for Commission purposes.
[6] TACs include estimsted catches of 15,000 tons by inshore gears.
[7] The recommended TAC for Div. 4WX (Nov 1976-Oct 1977) is 109,000 tons; removing the Div. 4W(a) projected catch of 25,000 tons leaves 84,000 tons for this area.

In order to institute the change from the current management regime to the revised management areas, as recommended by STACRES, the Commission will have to take the following steps:

(1) For the remainder of the 1975/76 season (1 Apr-31 Oct 1976) in Div. 4WX, the recommended TAC of 92,500 tons would replace the agreed TAC for Div. 4XW(b) and be allocated, taking into consideration the residual quota of 3,300 tons in Div. 4VW(a).

(2) For the 1976/77 season (Jul-Jun) in Div. 4V, the fishery is already under regulation as part of 1976/77 TAC (36,000 tons) in Div. 4VW(a); this TAC would have to be supplanted by the recommended TAC of 11,000 tons in Div. 4V for 1976/77, and the Div. 4W(a) portion of the existing TAC taken into account in Div. 4WX.

(3) For the 1976/77 season (Nov-Oct) in Div. 4WX, the allocation of the recommended TAC of 109,000 tons would have to take into account the fact that a TAC of 36,000 tons for 1976/77 (Jul-Jun) in Div. 4VW(a) has already been agreed to and allocated.

(4) For the 1977/78 season (Jul-Jun) in Div. 4V, the recommended TAC of 11,000 tons is to be considered by the Commission and nationally allocated.

m) Mackerel in Subareas 3 and 4

The status of the mackerel fishery in Subareas 3 and 4 is considered in conjunction with the overall assessment of the stocks in Subareas 3 to 5 and Statistical Area 6 (see under Mackerel in Section VII, 2(p)).

n) Argentine in Div. 4V, 4W and 4X (Res. Doc. 76/VI/56)

While catches were relatively low during 1971-73, averaging less than 5,000 tons, the nominal catch was 17,000 tons in 1974 and provisional statistics indicate a catch of 15,000 tons in 1975. The TAC was set at 25,000 tons for each of the years 1974, 1975 and 1976. New data on age validation and growth, which clarify earlier discrepancies in growth parameters, were presented. However, sufficient information has not been made available to make an accurate assessment of the yield potential of the stock in this area. The initial TAC of 25,000 tons was set above the estimated MSY catch, based on biomass estimates from research surveys and on general biological data, to allow for fishing-up of accumulated biomass from the lightly exploited populations. However, the catches were quite high in 1974 and 1975, and a further year with a potential catch of 25,000 tons (i.e. 1976) will likely reduce the stocks substantially below the relatively unexploited level of 1973. In view of the uncertainties about the status of the stocks, the TAC for 1977 should be reduced to the estimated MSY level. The Subcommittee therefore recommends that the TAC for 1977 be reduced to 20,000 tons.

Despite the regulation of this fishery with a precautionary TAC for almost three years, very little data have become available with which to determine the effects of fishing on these stocks. Without an adequate assessment, the catch in subsequent years should be reduced to ensure that the stocks are not overfished.

o) Squid-*Illex* in Suhareas 2 to 4

The assessment of *Illex* in Subareas 2 to 4 is considered together with the stock component in Suharea 5 and Statistical Area 6 (see under Squid-*Illex* in Section VII, 2(r)).

VII. SUBAREA 5 AND STATISTICAL AREA 6

1. Fishery Trends

The provisional nominal catch of all species in Subarea 5 and Stat. Area 6 decreased by 9% from 1,800,000 tons in 1974 to 1,646,000 tons in 1975, and the finfish catch declined by 11% from 1,140,000 tons in 1974 to 1,009,000 tons in 1975. The 1975 catch of finfish (excluding menhaden, billfishes, tunas and large sharks) plus squids was 854,000 tons, a 9% decline from the 1974 level of 942,000 tons. Decreased catches from 1974 to 1975 also occurred in the groundfish group (306,000 to 280,000 tons), pelagic fish (753,000 to 651,000 tons) and invertebrates (665,000 to 636,000 tons). The "other fish" group (77,000 tons) remained at about the same level as in 1974.

Species which showed declines in catch of more than 10% include yellowtail flounder (25,000 to 20,000 tons), red hake (33,000 to 28,000 tons), silver hake (130,000 to 114,000 tons), mackerel (295,000 to 251,000 tons) and the regulated "other finfish" category (132,000 to 116,000 tons). Within this "other finfish" category, which excludes all TAC species as well as menhaden, billfishes, tunas and large sharks, the most notable declines occurred in butterfish (13,000 to 11,000 tons), sculpins (2,800 to 150 tons) and ocean pout (3,700 to 300 tons). Menhaden catches also declined from 249,000 to 198,000 tona. Species showing only moderate declines were cod (36,000 to 34,000 tons) and herring (187,000 to 182,000 tons). Species for which the nominal catches increased from 1974 to 1975 include haddock (5,000 to 7,000 tons), pollock (12,000 to 14,000 tons) and flounders except yellowtail (21,000 to 26,000).

The total catch of all species declined by 3% in Subarea 5 from 805,000 tons in 1974 to 783,000 tons, and by 13% in Stat. Area 6 from 998,000 to 863,000 tons.

2. Species Review

Table 16 contains a summary of recent catches and TACs, including those recommended for 1977, for

stocks under consideration for management in Subarea 5 and Statistical Area 6. The TACs listed include quantities, if any, estimated to be taken outside the Convention Area.

Table 16. Subarea 5 and Statistical Area 6: summary of nominal catches (1971–75) and TACs (1973–77) by species and stock area. (Nominal catches for 1975 are based on advance provisional statistics for April 1976 assessments, and TACs in parentheses are those recommended by the Assessments Subcommittee.)

Species	Stock area	Nominal catches (000 tons)					TACs (000 tons)				
		1971	1972	1973	1974	1975	1973	1974	1975	1976	1977
Cod	5Y	8	7	6	8	9	10.0	10.0	10.0	8.0	(3.2)
	5Z	28	25	29	27	24	35.0	35.0	35.0	35.0	(15.0)
Haddock	5	12	7	6	5	7	6.0	0.0	6.0[1]	6.0[1]	(0.0)
Redfish	5	20	19	17	10	11	30.0	30.0	25.0	17.0	(9.0)
Silver hake	5Y	8	7	9	5	9	10.0	10.0	15.0	10.0	(5.0)
	5Ze	72	78	62	66	57	80.0	80.0	80.0	50.0	(70.0)
	5Zw+6	28	35	65	58	54	80.0	80.0	80.0	43.0	(50.0)
Red hake	5Ze	9	39	25	10	14	–	20.0[2]	20.0[2]	26.0	(16.0)
	5Zw+6	31	36	41	24	26	40.0[3]	50.0[3]	45.0[3]	16.0	(28.0)
Pollock	4VWX	12	20	30	25	25	50.0[4]	55.0	55.0	55.0	(20.0)
	5	14	13	13	12	13					
Yellowtail	5(E69°)	31	39	31	25	14	16.0	16.0	16.0	16.0	(7.0)
	5(W69°)+6					6	10.0[5]	10.0[5]	4.0	4.0	(0.0)
Flounders (except yellowtail)	5+6	28	24	22	21	23	25.0	25.0	25.0	20.0	(20.0)
Herring	5Y(total)	(51)	(62)	(32)	(37)	(37)					
	5Y(adults)	39	43	16	18	21	25.0	25.0	16.0	7.0	(0.0)
	5Z+6	267	174	202	150	145	150.0	150.0	150.0	60.0	(50.0)
Mackerel	3+4	24	22	38	45	37	–	55.0[6]	70.0	56.0	(0.0)[7]
	5+6	349	387	381	295	246	450.0	304.0	285.0	254.0	
Other finfish[8]	5+6	159	172	157	132	96	–	150.0	150.0	150.0	(150.0)[9]
Squid-*Illex*	5+6	25	49	59	56	46[10]	–	71.0[11]	71.0[11]	30.0	(30.0)
Squid-*Loligo*	5+6									44.0	(44.0)
Overall 2nd tier[12]	5+6	1140	1171	1159	942	833	–	923.9	850.0	650.0	(500.0)

1 TACs for by-catch with no directed fishery.
2 TACs pertain to 5Z(E69°).
3 TACs pertain to 5Z(W69°)+6.
4 TAC pertains to 4X+5 only.
5 TACs pertain to 5(W69°) only.
6 TAC pertains to 4VWX only.
7 TAC subject to re-assessment at 1976 Annual Meeting (see Section VII, 2(p)).
8 Excludes all TAC species and also menhaden, billfishes, tunas and large sharks (except dogfish).
9 Within this recommended TAC, advisory TACs are recommended for the following species: 25,000 tons of argentine, 40,000 tons of dogfish, 18,000 tons of butterfish, and 10,000 tons (including inshore fishery) of river herrings (*Alosa pseudoharengus* and *A. aestivalis*).
10 Catches not yet available for all countries by *Illex* and *Loligo* separately.
11 TACs pertain to *Illex* and *Loligo* combined.
12 Includes all finfish species (except menhaden, billfishes, tunas and large sharks) and squids.

a) Cod in Division 5Y (Res. Doc. 75/46)

Nominal catches in this area have fluctuated between 2,700 and 14,500 tons since 1932 and have averaged 7,100 tons over the past 10 years (1966-75), the provisional catch in 1975 being about 9,000 tons. The TAC, which was set at 10,000 tons annually for 1973-75, was reduced to 8,000 tons for 1976, based on (i) a decline from 1968 in the mean catch (in weight) per tow from USA autumn bottom trawl surveys; (ii) average historical catch levels with implications of an unknown but assumed considerable sport fishing component; and (iii) estimates of mortality suggesting that the recent fishery (1970-74) generated F-values of about 0.48 (Res. Doc. 75/46) which with M = 0.20 exceed F_{max} = 0.30. Although an update of the survey data suggest that the declining trend has stabilized since 1973, knowledge of the component of mortality caused by sport fishing is needed to interpret the relationships between catch abundance and associated fishing mortality rates. In the absence of interaction between stocks supporting commercial and recreational fishing, the average commercial catch of 7,350 tons in 1970-74 generated an F of 0.48. If recruitment remains stable, fishing at F_{max} = 0.30 would result in a catch of approximately 5,000 tons, and fishing at $F_{0.1}$ = 0.18 would produce a catch of about 3,200 tons. The Subcommittee therefore recommends that the TAC for 1977 be set at 3,200 tons.

b) Cod in Division 5Z (Res. Doc. 76/VI/42; 75/46)

Nominal catches of Georges Bank cod declines from 32,300 tons in 1937 to 8,100 tons in 1953, then increased rapidly from 10,400 tons in 1960 to 52,900 tons in 1966, and, after a sharp decline, stabilized around 26,000 tons annually during 1970-75. The TAC for this stock has been set at 35,000 tons since 1973, which was considered to be about the MSY level. Catch data from USA autumn bottom trawl surveys indicate a stable level of abundance since 1963, with good recruitment since 1970. A strong 1971 year-class became fully recruited to the fishery by 1974 and the 1975 year-class appears to be about equal in size to that of 1971. Although an analytical assessment (virtual population analysis) has not yet been completed for the stock, preliminary analyses suggest that the very high catches in the late 1960's may have generated F-values in the range of 0.55-0.65, which are considerably above the calculated value of $F_{max} = 0.3$, with M = 0.2. Cathes averaging about 26,500 tons during 1970-74 generated F-values which averaged 0.36 (Res. Doc. 75/46). If recruitment remains stable, fishing at a level associated with F_{max} would result in a catch of about 24,000 tons. If fishing is conducted at $F_{0.1} = 0.18$, the corresponding catch would be approximately 15,000 tons. The Subcommittee, therefore, recommends that the TAC for 1977 be set at 15,000 tons.

c) Haddock in Subarea 5 (Res. Doc. 76/VI/35)

Nominal catches declined precipitously from 127,000 tons in 1966 to 12,800 tons in 1970, the first year in which a TAC was adopted (12,000 tons). Since 1970, nominal catches have averaged 7,200 tons under TAC regulation. The Subcommittee has consistently advised a TAC of zero since 1972 (no directed fishery for haddock), and this was adopted by the Commission for 1974. However, the TACs for 1975 and 1976 were set at 6,000 tons to provide for by-catches up to that level. Provisional statistics for 1975 indicate a nominal catch of 6,700 tons.

Both commercial catch/effort data and USA autumn trawl survey data indicate a pronounced decline in abundance since 1967. Recruitment has been generally poor; however, the 1972 and 1975 year-classes were the strongest since that of 1967, although strength of the 1975 year-class is based only on one research survey and additional data will be required for a more definitive estimate. Both the stock size estimates (Table 17) and survey data indicate a decline in abundance in the late 1960's and early 1970's followed by an increase.

Table 17. Stock abundance, removals and recruitment estimates for Georges Bank haddock, 1968-77.

	Yearly estimates in millions of fish										
	1935-60[1]	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Stock size (age 2+)	145	70[2]	36	21	24	16	27	55	50	48	66[3]
Removals - total	63	35	16	8	9	5	8	12	12	12	14
- fishing[4]	41	25	11	5	5	2	3	3	3	4	4
- natural	22	10	5	3	4	3	5	9	9	8	10
Recruits (age 2)[5]	54	15	1	1	11	1	16	36	7	10	10

1 Average of yearly estimates from *Redbook* 1970, Part I, page 48.
2 Estimated assuming F = 0.5 and M = 0.2 during 1968.
3 Assuming that current TAC remains in effect for 1977.
4 Values computed on the basis of mean weight at age in USA data.
5 Values for 1968-75 computed using Hennemuth's (1969) index; values for 1976-77 estimated using Grosslein's (1969) index. From Hennemuth's common regression line, $Y_1 = 3.31 - 0.056(24) = 1.97$; Y_2 is estimated at t = 24 months from the fitted regression line for a given year-class, and estimated recruitment is $(e^{Y_2 - Y_1}) \times 81 \times 10^6$ fish.

Projections for 1976 and 1977 indicate that, if recruitment continues at the average level observed during 1972-75 (approximately 15 million fish), maintaining the existing TAC level of 6,000 tons would lead only to a stabilization of stock size in the late 1970's at about one-half of the pre-1960 level, while an increased TAC could lead to a substantial reduction in abundance. Even with better than average recruitment, by-catches would be expected to increase, thereby delaying somewhat the projected improvement in stock size. The Subcommittee recommends that removals in 1977 should be kept to the lowest possible level to allow for the most rapid recovery of the stock to the MSY level and therefore advises a zero TAC for 1977.

d) Redfish in Subarea 5 (Res. Doc. 76/VI/43)

Provisional statistics indicate a nominal catch of 10,600 tons in 1975, about the same as the 1974 catch but substantially below the 1975 TAC of 25,000 tons. Catch rates of USA commercial vessels, whose catches consisted of 50% or more of redfish, continued the declining trend which has been evident since 1968. USA autumn trawl survey length frequency data indicate an increase in abundance of pre-recruit fish which began to enter the commercial fishery in 1974, and recruitment of these fish will continue over the next few years. The survey length frequencies also indicate that lower recruitment will prevail for a period of years thereafter. Projection from the yield model indicates that fishing at a level of effort associated with F_{MSY} in 1977 would result in a catch of about 10,000 tons, which is below the long-term MSY estimate of 17,000 tons. Consequently, the Subcommittee recommends a TAC of 9,000 tons for 1977 to ensure controlling fishing effort at a level below F_{MSY}.

e) Silver hake in Division 5Y

The nominal catch increased from 5,200 tons in 1974 to 9,100 tons in 1975. While USA commercial catch per unit effort increased by 24% from 1974 to 1975, fishing effort increased by 41%. Catch per tow data from both spring and autumn surveys indicate an increase in stock abundance in 1975. Also, survey data show that the 1971-75 year-classes were stronger than those produced during 1966-70.

Virtual population analyses indicate that stock biomass decreased to a low in 1971 as the result of catches exceeding recruitment during the 1960's. The stock size has since begun to increase as a result of improved recruitment and in 1975 was about twice the 1971 level. However, the capture and discarding of undersized silver hake in the USA trawl fisheries for silver hake and shrimp has been high in recent years and has thus been detrimental to the recovery of the adult stock. However, insufficient data are available to adequately estimate the catch and age composition of the unreported discards. The fishing mortality, estimated from the relationship between fishing mortality and fishing effort in previous years, was 0.50 in 1975, compared with $F_{max} = 0.60$ and $F_{0.1} = 0.30$. Full utilization of the 1976 TAC of 10,000 tons would generate an F of about 0.55. If fishing mortality is reduced to $F_{0.1}(0.30)$ in 1977, a catch of about 5,000 tons would be taken. Bearing in mind the current low level of this stock and the desirability of rebuilding the stock to a higher level of abundance, the Subcommittee recommends a TAC of 5,000 tons in 1977.

f) Silver hake in Subdivision 5Ze

The nominal catch decreased from 66,400 tons in 1974 to about 56,500 tons in 1975. The USA commercial catch per unit effort increased by 50% from 1974 to 1975, following a 50% decrease from 1973 to 1974. The spring survey catch per tow index increased slightly in 1975 and the autumn index increased substantially to the highest level since 1968. Survey catches of ages 0 and 1 fish, as well as virtual population analyses, indicate that the 1971-75 year-classes are stronger than any produced during 1965-70, with the 1973-75 year-classes being estimated as the strongest observed since that of 1963. Improved recruitment has allowed the stock biomass to increase by about 2 to 3 times since the low level in 1969-70.

Fishing mortality in 1974-75 was estimated to be about 0.40-0.50 (about the level of F_{max}). Catch projection indicates that an F of 0.20-0.25 would be required to take the 1976 TAC of 50,000 tons. Fishing at the level of $F_{0.1} = 0.30$ in 1977 would produce a catch of about 70,000 tons. Since the stock biomass appears to be at a satisfactory level in comparison with recent levels and in view of the evidence indicating that the 1973-75 year-classes are strong, the Subcommittee recommends a TAC of 70,000 tons for 1977.

g) Silver hake in Subdivision 5Zw and Statistical Area 6

The nominal catch decreased from 58,400 tons in 1974 to about 53,700 tons in 1975. The USA commercial catch per unit effort increased by 33% from 1974 to 1975. Both the spring and the autumn catch per tow indices indicate an increase in stock abundance in 1975. Virtual population analysis as well as the autumn survey catches of age 0 fish indicate that the 1971-72 year-classes were the strongest produced since 1964. Survey data also indicate that the 1973 year-class was poor but that the 1974 year-class is possibly stronger than those of 1971 and 1972. The 1975 year-class is estimated to be about twice as strong as the poor 1973 year-class but slightly weaker than those of 1971 and 1972. Recent recruitment has, therefore, resulted in an increase in stock biomass from the rather low levels in 1970-71.

Fishing mortality increased from about 0.33 in 1972 to 0.50-0.55 in 1974-75, compared with $F_{max} = 0.45$ and $F_{0.1} = 0.30$ for this stock. Fishing mortality of 0.26-0.31 would be necessary in 1976 to

take the TAC of 43,000 tons. If fishing is carried out in 1977 at a level of effort associated with $F_{0.1}$ = 0.30, a catch of about 50,000 tons could be taken. The Subcommittee therefore recommends that the TAC for 1977 be set at 50,000, tons.

h) Red hake in Subdivision 5Ze (Res. Doc. 76/VI/55)

The nominal catch increased from 9,500 tons in 1974 to a provisional figure of 14,000 tons in 1975, nearly all of which was taken by USSR. The TAC for 1975 was 20,000 tons.

A virtual population analysis, presented by USSR, projects a catch of 20,000 tons in 1977 by fishing at F = 0.70 (F = 0.20 for age 2 fish). The 1974 year-class, which would provide about one-half or more of the catch in 1977, was taken to be equal to the largest on record, based on survey indices, and the 1973 and 1975 year-classes were assumed to be about average size. Also, it was assumed that the full USSR allocation of 19,000 tons would be taken in 1976. The USA survey data indicate a sharp increase in stock size in 1975, due to the large 1973 and 1974 year-classes. USA yield-per-recruit studies (Res. Doc. 74/19) indicate that, at M = 0.40, F_{max} = 0.70 and $F_{0.1}$ = 0.35. Fishing at $F_{0.1}$ in 1977, using the USSR estimates of stock size, would result in a catch of about 12,000 tons. Given the uncertainty of the current assessment and the fact that the stock appears to have increased, the Subcommittee recommends a TAC of 16,000 tons in 1977.

The Subcommittee noted that adequate assessments could not be done until ageing techniques are improved and agreed age composition data are available, and accordingly recommends that the ageing of red hake be included in the silver hake ageing workshop proposed for 1976.

i) Red hake in Subdivision 5Zw and Statistical Area 6

The nominal catch increased slightly from 24,000 tons in 1974 to about 26,000 tons in 1975, with USSR taking 24,000 tons and the remainder by USA. The TAC for 1975 was 45,000 tons.

A yield-per-recruit assessment, presented by USSR, indicates a catch of 35,000 tons in 1977 by fishing at F = 0.70. Research surveys indicated that the 1973 year-class was very large (about the same as the 1968-70 year-classes), and the 1974 and 1975 year-classes were assumed to be equal to the long-term mean of year-class size. Autumn trawl surveys indicated an increase in stock size in 1975 over the extremely low stock level measured in 1974 surveys. Also the abundance of age 0 fish in 1974 surveys was shown to be high. USA studies indicate that, at M = 0.40, F_{max} = 0.70 and $F_{0.1}$ = 0.35. Fishing at $F_{0.1}$ in 1977, using the USSR assumptions about year-class strength, would result in a catch of about 20,000 tons. Given the uncertainties about the validity of existing assessments and about the effects of fishing at either the F_{max} or the $F_{0.1}$ level on stock size, the Subcommittee recommends a TAC of 28,000 tons in 1977.

The Subcommittee noted that adequate assessments could not be done until ageing techniques are improved and agreed age composition data are available, and accordingly recommends that the ageing of red hake be included in the silver hake ageing workshop proposed for 1976.

j) Pollock in Subarea 5

The assessment of Pollock in Subarea 5 is considered together with the stock component in Div. 4VWX (see under Pollock in Section VI, 2(i)).

k) Yellowtail flounder in Subarea 5 (east of 69°W)

Provisional statistics indicate a nominal catch of 14,500 tons in 1975, in contrast with 16,800 tons in 1974. Stock abundance, as measured by autumn bottom trawl surveys and by the catch rates of USA commercial vessels, seemed to stabilize after 1971-73 under the TAC of 16,000 tons set to control fishing at F_{max} = 0.8. The catch per day fishing was 1.7 tons in 1975 and 2.0 tons in 1974 in contrast to an average of 2.6 tons per day in the 1970-73 period. The bottom trawl survey indices in 1974-75 averaged 8.8, compared with 14.5 for 1970-73. Abundance indices of age 1 fish, estimated from the autumn bottom trawl surveys in terms of the stratified mean number caught per tow, are as follows:

Year-class	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
No./tow	11.60	2.64	1.29	9.76	6.96	10.59	7.64	4.75	3.82	2.42	2.71	3.50	4.05
Log_e(No./tow+1)	1.774	0.760	0.586	1.344	1.492	1.451	1.322	1.074	0.970	0.641	0.670	0.839	0.617

These data indicate that the year-classes which will support the fishery in 1976-77 are less

abundant than those which supported the fishery in 1970-73. Age compositions of catches in 1975 indicate a large contribution of age 2 fish, although survey data did not show the increased abundance of this year-class. In view of the abundance of this age-group in the catches, it can be assumed that fishing mortality on it approximately doubled. This is the age-group that the mesh regulation (130 mm, manila) was intended to conserve, because yellowtail double their weight between age 2 and age 3. If higher yields are desired from this fishery, the fishing mortality on two-year-old fish must be reduced.

Utilizing available data on age composition and estimated mortality for 1975, catch and stock size projections were made for 1976 and 1977 (Table 18). Using F = 0.8 for fish of age 3 and older in the 1975 fishery and F = 0.4 for age 2 fish (based on fishing mortality for 1964-72 as calculated by Penttila and Brown (ICNAF Res. Bull. No. 10)), stock sizes in 1975 and 1976 were estimated. Using the same F-values for 1976, a catch of 12,500 tons is predicted. This catch probably approximates that which will actually be taken in 1976, based on the experience of the 1975 fishery and provisional figures for the 1976 catch. The level of recruitment assumed for 1976 and 1977 (42 million fish at age 2) is equal to the lowest level since 1962, as estimated from preliminary virtual population analysis (the mean value for 1962-72 is 56 million fish). The lack of adequate estimates of discards, both in the directed fishery and in by-catches, make the estimation of stock size from virtual population analysis rather inaccurate.

Table 18. Yellowtail in Subarea 5 (east of 69°W): catch and stock size projections, 1975-77.

Year	Age	Stock numbers[1]	F	Catch		Residual stock[2]
				Numbers	Weight	
		(10^{-3})		(10^{-3})	(tons)	(10^{-3})
1975	2	40,100	0.4	12,030		
	3	20,900	0.8	10,450		
	4	12,198	0.8	6,099		
	5	4,150	0.8	2,125		
	6	1,060	0.8	530		
	7	542	0.8	271		
	8+	212	0.8	106		
	Total	79,162		31,611		
1976	2	42,000	0.4	12,600	3,037	
	3	21,979	0.8	10,987	4,582	
	4	7,689	0.8	3,845	2,284	
	5	4,487	0.8	2,243	1,671	
	6	1,527	0.8	763	658	
	7	392	0.8	196	188	
	8+	277	0.8	139	140	(age 3 and older)
	Total	78,341		30,773	12,568	
1977	2	42,000	0.4	12,600	3,034	-
	3	23,100	0.8	11,505	4,797	23,100
	4	8,084	0.8	4,042	2,400	8,489
	5	2,829	0.8	1,415	1,054	2,974
	6	1,660	0.8	830	716	1,040
	7	565	0.8	282	270	611
	8+	248	0.8	186	187	301
	Total	88,486		30,860	12,458	36,515
1977	2	42,000	0.2	7,140	1,721	-
	3	23,100	0.4	6,576	2,742	28,153
	4	8,084	0.4	2,425	1,440	12,678
	5	2,829	0.4	849	504	4,610
	6	1,660	0.4	498	430	1,552
	7	565	0.4	170	163	911
	8+	248	0.4	166	167	446
	Total	88,486		17,824	7,176	42,050

[1] Stock numbers refer to beginning of the indicated year.
[2] Residual stock (age 3 and older) at the start of the following year.

If fishing is conducted at the level of F_{max} in 1977 for a predicted yield of 12,400 tons, the stock size will be maintained at about the relatively low level existing in 1975 and 1976. Fishing at $F_{0.1} = 0.4$ for a projected catch of 7,000 tons would result in increasing the stock size by about 10%. If fishing is continued in future years at the $F_{0.1}$ level and recruitment remains at about the current level, annual yields should increase to about 12,000 tons in 5-6 years and the stock size (age 3 and older) should increase to about 61 million fish, a level similar to those which prevailed in the 1962-73 period. The Subcommittee therefore recommends a TAC of 7,000 tons for 1977.

ℓ) Yellowtail flounder in Subarea 5 (west of 69°W) and Statistical Area 6

Three yellowtail populations are located in this management area. The Cape Cod and the southern New England stocks have been under a collective TAC regulation since 1971 and the Statistical Area 6 stock has been included since 1975. The provisional nominal catch from all three stocks was slightly less than 6,000 tons in 1975.

i) Cape Cod stock. The 1975 catch was about 2,000 tons which is similar to the long-term average. However, catch rates of USA commercial vessels declined from 1.9 tons per day in 1974 to 1.6 tons per day in 1975, indicating a possible decrease in stock size.

ii) Southern New England stock. Although the TAC regulations have greatly decreased removals since 1970, catch rates in the USA commercial fishery continued to decline during the period. Abundance indices from autumn surveys indicate a drastic decrease (90% since 1969) in pre-recruits (age 1), with the catch per tow in 1974 being among the lowest values observed during the entire series of years for which data are available (Table 19). Assuming that the 1976 pre-recruit index is equal to that for 1975, the stock size index will have decreased by about 80% between 1970 and 1977, and it is obvious that the current stock is extremely low. The catch per day fished by USA vessels has declined from well over 3.0 tons in each year during 1957-72 to 1.9 tons in 1974 and to 1.4 tons in 1975.

iii) Statistical Area 6 stock. Abundance indices indicate a 90% decrease in stock size between 1970 and 1975 (Table 19). If the 1976 year-class is assumed to be about the same size as that of 1975, the stock size in 1977 is projected to be extremely low in contrast to earlier levels.

Table 19. Catch per tow (age 1+) of pre-recruits and associated stock abundance indices for yellowtail in southern New England and Stat. Area 6 from USA autumn surveys.

	Southern New England		Statistical Area 6	
Year	No. per tow (age 1+)	Abundance index	No. per tow (age 1+)	Abundance index
1963	16.3		11.1	
1964	18.6		5.3	
1965	11.5		19.2	
1966	35.5		14.2	
1967	20.0	102.5	12.5	64.4
1968	10.0	119.2	11.6	67.3
1969	12.8	92.6	0.6	59.0
1970	7.3	71.9	1.9	36.8
1971	6.3	53.6	11.0	11.7
1972	4.3	40.0	0.6	22.4
1973	1.9	30.8	0.7	21.6
1974	1.1	20.1	0.04	7.5
1975	1.7	11.9	0.46	2.7
1976		8.1		1.2
1977		7.8		1.6

In the absence of sufficient information about relationships between the stock components in this area, the Subcommittee advises that a single management area should be maintained. Recognizing the depressed condition of the various stocks, the Subcommittee recommends that the TAC for 1977 be set at zero, with the knowledge that unavoidable catches may approach 4,000 tons. Without improved recruitment, even this level of removal will prevent the stock from recovering, and every possible measure should therefore be taken to reduce the level of by-catch. The decline in

catch from about 10,000 tons in 1974 to less than 6,000 tons in 1975 is even greater than the decline in catch per unit effort. Also, the stock abundance indices indicate that fishing mortality is higher than 1.0 whereas $F_{0.1} = 0.4$.

m) Flounders, except yellowtail, in Subarea 5 and Statistical Area 6 (Res. Doc. 75/65)

Provisional statistics indicate that the nominal catch was about 23,300 tons in 1975, slightly higher than the 1974 catch of 21,200 tons. The TAC for 1975 was 25,000 tons. While the bottom trawl surveys indicated a decline in biomass since 1963, no significant change was detected between 1974 and 1975. Examination of length frequency data for American plaice, witch flounder, winter flounder, summer flounder and windowpane flounder from the autumn trawl surveys indicates decline in modal lengths since 1963 but not in the most recent survey years.

The assessment for summer flounder, presented in 1975 suggested that a sustainable catch level of 20,000-22,000 tons might be possible for this component of the flounder group but that the estimates of the unreported catches in the sport fishery were probably at or above the sustainable yield. No new information was presented to update that assessment.

The TAC for flounders, except yellowtail, has been maintained at the level of 25,000 tons annually during 1973-75, on the basis of historical catches, research survey trends in abundance and general biological information. Considering the declining trends observed in the survey data (Res. Doc. 75/65) and in commercial catches, and noting the implications of additional fishing mortality on these species by the USA sport fishery, the Subcommittee recommended a TAC of 20,000 tons for 1976, stressing that every effort should be made to reduce the by-catches of these species in other directed fisheries in the area. The Subcommittee accordingly recommends that the TAC of 20,000 tons be maintained for 1977.

n) Herring in Division 5Y

i) Catch statistics and age composition. Provisional statistics indicate a nominal catch of about 20,500 tons in the 1975 fishery for adults out of a total catch of nearly 36,000 tons. Preliminary data for January to March 1976 show a catch of 3,800 tons which was slightly less than for the same period in 1975. The 1970 year-class continued to dominate in the catches during the early months of 1976, the age composition for ages 3 to 6 being 5, 7, 3 and 78% respectively, compared with 18, 10, 64 and 5% for the same ages in January-March 1975.

ii) Year-class size and recruitment. Additonal information since the January 1976 Special Commission Meeting consists of statistics on catches during the first three months of 1976 and preliminary data on year-class abundance from the 1976 spring juvenile herring survey. Some details of the juvenile herring survey are given in the following section on herring in Div. 5Z and Stat. Area 6, indicating that all year-classes appear to be very low in abundance. Age 2 herring are generally not taken in the Div. 5Y adult herring fishery and less than 1% (by weight) of the 1976 catch in January to March consisted of the 1974 year-class. Considering the very poor catch in the juvenile survey, this year-class was assumed to be about the same size as the poor 1969, 1971 and 1972 year-classes at age 3 (i.e. 64 million fish). The size of the 1973 year-class could not be resolved and two levels of abundance were chosen, as was done in the previous assessment (Part B, this volume). The lower level was the conventional size of 64 million fish at age 3 for poor year-classes. A more optimistic assumption as to the size of this year-class was that it was equal to the average of the sizes of the 1968 and 1972 year-classes (i.e. 91 million fish). The strengths of the other year-classes were assumed to be the same as used in the previous assessment.

iii) The TAC level for 1976. At the January 1976 Special Meeting, the Commission set a TAC of 7,000 tons for 1976 . . . "or an amount which is decided at the Annual Meeting in June 1976 by unanimous vote . . ." (Summ. Doc. 76/VI/6). The additional information since that meeting does not change the assumptions on year-class size that were used in the previous assessment. It should be noted, however, that the results of the 1976 juvenile survey suggest that the 1970 to 1972 year-classes may have been reduced in size more than has been assumed. If a catch of 7,000 tons is taken in 1976 and if the lower level assumed for the 1973 year-class is the more correct one, the adult stock size would be reduced below the minimum stock size constraint of 60,000 tons to about 56,000 tons at the start of 1977.

iv) The TAC level for 1977. In assessing the probable state of the stock in 1977, it is assumed that the 1976 TAC of 7,000 tons will be taken. Also, the mean weight-at-age and partial recruitment values used in the previous assessment (Part B, this volume) were adopted. The projected stock sizes at the beginning of 1978 in relation to projected catches in 1977 for a range of F-values are given in Table 20 and illustrated in Fig. 2. Depending on the assumption as to the size of the 1973 year-class, the stock size at the beginning of 1977

would be in the range of 56,000-60,000 tons. Under either assumption, fishing at F = 0.1 for a catch of about 4,500 tons in 1977 would result in maintaining the stock size at the beginning of 1978 to about the same level as at the start of 1977. If a catch of 7,000 tons is taken in 1977, the resultant stock size at the beginning of 1978 would be in the range of 53,750-57,750 tons. Fishing at $F_{0.1}$ = 0.38 in 1977 would yield a catch of 14,750-15,250 tons but the stock size at the start of 1978 would be reduced to 45,750-49,000 tons. Even a TAC of zero in 1977 would only increase the stock size to 61,000-65,000 tons, depending on the size of the 1973 year-class. Therefore, the Subcommittee recommends a TAC of zero for 1977.

Table 20. Div. 5Y adult herring: stock size (age 4 and older) in 1978 as a function of catch (age 3 and older) in 1977 for a range of F, assuming two levels of recruitment for the 1973 year-class in 1976. (Recruitment of the 1974 year-class is assumed to be 64 million fish.)

Stock size at start of 1976		Catch in 1976	Size of 1973 year-class	Stock size at start of 1977		F in 1977	Predicted 1977 catch	Stock size at start of 1978
(10^6)	*(000 t)*	*(000 t)*	*(10^6)*	*(10^6)*	*(000 t)*	*(100%)*	*(000 t)*	*(000 t)*
248	58	7	64	228	56	0.1	4.4	56.3
						0.2	8.4	52.3
						0.3	12.1	48.6
						0.4	15.5	45.2
						0.5	18.7	42.1
						0.6	21.5	39.2
248	58	7	91	250	60	0.1	4.6	60.0
						0.2	8.8	55.8
						0.3	12.6	51.9
						0.4	16.1	48.4
						0.5	19.4	45.1
						0.6	22.4	42.1

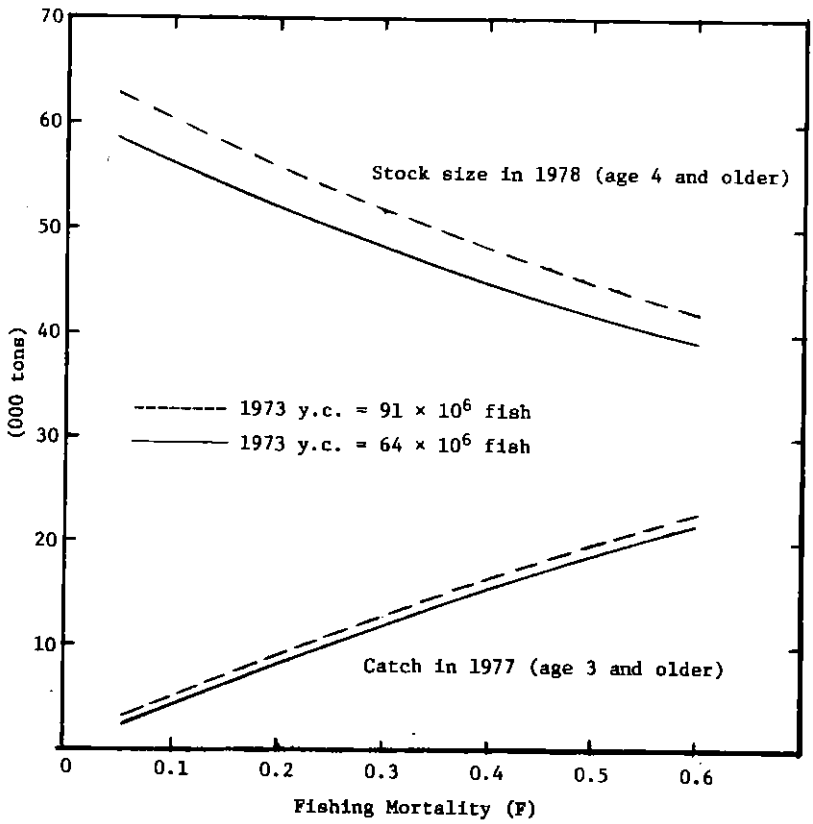

Fig. 2. Predicted herring catches in 1977 and stock sizes in 1978 for the Div. 5Y adult fishery at two levels of recruitment.

o) Herring in Division 5Z and Statistical Area 6

i) Catch statistics. Provisional statistics indicate a catch of about 144,000 tons in 1975, about 1,300 tons more than were reported at the January 1976 Special Meeting. Consequently, the estimates of stock size at the start of 1976, as calculated for the previous assessment (Part B, this volume), were not changed. The TAC for 1975 was 150,000 tons. Catch data for the first two months of 1976 were incomplete.

ii) Year-class size and recruitment. The only additional information available since the January 1976 Special Meeting is data from the March 1976 juvenile herring surveys. Data from the USA spring survey by *Albatross IV* were not available at the time of the assessment. However, information from juvenile herring surveys by *Ernst Haeckel* from GDR and by *Anton Dohrn* from FRG suggests that all year-classes are very low in abundance. The relationship of the 1973 year-class at age 3 to other year-classes, in terms of catch in numbers per tow from the 1973 to 1976 surveys, is as follows:

Year-class	Georges Bank (Strata 13-23) *Walther Herwig*	Georges Bank (Strata 13-23) *Ernst Haeckel*	S. New England (Strata 1-12, 25) *Walther Herwig*	S. New England (Strata 1-12, 25) *Ernst Haeckel*	Total
1970	3,232		1,056		4,288
1971	924		608		1,532
1972	27	15	2	3	47
1973	4[1]	6	12[1]	22	44

[1] *Anton Dohrn* was used in 1976.

The relationship of the 1974 year-class at age 2 to other year-classes, in terms of catch in numbers per tow from the same surveys, is as follows:

Year-class	Georges Bank and S. New England *Walther Herwig*	Georges Bank and S. New England *Ernst Haeckel*
1971	5.40	-
1972	2.18	-
1973	0.62	0.32
1974	0.00[1]	0.00

[1] *Anton Dohrn* was used in 1976.

The 1969 year-class constituted only about 5% of the nominal catch in 1975. The 1971 and 1972 year-classes appear to be nearly fished out. Lacking further information on the size of the 1974 year-class, recruitment at age 3 was assumed to be 550 million fish, the conventional level for poor year-classes. Two levels of abundance were assumed for the 1973 year-class: 550 million and 620 million fish at age 3 in 1976. The level of 620 million was arbitrarily chosen from the average size of the 1968 and 1972 year-classes at age 3. The sizes of the other year-classes in 1976 were as estimated at the January 1976 Special Meeting (Part B, this volume). Survey abundance indices suggest that this procedure may be over-estimating the abundance in 1976-78 of the 1971, 1972 and 1973 year-classes. Although some information was available, it was not sufficient for the Subcommittee to change the parameters that were used at the January 1976 Meeting, and, consequently, no change in the advice provided to the Commission at that meeting is recommended.

iii) The TAC level for 1977. The mean weight-at-age and recruitment values that were used in the previous assessment (Part B, this volume) were adopted for the present assessment. In calculating stock sizes for 1977, it was assumed that the 1976 TAC of 60,000 tons would be taken. The projected stock sizes at the beginning of 1978 in relation to projected catches in 1977 for a range of F-values are given in Table 21 and illustrated in Fig. 3.

At the January 1976 Special Meeting (Summ. Doc. 76/VI/6, Proc. No. 7, App. I), the Commission agreed to . . . "a level of catch for the herring stock in Division 5Z of Subarea 5 and in adjacent waters to the west and south within Statistical Area 6 for subsequent years which will maintain the adult stock at a level of at least 225,000 tons, and that the total allowable catch will be set at 60,000 tons or less per year, until such time as the adult stock reaches the level of 500,000 tons. Thereafter, the Commission will set the total allowable catch so as to maintain the adult stock at a level of at least 500,000 tons." Since the adult stock will not reach the level of 500,000 tons in 1977, the catch in 1977 must not

Table 21. Div. 5Z and Stat. Area 6 herring: stock size (age 4 and older) in 1978 as a function of catch (age 3 and older) in 1977 for a range of F, assuming two levels of recruitment for the 1973 year-class in 1976. (Recruitment of the 1974 year-class is assumed to be 550 million fish.)

Stock size at start of 1976		Catch in 1976	Size of 1973 year-class	Stock size at start of 1977		F in 1977	Predicted 1977 catch	Stock size at start of 1978
(10^6)	*(000 t)*	*(000 t)*	*(10^6)*	*(10^6)*	*(000 t)*	*(100%)*	*(000 t)*	*(000 t)*
978	204	60	550	995	218	0.1	17	263
						0.2	33	247
						0.3	48	232
						0.4	62	218
						0.5	74	205
						0.6	86	193
						0.7	96	177
						0.8	106	173
978	204	60	620	1,049	226	0.1	18	272
						0.2	35	255
						0.3	50	240
						0.4	64	225
						0.5	77	212
						0.6	89	200
						0.7	100	188
						0.8	110	178

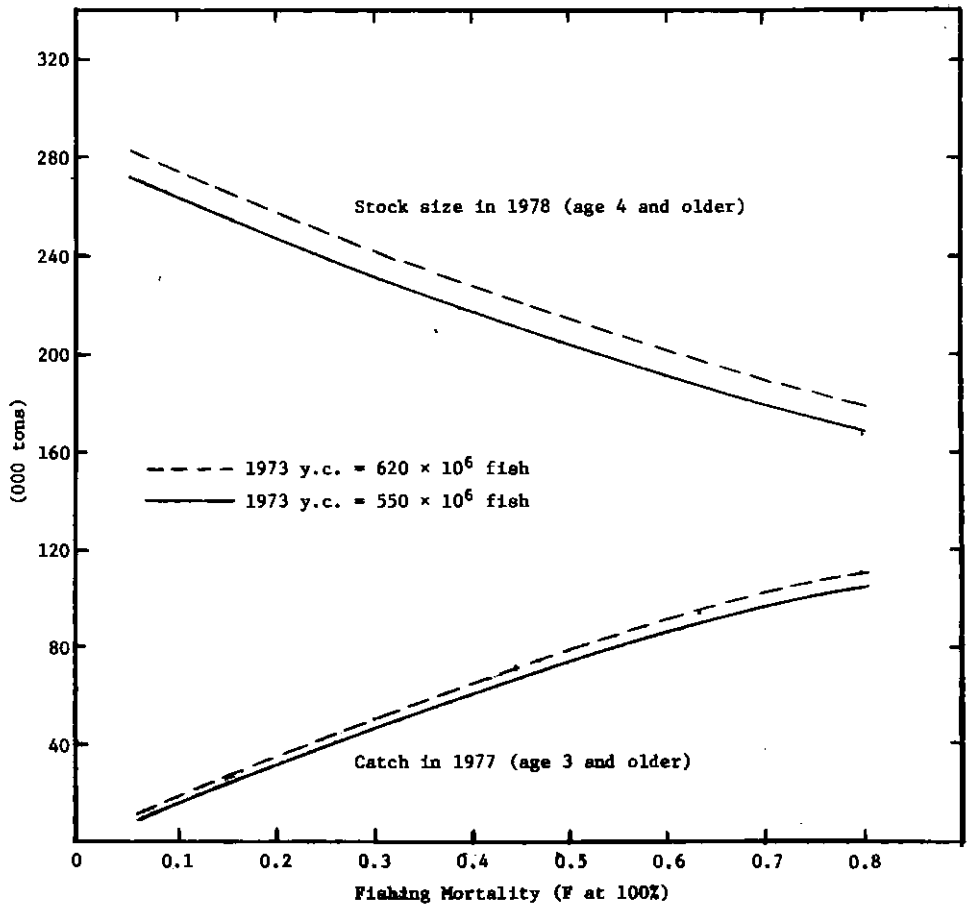

Fig. 3. Predicted herring catches in 1977 and stock sizes in 1978 for the Div. 5Z + Stat. Area 6 fishery at two levels of recruitment.

exceed 10,000 tons (Table 21). To maintain the stock size at the beginning of 1978 to the low level of 225,000 tons, fishing at F = 0.35 and at F = 0.40 in 1977 would yield a catch in the range of 56,000-64,000 tons, depending on the assumption as to the size of the 1973 year-class. Such a catch would be about the level associated with fishing at $F_{0.1}$ = 0.38 but it would not allow for any rebuilding of the stock in 1977. Furthermore, preliminary data from the March 1976 research surveys would indicate that such a catch in 1977 may cause a further reduction in stock size. In view of the uncertainties as to the actual abundance at the start of 1977, and noting the low abundance of the 1971-73 year-classes, the Subcommittee recommends that the TAC for 1977 be set below 60,000 tons at a level of 50,000 tons to allow the stock to rebuild by the same amount between 1977 and 1978 as between 1976 and 1977. This level of TAC would also reduce the probability that the size of the 1977 and subsequent year-classes will be adversely affected by a reduced spawning stock.

The Subcommittee requests STACRES at its 1976 Annual Meeting to examine more fully the effect on stock size of assumptions on year-class strength.

p) Mackerel in Subareas 3 to 5 and Statistical Area 6 (Res. Doc. 76/VI/13, 18, 29, 49, 52, 64; Summ. Doc. 76/VI/17, 18)

i) Catch statistics. Nominal catches in Subareas 3 and 4 decreased from 44,000 tons in 1974 to about 37,000 tons in 1975, and in Subarea 5 and Stat. Area 6 the decrease was from 295,000 tons in 1974 to 246,000 tons in 1975. The corresponding 1975 TACs for the two areas were 70,000 tons and 285,000 tons respectively. There was some question as to the accuracy of the reported nominal catch for 1975, it being suggested (Res. Doc. 76/VI/64) that the catch may be about 40,000 tons greater than that used in the assessment.

ii) Stock identity and biological characteristics. Additional tag returns in Subarea 5 and Stat. Area 6 in 1975 from releases in Subareas 3 and 4 (Res. Doc. 76/VI/49) confirm the north-south migration pattern of mackerel. The distribution pattern of returns during 1973-75 suggests a northerly shift in time of over-wintering from mainly Stat. Area 6 to Georges Bank. Data from USA research vessel surveys during 1968-75 indicate a similar trend (Res. Doc. 76/VI/13). New information from both USSR (Res. Doc. 76/VI/52) and Canadian (Res. Doc. 76/VI/18) research studies in 1975 indicates that about 50% of age 2 mackerel are mature with full maturity being reached at age 3.

iii) Abundance indices for 1975. The results of USA research surveys (Res. Doc. 76/VI/12) indicate a continuing decline in mackerel abundance in Subarea 5 and Stat. Area 6 in 1975. The USA spring survey catch per tow index declined by 96% from 1968 to 1975 and a decline of similar magnitude was observed in the autumn survey. The USA commercial standardized catch per day index increased steadily until 1968 before declining by 94% in 1974, but a moderate increase was evident in 1975. The distant water fleet (DWF) standardized catch per hour index increased from 1968 to 1970, declined in 1971 and 1972 and then increased in 1973 and 1974. The catch per day in the GDR fishery (Summ. Doc. 76/VI/18) declined in the spring fishery by 25% from 1974 to 1975. The catch per day in the Polish winter fishery (Summ. Doc. 76/VI/17) also showed some decline from 1974 to 1975. Preliminary results from the USSR fishery in 1976, in contrast with 1975, indicate a very slight decline in catch per hour. However, interpretation of the DWF catch-per-unit-effort data is complicated by changes in efficiency over the period under consideration.

iv) Catch composition in 1975. Mackerel catches in 1975 were characterized by a predominance of age-groups 1 to 3 and by a substantial reduction in the contribution of age-groups 4 and older (25% in 1975 compared to 44% in 1974). The decline in the percentage of older mackerel was evident in all subareas but particularly in Subarea 3 (Res. Doc. 76/VI/18) which has traditionally reflected an older age distribution of mackerel in the catches. The analyses presented below indicate that the severe reduction in the percentage of older fish (age 4 and older) in the catches has been due to the exertion of excessibe fishing mortality on these age-groups in recent years.

v) Assessment parameters for 1975. The following parameters were determined for use in the overall assessment of mackerel in the ICNAF Area:

(1) Catch at age in 1975. The numbers at age in the 1975 catch were derived from weighted age compositions of the catches by the various countries according to reported sampling data. Canadian age-length keys were used to convert USSR length frequencies from Subarea 4 to numbers at age. In the absence of reported catch statistics, it was assumed that Romania caught its 1975 quota allocation of 3,750 tons.

(2) Partial recruitment in 1975. Graphical plots of fishing mortality from virtual population analysis against age for several years indicated that recruitment was complete for age-groups 3 and older in 1975 and perhaps substantitally so for age-group 2.

(3) Fishing mortality in 1974 and 1975. Fishing mortality on the fully-recruited age-groups (3 and older) in 1975 was initially estimated by regression of F from virtual population analysis on DWF standardized effort for the period 1968-72 and by regression of F from virtual population analysis on indices of fishing effort from USA spring surveys for the same period. The fishing mortality estimated from the respective fishing effort measures in 1975 ranged from 0.5 to 1.4. Because of the wide variance associated with the effort based on survey indices and the confounding effect of efficiency changes on DWF effort, no resolution of the wide differences in estimates of F for 1975 could be achieved. It was decided, therefore, to accept the estimate of F in 1974 (0.80) from survey indices of effort in that year, since the F from virtual population analysis based on estimated effort from survey indices in 1973 and 1974 corresponded well with that predicted from the regression for the years 1968-72. The stock size (age 4 and older) at the start of 1975 was then computed from the estimated stock size and fishing mortality rate (age 3 and older) in 1974. The 1975 stock size, computed in this way, implied that the 1975 catch generated a fishing mortality of 1.1 for the fully-recruited age-groups (age 3 and older) in 1975.

As a check on the probability that the actual F-values were substantially lower in 1974-75 than estimated in this assessment, total mortalities for 1973-75 were also computed from numbers at age per tow in USA spring surveys. These analyaes produced estimates of F = 2.3 in 1973, 2.7 in 1974 and 2.7 in 1975 for age-groups 4 and older, suggesting that the actual fishing mortality rate in those years was high and of the order of magnitude used in this assessment.

vi) Recruitment estimates in 1975. Estimates of the stock size of age 1 fish (1974 and 1975 year-classes) and age 2 fish (1973 and 1974 year-classes) in 1975 and in 1976 (preliminary) were made using two independent approaches: (Method A) from regressions of year-class strength from virtual population analysis on USA research vessel indices of abundance (Res. Doc. 76/VI/29); and (Method B) from regressions of the relative abundance of ages 1, 2 and 3 fish in the mackerel stock (age 4 and over) on the proportional representation of these age-groups in the catches. The results are as follows:

	Estimated strength (millions)			
	Age 1		Age 2	
Year-class	Method A	Method B	Method A	Method B
1973	975-1522	-	436-637	1025-1250
1974	1612-1730	2460-2845	(980-1095)	-
(1975)	(426-1479)	-	-	-

Analysis of the age-specific distribution of fishing mortality in 1974 from virtual population analysis (assuming F = 1.1 on age-groups 3 and older in 1975) suggested that 2-year-olds were almost fully recruited (95%), and, considering the continued decline of older mackerel in the 1975 catches, it was considered prudent to treat age-group 2 as being fully recruited in 1975. The 1973 year-class was therefore computed from virtual population analysis to be about the level of 795 million fish in 1975, a level intermediate between the range of estimates of that year-class at age 2 by the two methods shown above.

The strength of the 1974 year-class at age 1 in 1975 was also computed from virtual population analysis, with the assumption that the average partial recruitment of age 1 fish over the 1968-73 period (25%) also applied in 1975. This produced an estimate of 1,590 million fish for the 1974 year-class in 1975, a level at the lower part of the range of estimates by Methods A and B above. Preliminary results of the USA spring survey in 1976 suggest that the 1975 year-class is also weak.

In the absence of any firm information relating to the strengths of the 1975 and 1976 year-classes, these were assumed to be about equal to the poorest on record (850 million fish at age 1, as estimated for the 1972 year-class). This assumption is conservative in view of the decline in recruitment as evidenced since 1968 when the strong 1967 year-class recruited to the stock as 1-year-olds.

vii) Results of assessment. The analyses of the available data, using the parameters as indicated above, result in estimates of catch, fishing mortality and stock size, as given in Table 22, and the following points are indicated:

(1) In the 1975 assessment, the under-estimate of the fishing mortality on fully-recruited age-groups for 1974 (0.6 as compared with 0.8 now used) has resulted in a substantially

greater under-estimate of the computed fishing mortality for 1975 (0.7 as compared with 1.1 now used).

(2) Estimates of the strengths of the 1972 to 1974 year-classes, used in the present analyses, are substantially less than those estimated or assumed for these year-classes in the 1975 assessment, the comparable values (in millions of fish with the new estimates in parentheses) being 774 (185), 2,644 (795) and 2,500 (1,590) for the 1972, 1973 and 1974 year-classes respectively.

(3) The combined effect of the under-estimation of fishing mortality and over-estimation of recruitment in the 1975 assessment means that the mackerel stock is now in such a drastically reduced state that the 1976 TAC, if fully utilized, will generate a fishing mortality of 4.50 on fully-recruited age-groups and will bring the spawning stock to near extinction in 1977.

(4) The severely depleted state of the mackerel, as indicated in Table 22 and Fig. 4, requires immediate and effective conservation measures, if the resource in Subarea 3 to 5 and Stat Area 6 is to be rebuilt to a level approximately that giving the optimum long-term yield. Of particular concern to the Subcommittee is the very low level of spawning stock predicted for 1977 (less than 2% of the 1970 level). The Subcommittee also stresses that, even with a zero TAC in 1977, a significant fishing mortality could be generated from by-catches of mackerel in other fisheries.

(5) The variance associated with research vessel survey data used to estimate recruitment and mortality may mean that the estimates of these parameters in the present assessment are conservative. However, unless these estimates are substantially pessimistic, the state of the mackerel stocks in 1977 will be essentially unchanged from that resulting from the present analyses. If these estimates are in fact only slightly conservative, the potential surplus production resulting from a zero TAC in 1977 would

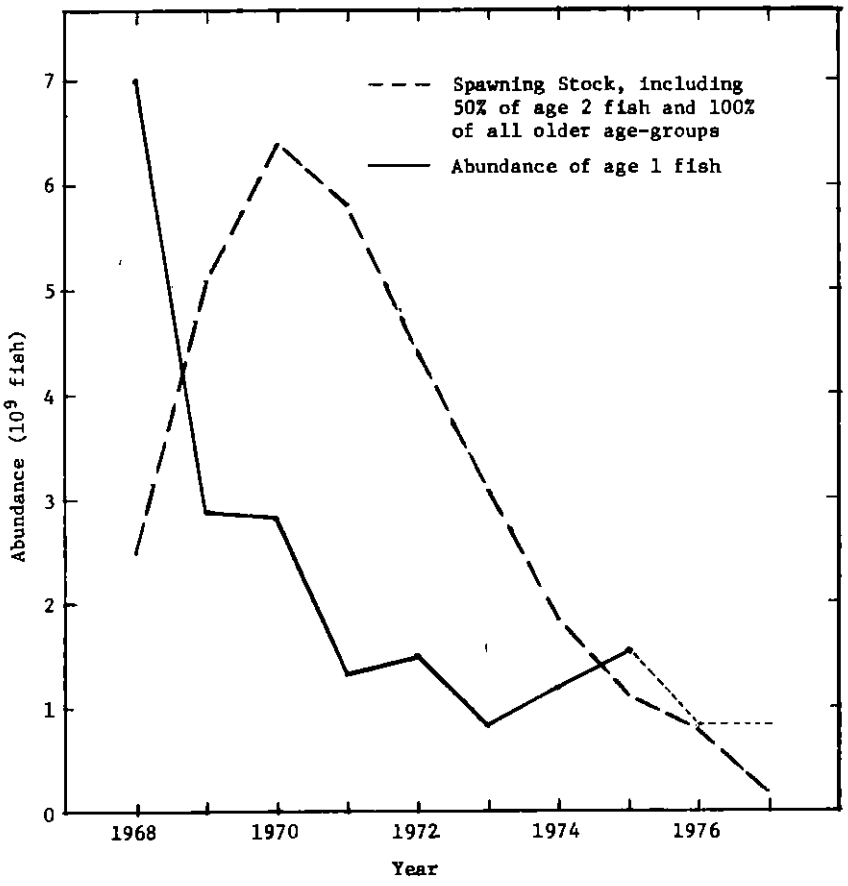

Fig. 4. Abundance of age 1 mackerel in relation to spawning stock size, 1968-77.

Table 22. Results of mackerel assessment for Subarea 3 to Statistical Area 6.

	Year-class	Catch, fishing mortality and stock size by year									
		1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Catch (10^6)	1959	0.1	0.9								
	1960	8.3	13.3	12.9	4.6	3.8	0.3				
	1961	1.3	3.1	19.3	5.1	0.2	0.1	0.1			
	1962	9.2	6.3	21.7	9.8	9.4	1.4	0.4			
	1963	14.3	6.8	14.1	11.1	13.5	4.9	0.8			
	1964	15.3	7.8	15.2	14.1	8.6	7.4	2.0	1.6	0.7	
	1965	57.4	26.1	43.6	48.6	37.2	15.3	8.3	3.4	1.3	
	1966	99.0	99.9	190.2	234.7	114.2	41.6	26.3	10.6	4.1	
	1967	94.5	189.9	408.9	566.2	432.7	217.1	117.3	41.8	16.2	
	1968	2.2	139.5	34.7	110.7	226.5	182.9	117.2	48.4	18.8	
	1969		3.2	143.0	288.7	287.7	261.3	118.5	57.1	22.1	
	1970			3.2	101.2	76.3	237.1	104.3	53.8	20.8	
	1971				1.1	41.8	356.3	270.4	86.4	33.5	
	1972					11.0	95.3	260.7	109.7	42.5	
	1973						0.3	102.9	470.8	182.3	
	1974							5.2	332.5	831.8	
	1975								2.1	391.4	
Total (10^6)		301.6	496.8	906.8	1395.9	1262.9	1421.3	1134.4	1218.2	1565.5	
Weight (000 t)		80.8	131.8	230.6	373.0	409.7	419.3	339.6	283.4	310.0	
Fishing mortality (F)	1959	0.006	(0.079)								
	1960	0.116	0.308	0.631	0.551	1.611	(0.575)				
	1961	0.024	0.083	1.226	1.876	0.361	0.348	(0.809)			
	1962	0.079	0.079	0.474	0.462	1.361	0.890	(0.809)			
	1963	0.100	0.070	0.226	0.313	0.903	1.250	(0.809)			
	1964	0.089	0.066	0.197	0.318	0.368	0.718	0.487	1.100	4.500	
	1965	0.106	0.071	0.181	0.354	0.573	0.562	0.795	1.100	4.500	
	1966	0.051	0.074	0.219	0.518	0.588	0.502	0.804	1.100	4.500	
	1967	0.016	0.044	0.140	0.327	0.506	0.590	0.873	1.100	4.500	
	1968	0.001	0.058	0.020	0.092	0.306	0.493	0.791	1.100	4.500	
	1969		0.001	0.060	0.185	0.317	0.606	0.711	1.100	4.500	
	1970			0.002	0.093	0.104	0.604	0.677	1.100	4.500	
	1971				0.001	0.032	0.470	0.937	1.100	4.500	
	1972					0.011	0.139	0.781	1.100	4.500	
	1973						<0.001	0.105	1.100	4.500	
	1974							0.003	0.275	4.500	
	1975									0.742	
	1976										
Weigbted $\bar{F}$		0.095 (3+)	0.079 (3+)	0.247 (4+)	0.371 (4+)	0.411 (3+)	0.575 (3+)	0.809 (2+)	1.100 (2+)	4.500 (2+)	
Stock size (10^6 fish)	1959	18.6	13.7								
	1960	87.5	57.7	31.4	12.4	5.3	0.8				
	1961	62.3	45.0	30.7	6.7	0.8	0.4	0.2			
	1962	140.3	96.1	65.8	30.3	14.2	2.7	0.8			
	1963	173.4	116.2	80.3	47.4	25.7	7.7	1.6			
	1964	207.9	140.9	97.7	59.4	32.0	16.4	5.9	2.7	0.7	
	1965	658.7	438.9	302.8	187.1	97.3	40.6	17.2	5.7	1.4	
	1966	2300.9	1620.1	1114.7	663.6	292.9	120.5	54.0	17.9	4.4	0.1
	1967	6992.6	5101.9	3617.0	2330.3	1244.7	555.7	228.2	70.6	17.4	0.1
	1968	3859.9	2871.9	2008.5	1458.7	986.0	537.7	243.4	81.8	20.2	0.2
	1969		3820.5	2829.3	1973.3	1215.4	655.7	265.0	96.5	23.8	0.2
	1970			1782.6	1322.1	892.9	596.2	241.4	90.9	22.4	0.2
	1971				2021.8	1514.6	1086.5	502.9	146.0	36.0	0.3
	1972					1156.2	847.1	546.2	185.3	45.7	0.4
	1973						1579.0	1192.0	795.3	196.1	1.6
	1974							2144.9	1589.8	894.6	7.4
	1975									(850.0)	299.8
	1976										(850.0)
Total (10^6)[1]		10642.2	10502.4	10178.2	8091.3	6321.8	4468.0	3298.8	3082.5	2112.7	1149.8
Wt. (000 t)[1]		1974.4	2529.1	1986.3	1816.1	1555.9	1177.4	785.6	574.2	374.2	136.6
Spawning stock[2]	Total	2499.2	5079.6	6344.6	5782.6	4360.7	3077.6	1833.7	1095.0	815.4	160.4
	Wt.	880.3	1619.3	1599.2	1564.3	1359.6	1016.4	635.7	357.9	215.1	29.6

[1] Stock size, age 1 and older.
[2] Spawning stock, including 50% of age 2 fish and 100% of all older age-groups.

rebuild the mackerel population to levels providing the optimum yield, a policy which would also increase the yield per recruit of these year-classes. On the basis of the present assessment, a zero TAC for mackerel in 1977 is indicated. At the present time, therefore, the Subcommittee, with the exception of scientists from GDR, Poland and USSR, recommends a zero TAC for 1977.

(6) Scientists from GDR, Poland and USSR feel that the advice on the sharp decrease for the TAC level for 1977 was based on incorrect initial estimates used in the assessments. High fishing mortality and low recruitment figures were calculated using *Albatross IV* groundfish survey abundance indices. While agreeing that the general trend shown in these surveys is disturbing, they nevertheless feel that these surveys are likely to produce very variable results, since mackerel is a pelagic schooling species encountered in clusters. The groundfish survey data may have indicated a steeper decline in abundance than that which in fact occurred, and their use for estimating fishing mortality would therefore lead to an over-estimate. Since it was the opinion of the above-mentioned scientists that there was no strong scientific evidence for the enormous change in the 1975 initial assessment data in comparison to estimates used in previous years, these scientists were unable to agree with the opinions presented above by the Subcommittee. Scientists of the above-mentioned countries will, therefore, present to STACRES at the 1976 Annual Meeting a new assessment based on other estimates of initial data, also taking into account the information from the commercial fisheries during the early part of 1976.

viii) Data Requirements for a Meeting in Late 1976

The Subcommittee met on 18 June 1976 at the request of the Chairman of Joint Panels 3, 4 and 5 to consider whether sufficient new information could be made available for consideration at a meeting in early December 1976 to allow resolution of scientific disagreement on the status of the mackerel resource and, if such a meeting was considered feasible, to specify the information required. Discussion centred on what new data could be made available, the format of such data and the time scale in which the data could be provided. It was indicated that more detailed data for the years prior to 1976 (with the exception of some research vessel survey data) could not be provided in time for the meeting. However, a variety of data for 1976 could be made available in sufficient detail to significantly increase the possibility of resolving some of the difficulties encountered at this meeting as well as at the April 1976 assessments meeting. While all of the problems in reaching agreement on the TAC for mackerel do not relate to the availability of new data, it was agreed that, if the new data described below are provided, they would be sufficient to merit a reconsideration of the status of the mackerel stock in 1977 at a meeting in early December 1976. The data and analyses required and the formats and timetable for their provision are as follows:

(1) Submission of individual length and age samples (to the extent possible) for the first and second quarters of 1976 as obtained from the catches of commercial, scouting and research vessels fishing in Subareas 3 to 5 and Stat. Area 6, to reach the Secretariat by mid-October 1976. These samples should each include weight at age or sample weight, where possible.

(2) Submission of mackerel catch and effort data for the first and second quarters of 1976 for the commercial fishing fleets by division and month (as on STATLANT 21B forms) to reach the Secretariat by mid-October 1976.

(3) Mackerel catch and effort data for the commercial fleets by month and division for the remainder of 1976 (including estimates for December) to be made available at the time of the meeting in early December in the same format as (2) above.

(4) Because of technical difficulties, commercial sampling data for the catches in the third quarter cannot be submitted to the Secretariat in the normal way (i.e. length and age frequencies and age-length keys) in time for the meeting. However, some arrangement similar to the International Observer Program should be employed whereby scientists from interested countries could be placed on board of vessels of other countries engaged in the mackerel fishery to sample the catches and submit these samples directly to the Secretariat. This would ensure that samples from the fishery in the third quarter would be available by mid-October.

(5) Additional analyses of research vessel data for abundance estimates, particularly for recruiting year-classes, and tow by tow catch data from research vessel surveys should be made available to the meeting.

q) Other finfish in Subarea 5 and Statistical Area 6 (Res. Doc. 76/VI/61)

This category consists of an aggregation of finfish species (except menhaden, billfishes, tunas and large sharks), for which individual assessments are lacking or are available only in preliminary form. Preliminary data for 1975 indicate a total nominal catch of about 96,000 tons, in contrast to the 1975 TAC of 150,000 tons. No new assessments were available for any of the species, and nominal catches were not available by species or on a monthly basis. The Subcommittee noted that for some species there was the potential for development of an intensive directed fishery under the current regulations, and that such a development would not be known in time to advise the Commission on the consequences. It was agreed that advisory TACs should be set for certain species and that montbly catches of these species be reported to the Secretariat, so that member countries can be notified if catches approach these limits and so that the Subcommittee will have more detailed information on these species at its mid-term meetings. The Subcommittee, therefore recommends that the 1977 TAC for "other finfish" be set at 150,000 tons, with advisory TACs within this total as follows: 25,000 tons for argentine; 40,000 tons for dogfishes; 18,000 tons for butterfish; and 10,000 tons (including inshore fishery) for river herrings (*Alosa pseudoharengus* and *A. aestivalis*).

River herrings (Res. Doc. 76/VI/61). A study of the yield and abundance of *Alosa pseudoharengus* and *A. aestivalis* is Stat. Area 6 indicates that, since the advent of the offshore fishery in 1968, catches and catch rates in the traditional USA river fisheries have decreased markedly and the proportions of virgin fish in the rivers have increased. No age or length composition data were available for offshore catches, but it is certain that significant quantities of young fish (ages 2 to 4) would be available and be caught. The effects of even small catches of young fish offshore would be very significant in terms of stock size and yield. It is probable that, although the total catch (offshore and inshore) increased only in 1969, the offshore catcb represents a factor which has led to decreased productivity rather than just a replacement yield for reduced inshore catches. The Subcommittee accordingly recommends that the offsbore catches of river herrings be kept to a minimum and the inshore catches be limited to 10,000 tons, until an assessment of the productivity and the effect of fishing can be completed. It is important that this work be completed in 1976-77.

r) Squid-*Illex* in Subareas 2 to 5 and Statistical Area 6 (Res. Doc. 76/VI/3, 30, 31, 41, 65)

The breakdown of squid catches by *Illex* and *Loligo* separately was still not provided by all countries for 1975, and consequently it is not possible at this time to indicate what proportion of the squid catch of about 46,100 tons in Subarea 5 and Stat. Area 6 consisted of *Illex*. Assuming that only *Illex* is caught in Subareas 2 to 4, the catch in 1975 was 17,400 tons. Discussion of available research data indicated that, although stock relationships have not been fully elucidated, the approach chosen in 1975 to assess *Illex* as a single stock complex ranging from Subarea 2 southwestward to Stat. Area 6 should be continued. As the species occurs in Subarea 5 and Stat. Area 6 throughout the year, suggesting that a component of the stock remains resident there, the effects of harvesting individual components of the stock must be considered. Stock structure studies are therefore needed to clarify this problem.

Preliminary estimates of stock size were made from the results of USSR trawl surveys in June 1972, using a systematic coverage of the area from the Scotian Shelf to southern New England (minimum estimate of 110,000 tons), and from a stratified random survey in 1975 (196,000 tons, but apparently including some *Loligo*). The spring and autumn bottom trawl surveys in 1975 indicated an increase in abundance, but, since this species has a one-year life cycle, the individuals observed in 1975 will not be available to the 1977 fishery. Analyses of yield-per-recruit and stock-recruit considerations indicated that removals could be about 40% of the stock biomass. However, there is considerable uncertainty about the actual quantities caught in recent years and thus in the subsequent estimation of stock size and also in the parameters used in the analyses. These estimates must be improved if the Subcommittee is to make more meaningful recommendations for the management of the fishery. In the absence of reliable estimates of stock size and in view of the uncertainty about the nominal catches, the Subcommittee agreed that preemptive quotas should be maintained to regulate the orderly development of the fishery and that TACs should be set for Subareas 2 to 4 and for Subarea 5 and Stat. Area 6 separately, so that fishing effort cannot be directed entirely to one or the other component of the stock complex. Recent removals are estimated to have been in the range of 20,000-22,000 tons in Subarea 5 and Stat. Area 6 and about 10,000 tons in Subareas 2 to 4, although 17,400 tons were reported from the latter area in 1975. The Subcommittee recommends that the TAC for 1977 be 55,000 tons for Subarea 2 to Stat. Area 6, with 25,000 tons for Subareas 2 to 4 and 30,000 tons for Subarea 5 and Stat. Area 6.

s) Squid-*Loligo* in Subarea 5 and Statistical Area 6 (Res. Doc. 76/VI/14, 30, 31, 41, 64, 65)

The breakdown of squid catches by *Illex* and *Loligo* separately was still not provided by all countries for 1975, and consequently it is not possible at this time to indicate what proportion

of the squid catch of about 46,100 tons consisted of *Loligo*. Also, estimates of catches in earlier years are not yet known to any degree of precision, although countries have been requested to provide the appropriate statistics.

The information available for assessment of *Loligo* includes (i) a series of minimum biomass estimates from Japanese commercial data for the fishing seasons 1968/69 to 1973/74 which indicate a stable population in the area; (ii) USA research survey indices which indicated an increase in abundance through 1975; (iii) a virtual population analysis, which indicated a stock size of about 92,000 tons (1,510 million individuals) at the start (October) of the 1972/73 fishing season and about 89,000 tons (1,430 million squid) at the start of the 1973/74 season; (iv) autumn survey catch data which indicate a minimum biomass estimate of 83,000 tons for the period 1972-75, being in agreement with the estimates from virtual population analyses; and (v) yield-per-recruit and stock-recruit considerations which indicate that removals of 40% of the stock biomass would seem reasonable if a moderate stock and recruitment relationship holds. If no such relationship holds, exploitation rate estimates range from 75 to 95% depending on the constants used. The Subcommittee feels that the assumption of a moderate stock and recruitment relationship is warranted until more specific information is available.

Although there is an urgent need for more accurate estimates of removals and for considerable refinement is the determination of the parameters used in the analyses, the studies available suggest that the TAC of 44,000 tons, which was set for 1976, will ensure the maintenance of current stock size. Rough estimates of catches since 1970 give an average of 33,000 tons annually. Since there appears to be no significant change in stock abundance in recent years, the Subcommittee recommends a TAC for 1977 of 44,000 tons, which, if realized, would represent a 30% increase above recent catches.

t) Second-tier overall TAC in Subarea 5 and Statistical Area 6

At its Special Meeting in October 1973, the Commission agreed that the total catch of finfish (except menhaden, billfishes, tunas and large sharks) plus squids should be regulated to an amount that will allow the biomass of stocks in the area to recover to a level which will produce the maximum sustainable yield.

In attempting to evaluate the effectiveness of these regulations in arresting the decline in stock abundance, the Subcommittee reviewed the time series of biomass levels indicated by research vessel surveys. These data were obtained from autumn surveys and should therefore be an indication of the biomass at the beginning of the following year. The survey indices indicated that the biomass estimate for 1976 was substantially higher than that for 1975 and somewhat higher than that for 1974. With all species included, the average biomass estimate for 1974-76 was still lower (23%) than the estimate for 1971-73, but, with herring and mackerel excluded, the biomass estimate for 1974-76 was about the same as that for 1971-73. The Subcommittee was unable to conclude at this point whether the increase in biomass estimated from the surveys reflects an actual increase in biomass in the area, given the fluctuations that occur in survey indices of abundance between years. However, it is encouraging that the decline in the survey estimate did not continue into 1976.

The Subcommittee also reviewed an analysis of the effects of by-catch on national catches in the area, from linear programming techniques. Using 1974 by-catch ratios to evaluate 1976 overall TAC in relation to by-catch indicated that an 18% reduction in the sum of the TACs would be required in 1976 to allow for by-catch, and hence the overall TAC of 650,000 tons recommended for 1976 by the Subcommittee in 1975 seemed appropriate. It was also noted that the by-catch ratios in directed fisheries had declined from about 30% in 1972 and 1973 to about 18% in 1974. It could not be determined whether a further decline had occurred in 1975.

Given the new information on by-catch rates and possible biomass changes and also the adoption by the Subcommittee of $F_{0.1}$ rather than F_{max} as an appropriate basis for recommending 1977 TACs for many stocks in all subareas, the Subcommittee discussed the need for continuation of the second-tier TAC. It was pointed out that the second-tier TAC was adopted by the Commission to resolve three problems: (i) to compensate for by-catch mortality which is difficult to quantify and control by more direct means; (ii) to take some account of species interactions which are not satisfactorily taken into account in single species stock assessments, and (iii) to allow recovery of the total biomass from the reduced level in recent years to a level giving the maximal or some optimal yield in a fairly short period of time.

It was noted that by-catch ratios in directed fisheries had declined between 1973 and 1974 and that recently introduced regulations, such as closed areas, could reduce these further by 1977. If the change in the basis of TAC regulation from F_{max} to $F_{0.1}$ affects all species more or less proportionately, then by-catches could be expected to change in about the same way. However, since it has been species with very restrictive TACs (e.g. zero TAC for haddock) that have

caused the most serious by-catch problems, the general reduction in exploitation rate, implied by fishing at $F_{0.1}$, should ease these problems. There is, however, an increasing number of stocks with recommended TACs of zero, which will create new by-catch problems. There is also the likelihood that not all by-catch problems are reflected in the Commission's statistics due to deficiencies in by-catch and discard reporting and that this problem is worse, perhaps substantially worse, than is apparent. Despite the many uncertainties regarding the by-catch situation in 1977, it is likely that significant by-catch problems will still exist and that this remains a valid rationale for retaining a restrictive second-tier TAC.

The implications of biological interactions on the estimated level of species TACs and on the relative level of a second-tier TAC to the sum of the species TACs remain a matter on which there is divergent opinion. To some extent, in assessing single stocks over an extensive historical period, interactions with other species are "built-in" to the assessment. These interactions may change, however, when substantial changes in stocks are induced by fishing, and these are not at present predictable. It is uncertain whether this will result in net increase or decrease in productivity. A further aspect is that, in assessing stocks with a short time frame of information (and a significant proportion of the resouces in Subarea 5 and Stat. Area 6 fall into this category), there is less likelihood that the assessment will take adequate account of inter-relationships with other species.

An objective of the management policy in this area has been to restore the biomass to a level of about 4 million tons, the level considered appropriate for removing the maximum sustainable yield. The implication of fishing at $F_{0.1}$ is that the biomass associated with this level in the long term would be somewhat higher than that at F_{max}. While it may be necessary to review the biomass objective, at the present level of biomass the exact level to be achieved is of little practical importance at this time, as neither level will be achieved in 1977. However, fishing at $F_{0.1}$ will result in a faster increase in absolute biomass and the level of 4 million tons will be reached faster. While fishing at $F_{0.1}$ reduces the dependence on the second-tier TAC for stock rebuilding, a restrictive second-tier TAC would provide an additional safeguard.

The Subcommittee agreed that the second-tier TAC was still a relevant management measure and that it should be set at some level lower than the sum of the recommended TACs. The TACs recommended by the Subcommittee sum to 505,000 tons, assuming that the 1977 TAC for mackerel is zero and that the 1977 catch of pollock in Subarea 5 and Stat. Area 6 is 7,000 tons, and it was agreed that 500,000 tons should be used as an upper reference point. Some downward adjustment is required to take by-catches into account. If the by-catch situation in 1977 were similar to that in 1974, a reduction of approximately 20% is indicated. However, given the substantial changes in regulations and TACs since 1974, and the yet to be decided national allocations for the 1977 TACs, this degree of adjustment may be inappropriate. It was therefore decided that a decision on the required percentage reduction be postponed to the 1976 Annual Meeting, pending new linear programming solutions based on the recommended TACs for 1977.

VIII. OVERALL GROUNDFISH FISHING EFFORT IN SUBAREAS 2 TO 4

The regulation of groundfish fishing effort in Subareas 2 to 4 was discussed in relation to the advice, if any, that could be given on appropriate levels of fishing effort in 1977. It was noted that in three of the effort management areas (Subareas 2 + Div. 3K, Div. 3LNOP, and Div. 4VWX) catch rates in 1975 showed no substantial change from the 1974 level, and that the overall decline in catch rates in the 1970's did not reflect any beneficial effects of catch quota regulations. The substantial reductions in some TACs recommended for 1977 and the recommendations for others based on $F_{0.1}$ rather than F_{max}, indicate that no increase in fishing effort can be recommended for 1977.

Recommendations of a more detailed nature cannot be made at this time, particularly since the precise objective(s) to be achieved by the regulation have not been stated by the Commission. If the objective is, for example, solely to provide the basis for more accurate surveillance and enforcement, then the Subcommittee should attempt to advise on the number of days required to be fished to attain the catches corresponding to the levels of TAC to be set. However, if the regulation is designed to provide a safeguard against the deleterious effects of overly optimistic TAC calculations or to provide an effective measure to discount by-catch problems, then different approaches should be taken. Also, it is necessary to know the Commission's intentions on the degree of flexibility in the transfer of effort among areas from one year to another in order to evaluate the likely effectiveness of the regulation in achieving a particular objective.

The Subcommittee discussed the effectiveness of effort regulation as a safeguard against overexploitation of a stock for which the TAC has been set too high. In such a case, if the effort has been set at a level approximating that which is likely to achieve the desired level of fishing mortality on the stock, this would prevent the TAC from being taken. Such would be the case if the effort regulation pertained to a particular species. In the case of cod in Subarea 2 and Div. 3K, for example, where cod is by far the most important species, the effort regulation could provide this safeguard. However, in situations

where a number of species stocks are within the effort regulation area, sufficient flexibility would exist to divert enough effort to take full advantage of stock assessment errors to the serious detriment of the stocks. In this regard, the smaller the effort regulation areas are, the less likelihood there is of this happening. The amount of reallocation of effort allowed among areas is also a relevant factor.

The effects that the regulation may have on catch per unit effort are difficult to predict, but it is likely that catch rates under an effort regulation will not be directly comparable to those of previous years and hence they must be interpreted with caution. There will be an incentive to maximize catch rates by a wide variety of ways, and these have been dealt with in detail in previous reports of the Subcommittee and effort limitation working groups. Limitations to reallocation of fishing effort among areas could, however, have the reverse effect if vessels were limited to fishing in areas of low catch rate because they were not allowed to transfer to other areas where the catch rates were higher.

The effects of fisbing the stocks at $F_{0.1}$ in 1977 will not have a significant effect on catch rates in 1977 but could be expected to result in observable increases in catch rates in 1978 and subsequent years. Tbe level of fishing effort in each management area in relation to the fishing mortality that it would generate has not yet been accurately determined, and hence it remains to be demonstrated whether further adjustments in effort are required to achieve $F_{0.1}$. The Subcommittee points out, however, that the benefits of increasing catches and catch rates to be anticipated after 1977 is not a rationale for increasing the total effort, as these higher catches will be attainable at the same level of effort.

IX. OTHER MATTERS

1. Primary Productivity and Fisheries Yield (Res. Doc. 76/VI/11)

A research document summarizing results of plankton collections during a research vessel cruise in Subareas 3 and 4 was discussed. It was indicated that this type of primary productivity research was necessary to further our understanding of the relationship between fisheries and primary productivity. Correlation between plankton abundance and the amount of fish caught in individual hauls was indicated, but as pointed out it would be difficult to generalize from the data presented. The Subcommittee hopes that studies of this type are continued.

2. Estimation of Parameters

a) New techniques (Res. Doc. 76/VI/8)

A new approach to estimating natural mortality from the relationship of this parameter to age at sexual maturity was discussed. The Subcommittee noted that, although this approach might be useful as a first approximation of natural mortality especially in developing fisheries, such natural mortality estimates should be used with caution because of, among other things, the degree of variability inherent in such relationships, the degree of uncertainty in values of natural mortality estimated with present techniques, and the fact that natural mortality might change in response to fishing pressure and the effects of density-dependent growth, age at maturity, etc. In particular, values of natural mortality which are estimated as extremely high or extremely low should be carefully considered to determine the reasons for such high or low values.

b) Level of sampling in various stocks

Again in 1975, no sampling data were available for a number of stocks and the data that were available for some other stocks were so scanty that they could not be used in assessments of these stocks. As has been emphasized on many occasions before, the accuracy of the advice provided to the Commission is very dependent on the adequacy of the data base upon which the assessments are based. The Subcommittee again urges Member Countries to provide their scientists with the resources to improve their sampling efficiency in future years.

c) Reporting of length and age samples by sex for certain species

Although the absolute necessity of reporting length and age samples by sex for such species as the flatfishes and redfish, in which significant differences in growth rate, natural mortality rate, age at maturity, etc., are exhibited between the sexes, has been emphasized before by the Subcommittee (*Redbook* 1975, page 63) and recommended by the Statistics and Sampling Subcommittee, some sampling data were submitted to the present meeting for these species as unsexed fish. The Subcommittee once again urges scientists in the various countries to provide length and age data by sexes separately for these species, as unsexed data cannot be used in assessments. A complete list of these species is given in *Redbook* 1974, page 128, and also in *Sampling Yearbook*, Vol. 19, pages 9-10.

d) Ageing workshop for cod (Summ. Doc. 76/VI/13 + Addendum 1; Res. Doc. 76/VI/32)

A draft report of the Ageing Workshop, held in October 1975 at the Institute for Fisheries Investigations, Vigo, Spain, was discussed (Summ. Doc. 13 + Addendum 1) as well as another paper related to the problem of age determination of cod (Res. Doc. 76/VI/32). The report showed that, when the samples from different areas were combined to construct an age-length key for each reader, substantial differences in age composition could be observed among certain individual readers. Thus, differences in ageing between readers may have a significant effect on age compositions used in assessments, especially in those cases where data are scanty and age compositions are inconsistent from year to year. Where age compositions are consistent from year to year, even if biased, the effect on assessments is not as significant.

It was noted that there seemed to be a lack of clear guidelines when interpreting otoliths, and that this allowed for a high degree of subjectivity. Most of the differences observed arose from the difficulty of determining which rings were checks or splits. Other problems were associated with determining the first annulus and interpreting the edge of the otolith. The problems seemed to be greater for cod otoliths from Div. 2J, 3K and 3L than for otoliths from Div. 3N, 3O and 3P.

It was generally agreed that more studies are required (otolith structure in each area, deposition of material in the edge, etc.) in order to minimize the degree of subjectivity, and that clear guidelines for age reading for each area be formulated, perhaps in the form of a handbook on otolith interpretation. It was also suggested that all of the photographs, slides and otoliths used in the workshop should be filed with the Secretariat and be available for examination by readers who were not able to attend the workshop. The results of these readings could be compared with those from the workshop.

The Subcommittee considered that the whole or a part of the samples used in the workshop should be circulated for re-reading by the workshop participants. This would permit the estimation of within-reader varisnce and a more accurate analysis of the observed differences between readers. It was noted that the results of such further studies would not likely be available until the 1977 Annual Meeting. It was also suggested that the final report should include the ageing experience of each participant in the workshop together with the nationality of each reader, the areas in which the reader is most expert and the number of years of experience in reading otoliths from each area.

The Subcommittee noted that, if the differences in age determination were random, the calculation of fishing mortalities would not be seriously affected, and the effects of these differences would not be severe if a sufficient number of age determinations were available so as to average out the biases. In any case, it was thought that the re-reading of the many thousands of otoliths for previous years would not be possible.

The Subcommittee observed that the results of the Vigo Workshop in October 1975, together with those of the Bergen Workshop in 1962, constitute a large volume of material suitable for a more vigorous analysis of ageing problems than has previously been possible.

e) Accuracy of catch statistics

All techniques for the calculation of TACs rely implicitly on the availability of accurate statistics of catches from both directed and by-catch fisheries. Any inaccuracy in the reported statistics produce errors in the stock assessments and hence in the recommended TACs. This would be particularly the case for those stocks which are assessed by virtual population analysis (cohort analysis), as an error in the level of catch affects not only the estimates of fishing mortality and recruitment for the year in which the error was made but also the estimates for the preceeding years. This may, in turn, lead to biases in the prediction of the TACs.

f) General production models (Res. Doc. 76/VI/34, 44)

Two papers were presented involving the use of the Schaefer stock production model. Res. Doc. 76/VI/34 describes the behaviour of a model subject to stochastic variation in its parameters. An interesting feature of this model was that the variations were autocorrelated. The model was intended to simulate the effects of environmental conditions which may tend to be good or bad for several years. It was suggested in the discussion that such a system might be better managed at a level below the MSY level of fishing effort. Res. Doc. 76/VI/44 presents methods for determining the parameters of a Schaefer stock production model in a disequilibrium situation.

g) Evaluation of abundance indices for pelagic species from research surveys

The Subcommittee considered that, although the results of survey data have been useful to indicate trends in abundance, they have not resulted in estimates of recruitment which are sufficiently precise for situations when the calculation of TACs are based principally on assumed values for

recruiting year-classes. This problem could perhaps be resolved by further attention to survey design for pelagic species, and it was agreed that the Biological Surveys Subcommittee should be requested to examine this matter further.

3. Documentation of Background Information for Stock Assessment (Summ. Doc. 76/VI/8)

The extent to which it is necessary to document background information on the assessment of each stock for use at subsequent meetings of the Subcommittee was discussed. It was indicated that, for many of the stocks assessed at this meeting, background data on stock size, fishing mortality and catch in numbers are not included in the Subcommittee's report because of the impractability of listing such detailed information for each of the many stocks under TAC regulation. This problem is further aggravated by the increasing practice of including such background information in working papers rather than in research documents, despite the agreed practice of not referring to working papers in the report. The Subcommittee discussed the usefulness of the stock record data in Summ. Doc. 76/VI/8, which lists the background information used at the 1975 meetings of the Subcommittee in assessing the stocks. It was concluded that these stock records, with appropriate modifications to make provision for including more extensive information for some stocks and more complete descriptions of, for example, the details of estimating catch at age from age-length keys, could provide the sort of detailed information on past assessments which is necessary when re-assessing the stocks at current Subcommittee meetings.

The situation could be further improved if agreement could be reached on permitting the reference to working papers in the Subcommittee's report, and it was recommended that STACRES consider further the status of working papers at the 1976 Annual Meeting. Also it was noted that scientists should be encouraged to use the Research Document series for reporting information which may need to be referred to in the report of the Subcommittee. It was concluded that the Chairman of the Assessments Subcommittee, in correspondence with the conveners of *ad hoc* working groups, should attempt to improve the stock record format to be used for summarizing the background assessment data from this meeting.

4. International Herring Tagging (Res. Doc. 75/38; 76/VI/48, 66)

The Assessment Subcommittee discussed the possibility of undertaking a major international herring tagging program to address the problem of herring stock intermixture. Management to date has been placed separately on fisheries harvesting the three major spawning stocks but under an overall regulation regime that would minimize adverse effects on the stocks if, in fact, a significant intermixture occurs. Currently, however, the extremely low level of the stocks in Subarea 5 and Stat. Area 6 and the declining stock size in Subarea 4 raise questions about the continued validity of the latter assumption. Knowledge of the stock(s) to which juvenile herring recruit has also become more critical to assessment as the adult stocks have declined. There is, thus, the need for obtaining information on the degree of intermixture so that appropriate management regulations can be developed. Herring tagging has been demonstrated to be technically feasible by Canadian biologists (Res. Doc. 75/38; 76/VI/48) and has already shown that there are inter-relations between herring from southwest Nova Scotia and Chedabucto Bay (Div. 4W), the Gulf of Maine (Div. 5Y), and Georges Bank (Div. 5Z). The Subcommittee, therefore, strongly recommends that a major international herring tagging study be conducted in several areas as soon as possible.

Tagging areas and numbers of tags to be released according to various objectives were discussed (Res. Doc. 76/VI/66). However, final details should be decided at the 1976 Annual Meeting and each country should be prepared to discuss their participation in detail. Such a large undertaking will require the assistance and cooperation of several countries (particularly on Georges Bank) in the tagging program and all countries in reporting the recaptures. Such an operation should provide information to improve the present management system, in so far as stock overlap is concerned, and will help to ensure that fishing effort is not concentrated on any one stock (such as the small Jeffreys Ledge stock in Div. 5Y). It may also indicate to which adult spawning populations the juvenile herring in Maine and New Brunswick recruit. This in turn might allow management of the complete stocks (by age and area).

APPENDIX II. REPORT OF BIOLOGICAL SURVEYS SUBCOMMITTEE

Chairman: J. Messtorff

Rapporteur: S. A. Akenhead

The Subcommittee met on three occasions during 31 March-6 April 1976 at Dartmouth, Canada, in conjunction with the spring meeting of the Assessments Subcommittee, and again on 31 May 1976 at Montreal, Canada, in conjunction with the Annual Meeting of STACRES, to consider the relevant items on the STACRES Agenda (Part E, this volume). The main considerations involved a review of survey activity in the ICNAF Area in 1975 and survey plans for 1976/77, the elaboration of guidelines for assignment of survey priorities, the development of a pilot project for reporting groundfish survey data to the Secretariat for computer processing, plans for the editing of submissions for the ICNAF Manual on Groundfish Surveys, and further discussion on hydroacoustic survey methods.

1. Review of Survey Results Relevant to Assessments

The Subcommittee concurred with the suggestion of the Assessments Subcommittee that the results of surveys, which were relevant to stock assessments, could better be considered by the assessment working groups in conjunction with discussions on individual stocks. Research documents containing information relevant to assessments were noted as follows: Res. Doc. 75/IX/139; Res. Doc. 76/VI/3, 11, 12, 13, 23, 24, 25, 26, 29, 41, 43, 47, 51, 53, 54, 59, 60, 87.

2. Review of Survey Activities in 1975

An inventory of surveys conducted by member countries in the various subareas and statistical areas during 1975 is listed in Table 1. The design of this table differs somewhat from that in the 1975 Report of the Subcommittee to the effect that (a) surveys are listed for the calendar year, and (b) information is given for three types of surveys (stratified random groundfish surveys, larval and juvenile herring surveys, and other surveys). Totals and sub-totals are provided for ease of summarizing survey activity. It was noted that the juvenile herring surveys use the stratified random design for groundfish surveys in the same area. The groundfish surveys listed under "other surveys" in Table 1 are mainly programs using fixed stations or transects. Some special surveys were undertaken with emphasis on single species (e.g. shrimp, squids, capelin, scallops) and, in addition, some hydroacoustic surveys were carried out.

The total survey activity in 1975 was of approximately the same magnitude as in 1974. However, there was an apparent decrease in Subareas 3 and 4 and an increase in Subarea 5 and Stat. Area 6. The level of survey activity did not change significantly in Stat. Area 0 and Subareas 1 and 2 but remained at a low level in contrast to that in the southern part of the ICNAF Area.

3. Survey Plans and Coordination for 1976/77

Surveys carried out to date in 1976 or planned for the remainder of 1976 and the early part of 1977 are summarized in Table 2.

A provisional schedule for the joint larval herring surveys to be conducted in the Georges Bank-Gulf of Maine area during the autumn and winter of 1976/77 was arranged as follows, subject to confirmation by correspondence with Dr. M. D. Crosslein (USA) who agreed to continue as Task Force Leader:

R/V *Wieczno* (Poland)	- 20 September to 12 October 1976
R/V *Belogorsk* (USSR)	- 15 October to 5 November 1976
R/V *Anton Dohrn* (Fed. Rep. Germany)	- 8 November to 25 November 1976
USA vessel	- 29 November to 18 December 1976
USA vessel	- 7 February to 25 February 1977
R/V *Wieczno* (Poland) (tentative)	- March and/or April 1977

In the event that additional time is available on the September-November cruises listed above, it is proposed that the time be utilized for larval patch studies and/or in support of the herring tagging program on Georges Bank. In addition to the standard Bongo hauls and hydrographic coverage tentatively scheduled for R/V *Wieczno* in March or April 1977, priority will be given to special midwater trawl hauls for post-larval herring and their competitors and predators, if shiptime is available.

Bottom trawl surveys directed toward juvenile herring in Subarea 5 and Stat. Area 6 are again tentatively scheduled for the R/V *Anton Dohrn* and R/V *Ernst Haeckel* in the spring of 1977. It is proposed that these surveys be conducted during the period 1-25 March 1977 using the same sampling methods as in 1976. Concurrent larval herring sampling will form a part of the survey program as in previous years.

4. Guidelines for Assignment of Priorities for Survey Programs

With reference to the discussion at the 1975 Annual Meeting of the need to establish a basis for assigning priorities to survey programs, the Subcommittee set up an *ad hoc* working group to consider how this could best be achieved. Mr. J. G. Pope (UK) suggested a set of tables that could be useful as an aid in establishing guidelines and priorities and agreed to prepare a paper describing the value of surveys for the stocks under quota regulation, in conjunction with the designated experts of the Assessments Subcommittee. These experts were provided with appropriate questionnaires to be completed and returned to Mr. Pope, but time did not permit the completion of the paper for the Annual Meeting. It was agreed that the Chairman should contact Mr. Pope and arrange to have the document completed as soon as possible and circulated to the members of the Subcommittee.

Table 1. Inventory of biological surveys conducted in the ICNAF Area during 1975. (For herring surveys both the number of trawl sets and the number of plankton stations are given.)

	Groundfish surveys using ICNAF stratification scheme				Coordinated larval and juvenile herring surveys					Other surveys				
Sub-area	Div.	Country	Months	Sets	Div.	Country	Months	Sets	Plank.	Div.	Type	Country	Months	Sets
0	No stratification scheme									0	Groundfish	USSR	7,8	?
1	No stratification scheme									A	Shrimp	DEN	7-10	69
										B	"	DEN	7,8,10	9
										C-F	"	DEN	5,7,10,11	5
										C	Groundfish	DEN	4,6,8	4
										D	"	DEN	1,4,6,8-11	18
										E	"	OEN	4-6,8,11	15
										D-F	"	FRG	7,8	~20
											"	USSR	7,8	?
														>140
2	J	FRG	11,12	44						J	Groundfish	CAN	11,12	11
											"	GDR	2	34
											"	USSR	2	?
											Shrimp	CAN	10,11	9
											Capelin	CAN	10,11	15
											Acoustic	USSR	10	-
														>69
3	K	FRG	11,12	28						K	Groundfish	CAN	11,12	(see 2J)
	LNO	CAN	5	113						LNO	"	USSR	6-9	?
	N	CAN	6,7	16						Pn	"	CAN	10	57
	Ps	CAN	6	64						P	"	FRA	1,2	28
				221						P	Herring	FRA	4	?
										KLNO	Capelin	NOR	6,7	?
										N	"	CAN		2
										K	Acoustic	USSR	10	-
										N	"	USSR	6	-
														>87
4	VWX	CAN	2-7,8	188	X	CAN	3,4	-	100	RST	Groundfish	CAN	10	(see 3Pn)
	X	USA	3	49		CAN	11	-	100	RV	"	FRA	1,2	54
		USA	10	90		FRG	3		(see 5Z)	W	"	USSR	11	?
		USSR	8	(see 5Z)					200	X	Squid	FRA	5[1]	57
				327										>111
5	YZ	USA	3,4	244	Y	USA	9,10	-	106	Z	Squids	FRA[1]	5,11,12	47
		USA	10	119		USA	10,11	-	48		Scallop	USA	9,10	144
	Z	USSR	8	98	Z	USA	2	-	86		Acoustic	USSR	3,4	-
				461		GDR	3	33	-					191
						FRG	3	77	60					
						USA	5	-	67					
						USSR	9,10	-	100					
						FRG	10,11	-	100					
						USA	12		93					
								110	660					
6		USA	3,4	260	6	POL	3	55	22	6	Scallop	USA	8	100
		USA	9	54							Acoustic	USSR	3,4	-
		USA	10	190										100
		USA	12	96										
		USSR	8	(see 5Z)										
				600										
Total				1653				165	882					>698

[1] Surveys conducted using standard groundfish stratification scheme.

Table 2. Biological surveys planned for the ICNAF Area in 1976/77.

Country	Type of survey	Area	Dates	Year
Canada, Newfoundland	Groundfish	3LNO	Apr 1-14	1976
	"	3LNO	Apr 20-May 4	
	"	3P	May 11-21	
	"	3P	May 27-Jun 10	
	"	3LN	Sep 7-24	
	"	3LN	Sep 30-Oct 13	
	"	4RST	Nov 16-Dec 6	
	Capelin (acoustic)	3LNO	Jun 15-Jul 1	
	" "	2J,3K	Oct 19-Nov 9	
	Groundfish	4RST	Jan 11-25	1977
	"	3M	Feb 1-17	
	Capelin (acoustic)	3L	Feb 23-Mar 10	
Maritimes	Groundfish	4WX	Apr 27-May 7	1976
	"	4VWX	Jul 6-Aug 6	
	"	4T	Sep 7-30	
	"	4WX	Oct 5-18	
	Acouatic (cod)	4T	Jun 2-18	
	Acoustic	4W	Jul 7-Jul 22	
	Eggs and larvae	4T	Jun 21-Jul 2	
	" " "	4WX	Aug 12-31	
	Larval herring	4X	Mar 23-Apr 10	
	" "	4T	May 26-Jun 14	
	" "	4T	Sep 16-30	
	" "	4X	Nov 8-26	
	Herring tagging	4TVn	May 11-28	
	" "	4VW	Nov 30-Dec 20	
	Pelagic trawling (silver hake)	4WX	Oct 21-Nov 2	
	Acoustic (cod)	4Vn	Jan 17-28	1977
	Eggs and larvae	4WX	Mar 16-21	
	Larval herring	4X	Mar 21-Apr 4	
Quebec	Groundfish	4RS	May 10-Jun 20	1976
	Shrimp	4S	Apr 10-May 8	
	"	4S	Oct 1-18	
Cuba	Acouatic and trawl	6	Jun	1976
	" " "	5	Jun-Jul	
	" " "	4	Jul-Aug	
Denmark, Greenland	Groundfish	1CDE	Apr-Jun	1976
	"	1E	Jul	
	"	1CDE	Sep-Nov	
	Shrimp	1AB	May	
	"	1CD	Jun	
	"	1A	Jul, Oct	
	"	1B	Nov	
	Shrimp (photographic)	1ABCD	May, Jun, Sep	
	Plankton	1BCD	Jul	
	"	1D	Quarterly	
Fed. Rep. Germany	Juvenile herring and plankton	5Z	Mar	1976
	Larval herring	5YZ	Nov-Dec	
	Groundfish	1,2J,3K	Oct-Dec	
	Juvenile herring and plankton	5Z	Mar-Apr	1977
France	Groundfish	2HJ,3KLP 4RTV	Jan 8-Mar 12	1976
	"			
	Herring	3P,4RVW	Mar 15-31	
	Groundfish and squid	4WX,5YZ,6	Oct 19-Nov 29	
	Shellfish	3P	Dec 2-14	

Table 2. (Continued)

Country	Type of survey	Area	Dates	Year
German Dem. Rep.	Groundfish	0,2J,3K	Jan-Feb	1976
	Juvenile herring	5	Mar	
	Juvenile herring	5	Mar	1977
Japan	Squid-*Illex* (jigging)	4,5,6	Jun 2-Oct 13	1976
Poland	Groundfish	5,6	May	1976
	Larval herring	5	Apr	
	" "	5	Sep 20-Oct 30	
	Groundfish	5,6	Feb-Apr	1977
USSR, PINRO	Capelin (trawling and acoustic)	3NO	May-Jun	1976
	Groundfish (trawling)	2J,3KLNO	Jun-Aug	
	Capelin (acoustic and trawling)	2J,3K	Oct-Nov	
	Shrimp (trawling)	1B	Oct-Nov	
	G. halibut (trawling)	0,1,2	Nov-Dec.	
	Capelin (trawling and acoustic)	3NO	May-Jun	1977
	Groundfish (trawling)	2J,3KLNO	Jun-Aug	
	Capelin (trawling and acoustic)	2J,3K	Oct-Nov	
	Shrimp (trawling)	1BC	Oct-Nov	
	G. halibut (trawling)	0,1,2,3K	Nov-Dec	
	R. grenadier (trawling)	0,1,2,3K	Jul-Dec	
ATLANTNIRO	Silver and red hakes	5Z	Jun-Jul	1976
	Larvae, plankton, hydrology	5Z	Aug	
	Groundfish (trawling)	5Z	Aug	
	Silver hake (trawling)	4W	Nov	
	Silver and red hakes	5Z	Jun-Jul	1977
	Plankton, hydrology	5Z	Aug	
	Groundfish (trawling)	5Z	Aug	
	Silver hake (trawling)	4W	Nov	
USA	Larval herring	5	Feb	1976
	" "	5	Dec	
	Groundfish	4X,5,6	Mar-May	
	"	4X,5,6	Oct-Nov	
	Plankton	5	Jul-Aug	
	Larval herring	5	Jan-Feb	1977

5. Reporting and Processing of Survey Data

In the light of the Secretariat's new data-processing potential (a remote job entry terminal connected to IBM 370 and CDC 6400 computers), the question of member countries submitting data to the Secretariat for computer processing was again discussed. An *ad hoc* working group was set up to consider the essential requirements for the reporting of survey data to the Secretariat. The Working Group proposed a set of forms to standardize the reporting and to facilitate the processing of groundfish survey data. Drafts of these forms and an explanation of the concepts behind them are given in Annex 1.

In order to atudy the feasibility of reporting survey data to the Secretariat for processing, the Subcommittee proposed that a pilot study be undertaken using a limited amount of groundfish survey data. Initially the project will be aimed at processing the data of member countries which do not have adequate computing facilities to process their data in detail, but it could form the basis for a centralized survey data base. Dr. J. Messtorff (FRG) stated that his country would be willing to participate in the pilot study. It was pointed out that the limitations on staff and key-punching time at the Secretariat could slow the completion of analyses following the receipt of the data, but that the use of optical-scanning devices would reduce the cost and efficiency of processing. It was also noted that, because several countries have computer programs for processing survey data, the problem of programming would probably be less time-consuming.

6. Manual on Groundfish Surveys

The Subcommittee noted that two of the several contributions for the manual, requested in accordance with the procedure adopted at the 1975 Annual Meeting (*Redbook* 1975, pages 69, 71-73), were submitted for consideration: Res. Doc. 76/VI/99 by Dr. W. Doubleday and Res. Doc. 76/VI/119 by Dr. T. K. Pitt. In order to expedite the editing of the manual, the Subcommittee set up an editorial group, consisting of Dr. W. Doubleday (Coordinator), Dr. J. Messtorff, Dr. M. D. Grosslein, Dr. T. K. Pitt and the Secretariat. A deadline of 1 September 1976 was set for the submission of the outstanding sections, and contributors were urged to forward these as soon as possible by airmail to the Secretariat for subsequent distribution to the members of the editorial group. It is hoped that a preliminary draft of the manual will be available for consideration at the next meeting of the Subcommittee.

7. Hydroacoustic Surveys

Discussions took place in conjunction with a review of acoustic survey techniques (Res. Doc. 76/VI/10 by Mr. J. B. Suomala and Res. Doc. 76/VI/116 by Dr. V. A. Rikhter), and at the request of the Assessments Subcommittee for a consideration of survey design for pelagic species.

Res. Doc. 76/VI/10 deals with the bias in the estimation of density estimates by hydroacoustic surveys due to problems associated with distinguishing "coherent" and "incoherent" signals resulting from insonified schools of fish. The Subcommittee was informed of the interest in this subject of the FAO Working Party for Hydroacoustics and Fish Abundance which has plans for a comprehensive review of the basic problem of target strength estimation, and noted that Mr. Suomala is a member of the Working Party. Mr. Sandeman (Canada) remarked that the Northern Pelagic, the Northern Demersal and the Gear and Behaviour Committees of ICES were planning a joint session at the 1976 ICES Annual Meeting to consider acoustic methods of abundance surveying. Dr. Doubleday (Ganada) initiated a useful discussion on the possible lack of robustness of hydroacoustic estimates of abundance in relation to the assumptions that are made and on how the comparison of acoustic estimates with simultaneous catches may provide solutions, empirical or otherwise, to problems of the type raised by Mr. Suomala. Mr. Parrish (UK) pointed out that these errors stem from the integration of hydroacoustic echoes and that they would be avoided to the extent that individual fish could be counted using high resolution equipment.

Res. Doc. 76/VI/116 by Dr. Rikhter (USSR) focused attention on the question of using hydroacoustics in conjunction with trawling to give abundance estimates. The question of whether pelagic fish deserved distinction from any other clustered species was discussed. Dr. Brown (USA) stated that, as long as the fraction of the population sampled remained constant from one year to the next, no distinction was necessary. The use of hydroacoustics to produce strata for survey trawling for clustered species and for use as an associated variable in generating an abundance index was recognized as a valuable idea. Dr. R. J. Varea (Cuba) reported that his country plans to carry out hydroacoustic surveys for silver hake in 1976 using high resolution equipment in conjunction with comparative trawling in Subareas 4 and 5 and Stat. Area 6. Other hydroacoustic surveys are indicated in Tables 1 and 2.

8. Review of Relevant Matters from the April 1976 Meeting of the Environmental Working Group

The Subcommittee noted the Report of the Environmental Working Croup (Summ. Doc. 76/VI/36), and especially that the time series of data from the larval and juvenile herring surveys was beginning to yield some cogent results. In particular, the analyses indicate that the over-winter mortality of larvae seems to be critical to year-class success. The necessity of continuing the monitoring of larval production, growth and mortality was therefore stressed. The Subcommittee endorsed the recommendation of the Environmental Working Group that Dr. Grosslein remain as Task Force Leader for this cooperative survey program in 1976/77.

9. Other Matters

In order to enable further consideration of survey design for pelagic species at forthcoming meetings, the Subcommittee encourages the submission of papers on survey design for clustered fish species, using acoustic techniques to optimize the trawling required.

ANNEX 1. REPORT OF *AD HOC* WORKING GROUP ON GROUNDFISH SURVEY REPORTING FORMS

Convener: J. Messtorff Rapporteur: S. A. Akenhead

The Working Group, with representatives from Canada, Federal Republic of Germany and USA, met on 2 April 1976 at the request of the Subcommittee to examine the feasibility of reporting groundfish survey data to the Secretariat for processing and to draft the reporting forms.

1. Reporting Requirements

The Working Group considered that the primary objective of reporting survey data to the Secretariat would be to facilitate the analysis of the data for use by the Assessments Subcommittee, by generating weight length and age frequencies, age-length keys, length-weight regressions and mean weights at age. Following a discussion on the minimum data requirements, the Working Group agreed to the following arrangement.

a) Organization of the Information

The Working Group agreed that the relevant survey data could be resolved into three levels of information for purposes of reporting: (i) survey materials and methods, (ii) stations occupied during the survey, and (iii) details of species at each station. The first level should contain information which is constant throughout the survey, including a reference to the stratification scheme, vessel, and a description of the gear used and concurrent sampling (e.g. hydroacoustic, etc.), and also including techniques of measurement and users' species codes. The second category should contain station identification information fixing the location in time and space of each particular tow, including the details of the tow, length frequencies, catch composition by species, and associated environmental data. The third level of the hierarchy would include such information as lengths, weights, ages, maturity, etc., of individual fish. Forms 1, 2 and 3 attached reflect the nature of the minimum data requirements.

b) Sequence of Reporting

Because some of the data require laboratory examination or are not convenient to process during the survey, it was considered that two sets of data might be reported separately. The first would be reported soon after the survey ended and would include the information required under the first two categories mentioned in (a) above. The second set of data, to be reported at a somewhat later time, would include the biological information on each specimen. The delayed reporting of the second set of data would not retard the processing of the first set, as there would be a minimum of replication of the first set included in the second set.

2. Pilot Study for Reporting Survey Data

To study the feasibility of reporting groundfish survey data, a pilot study was proposed that would allow the Secretariat to deal with the computer programming aspects of the problem and to estimate the workload involved before undertaking the commitment to process a very large volume of survey data. The pilot study should consist of the processing of survey data already recorded but not yet processed by one of the ICNAF member countries. For purposes of the pilot study, the information to be reported would be similar to that indicated on the attached forms, pending a final decision of the requirements to be specified in the Manual on Groundfish Surveys, which should be drafted for review at the 1977 Annual Meeting.

SURVEY CHARACTERISTICS

Vessel Name:	Country:	Reported by:
Survey Identification Number:	Strata Design Reference:	
Gear Reference Number:	Plankton Data Reference:	
Date When Cruise Started:	S T D Data Reference:	
Date When Cruise Ended:	X B T Data Reference:	
ICNAF Subarea(s) Surveyed:	Water Chemistry Reference:	
Number of Stations:	Primary Production Reference:	

Species Identification			Sampling Data (✓)					Techniques	
ICNAF Code	Scientific Name	User Code	Length	Weight	Age	Sex	Mat	Length Meas.	Ageing Method

Biol. Surveys FORM 1

STATION CHARACTERISTICS (CATCH)

Survey Identification Number:	Stratum Identification Number:
Sequential Station Number:	Tow Number in This Stratum:
Date (Day, Month, Year):	Position (Lat., Long.):
Start of Tow (GMT):	Duration of Tow (Min.):
Direction of Tow (True):	Speed of Tow (Naut. Miles):
Distance over Bottom:	Depth Range (Min/Max/Avg):

Wind Force:	Wind Direction:	Sea State:
Bottom Temp. (°C):	Bottom Sal. (°/₀₀):	Light Condition:

SPECIES COMPOSITION OF CATCH

Species Code	Number Caught	Weight Caught	Species Code	Number Caught	Weight Caught	Species Code	Number Caught	Weight Caught	Species Code	Number Caught	Weight Caught
Total Weight of Catch (kg):											

Biol. Surveys FORM 2A

STATION CHARACTERISTICS (LENGTH FREQUENCIES)

Survey Identification Number:	Stratum Identification Number:
Sequential Station Number:	Tow Number in This Stratum:
Date (Day, Month, Year):	Position (Lat., Long.):

Length (cm)	LENGTH FREQUENCIES (Insert Species Codes and Sex (if Applicable) in the Boxes Below)													
0														
1														
2														
3														
4														
5														
6														
7														
8														
9														
0														
1														
2														
3														
4														
5														
6														
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5														
6														
7														
8														
9														
0														
1														
2														
3														
4														
5														
6														
7														
8														
9														
TOTALS														

Biol. Surveys FORM 2B

SPECIES CHARACTERISTICS

Survey Identification Number:	Stratum Identification Number:
Sequential Station Number:	Tow Number in This Stratum:
Date (Day, Month, Year):	Position (Lat., Long.):

SPECIES CODE:					SPECIES CODE:					SPECIES CODE:				
Length	Weight	Age	Sex	Mat.	Length	Weight	Age	Sex	Mat.	Length	Weight	Age	Sex	Mat.

Biol. Surveys Form 3

APPENDIX III. REPORT OF STATISTICS AND SAMPLING SUBCOMMITTEE

Chairman: Sv. Aa. Horsted

Rapporteurs: V. M. Hodder
S. A. Akenhead

The Subcommittee met during 31 May to 2 June 1976 to consider and report on matters referred to it by STACRES (see Part E of this volume for Agenda). Representatives attended from all member countries, except Bulgaria, Iceland, Italy and Romania, and observers were present from ICSEAF, ICES and FAO.

1. ICNAF Statistical Activities

The Assistant Executive Secretary reviewed the summary of statistical activities as presented in Comm. Doc. 76/VI/15, noting that considerable progress was made since the last Annual Meeting in establishing an automated data base. In January 1976 the Secretariat acquired its in-house terminal, which is linked to an IBM 370 computer, with the option to use a CDC 6400 computer if and when required. Mr. Scott Akenhead joined the Secretariat staff in July 1975 as Biostatistician, and an additional statistical clerk was taken on staff toward the end of 1975.

a) ICNAF Statistical Bulletin

The Subcommittee noted that Vol. 24 for 1974 was issued in January 1976, with the delay in publication due to the late arrival (as in the previous year) of STATLANT 21B statistics from two countries. The Subcommittee stressed the importance of having the detailed catch and effort statistics available for use by scientists as soon as possible after each Annual Meeting and again urges member countries to adhere as closely as possible to the deadline of 30 June.

The Subcommittee noted the revisions to the ICNAF list of species as prepared by the Assistant Executive Secretary and the CWP Secretary following the mandate given them by the Subcommittee at the 1975 Annual Meeting and agreed to the use of this revised list in future statistical publications.

b) Advance Monthly Statistics for Assessments

The Subcommittee was informed that the advance statistics for the April 1976 Meeting of the Assessments Subcommittee, requested by Circular Letter in December 1975, were very incomplete, even worse than in the previous year, when the program of requesting preliminary data was initiated. The Subcommittee noted that the provisional monthly catch statistics resulting from the Commission's requirement for reporting by stock area was not very suitable for use in conjunction with sampling data reported by ICNAF divisions or subdivisions, and urged that member countries make every effort to ensure that the advance statistics are reported in accordance with the requirements of the Assessments Subcommittee by month, division and major gear category.

c) Statistics on Discards (Summ. Doc. 76/VI/29)

The Subcommittee noted the sparseness of information on discards, reported in Summ. Doc. 76/VI/29, particularly in regard to the absence of data from several countries with significant fisheries in the ICNAF Area. The problem of discarding at sea was considered to be very important, and, recognizing that the Commission now requires that data on discards be recorded in fishing logbooks, the Subcommittee noted that considerable improvement in the reporting of discards statistics for 1975 could be expected. It was pointed out that national scientists should take an active interest in analyzing the logbook data on discards to ensure that the most reliable information is submitted to the Secretariat.

d) Adequacy of National Reporting of Fishery Statistics

The Assistant Executive Secretary informed the Subcommittee that there has been little improvement in quality and promptness of reporting STATLANT statistics by national statistical offices in recent years, despite the urging by STACRES, and even by the Commission, that member countries provide the resources necessary to enable their statistical offices to carry out the requirements of STACRES. A major difficulty is the failure on the part of some countries to submit their reports in accordance with the established deadlines, and this results in serious gaps in statistical tabulations prepared by the Secretariat for use of the various subcommittees and working groups of STACRES. Member countries are again urged to comply as closely as possible with the established procedures for reporting.

e) Review of STATLANT Forms

The Subcommittee reviewed the new STATLANT 21A and 21B forms, prepared by the CWP and approved

in principle on the basis of a draft version presented at the 1975 Annual Meeting. It was noted that the new forms were introduced into the STATLANT program early in 1976 for the reporting of fishery statistics for 1975, and that the notes for the completion of Form 21B would be modified later this year to provide for the reporting of detailed catch and effort statistics by 30' × 30' unit areas and by twice-monthly time periods, when statistics for 1976 are solicited early in 1977. It was further pointed out that, with the much greater breakdown of catch and effort statistics required for 1976 and subsequent years, it would be necessary to have the catches recorded in a unit smaller than the "metric ton" unit now used. Noting the need to introduce the smaller unit in the request for 1976 data early in 1977, the Subcommittee

recommends (2)

that for statistics reported by 30' × 30' unit areas and twice-monthly time periods the weight unit be the "kilogram", pending consideration of this matter at the next session of the CWP.

2. List of Fishing Vessels

The Assistant Executive Secretary reported that the publication of the 1974 List of Vessels, issued in February 1976, was delayed for nearly a year due to late submission of reports from two countries, and the list for one country was not received. Immediately after the publication of the 1974 list, member countries were requested to update their 1974 lists to the status of 1975. Revisions received up to the time of the Annual Meeting are presented in Summ. Doc. 76/VI/34 and Addendum. It was pointed out that updated computer lists are available upon request to the Secretariat. It was suggested that for research purposes a partial list of revisions need not be reproduced as a summary document until after all or most countries have reported, which is likely to be after the Annual Meeting, but that a report be made on the status of information available at the time of the Annual Meeting. It was, however, agreed that STACTIC's possible interest in this matter should be taken into consideration.

3. Statistical Activities of Other Agencies

a) The Subcommittee reviewed the ICES Statistical Committee's Report (Summ. Doc. 76/VI/25), and also extracts of resolutions passed at the 1975 Annual Meeting of ICES (Summ. Doc. 76/VI/26). The Subcommittee noted that some of the tables in the most recent issue of Bulletin Statistique were produced from computer tabulations.

b) The Assistant Executive Secretary informed the Subcommittee that correspondence with the Secretary of the CWP indicates that the ninth session of the CWP will probably be held in late summer or autumn of 1977 at the ICNAF Secretariat Office in Dartmouth, Canada. Since the country representation for ICNAF has been undertaken by USA during the last two sessions of the CWP, the Subcommittee

recommends (3)

that Canada be nominated to represent ICNAF at the next CWP session. Other ICNAF representatives would be the Assistant Executive Secretary and the Chairman of the Statistics and Sampling Subcommittee.

4. Review of Sampling Activities

a) ICNAF Sampling Yearbook

Volume 19, issued in February 1976, contained lists by species of all available 1974 sampling data reported to the Secretariat. The Biostatistician noted that a section entitled "ICNAF Sampling Program" was introduced for the first time and expressed the need for the Subcommittee to review this section (reproduced as Appendix to Summ. Doc. 76/VI/27) with a view to improving the guidelines. Point by point discussion of the guidelines resulted in a number of proposals for improvement which the Secretariat will introduce in future issues. It was also proposed that a section of the yearbook be devoted to the presentation of length-weight data.

The Subcommittee welcomed a proposal that an exchange of sampling manuals, which have been developed by various countries, be undertaken through the Secretariat, and suggested that English copies of such manuals be sent to the Secretariat for distribtuion to interested scientists.

b) Adequacy of Sampling

The Biostatistician reviewed Summ. Doc. 76/VI/33, which indicated that the minimum sampling requirement was met for less than 60% of the stocks for length sampling and less than 50% for age in 1974, noting that the percentages pertain only to named TAC species with no consider-

ation of data for species included in the species groups referred to as "Flounders, except yellowtail" and "Other finfish". For five TAC stocks no sampling data were available. The lack of improvement in the quality and quantity of sampling data reported for 1974 is very discouraging and member countries were again urged to adequately sample their commercial catches and report the data to the Secretariat. The Subcommittee agreed that this type of analysis of the sampling data should be continued in order to monitor the adequacy of reporting by member countries in future years.

c) Early Requirement for Sampling Data

The Subcommittee reiterated the importance of the national reporting of all available sampling data to the Secretariat early enough in the calendar year to ensure that the data are available for the use of assessments scientists in advance of the mid-term meeting of the Assessments Subcommittee. It was agreed that the Secretariat continue the procedure of the past two years in soliciting the data prior to the 1977 meeting of the Assessments Subcommittee.

d) Report on Special Sampling Project

Res. Doc. 76/VI/100 was presented by Dr. Doubleday who thoroughly analyzed the available data on cod, mackerel and silver hake, reported by several member countries in response to recommendations of the Subcommittee at the 1974 and 1975 Annual Meetings. The major conclusions of the study are:

(i) Monthly age-lengths keys for silver hake and mackerel are desirable, instead of quarterly keys as at present.

(ii) The detailed spatial reporting of sampling data is less likely to improve the precision of age composition of catches than is the reporting on a smaller time scale.

(iii) The distribution of sampling throughout the fishery is considered a very important factor relevant to improvement of sampling methods.

(iv) The problem of age determination would appear to be one of the most serious problems.

Discussion of Res. Doc. 76/VI/100 indicated that there are some definite advantages of data-processing at the Secretariat over processing by individual countries, and the Subcommittee accordingly

recommends (4)

(i) that STACRES proceed to implement the establishment of an adequate base of sampling data at the Secretariat in order to provide the basic information required for scientific studies; and

(ii) that a small group of consultants be nominated, together with the Secretariat, to specify the requirements and costs of implementing such a detailed data base, including methods of processing, in order that subcommittees and working groups may be provided with such tabulations and data analyses as required to carry out their tasks.

It was suggested that a representative from each of Canada, USA and USSR might form the nucleus of this group, which should meet for about a week at the Secretariat Office in advance of the next Annual Meeting. Since such a meeting would be in the nature of a consultation to aid the Secretariat in appraising the implementation of such a program, it would be considered appropriate that ICNAF pay the expenses of participants to this meeting, should it be necessary.

5. International Scientific Observer Scheme

The Chairman reviewed the status of the International Scientific Observer Scheme as contained in the June 1975 Meeting Proceedings No. 4. It was noted that STACRES' comments on the scheme, to the effect that there should be a clear distinction between the Observer Scheme and any program under the Joint Enforcement Scheme, were incorporated in the Commission's resolution relating to the adoption of a scientific observer scheme. While still expressing its great interest in the Scientific Observer Scheme, and noting that such a scheme would contribute materially to the development of sampling techniques at sea, the Subcommittee noted that no national reports on implementation of the scheme were available.

6. Review of Pertinent Papers

a) Conversion Factor for Lumpfish

Res. Doc. 76/VI/94 describes Danish (Greenland) material collected to determine conversion factors from lumpsucker roe to whole round fish. It was noted that the use of the proposed overall factor of 3.31 for Greenland catches would mean that lumpsucker males sold locally for consumption would also be included in the nominal catch.

b) Measuring of Roundnose Grenadier

Res. Doc. 76/VI/93 proposes that, since roundnose grenadiers frequently have lost part of their whip-shaped tails, specimens could best be measured from the tip of the snout to the beginning of the anal fin. The paper gives the relationship between this partial length and the total length for undamaged fish and further proposes that length samples be recorded by this partial length in half-centimetre groups. While agreeing that this method of measurement could overcome the problem of getting unbiassed samples of whole fish, it was agreed that the actual reporting and grouping of individual data should be discussed further next year when more data, including ages, are available. The Subcommittee therefore considered that, for the time being, there should be no change in the requirements for reporting data on roundnose grenadier (i.e. the length data should continue to be reported as total length in 3-cm groups and by sex).

7. Acknowledgement

The Subcommittee expressed its appreciation for the important analyses carried out by Dr. W. G. Doubleday in regard to the Special Sampling Project and for the great amount of work by the ICNAF Secretariat in keeping up with the increasing workload of collecting and reporting detailed statistical and biostatistical data. Appreciation was also expressed for the cooperation between the ICNAF Secretariat and the CWP Secretary.

APPENDIX IV. REPORT OF *AD HOC* WORKING GROUP ON FISHING EFFORT STUDIES

Chairman: R. C. Hennemuth

Rapporteur: B. W. Jones

The Working Group met on 1 June 1976 to consider the items referred to it by STACRES (Part E, this volume). Representatives attended from Canada, Cuba, Denmark, France, Federal Republic of Germany, German Democratic Republic, Japan, Norway, Poland, Portugal, Spain, USSR, UK and USA, and observers from FAO and ICSEAF.

1. Review of Papers on Fishing Effort Studies

The Chairman briefly reviewed the report of the Working Group from the 1975 Annual Meeting with respect to requests for specific studies. He noted that there were no contributions relating to quantitative studies on changes in gear and operating factors by vessel types that occurred during 1971-75 with the increase in the mackerel fishery in Subarea 5 and Stat. Area 6. However, four papers were presented and discussed relevant to analyses based on the Div. 5Z Pilot Study Data.

a) Variability of the Catchability Coefficient (Res. Doc. 76/VI/106)

This paper presents a study of variability of q as measured by variation in daily catch per effort. Daily records of large (1800+ GRT) vessels of Federal Republic of Germany, Japan and Poland for two years from Div. 5Z and Stat. Area 6 were examined to determine the source of the variation. Catch and effort (hours fished) data were fitted to a covariance model with effort as a covariable. Year, season, 30' unit area and vessel factors were included in the model. Separate analyses were run by country and area (5Ze, 5Zw, 6A, 6B+C). The relationship between catch and effort for Polish data could be considered to be linear, but this was not the case for data of Federal Republic of Germany and Japan. The implication of the non-linear relationships is that a desired reduction in fishing mortality (to be achieved by proportionally reducing the fishing effort based on the number of days fished) could in theory be nullified by increasing the number of hours fished per day. Moreover, comparisons of catch per hour fished between, say, 30' unit areas is dependent on the pre-selected number of hours fished. For data in which the species composition of the catches was similar within year and divisions, the time factors had higher F ratios than 30' unit area and vessel factors; where the species composition of catches varied over time, the F ratios of vessel and 30' unit area factors were higher. The estimated 30' unit area effects for each country's data were fairly consistent between countries, except where the species composition of the catches of the three countries differed considerably. The estimated year effects for each country's data were in all cases closer to the ratios of total catch to total days fished (using the same data) than to the ratios of total catch to total hours fished.

b) Fishing Power Studies (Res. Doc. 76/VI/117)

This paper presents an analysis of data for large (1800+ GRT) vessels of Federal Republic of Germany, Japan and Poland. Working with area/day blocks, coefficients of relative fishing power were calculated, together with standard deviations and coefficients of variation. Within a country, relative fishing power coefficients varied depending on which vessel in the fleet was used as the standard. There was a large amount of variation in the fishing power, and coefficients of variation were often in excess of 100% and rarely less than 50%. The distributions of catch per unit effort were examined, with that for Federal Republic of Germany vessels approaching a normal distribution while those of Japanese and Polish vessels being much more skewed. It was observed that the relative fishing power coefficients were always greater than or equal to the ratio of mean catch per unit effort for two vessels based on the same data. In view of this, it was noted that, unless data are reported on a fine enough scale to accurately estimate relative fishing power coefficients, using the ratio of means to estimate these coefficients results in an over-estimation of the fishing effort corresponding to a desired level of fishing mortality.

c) Changes in Efficiency of Certain Fleets, 1960-73 (Res. Doc. 76/VI/105)

This paper presents some notes on changes in efficiency of certain fleets fishing in Subarea 5 and Stat. Area 6 during 1960-73. Catch and effort data were used to calculate the standard error (SE) of catch per unit effort (CPUE) and also $\overline{CPUE}/SE$ as measures of fishing efficiency. The standard error of CPUE would be expected to decrease and level off with time if a fleet attempted to maximize CPUE at all times. A sharp change in this statistic could indicate the adoption of a new fishing pattern. The standard error of CPUE is not independent of changes in CPUE, and in order to overcome this disadvantage the $\overline{CPUE}/SE$ was also used. These statistics were found to be informative in indicating when changes in fleet operations occurred, which are not evident from inspection of CPUE data alone. The use of a new learning index suggested that

sharp and continued increases in efficiency occurred for the larger (1800+ GRT) vessels of German Democratic Republic, Poland and USSR after these vessels entered the fishery in Subarea 5 and Stat. Area 6, whereas similar increasea were not apparent for the smaller vessels of these and other countries.

d) Variability of Research Vessel Trawl Surveys (Res. Doc. 76/VI/104)

The paper presented information on variability of *Albatross IV* catch per tow in relation to variation in catch per unit effort of commercial veasels. Data from the Subarea 5 Pilot Study were used to provide the comparable estimates of variation for commercial vessels. The latter proved to be lower than the former, but the commercial data involved more vessels and many more tows per unit area than the *Albatross IV* which averaged about 5 tows per unit area.

2. Review of Other Relevant Papers

A paper on the peculiarities of diurnal vertical migrations of mackerel in the Northwest Atlantic was presented (Res. Doc. 76/VI/111). The diurnal variation in availability of mackerel to bottom trawls is described. Mackerel were found on or close to the bottom during the daylight hours but moved off the bottom to feed on plankton during the night.

3. Problems in Implementing Fishing Effort Regulations in Subareas 2 to 4

The Working Group was unable to comment on this matter, as it was considered too early to appraise the effects of the effort limitations in Subareas 2 to 4, which are being implemented for the first time in 1976.

4. Future Fishing Effort Studies

The Working Group agreed that it should not be necessary for the Group to meet again on a routine basis but that it could be reconvened if there was a specific requirement or project to deal with.

APPENDIX V. REPORT OF ENVIRONMENTAL SUBCOMMITTEE

Chairman: H. W. Hill

The Subcommittee met on 1 June 1976 at Montreal, Canada, to consider the agenda items referred to it by STACRES (see Part E, this volume). Prior to this meeting, the Environmental Working Group met during late April 1976 to review progress on research plans agreed to at the 1975 Annual Meeting, and its report is appended as Annex 1. In considering the various agenda items, the following papers were reviewed: Summ. Doc. 76/VI/12, 16, 17, 18, 20, 23, 31, 32 and 36: and Res. Doc. 76/VI/2, 4, 5, 6, 7, 11, 36, 37, 68, 70, 71, 72, 73, 74, 76, 77, 78, 81, 84, 85, 86, 88, 89, 92, 95, 97, 114 and 115.

1. Review of Environmental Working Group Report

The Working Group, chaired by Mr. E. J. Sandeman (Canada) met at Szczecin, Poland, during 26-30 April 1976 to review progress and consider further plans for research in Gulf of Maine-Georges Bank and Flemish Cap areas, to review the proposed standard oceanographic sections and stations, and to specify the data products required of MEDS (Marine Environmental Data Service).

a) Gulf of Maine-Georges Bank Area

The Subcommittee noted the considerable amount of progress made during the year in accord with recommendation 29 of the 1975 Annual Meeting (*Redbook* 1975, page 92), and in particular noted that the time series of data from the herring surveys was starting to yield cogent results. In this respect, the results from larval and juvenile surveys have indicated that the over-winter mortality of larvae is critical to year-class success. This supports the hypothesis, initially agreed by the Working Group, that the relative success of a year-class is determined during the first year of life.

A general discussion of hypotheses and the factors likely to control success of year-classes of herring was a highlight of the Szczecin meeting. Following agreement that the model presented in Res. Doc. 76/VI/4 could represent a conceptual model of the dynamics of the Georges Bank herring stock, the assumptions inherent in the model were examined with a view to the possibility of testing them. Recognizing the necessity of continuing the monitoring of larval production, growth and mortality and noting that research vessel time is limited, the Subcommittee considered that the following program could be implemented during the 1976/77 season, and accordingly

recommends (10)

i) that herring scales, as well as otoliths, for the Georges Bank stock be collected and back calculated;

ii) that relationships between ℓ_1 and year-class size from sequential population analysis, between the growth rate of 1+ herring and stock biomass, between the growth rate of 1+ herring and stock biomass of other species, and between the growth rate of herring and other environmental factors, be examined through the use of correlation analysis;

iii) that, because predation is considered important as a stabilizing mechanism, greater emphasis be placed on surveying for predators, involving an expanded program of stomach analysis of all possible predators; and

iv) that the maturity data collected through commercial sampling be analyzed to study possible shifts in the maturity ogive which could be an important population control mechanism.

With respect to *(iii)* above, it is suggested that stomach content data be collected from fish caught in commercial and experimental trawls, and that fine-meshed midwater trawl sets be made, in addition to the standard Bongo hauls, to catch smaller organisms which could compete with herring larvae and juveniles.

The Subcommittee was firmly of the opinion that greater emphasis should be placed on understanding the distribution of juvenile herring in the second six months of life but it was unable to identify the necessary resources for this program. It also recognized the necessity of studying the fine structure of the vertical distribution and identifying the processes responsible for larval retention systems, and considered that the study of a larval patch is of such priority that it should again draw the attention of member countries to recommendation 29(vi) (*Redbook* 1975, page 92.

The Subcommittee was appreciative of the work done by the task force leader during the year, and

recommends (11)

that Dr. M. D. Grosslein continue as task force leader of the Cooperative Larval Herring Surveys for 1976/77.

b) Flemish Cap

At the 1975 Annual Meeting, Dr. Konstantinov (USSR) and Dr. Wolford (USA) were nominated to participate in a joint study of the long time series of USSR and USA data available from the Flemish Cap area, in accord with recommendation 30 (*Redbook* 1975, page 92). Unfortunately, they have been unable to prepare a joint report for this Annual Meeting. Although it is understood that both have prepared separate reports, only Dr. Wolford has been able to present his to the Subcommittee to date. Since a large proportion of the data available for this area has been collected by USSR but not yet presented to the Subcommittee, it seemed clear that progress toward a research proposal for Flemish Cap could not be made at the present meeting. However, the Subcommittee reaffirmed the desirability of proceeding with this proposal and noted that the US Coast Guard will actively support the research if there is substantial interest by other member countries. The Subcommittee considered that rapid progress would be most likely if a meeting could be arranged between the relevant interested scientists, and accordingly

recommends (5)

that Dr. Konstantinov be asked to convene a meeting of a small group of scientists (including the Subcommittee Chairman and Dr. Wolford), who might be directly concerned with a coordinated international experiment on Flemish Cap, to further examine the data base, to appraise the suitability of Flemish Cap as an area worthy of special study and, if the outcome of this appraisal is favourable, to develop a preliminary proposal for consideration at the 1977 meeting of the Environmental Subcommittee.

c) Standardization of Oceanographic Sections and Stations

The Subcommittee studied the proposed sections and stations listed in Circular Letter 76/25 and those in Res. Doc. 76/VI/37, and accordingly

recommends (6)

that the sections and stations listed in Circular Letter 76/25, after some minor editorial amendment, and those listed in Res. Doc. 76/VI/37 Corrigendum be adopted as standard ICNAF oceanographic stations.

It is proposed that a complete and fully amended list of standard sections with individual station positions and approximate deptbs be assembled by Mr. Sandeman and circulated to member countries by the Secretariat. The Subcommittee noted that useful oceanographic work is being carried out by the US Coast Guard and encouraged them to occupy the standard sections as often as possible.

d) Investigation of Base Periods

The Subcommittee agreed with the conclusions of the Working Group that, until further definitive progress is made in developing station averages along standard sections as proposed by Dr. Trites (Annex 1), ICNAF should adopt a set of procedures, and therefore

recommends (12)

i) that the base periods for the ICNAF Area be 10-year periods, such as 1951 to 1960, 1961 to 1970, etc.;

ii) that anomaly bases be calculated as the arithmetic mean of the relevant individual means for each year of the base period;

iii) that the degree of variability of the anomaly be indicated by estimating the standard deviation about the base for each anomaly published;

iv) that a review of these procedures be carried out by the Subcommittee after three years to assess how the system is working; and

v) that, in order to help establish the new procedures, MEDS, as oceanographic centre for ICNAF, calculate baselines of 10-year averages with standard deviations for those parts of the ICNAF Area where sufficient data are available.

Noting the importance of having all available data for the ICNAF Area incorporated into the data base, the Subcommittee further

recommends (13)

that oceanographic data collected by USSR and by US Coast Guard, as well as all available STD/CTD data, be incorporated into the data base before the baseline analyses are carried.

e) Data Products Required of MEDS

The Subcommittee agreed that the primary requirement for data products from MEDS is for atlases of the type proposed in Res. Doc. 76/VI/76. Recognizing that temperature data are probably the most complete relative to other parameters, the Subcommittee suggested that emphasis might first be placed on temperature in respect of the Georges Bank larval herring program. The form of the atlases and schedules for their production could not be determined at this meeting, but the Subcommittee

recommends (14)

that Dr. Schlitz, in consultation with MEDS, should as soon as possible prepare a detailed outline of a proposed atlas for the Georges Bank area, and that MEDS should attempt to produce such an atlas for presentation to the next meeting of the Subcommittee.

It was noted that success in producing annual atlases would be dependent on the timeliness and completeness of the annual submission to MEDS, and all member countries are therefore requested to submit their data within six months of collection, as recommended at the 1975 Annual Meeting (*Redbook* 1975, page 90).

2. Plankton Sorting Centre

The Subcommittee noted with interest the information in Res. Doc. 76/VI/115 on the establishment and development of the Plankton Sorting and Identification Centre at Szczecin, Poland. Developed jointly by Poland and USA, the centre is now well established with a staff of 21 including 18 sorters and taxonomic specialists, and it has begun the comprehensive sorting of the archived backlog of samples (0.333 mm mesh) from the 1971 to 1975 larval herring surveys. Processing includes enumeration and identification of invertebrate components as well as ichthyoplankton, and analysis is expedited by an efficient data management system which includes rapid entry of all field and laboratory data into the computer with an optical scanning device. Computer-generated printouts of station data and cruise tracks are now being produced for the ICNAF surveys, and data summaries of the sorted samples will soon be forthcoming. The Subcommittee's attention was called to Res. Doc. 76/VI/81 and 84, which describe aliquot procedures and sorting protocols at the centre. It was noted that the ICNAF larval herring samples would get top priority during 1976. The Subcommittee was strongly of the opinion that the Director of the Sorting Centre should be invited to participate in relevant future meetings of the Subcommittee and its Working Group.

3. Marine Environmental Data Service (MEDS)

a) Progress Report for 1975/76

MEDS has commenced a program for the acquisition of outstanding historical data by preparing for each member country a list of cruises in the ICNAF Area for which data are on file through exchange with the US National Oceanographic Data Centre (NODC) or World Data Centre A. As each list is completed, it is forwarded to the national representative with a request for verification of completeness and for the submission of available data not included.

Also as MEDS becomes aware of other cruises in the ICNAF Area, data for those cruises are specifically requested. This project has yielded data for 1,800 stations to date.

The Subcommittee noted, from Res. Doc. 76/VI/2, that some 70,000 temperature observations have been taken by USSR in a 10-year period, but very little of these data has been submitted to MEDS. Dr. Rikhter observed that much of these data might be held at the Institute in Kaliningrad and might not yet be available through World Data Centre B in Moscow. It was suggested that the Director of MEDS correspond directly with the Directors of ATLANTNIRO and PINRO in order to arrange for the inclusion of these data in the ICNAF data base.

b) Data Products Being Produced and Envisaged

It was reported that MEDS was producing horizontal contour maps to scales suitable for overlay-

ing on available charts. These maps can show a variety of parameters selected by time period and area. It is expected that vertical section contouring will be available later this year.

c) National Data Exchange Representatives

MEDS reported that it had received the names of national representatives for Cuba, Denmark, Federal Republic of Germany, German Democratic Republic, Japan, Norway, UK, USA and IGES. All other member countries are requested to forward their nominations to MEDS (or to the ICNAF Secretariat) as soon as possible.

d) Experimental Use of ROMBI Forms

There is little progress to report on this matter so far. A few countries have been using ROMBI forms on an experimental basis, but there has yet been no reaction from these countries on the usefulness of the form.

4. Review of Environmental Conditions in 1975

a) West Greenland

Winter cooling was severe in this area with sea ice over the shallow parts of Fyllas Bank in February, although in the deeper layers off the western slope of the bank relatively high temperatures prevailed. However, even in July, negative temperature anomalies extended over most of the water column in the latter area, with below-average salinities, indicating a strong inflow of polar water. In August, an inflow of polar water occurred bringing unusually cold water to 50 miles west of Fyllas Bank. During the autumn the normal warm influence of the Irminger Current occurred in the deeper layers off the western slope of the bank, the temperature at 350-500 m exceeding 5°C in November.

b) Labrador Shelf and Newfoundland Area

Temperatures in the 0-200 m layer were generally lower than average over the first half of the year in these areas and until October in the deeper layers, but in November-December above-average temperatures were recorded above Hamilton Bank. On the southern edge of Grand Bank, the Gulf Stream kept temperatures generally above normal with a positive anomaly of 4.5°C in September and associated higher salinity in the surface layers. The Labrador Current transport was observed to be well below average in the Flemish Cap Channel in June but was double the norm over the Labrador Shelf in August.

c) Gulf of Maine and Georges Bank

Mean bottom temperatures over Georges Bank in the spring and autumn fell during 1975 to about the long-term average level after several years of increasing mean temperatures in the spring over the period 1971-74 and in the autumn since 1969. In the Nantucket Shoals area, the peak 1974 temperatures were particularly noticeable at 30 m and near the bottom during the autumn. In the Gulf of Maine, the spring and autumn bottom temperatures have shown an overall increasing trend during 1968-74 and this seems to have continued into 1975 in the western half of the Gulf during the spring, but elsewhere and during the autumn the bottom temperatures decreased during 1975, as occurred on Georges Bank.

5. Continuous Plankton Recorder Results for 1975

Continuous plankton recorder surveys were continued during 1975 on the same basis as in earlier years, but sampling has been seriously affected by changes in shipping schedules, particularly in Subarea 4 which was sampled only in December. In Subarea 3 phytoplankton was abundant in April and also at the end of the year. Copepods were numerous from July to September, but there was no sampling in May when they are usually most abundant. *Calanus finmarchicus* was particularly abundant during July-September and the numbers of Euphausiacea were above average for all months in which samples were taken except March, but the numbers of young fish were unusually low. Only *Sebastes* spp. and Clupeidae were found in the samples, and even these species were absent in Subarea 3 in those months when peak numbers were found in earlier years.

6. Weather and Ice Reporting by Fishing Vessels

At the 1975 Annual Meeting, it was recommended that the Secretariat contact national meteorological agencies to arrange for a representative sample of fishing vessels to use the SHRED form for reporting weather and ice conditions to coastal radio stations. This was done following the 1975 Annual Meeting and a number of vessels was reported as having recently begun to use the SHRED form.

7. Other Matters

a) Report on Monitoring Gulf Stream Meanders

A brief review was presented of a new USA program of monitoring the effects of large Gulf Stream eddies and meanders on environmental conditions in Subarea 5 and Stat. Area 6 (Res. Doc. 76/VI/86). The study is directed primarily at the meanders on the shoreward side of the Gulf Stream and the warm core eddies which sometimes form from these meanders, particularly since they can have considerable effect on shelf circulation. The location and movements of meanders and eddies are continuously monitored with infrared radiometer imagery from satellites, and when one approaches close to the shelf its depth and boundary slopes are measured by ships. Possible influences of these features on marine organisms may arise through injection of warm saline water into the colder and less saline water of the shelf, and the entrainment of significant quantities of shelf water. A brief description was presented of the movements, characteristics and effects of an unusually large warm core eddy (initially larger than the whole of Georges Bank) which was first observed by satellite in February 1976 and subsequently monitored by the research vessels *Ernst Haeckel*, *Wieczno*, *Albatross IV* and *Belogorsk* in March and April.

b) Environmental Data from Oil Explorations

Mr. Horsted (Denmark) reported that a considerable amount of environmental data was now being collected by the Danish Government and oil companies along the West Greenland Shelf and that these data would eventually become available for possible incorporation into the ICNAF data base (MEDS).

8. Future Meetings

The Subcommittee

recommends (15)

that the next meeting of the Environmental Working Group (or Subcommittee) be held prior to the 1977 Annual Meeting of STACRES and that there be appropriate representation at that meeting by German Democratic Republic and USSR.

9. Appreciation

The Chairman expressed the thanks of the Subcommittee to Mr. Sandeman (Convener) and other members of the Working Group for the progress made during the year and to Dr. Wolford for the continued cooperation of the US Coast Guard. He concluded the meeting by expressing his personal gratitude for the work and cooperation of all members of the Subcommittee over the last three years.

ANNEX 1. REPORT OF THIRD MEETING OF ENVIRONMENTAL WORKING GROUP

Chairman: E. J. Sandeman

The third meeting of the Working Group was held at Szczecin, Poland, during 26-30 April 1976 to further review the considerable progress made since the second meeting of the Group in 1975 (*Redbook* 1975, page 95) and to examine relevant hypotheses concerning recruitment mechanism. Such matters as the standardization of oceanographic sections, stations and base periods were considered as well as standardized formats for the exchange of environmental data. The opportunity was also taken to visit the Plankton Sorting Centre at Szczecin, and observe procedures for sorting and quality control. Representatives attended from Canada (P. F. Lett, E. J. Sandeman, R. W. Trites); Federal Republic of Germany (G. Joakimsson, M. Stein); Poland (I. Dunin-Kwinta, L. Ejsymont, S. K. Grimm, A. J. Paciorkowski, J. Piechura, A. Piotrowski, E. Stanek); and USA (M. D. Grosslein, R. G. Lough, R. J. Schlitz, T. C. Wolford).

I. HERRING IN GEORGES BANK-GULF OF MAINE AND ASSOCIATED AREAS

1. Larval Herring Studies During 1975/76 Season

At the 1975 Annual Meeting the Environmental Subcommittee endorsed the recommendation of the Working Group that monitoring of larval production should be continued for at least the next two years in the Georges Bank-Gulf of Maine area, using standard methods of sampling and consisting of 4 or 5 cruises between September and December and 2 cruises in February and March (*Redbook* 1975, page 97).

a) Overview of 1975-76 Larval Herring Survey Program

Dr. Grosslein, as Task Force Leader for the coordinated survey program, summarized the survey activity between September 1975 and April 1976. Four extensive surveys were made over the Georges Bank-Nantucket Shoals region during September-November 1975 (*Belogorsk*, 24 Sep-10 Oct, 15-31 Oct; *Anton Dohrn*, 31 Oct-15 Nov; *Albatross IV*, 2-17 Dec). The inshore western Gulf of Maine was covered once by US vessel *Challenge* during 4-9 September, and both the western and eastern Gulf of Maine was surveyed by *Delaware II* during 23 September to 2 October. The eastern Gulf of Maine (i.e. southwest Nova Scotia) and the Bay of Fundy areas were surveyed by *E. E. Prince* during 5-14 November.

Minimum sampling on all of the Gulf of Maine surveys included standard Bongo hauls as well as temperature profiles and surface salinities. On the *Deleware II* cruise, Nansen casts were also made at some stations for salinity, nutrients and chlorophyll. In the Georges Bank-Nantucket Shoals region, Bongo and Neuston hauls were made at both the standard ICNAF stations and at extra stations in larval aggregations. Oceanographic coverage for this area was the most complete achieved to date, including TS profiles, nutrients, chlorophyll and oxygen at nearly all standard stations on all cruises. Primary production measurements with ^{14}C were also made at selected stations on the December 1975 and February 1976 cruises of *Albatross IV* as well as on the *Wieczno* cruise in April 1976.

A special cruise by *Deleware II* was scheduled for October to attempt to follow a patch of newly-hatched larvae near the *Helgoland* site. Unfortunately, spawning was later than expected and the vessel could not be rescheduled.

b) Results from Spawning Studies and Larval Surveys

Canada had little to report from the cruise in November as the data have not yet been completely analyzed. However, the results from the survey did give some insight, when combined with seabed drifter data, on larval retention mechanisms in the Bay of Fundy.

Federal Republic of Germany reported on the numbers of herring larvae caught in the 0.505 mm meshed Bongo net hauls during the November survey of the *Anton Dohrn*. On Georges Bank the numbers of larvae in 1975 were substantially lower than in 1973 and 1974 but higher than in 1971 and 1972. On Nantucket Shoals the 1975 catches were also substantially below those of 1973 and 1974 but were about the same as in 1971 and 1972. The ratio of <10 mm larvae to ≥10 mm larvae on Nantucket Shoals was low in 1971, increased to a maximum in 1973 and then declined to a low value in 1975. On Georges Bank the ratio of <10 mm to ≥10 mm larvae was also highest in 1973, but the ratios in 1971, 1972, 1974 and 1975 were about the same. The greatest abundance of larvae in both areas was observed in 1973, this being attributed to the spawning of the strong 1970 year-class for the first time. Also, it was thought that the high ratio of small to larger larvae in 1973 might be related to the initial and possibly later spawning of the 1970 year-class. Hatching success was assumed not to have varied substantially over this period. Discussion highlighted the difficulty of obtaining representative samples of recently-hatched herring larvae, and the Working Group emphasized the necessity of sampling very close to the

herring larvae, and the Working Group emphasized the necessity of sampling very close to the bottom if unbiased samples of yolk-sac larvae are to be obtained. Data on larval herring catches made at night during the juvenile herring surveys by *Walther Herwig* and *Anton Dohrn* in March 1973-76 were presented (Res. Doc. 76/VI/79). In 1973 it was found that larvae sampled by their becoming tangled in the knots of the bottom trawl showed a similar size distribution to those caught in the 0.505 mm Bongo net.

Poland was unable to take part in the larval herring program in the autumn of 1975 because of mechanical troubles on the *Wieczno*, but the vessel conducted a full-scale larval herring and hydrographic survey on Georges Bank in April 1976 (Res. Doc. 76/VI/114).

The USSR vessel *Belogorsk* conducted two surveys in the autumn of 1975 (the first filling the gap left when the Polish vessel *Wieczno* could not take part), but USSR representatives were not present and no results of these surveys were available.

USA presented distribution maps of larval herring taken in December 1975 and February 1976. In the Nantucket Shoals area in December, the length frequency was bimodal (10 and 18 mm) with about twice as many larvae in the larger-sized group. However, as in the previous years, the smaller mode had disappeared in February. One hypothesis is that predation removes the smaller larvae. The size distribution of larvae on Georges Bank was essentially unimodal in December (18 mm), but by February these had grown to 30 mm. Data were presented on the growth and mortality rates on Georges Bank (not Nantucket Shoals) between the 1973/74 and 1975/76 seasons (Table 1). It is noted that the mortality rate declined as the growth rate increased. This fits in well with the theoretical basis of growth and death models of Cushing, Ware, and others. The point was raised that the principal mortality of herring larvae was occuring in areas of winter concentration.

Table 1. Mortality and growth of herring larvae on Georges Bank, 1973-76

Season	Sampling period	Larval abundance	Instantaneous mortality per day (%)	Mean length (mm)	Instantaneous growth per day (%)
1973/74	Dec 13	5076		15.1	
	Feb 14	406	3.93	22.9	3.08
	Mar 24			30.1	
1974/75	Dec 13	7410		16.5	
	Feb 14	506	3.87	26.7	3.30
	Mar 17			30.0	
1975/76	Dec 9	1120		17.4	
	Feb 16	457	1.27	31.1	3.87
	Mar 5			31.6	

c) Other Aspects of Larval Herring Studies

Extrusion of larvae through the meshes of the sampling gear is a source of potential bias. However, USA scientists reported that, although the complete results were still not analyzed, examination of the data from two *Albatross* cruises showed that for >8mm larvae there was no statistically significant difference between the 0.333 mm and the 0.505 mm meshed nets.

2. Environmental Conditions in Georges Bank-Gulf of Maine Area

Five papers were reviewed in connection with environmental conditions in the area, four of them having been presented as Res. Doc. 76/VI/4, 77, 78 and 85 and one as a working paper.

Standardization of continuous temperature measurements and increased nutrient and chlorophyll sampling were implemented on larval herring cruises during 1975. The Working Group was particularly pleased to note the latter in relation to its recommendation at the 1975 meeting (*Redbook* 1975, page 98) and encouraged participants to continue this important aspect of the work.

Temperature conditions throughout the area were not significantly different in 1975/76 from those in 1971-73. The relatively cool water on the north-eastern part of Georges Bank and east of Nantucket Shoals appears to be a semi-permanent feature during the autumn. Temperature gradients lessened in December and nearly isothermal conditions existed in February with mean temperatures for Georges Bank identical to those in 1974 (9.9°C in December and 5.7°C in February).

Long-term seasonal temperature trends from 1962 to 1972 were determined for the continental shelf area, and these were augmented for the Gulf of Maine and Georges Bank in spring and autumn by bottom temperatures for 1968-75. Both in the Gulf of Maine and on Georges Bank, a general warming was seen in the spring beginning in 1964. Although different base periods were used, a warming of 2 to 3°C was observed. The bottom temperature data for the Gulf of Maine indicated that a sudden influx of warm bottom water may have occurred in the autumn of 1971. However, the autumn data generated considerable discussion because of an apparent divergence between the two sets of data. The cause of the discrepancy could not be resolved.

A preliminary report was given on data collected on a series of hydrographic sections in the Northeast Channel between Georges Bank and Browns Bank, by the US Coast Guard and on ICNAF larval herring surveys, with 21 oceanographic sections across the Northeast Channel being taken during 1975. Slope water was regularly present in the channel from March to December and frequently it was found inside the channel sill. Such intermittent incursions of warmer, more saline slope water are consistent with a presumed sporadic flow into the Gulf of Maine.

The Working Group noted with satisfaction the increased oceanographic activity and that the important section across the Northeast Channel has been occupied at least once a month throughout the spring of 1976. In keeping with its recommendation of last year (*Redbook* 1975, page 98), the Working Group welcomed the plans by USA for deployment of several current meters with temperature sensors on moorings on the sill of the Northeast Channel. It was hoped that these arrays would be deployed by late August or September 1976 and anticipated that measurements would be made over the period of a year.

3. Spring Juvenile Surveys and Other Studies on Juvenile Herring

The Working Group reviewed a paper on the 1976 spring trawl surveys by *Albatross IV*, noting that no age 2 herring (1974 year-class) were caught on Georges Bank and in the southern New England area, the main areas surveyed by *Anton Dohrn* and *Ernst Haeckel*. In previous spring surveys, significant numbers of age 2 herring were caught, particularly by *Walther Herwig* in 1973 and 1974, and this suggests that the 1974 year-class may be even weaker than the 1971 to 1973 year-classes. There is still some uncertainty as to the distribution and availability of age 2 herring in the spring, and there are some inconsistencies in the relative strengths of certain year-classes, as measured by successive survey abundance indices at different ages (ages 2 to 4). In particular, it was noted that the ratio of the abundance of the 1971 to 1972 year-classes was much larger, as indicated by catches of age 3 herring in the spring surveys of *Walther Herwig*, than was the case for 2-year-old herring (see Summ. Doc. 76/VI/22, pages 40-41). On the other hand, the *Albatross IV* survey catches showed relatively smaller differences in the ratios of the 1971 and 1972 year-classes at age 3. Also, it was noted that the ratios varied somewhat with the area of the survey. Nevertheless, there is a basic pattern of consistency in the overall ranking of the year-classes based on the spring surveys, which indicated substantially reduced recruitment since the appearance of the 1970 year-class and that the sizes of the 1973 and 1974 year-classes are even smaller than those of 1971 and 1972. This pattern does not correlate well with the year-class abundance indices based on the numbers of larvae in December. There were four to ten times as many larvae in December of 1973 and 1974 as in December of 1971 and 1972 (Res. Doc. 75/112), and yet, as noted in the report of the April 1976 Meeting of the Assessment Subcommittee, survival to ages 2 and 3 from trawl surveys in the spring seemed to be lower for the 1973 and 1974 year-classes than for those of 1971 and 1972. This implies that the mortality which occurred after December was most important in determining the size of these year-classes. The over-winter mortality estimate for the most recent sampling period (1975/76) was considerably lower (and larval growth slower) than in the two previous winters (Table 1). The larval abundance in February 1976 was about the same order of magnitude as in February of 1974 and 1975, whereas the larval abundance in December of 1973, 1974 and 1975 was in the ratio of 5:7:1. This tends to further confirm the hypothesis that over-winter mortality is critical to year-class success.

The Working Group again noted the need for information on post-larvae during the second half of the first year of life, but considered it unwise to abandon the monitoring of the fall-winter larval production, growth and survival, because some of the factors responsible for variation in over-winter mortality (e.g. growth rate in relation to size and robustness of larvae as they enter the winter period) may actually operate during the autumn months. The question arose whether some of the vessel time devoted to spring trawl surveys might be diverted to midwater trawl surveys in order to follow the herring from larval to post-larval and early juvenile stages. It was concluded that, despite the variability in the spring survey abundance indices, they represent the only source of pre-recruit abundance data at age 2 and hence are essential for determining the total allowable catches. In addition, these pre-recruit indices provide a basis for correlation analysis of the timing and consistency of natural mortality in the larval and juvenile stages. It was suggested that more information on fishing power differentials between the vessels conducting the surveys would be desirable in the hope that more accurate abundance indices could be calculated. However, it was

recognized that fishing power experiments are extremely time-consuming and a time series of such data would be required. Considering the available resources, the Working Group does not consider it wise to recommend a diversion of ships from the current spring survey program to carry out fishing power comparisons. Midwater-trawl sampling of post-larval and early juvenile stages should get higher priority, if additional ship time becomes available.

4. General Plankton Studies

The Working Group was pleased to note the efforts that have been made towards obtaining a better base for understanding the zooplankton dynamics, following the presentation of three papers on this subject (Res. Doc. 76/VI/82, 83, 97).

An examination of the distribution of copepods in the coastal waters of the western Gulf of Maine in 1966 showed that two species, *Pseudocalanus minutus* and *Calanus finmarchicus*, constituted over 70% of the biomass of copepods in winter, spring and summer, while three species, *P. minutus*, *Temora longicornis* and *Centropages typicus*, accounted for 85% of the biomass in the autumn. In this inshore area, the seasonal changes in dominant copepods indicated that the depth of the water column rather than any particular range of temperature or salinity was the most important environmental factor governing the distributions.

Zooplankton volumes in the Georges Bank-Gulf of Maine area were reported for the spring and fall of 1973 as a first step in the tropho-dynamic approach to understanding the dynamics of multi-species fisheries. Spring zooplankton biomass was higher than the autumn. Georges Bank had a higher zooplankton standing stock than the Gulf of Maine or western Nova Scotia areas for both spring and autumn. Zooplankton values were approximately equal for both seasons on Georges Bank.

The Working Group noted with satisfaction the first results from the Plankton Sorting Centre of the analysis of plankton in the 0.333 mm mesh Bongo samples, providing a description of the distribution and abundance of zooplankton in the Georges Bank-Gulf of Maine area, based on samples from the larval herring survey by *Wieczno* during 27 Sep-18 Oct 1974. The paper provided comparisons between the 10 most dominant taxa in relation to their total biomass. The concentrations of copepods in the areas of larval herring abundance were noted and discussion centred on the mechanisms which might be involved in retaining and concentrating herring larvae and their food organisms within the 100 m contour. Potential predators of herring larvae, such as chaetognaths and euphausids were observed throughout the distributional area of the larvae.

5. Progress on Other Specific Studies (*Redbook* 1975, page 99)

a) No new information was available on diurnal movements of herring larvae.

b) With regard to the establishment of a complete series of larvae of known age, USA reported on work being done with a scanning electron microscope. A good correlation was found between apparent daily growth rings on the otolith and the age in days for some species of fish. It is hoped that this work will be extended in 1976 to herring larvae of known age, which have been reared in the laboratory under different environmental conditions.

c) No new information was available on monitoring the abundance of phytoplankton and zooplankton with continuous plankton recorders, although the use of such instruments would provide useful information on the patchiness of larvae.

d) With regard to the acquisition of further data on egg mortality in relation to egg size and quality, USA reported briefly on the *Helgoland* experiment, noting that, in addition to the technical problems and extreme weather conditions, the herring did not spawn close to the site of the habitat.

e) Various length conventions have been used by the participants in measuring larvae collected on the surveys since the ICNAF Larval Herring Survey Program began in 1971. Four different measurements have been used: (i) standard length to nearest mm from snout to base of caudal fin; (ii) standard length to mm below; (iii) total length to nearest mm; and (iv) total length to mm below. The question as to whether there is a significant difference among the various length measurements in relation to length frequency distributions was addressed in Res. Doc. 76/VI/58. The Working Group noted the need for more rigorous and standardized subsampling procedures, as well as the desirability of adjusting basic length measurements of larvae to standard length (nearest mm) for future analysis of growth and mortality. This problem will be resolved for the 0.333 mm Bongo samples, all of which will be processed by the Sorting Centre using standardized procedures.

6. Review of Procedures at the Plankton Sorting Centre

Dr. L. Ejsymont, Director of the Centre, provided the Working Group with a review of the organization

and operation of the Plankton Sorting and Taxonomic Centre (see Res. Doc. 76/VI/115). He described the progress to date in the sorting of plankton samples from the various cruises of the joint ICNAF larval herring surveys and elaborated on the methods which have been established. Present priorities, which were established by an advisory committee of USA and Polish scientists, include the analysis of 0.333 mm mesh samples from the 1971-75 larval herring cruises as the highest priority, and the Working Group was pleased to note the progress made to date from the first results of the work (Res. Doc. 76/VI/97). It was further noted that in the future the Sorting Centre would be prepared to consider sorting plankton samples other than those of the joint ICNAF larval herring surveys.

The results of a workshop, convened in March 1976 to measure the variance associated with the subsampling procedures and to establish standard sorting protocols, were reviewed. Papers were presented on measuring the variance of subsamples in relation to counts of zooplankton made at different aliquot levels and with three different splitting devices (Res. Doc. 76/VI/81) and on the interim sorting protocols for zooplankton samples (Res. Doc. 76/VI/84 and Corrigendum). It was noted that the nomogram method developed by Tschislenko is now being used by the staff of the Sorting Centre to estimate the contribution of the more numerous zooplankters to the total biomass, and it is hoped that better methods being developed at the Narragensett Laboratory will be substituted in the next few months. The Working Group expressed its satisfaction with the recommended protocols (Res. Doc. 76/VI/84) and noted that these were open for discussion and possible revision. In particular, the Working Group requests that ICNAF scientists should carefully examine the taxa list (Res. Doc. 76/VI/84, Attachment 2) to determine if other taxa should be added.

A visit to the Sorting Centre allowed the Working Group to observe the processing of the samples, aliquotting methods, sorting and identification procedures and the archiving of representative samples. The Working Group was impressed with the calibre of the staff and the high quality of work being done by the Sorting Centre. There is no doubt that the results will play an important part in improving our knowledge of secondary production on Georges Bank. Because knowledge of the Sorting Centre is largely confined to Polish and USA scientists, the Working Group suggested that a general description of the Centre and the work being done there would be useful to all ICNAF scientists and that the Director of the Centre might prepare such a document for presentation to the Environmental Subcommittee (see Res. Doc. 76/VI/115).

7. Status of Data Processing Plans and Progress Toward Standardization and Transfer of Time Series Data to the Computer Data Bank

Dr. Grosslein reported that the time series of 1972-75 data on sorted larvae from the 0.505 mm mesh nets was now on a computer and that a list of available computer printouts will be distributed to participating scientists. Samples of computer printout were examined by the Working Group, and, although it was planned that the majority of the available output would be in standard form, more specialized outputs could be made available if requested. At present, MARMAP plankton data and oceanographic data are not compatible, but it is anticipated that these will be made so during the ensuing year.

The Working Group discussed the general problem of data availability and the necessity of providing some rights to scientists who collected the data, while still recognizing the desirability of opening the data base to other users as quickly as possible. It was generally agreed that a committee would provide the necessary institutional mechanism to accomplish this, and at the same time it could highlight analyses needed on various components of the plankton community as well as minimize duplication of analytical effort. Although it was accepted that USA should play the lead role in the computer analysis of the data, the composition of the committee or its terms of reference were not discussed further. The matter was flagged as one for consideration at a future meeting of the Environmental Subcommittee.

8. Review and Discussion of Hypotheses on Factors Controlling Success of Year-classes of Herring

Mr. P. Lett presented two papers on factors controlling year-class success in herring. The first of these (a working paper) provided a useful review of density-dependent and independent processes which may affect recruitment in herring. Discussion ranged over facets of the early life history from the factors which are likely to affect egg production through larval energetics. In particular, it was noted that very little is known about the ecology of juvenile herring after metamorphosis, and that this could be one of the important periods in the life history of herring in determining the sizes of recruitable year-classes. An examination of density-dependent ℓ_1 growth, the length at the formation of the first annulus, was suggested as a holistic method which might provide some insight into the ecology of herring during this early period. Predation was also discussed as being a further important component of the overall density-dependent recruitment mechanism.

In the second paper (Res. Doc. 76/VI/4), a stochastic model was developed to study the possible effects of temperature perturbations, predation and competition from mackerel on the recruitment pro-

cesses and general dynamics of Gulf of St. Lawrence herring. The paper attempts to elucidate some general hypotheses concerning recruitment which could be tested using data gathered from the Georges Bank area. Multivariate regression models were used to determine the structural equations for portions of the life history of herring. Temperature and the abundance of age-group 0 mackerel affected the herring growth rate, but neither herring biomass, total mackerel biomass nor total pelagic biomass had any measurable effect on the herring growth rate. The growth rate of herring, coupled with adult stock size and environmental effects, mediated through temperature, accounted for most of the variation in the abundance of <10 mm larvae. Predation, tempered by the available food density, was hypothesized and discussed as a possible major mechanism for stabilizing the population and a fine-tuning mechanism for year-class formation.

The Working Group concluded that the model, presented in Res. Doc. 76/VI/4, could represent a useful conceptual paradigm of the dynamics of the Georges Bank herring stock, and proceeded to examine the assumptions inherent in the model with a view to the possibility of testing them:

a) Egg production is related to the production of the adult stock

A review of several fish species in which there appeared to be a relationship between food intake and egg production lends support to this assumption. Furthermore, if somatic and gonadal growth are coupled, the measurement of one should provide an index for the other, and it might be expected that the total somatic production ($P = N\Delta W$) would be an index of egg production of the adult stock (Res. Doc. 76/VI/75). Under this assumption, because of the depleted state of the stock, the Georges Bank herring would now be expected to demonstrate growth (both somatic and gonadal) at a maximum rate.

On the other hand, there is little evidence of density-dependent processes causing substantial variation in growth rate of adult herring. However, environmentally-induced changes in growth rate have been observed, and these are the kinds of changes which may be important in determining the overall egg production of the adult stock. Unfortunately, the effects mediated by temperature would be difficult to measure under field conditions.

To test tbis hypothesis, a laboratory experiment is required in which the ration size can be varied to study resultant variations in fecundity. The Working Group recognized the value of such experiments but, apart from encouraging them, could not recommend additional studies on egg production at this time. It was suggested, however, that it would be useful to examine the current average fecundity at length and age, as the growth potential at this time might be maximum due to the low stock abundance of both herring and mackerel.

b) The abundance of larvae is directly proportional to the abundance of eggs

The Working Group noted that there were some rather serious gaps in knowledge on this stage of the life history and that it was desirable to acquire further knowledge on egg mortality in relation to egg size, quality and predation, as well as on environmental variables. For the present, it was assumed that hatching success and the earliest stages of larval survival are directly proportional to the number of eggs spawned. Therefore, predatory rates by haddock and other demersal species must be directly proportional to the number of eggs spawned. However, it was noted that the haddock population in the area is at a low level and consequently herring egg predation by this species may not be very important.

The *Helgoland* experiment was to have involved intensive studies on the spawning and density distribution of eggs, subsequent egg survival and hatching success, but, due to late spawning and technical difficulties, the experiment was not able to achieve all of the desired objectives. Future studies of this nature may provide better insight into this phase of herring life history.

c) Density-dependent growth cannot be shown in the adult stage of herring but it can be demonstrated for larval and juvenile stages

Density-dependent ℓ_1 growth appears to occur for herring in certain areas. This relationship was presented in the light of a population stabilizing mechanism by which both year-class size and the length at the end of the first year of life are simultaneously fixed and remain invariate. The Working Group agreed that the back calculation of herring scales was a possible fruitful area for future research. In addition to elucidating an important component of the recruitment mechanism, back calculation may itself be useful as a predictive tool in determining year-class size. Information from back calculation is easily obtained and relatively inexpensive, and, since the accuracy of this type of measurement is high, its usefulness as a predictive tool is certainly enhanced.

Back calculation from scales or otoliths will also provide information on the growth of Georges Bank herring. The growth rates can then be correlated with the biomass of the stock between

1960 and 1975 to determine whether density-dependent growth is observable for the stock in its severely depleted state. Correlation analysis could also be used to test the effects of the densities of other fish biomasses on the growth of herring. Supporting evidence for these correlations could be gained by stomach content analyses of species other than herring to determine if they are competing with herring.

Environmental effects mediated through temperature have also been shown to alter the growth rate of adult herring. This hypothesis could also be simply tested by using the information gained from back-calculated herring scales through correlation analysis. The Working Group therefore

recommends (10)

i) that herring scales for the Georges Bank herring stock be collected and back-calculated;

ii) that the relationship between ℓ_1 and year-class size from sequential population analysis, between the growth rate of 1+ herring and stock biomass, between the growth rate of 1+ herring and stock biomass of other species, and between the growth rate of herring and other environmental factors, be examined through the use of correlation analysis; and

iii) that stomach content data be collected from fish caught in commercial and experimental trawls, and that suitable midwater trawl hauls be made, in addition to the standard Bongo nets, in an effort to catch the smaller organism which could compete with herring larvae and juveniles.

d) Predation by mackerel and cannibalism by herring are important as a stabilizing mechanism for the herring population. It was also hypothesized that predation on small herring larvae by other types of zooplankton could be an additional important factor. The Working Group therefore

recommends (10)

that greater emphasis be placed on surveying for predators, particularly in the spring, involving a greatly expanded program of stomach analysis of all possible predators.

e) Shifts in the maturity ogive in relation to herring length could be an important control mechanism

Although it is assumed that maturity is a fixed function of length, evidence was presented for species other than herring indicating that these ogives can indeed shift. The dramatic effects of these shifts on egg production were elucidated. The Working Group accordingly

recommends (10)

that the maturity data collected through commercial sampling be analyzed to study the effects of shifts in the maturity ogives on egg production.

f) The stock being investigated is well delineated

It was acknowledged that the delineation of the Georges Bank spawning stock can be improved, but that this would require a substantial augmentation of the present program. It was noted that tagging studies are planned to help elucidate tbis problem. While emphasizing the need for greater emphasis on the distribution of juveniles during the second half of their first year of life, the Working Group was unable to recommend that increased resources be committed to this program at this time.

g) Herring larvae are retained through behavioural response to tidal flow

A review of the literature indicated that there was a mechanism whereby larvae could maintain their position in the water column by varying their depth in relation to tidal flow. Temperature, salinity and light were identified as other key environmental variables which would aid larvae in orientating themselves. In addition, there is evidence indicating that larvae in the Bay of Fundy used areas of upwelling to aid them in maintaining their position in the spatial horizontal plane. It has been noted that the over-wintering location of herring larvae on Georges Bank is well defined and that these larvae appear quite efficient at maintaining a relatively constant position.

The Working Group discussed in some detail the ways and means of studying the fine structure of the vertical distribution and of identifying the processes responsible for larval retention system. It is apparent, from the limited number of research vessels available, that little work

can be done towards this goal during the ensuing year. However, the Working Group regards the study of a larval patch to be of such priority that it reiterates the recommendation of the 1975 Annual Meeting (*Redbook* 1975, page 98, rec. 29(vi)) viz, "that a special sampling study to follow an isolated patch of larvae on Georges Bank be attempted in 1975 and/or 1976, with a view to identifying the processes responsible for larval loss from the system, and providing information on the fine-scale variations in growth, mortality, dispersion, feeding and vertical distribution, as a basis for evaluating the feasibility of quantitative estimation of these processes and contributing to knowledge of sampling errors inherent in the present data base".

This study should include recording current meters in the path of the drifting larval patch, as well as drifting buoys and/or the release of dyes to measure Lagrangian and Eulerian advection and dispersion parameters. It was suggested that a useful start might perhaps be made by the deployment of one or two meteorological-type buoys on the spawning beds to measure temperature, conductivity and currents at the bottom, in midwater and at the surface.

The Working Group was pleased to note that USA attempted a patch experiment in 1975 in connection with the *Helgoland* experiment. Results were disappointing because the timing of the hatching did not coincide with the availability of the research vessel. It was noted that another attempt will be made during September-October 1976.

9. Plans for the 1976/77 Field Operations

The 1976/77 field operations, involving plankton and hydrography, are planned to continue in basically the same manner as in 1975/76, except for additional emphasis on (a) attempts to conduct a patch study along the lines outlined above (each survey vessel should spend at least a day in the vicinity of a concentration of larvae and attempt to study the vertical distribution of plankton in relation to the tidal cycle, obtaining approximate estimates of tide by drogues at three levels with positions being taken relative to a fixed buoy), and (b) possible additional Neuston net and midwater trawl sampling to extend our knowledge of late spring distribution of larvae and juveniles following metamorphosis, as well as sampling for larval predators.

A more detailed description of both the plankton and hydrographic sampling methods will be circulated to participating countries during the summer, as was done prior to the implementation of the 1975/76 program. The proposed schedule for the 1976/77 larval herring surveys in the Georges Bank-Gulf of Maine areas is as follows:

Wieczno (Poland)	- Sep 20-Oct 12	USA vessel	- Nov 29-Dec 18
Albatross IV (USA)	- Sep 28-Oct 15	USA vessel	- Feb 7-25
Belogorsk (USSR)	- Oct 15-Nov 5	Vessels unscheduled to date	- March-May
Anton Dohrn (FRG)	- Nov 8-25		

In the event that additional time is available on the first four cruises listed above, it should be utilized for larval patch studies and/or support for the herring tagging program. In addition to the standard Bongo and hydrographic coverage during the spring cruises, priority should be given to special midwater trawl sampling for post-larval herring as well as for competitors and predators, if ship time is available.

10. Task Force Leader for 1976/77

The Working Group unanimously agreed that Dr. M. D. Grosslein remain as Task Force Leader of the ICNAF Larval Herring Survey Program for 1976/77.

II. FLEMISH CAP

1. Special International Coordinated Study

The discussion of Flemish Cap as an area worthy of a special international coordinated study aimed at determining the factors involved in the production of good and poor year-classes of the major groundfish stocks was initiated at the 1975 Meeting of the Working Group (*Redbook* 1975, page 99), at which time a joint study of existing data was recommended to be carried out by Dr. Konstantinov (USSR) and Dr. Wolford (USA). Since it has not yet been possible for these scientists to prepare a joint report and since Dr. Konstantinov was unable to attend the Working Group meeting, the deliberations of the Group were necessarily limited.

Dr. Wolford presented a paper based principally on US Coast Guard data taken in the Flemish Cap area,

which was identified as a region with relatively stable temperature conditions in the near bottom water layers around the Cap and with relatively weak and variable surface currents (computed from dynamic topography). Since a large proportion of the data for this area has been collected by USSR but not yet available for study by the Working Group, it was evident that further discussion on Flemish Cap as an area suitable for a coordinated study was not possible at this time. Accordingly, it was agreed

a) that no further progress could be made until Dr. Konstantinov's report became available and a full discussion with USSR scientists has taken place;

b) that only with the full participation of scientists from USSR would it be possible to examine the desirability of developing a proposal for the Flemish Cap study;

c) that a small *ad hoc* working group (including Dr. Konstantinov and Dr. Wolford) be set up to provide the means for further appraisal of Flemish Cap as an area worthy of a special cooperative study; and

d) that the Chairman of the Working Group correspond with Dr. Bogdanov (USSR) to seek the cooperation of USSR scientists in this matter.

The Working Group proposed that the Chairman should, through The Environmental Subcommittee, convey its appreciation to the US Coast Guard for continuing support and for Dr. Wolford's valuable contribution to the work of the Group.

III. STANDARDIZATION OF OCEANOGRAPHIC SECTIONS, STATIONS AND BASE PERIODS

1. Oceanographic Sections and Stations

At the 1975 Annual Meeting, STACRES adopted a partial list of standard oceanographic sections (*Redbook* 1975, page 100), and Dr. Trites (Canada) agreed to develop proposals for station positions on these standard sections. At that time, the oceanographic data for Georges Bank, Gulf of Maine and Southwest Nova Scotia areas had not yet been sufficiently analyzed to enable proposals to be made for specific sections in these areas. Dr. Schlitz (USA) agreed to examine the information available for these areas in order to identify the most appropriate sections and both Dr. Schlitz and Dr. Trites agreed to develop proposals for consideration of the Working Group.

a) Proposed Stations on Standard Sections Adopted by STACRES in 1975

A list of proposed stations (positions with approximate depths) was circulated by the Secretariat prior to this meeting of the Working Group (Circular Letter 76/25). This list was reviewed and the Working Group accordingly

recommends **(6)**

that the list of stations proposed in ICNAF Circular Letter 76/25, Appendix II, be adopted as ICNAF standard oceanographic stations.

b) Proposed Sections for Southern Part of ICNAF Area

In accordance with the Working Group's request, proposals for sections in the southwest Nova Scotia, Gulf of Maine and Georges Bank areas were presented by Dr. Schlitz (Res. Doc. 76/VI/37) and by Dr. Trites. These were reviewed by the Working Group, and the following sections were agreed to:

i) a section line across Roseway Basin and Baccaro Bank;

ii) a section line to include US Coast Guard A-5 (partial) and extending across Browns Bank to Cape Sable;

iii) a section line along 67°W longitude;

iv) a section line along 69°W longitude; and

v) a section line along 71°W longitude.

The Working Group agreed that the geographic positions for stations on the foregoing sections, together with approximate bottom depths, should be prepared by Dr. Schlitz and submitted to the

Environmental Subcommittee at its June 1976 Annual Meeting. It was further agreed that the Chairman of the Working Group should convey to the US Coast Guard ICNAF's continuing interest in having their vessels occupy the standard sections as often as possible.

2. Investigation of Base Periods

At previous meetings of the Working Group, it was recommended that MEDS (Marine Environmental Data Service of Canada) should examine the time series of environmental data from the ICNAF Area specifically to evaluate the possibility of finding useful base periods. Working papers on this matter were presented by MEDS (Dr. Wilson) and by Dr. Trites. Following a review of these papers, Dr. Trites proposed an approach which would permit the development of "station" averages along the standard sections for semi-monthly intervals whenever 5 or more stations had been occupied over a 5 or more year period. While it was recognized that this would probably not produce meaningful averages at stations located in or near the frontal zones, it was felt that for many of the stations the seasonal signal was the dominant one.

The Working Group agreed that further work on the determination of useful base periods was necessary, and accordingly

recommends (12)

that, until further definitive progress is made in developing station averages along standard sections as proposed by Dr. Trites, STACRES should adopt the following procedures:

a) Base periods for the ICNAF Area should be 10-year periods, such as 1951-60, 1961-70, etc.

b) Anomaly bases should be calculated as the arithmetic mean of the relevant individual means for each year of the base period.

c) The degree of variability of the anomaly should be indicated by calculating the standard deviation about the base mean for each anomaly published.

d) A review of these procedures should be carried out by the Environmental Subcommittee after three years to assess how the system is working.

e) In order to set up the new procedure, MEDS, as oceanographic data centre for ICNAF, should calculate baselines of 10-year means with standard deviations where sufficient data are available.

f) USSR data and US Coast Guard data, as well as all available STD data, should be incorporated into the data base before the analyses are carried out.

3. Marine Environmental Data Service

Several members of the Working Group noted that the data bank was not as complete as it should be. It was agreed that the Chairman should explore the problem in consultation with MEDS and present a report on the matter to the next meeting of the Environmental Subcommittee.

4. Development of Atlasses

The Working Group agreed that careful consideration should be given to the possibility of preparing an atlas for the Georges Bank area, utilizing oceanographic data from the cooperative larval herring survey program. It was agreed that Dr. Schlitz should, as soon as possible, prepare a detailed outline for a proposed atlas of the Georges Bank area, including sample products, if possible.

5. Use of ROMBI Form

The Environmental Subcommittee had previously recommended that the ROMBI form be introduced on an experimental basis, in order to evaluate their usefulness. In view of the limited use which has been made of these forms to date, it was agreed that further time for evaluation would be necessary before a meaningful appraisal could be made.

6. Salinity Inter-comparisons

Dr. Schlitz reported on an inter-comparison experiment that was conducted on salinity determined from cruises of three ships in the Georges Bank larval herring survey program. He found salinity differences as high as 0.04 and 0.05. In the light of such large differences, the Working Group

recommends (16)

that Dr. Schlitz and Dr. Wolford examine the salinity measuring problem further, as time permits, and report their findings to the next meeting of the Working Group.

IV. OTHER MATTERS

1. Participation in Working Group Meetings

While the Working Group recognized and appreciated the important part played by scientists from German Democratic Republic and USSR in the cooperative larval herring survey program and in the further development of a proposal for Flemish Cap, it expressed deep disappointment for the lack of representation from these countries at this and other Working Group meetings. The Group emphasized the difficulty of holding meaningful discussions and making adequate plans for future work when representation from countries conducting significant oceanographic research in the ICNAF Area is missing. By holding this meeting of the Working Group in eastern Europe, it had been hoped that greater participation of scientists from Europe would be forthcoming. The Working Group was at a loss in knowing how to achieve greater participation of scientists who are active in the programs being carried out, except to reiterate the 1975 Annual Meeting recommendation (*Redbook* 1975, page 94) "that all member countries be encouraged to ensure appropriate representation at the working level at subsequent meetings of the Environmental Working Group".

2. Future Meetings

Bearing in mind the recommendation of the 1975 Annual Meeting that the herring larval survey program should continue for at least two years, and noting further information will be available from surveys to be conducted during the autumn of 1976 and the spring of 1977, the Working Group anticipates that a meeting in May-June 1977 will be one of decision, and

recommends (15)

that the next meeting of the Working Group be held prior to the 1977 Annual Meeting of the Environmental Subcommittee.

APPENDIX VI. REPORT OF *AD HOC* WORKING GROUP ON PLANNING FOR INTERNATIONAL HERRING TAGGING PROGRAM

Convener: V. C. Anthony

The *ad hoc* Working Group was established by STACRES to make plans for an international tagging program to begin during the latter part of 1976. The group met on 31 May 1976 with representatives present from Canada, Federal Republic of Germany, Poland, USSR and USA.

1. Need for Tagging Program

The management of the herring stocks in Subareas 4 and 5 has been conducted separately on the fisheries in Div. 4XW(b), Div. 5Y and Div. 5Z + Stat. Area 6, although stock boundaries have never been well defined. Recent tagging by Canada indicates that significant mixing of herring from the three spawning areas may occur at various times of the year. Consequently, such inter-mixing should be taken into account for proper management of the stocks. Severe declines in the present stock sizes accentuate the need to determine the extent of inter-mixing and, if possible, to delineate the stocks more precisely than is the case at present. A herring tagging program appears to be the only way that a proper management framework by time and area can be developed. The juvenile herring fisheries have never been included in the overall management regime for herring, since it was not known to which adult stocks they recruited to or were derived from. Successful management requires the inclusion of these fisheries on juveniles in order that the total fishing mortality on these stocks can be regulated.

2. Tagging Objectives

The primary objective of the tagging program is to describe the seasonal migration and inter-mixture of adult and juvenile stages of the herring stocks by

a) defining the feeding, spawning and over-wintering areas;

b) defining recruitment migrations from the juvenile fisheries;

c) defining quantitatively the proportion of inter-mixing of stocks present in feeding and over-wintering areas; and

d) providing estimates of mortality rates.

3. Time and Area of Tagging

It is proposed that herring tagging be carried out in Subareas 4 and 5 and Stat. Area 6 during 1976, 1977 and 1978. Plans for tagging in 1976 and 1977 are set out in Table 1.

a) Divisions 4R, 4T and 4V

The fishery on over-wintering herring in Div. 4V may be exploiting fish from the Div. 4T spawning stock. Canadian tagging programs are already in progress (20,000 tags have been applied in Div. 4RT) to determine the extent of migration between these areas. In addition, 55,000 tags will be applied, if possible, in Div. 4RT in various parts of the distribution range in order to assess inter-mixing. In December 1976, 20,000 tags will be applied on the migrating adults in Subdiv. 4Vn.

b) Division 4W

A relationship has been established between herring exploited in the Div. 4W(a) winter fishery and in the Div. 4WX summer fishery from earlier tagging. In January 1976, 20,000 tags were applied by Canada to over-wintering juveniles and adults in the Chedabucto Bay area of Div. 4W.

c) Division 4X

Tagging (25,000 tags) will be attempted in August-September 1977 on spawning grounds off southwest Nova Scotia. This will be a repeat of earlier tagging operations, with spawning adults being tagged.

d) Division 4X and 5Y (juveniles)

A minimum of 25,000 herring will be tagged along the Maine coast during June-October 1976 by USA. Both juvenile and adult herring will be tagged depending on the availability of herring

Table 1. Initial tagging plans for the International Herring Tagging Program. (Other areas and times of tagging will depend on the early results of these experiments.)

Area	Location	Approximate time of tagging	Minimum no. expected to be tagged	Type of herring to be tagged	Collecting method	Country supplying collecting vessels	Country supplying support vessels
4R	Gulf St. Lawrence	Aug 1976 Nov-Dec 1976	10,000 20,000	Feeding adults Migrating adults	Trap Purse seine	Canada Canada	Canada Canada
4RT	Gulf St. Lawrence	Apr-May 1976	10,000[1]	Migrating adults	Purse seine	Canada	Canada
4T	Gulf St. Lawrence	May 10-25, 1976 Sep 1976	10,000[1] 25,000	Spawning adults Spawning adults and juveniles	Trap Purse seine	Canada Canada	Canada Canada
4Vn	Cape Breton	Dec 1976	20,000	Overwintering adults	Purse seine	Canada	Canada
4W	Chedabucto Bay	Jan 10-30, 1976	20,000[1]	Overwintering adults and juveniles	Purse seine	Canada	Canada
4X	Bay of Fundy SW Nova Scotia	Jan-Aug 1977 Aug 1977	30,000 25,000	Juveniles Spawning adults	Weir Purse seine	Canada Canada	Canada Canada
5Y	Maine Coast	Jun-Oct 1976	25,000	Feeding adults and juveniles	Stop seine	USA	USA
	Maine Coast	Jun-Oct 1977	60,000 90,000	Juveniles	Stop seine, Purse seine	USA	USA
5Y	Jeffreys Ledge	Oct 1-30, 1976 Mar-Apr 1977	30,000 30,000	Spawning adults Migrating adults	Purse seine Purse seine	USA USA	USA USA
5Z	Georges Bank	Sep 15-Oct 15, 1976	30,000	Spawning adults	Purse seine	USSR	USSR[2]
6A	Long Island Sound	Jan-Feb 1977	20,000	Overwintering adults	Purse seine	USA	USA
6A	(or 5Zw)	Apr 1977	30,000	Migrating adults	Purse seine	?	FRG,GDR Poland[3]

[1] Project completed.
[2] R/V *Belogorsk*.
[3] R/V *Anton Dohrn*, *Ernst Haeckel* and *Wieczno*.

and the development of tagging procedures. This is basically a pilot study to determine the feasibility of tagging small herring. Tagging of juvenile herring in the New Brunswick area of the Bay of Fundy will be carried out by Canada in the summer of 1977.

e) Division 5Y (adults)

Tagging (30,000 minimum) on the spawning grounds of Jeffreys Ledge will be attempted by USA during October 1976 and also in the same general area during March-April 1977 (30,000 minimum). The USA herring catch in this area peaks in March-April and again in September-November. Those taken in the spring may be migrating through this region from over-wintering areas.

f) Division 5Z and Statistical Area 6

Spawning herring will be tagged (30,000 minimum) on the northern edge of Georges Bank during 15 September to 15 October 1976. Herring ideally should be tagged immediately after spawning to avoid the high catch rates of the international fleet in this area during August-September, but the possibility of unfavourable weather conditions in October-November and the rapid movement of herring away from the spawning area after spawning necessitates tagging somewhat earlier than desirable. The tagging of 30,000 or more adults in Div. 6A during April 1977 will be attempted in order to assess the relationship between herring over-wintering south of Long Island and those feeding and spawning in Subareas 4 and 5. The same objective applies to the tagging of 20,000 or more herring in Long Island Sound (off Rhode Island) in January-February 1977.

4. Tagging Procedures

The tagging procedures are derived from information in Res. Doc. 75/38 and 76/VI/48 which provide preliminary results of Canadian herring tagging studies, from Res. Doc. 76/VI/66 which provides estimates of the minimum numbers of herring that should be tagged to meet certain objectives, and from Res. Doc. 76/VI/101 which describes tagging techniques used by Canada in herring tagging studies in Subarea 4.

A four-man tagging team seems to be the best unit, and it is expected that such a team can tag 500-800 fish per hour if conditions are ideal. Based on experience from Canadian tagging, an average of 1,000 fish tagged per day can be expected. If good weather conditions prevail, several tagging teams should be employed.

In the offshore areas, herring for tagging will he collected by purse seine, as other methods of capture cause damage to the fish and are not considered feasible at this time. In inshore areas, herring for tagging will be obtained by purse seine, beach seine or weir. The method of tagging should be similar to that given in Res. Doc. 76/VI/101.

The tags used in all experiments will be the same, that is, the FD-68B (ORFD-67) Floy Anchor Tag as described in figure 4 of Res. Doc. 76/VI/101. This tag is an external yellow tag applied by a tagging gun under the doraal fin and anchored against the inter-neurals. A smaller tag whose attachment goes completely through the fish is being developed by Canada and may be used on juvenile herring in 1977. The tags to be used in all studies will each contain a 6-digit number preceded by the letters "INT HER" (e.g. INT HER 123456). About 100,000 tags will he needed for tagging experiments planned for the remainder of 1976 and January-February 1977, and the cost will be about $18,000. Since it would be convenient to purchase the tags in a single order, it is recommended that the purchase be undertaken by the Secretariat, with the cost to be borne by those countries which have an interest in the herring tagging experiment.

The reward payment should be $3.00 or equivalent and should be paid by the country which receives the tag. Each country should develop its own procedure for detecting tags, depending on the handling and processing methods after the herring are taken on board the vessel or landed on shore. The recovery procedure is very important and should be considered carefully by each country fishing in Subareas 4 and 5 and Stat. Area 6. Tags (1,000) will be supplied to Federal Republic of Germany, German Democratic Republic, Poland and USSR for recovery experiments. Small numbers of these tags should be attached to herring (without the knowledge of the processing crew) as they are brought on board a vessel to determine return rates, according to the handling and processing methods for the vessels of each country. A reward of $3.00 or equivalent should also be paid for these tag returns. These experiments should be conducted in the autumn of 1976, if possible, and the results reported to STACRES as soon as possible. Experiments to determine tagging mortality will also be conducted and records kept of the condition of each fish upon release, using appropriate criteria (to be developed) for classifying fish condition.

Each country should appoint a scientist to serve as coordinator and report the tag returns to the Secretariat on a quarterly basis starting on 1 October 1976. The Secretariat will notify all

countries by circular letter, as soon as possible after the end of each quarter, listing the tags recovered by each country, the release date and location, and the recovery date and location. The Secretariat will be kept informed of all herring actually tagged.

Posters describing the herring tagging program and the reward to be paid will be provided by Canada as a guide for other countries involved in the herring fishery to prepare posters in their native language and provide such posters for display on board of all fishing vessels and/or in areas where tags are likely to be recovered.

In order to facilitate the interpretation of tag returns from the international tagging experiment, it is recommended that herring catch and effort data be reported biweekly by 30' × 30' unit areas in conjunction with the reporting of tag returns. It was also agreed that Dr. W. T. Stobo (Canada) act as coordinator of these tagging activities.

APPENDIX VII. REPORT OF *AD HOC* WORKING GROUP ON MACKEREL

Chairman: Ø. Ulltang

Rapporteur: G. H. Winters

The *ad hoc* Working Group was established by STACRES at the Annual Meeting to review additional data on mackerel which have become available since the April 1976 Meeting of the Assessments Subcommittee. The Group met on 2-3 June 1976 with representatives attending from Canada, Federal Republic of Germany, German Democratic Republic, Norway, Poland and USA and an observer from FAO. Additional data and their further analyses are contained in Res. Doc. 76/VI/107, 110 and 111, together with information from the USA spring bottom trawl surveys.

1. Assessment Parameters for 1975

The new data provided some further estimates of fishing mortality, partial recruitment and year-class sizes, which are compared below with the estimates of these parameters considered at the April 1976 Meeting of the Assessments Subcommittee (see Part C, Appendix I, this volume).

a) Fishing Mortality in 1974 and 1975

At the April 1976 Meeting, the fishing mortality (F) for ages 3 and older in 1975 was estimated to be 1.1 from a regression of F (age 4+) from virtual population assessment (Res. Doc. 75/18) on indices of fishing effort from USA spring surveys for the period 1968-72. The same procedure was adopted at the present meeting of the working group except that 1975 was used as the terminal year for the virtual population analysis, thereby providing a fairly reliable estimate of F (age 3+) in 1973. Regression analysis of F (age 3+) on indices of fishing effort from USA spring surveys was then computed for the 1968-73 period. Estimates of F (age 3+) in 1975 were then obtained by two methods: (i) interpolation of F (age 3+) from effort indices in 1974 and projection of stock size to 1975 from 1974 catch data; and (ii) direct interpolation of F from effort indices in 1975. Values of F (age 3+) in 1975 by these two methods were estimated to be about 0.7 and 0.8 respectively. No further refinement of these estimates was possible.

b) Partial Recruitment in 1975

Estimates of the degree of recruitment of age-group 1 (25%) and age-group 3 (fully recruited) were unchanged from the April 1976 Meeting. From graphical plots of fishing mortality against age, it was concluded at the April meeting that recruitment was essentially complete at age 2 in 1975. At the present meeting, further estimates of the degree of recruitment of age-group 2 in 1975, computed from a regression of partial recruitment on stock size (age 3+) for the 1968-73 period, indicated a range of 70-73% (Res. Doc. 76/VI/107). It was pointed out, however, that the partial recruitment of age-group 2 has been increasing in recent years, and estimated to be 84% and 95% for 1973 and 1974 respectively (Res. Doc. 76/VI/107). Nevertheless, some scientists felt that the partial recruitment of age 2 fish was not in excess of 90% in 1975, and no further refinement of the range of estimates (90-100%) was possible.

c) Size of 1975 and 1976 Year-classes

In the absence of any firm information on the strengths of the 1975 and 1976 year-classes, these were assumed to be equal to the poorest on record (850 million fish as estimated for the 1972 year-class at age 1) at the April 1976 Meeting. At the present meeting, new data from the USA spring survey in 1976 indicated that the 1975 year-class is the poorest on record, being estimated at 452 million fish at age 1. Some scientists were willing to accept a level of 50% above this estimate (675 million fish), while others felt that the inherent variability in such surveys did not allow a precise estimate to be made and proposed instead a level of 1,400 million fish, the median level of the 1970-74 year-classes (Res. Doc. 76/VI/107). In both situations the 1975 and 1976 year-classes were assumed to be of equal strength.

2. Options for Stock Assessment and Catch Prognosis

Because of the disagreement on the basic parameters noted above, assessments of stock size and catch were carried out using the two options defined in the following table. Under both options, it was assumed that the 1976 catch would be 310,000 tons (the TAC for 1976) and also 275,000 tons.

	1975 F (age 3+)	Partial recruitment		Size of 1975 year-class	Size of 1976 year-class
		Age 1	Age 2		
Option 1	0.8	25%	100%	675×10^6	675×10^6
Option 2	0.7	25%	90%	1400×10^6	1400×10^6

3. Results of Assessments

The results of the alternative assessment options are given in Table 1. They suggest that (a) the 1976 TAC of 310,000 tons will generate a level of fishing mortality higher than any previous estimate since the fishery began and in any case higher than F_{max} of 0.75; (b) the spawning stock will be reduced to a level in the range of 160,000-350,000 tons at the beginning of 1977, representing a continuous decline from the peak level of nearly 1.7 million tons in 1969 (Fig. 1); and fishing at $F_{0.1}$ in 1977 will generate catches of 55,000 and 115,000 tons for the two options respectively and in each case will allow for some increase in spawning stock from 1977 to 1978, although such levels of spawning stock size will be below the levels estimated for the beginning of 1976. Fig. 2 and 3 illustrate the relationship between 1977 catch and 1978 spawning stock on the one hand and fishing mortality on the other for options 1 and 2 respectively.

Table 1. Mackerel in Subareas 3 to 5 and Stat. Area 6: spawning stock size and catch projections in 1976 to 1978 for two options with respect to fishing mortality in 1975, partial recruitment of age-groups 1 and 2, and recruitment of the 1975 and 1976 year-classes, using two levels of 1976 catch for each option.

	Parameters	Option 1		Option 2	
Fishing mortality	F 1975 (age 3+)	0.8		0.7	
Partial recruitment	F (age 1)	0.25 × F(age 3+)		0.25 × F(age 3+)	
	F (age 2)	1.00 × F(age 3+)		0.90 × F(age 3+)	
Recruitment	1975 year-class	675×10^6		1400×10^6	
	1976 year-class	675×10^6		1400×10^6	
1976 projections	Spawn. stock (000 tons)	345.6		429.4	
	F (age 3+)	1.27	1.03	0.91	0.76
	Catch (000 tons)	310.0	275.0	310.0	275.0
1977 projections	Spawn. stock (000 tons)	162.0	198.9	311.5	349.0
	$F_{0.1}$ (age 3+)	0.35	0.35	0.35	0.35
	Catch (000 tons)	54.5	64.5	105.3	115.5
1978 projections	Spawn. stock (000 tons)	174.5	200.2	356.5	383.3
	$F_{0.1}$ (age 3+)	0.35	0.35	0.35	0.35
	Catch (000 tons)	59.9	66.5	119.1	126.0

4. Predicted and Observed Catch Composition in 1976

Preliminary data on the age composition of USSR catches in the first quarter of 1976 (Res. Doc. 76/VI/110) were prorated to the 1976 TAC of 310,000 tons. These data indicate a predominance of age 3 mackerel (1973 year-class) compared with a predominance of age 2 fish (1974 year-class) in the predicted catch composition for 1976. Furthermore, the estimated number of age 3 fish in the prorated catch (703 million) is larger than the predicted population of that age-group (331 million and 464 million fish for options 1 and 2 respectively), implying that the strength of the 1973 year-class is under-estimated. It was pointed out by some scientists that there appeared to be some inconsistencies between the length composition data presented in Res. Doc. 76/VI/110 and data for the same period presented at the April 1976 Meeting, while other scientists indicated that the data were not necessarily inconsistent. Thia problem could not be resolved, and no firm conclusion could therefore be drawn as to the accuracy of the predicted catch composition for 1976.

5. Consideration of Stock and Recruitment

The available information on stock and recruitment for the 1966-73 period is shown in Fig. 4. It was generally agreed that a minimum stock constraint would be desirable to prevent recruitment overfishing of mackerel and that 500,000-1,000,000 tons was a desirable range toward which the spawning stock should be rebuilt. Some scientists considered that 500,000 tons was a minimum level, which should be achieved as soon as possible, and that a zero TAC for 1977 was a necessary conservation

measure. Other scientists felt that fishing at $F_{0.1}$ with a TAC of 115,000 tons in 1977 would allow the spawning stock to recover to a range of 357,000-383,000 tons in 1978 (depending on the catch achieved in 1976) and that this level was an adequate conservation objective for 1978.

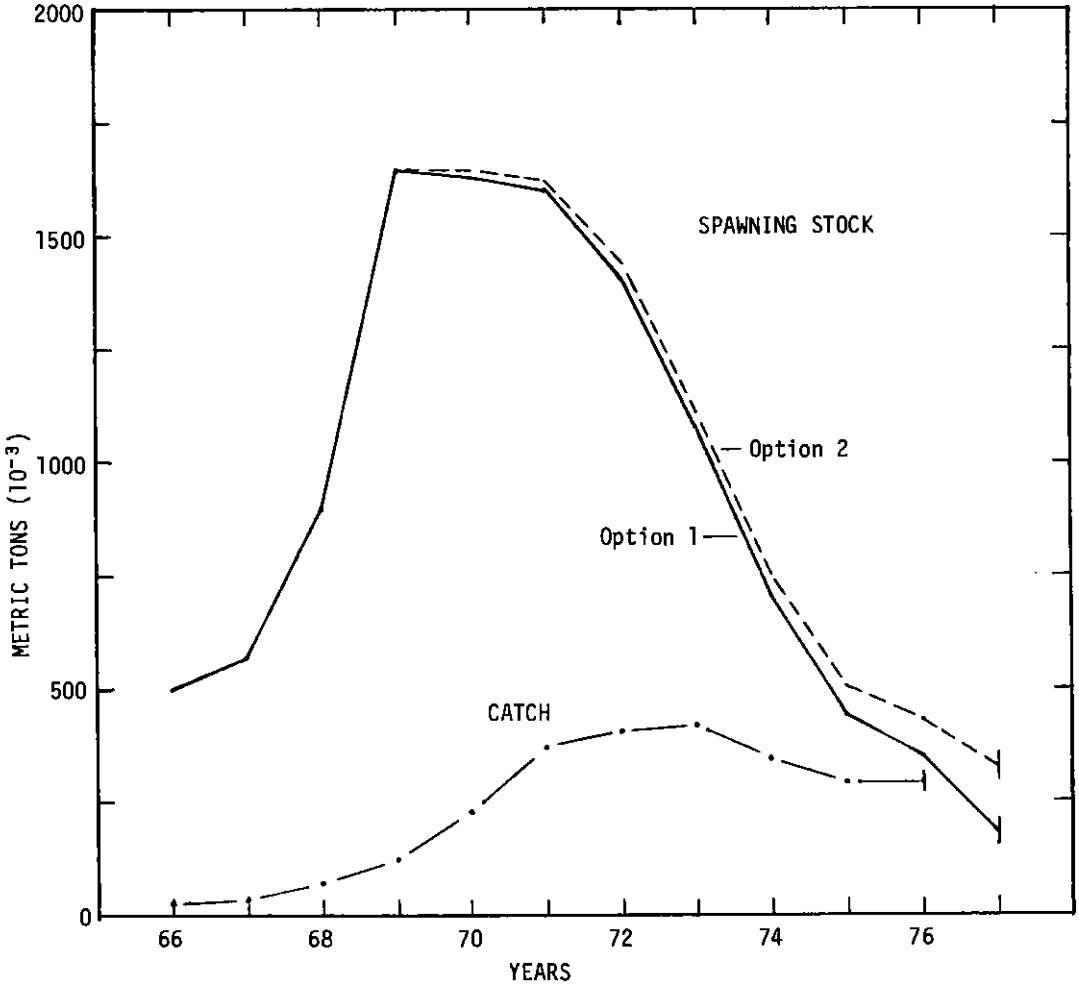

Fig. 1. Mackerel in Subareas 3 to 5 and Stat. Area 6: catch and spawning stock size, 1966-76, for assessment Options 1 and 2.

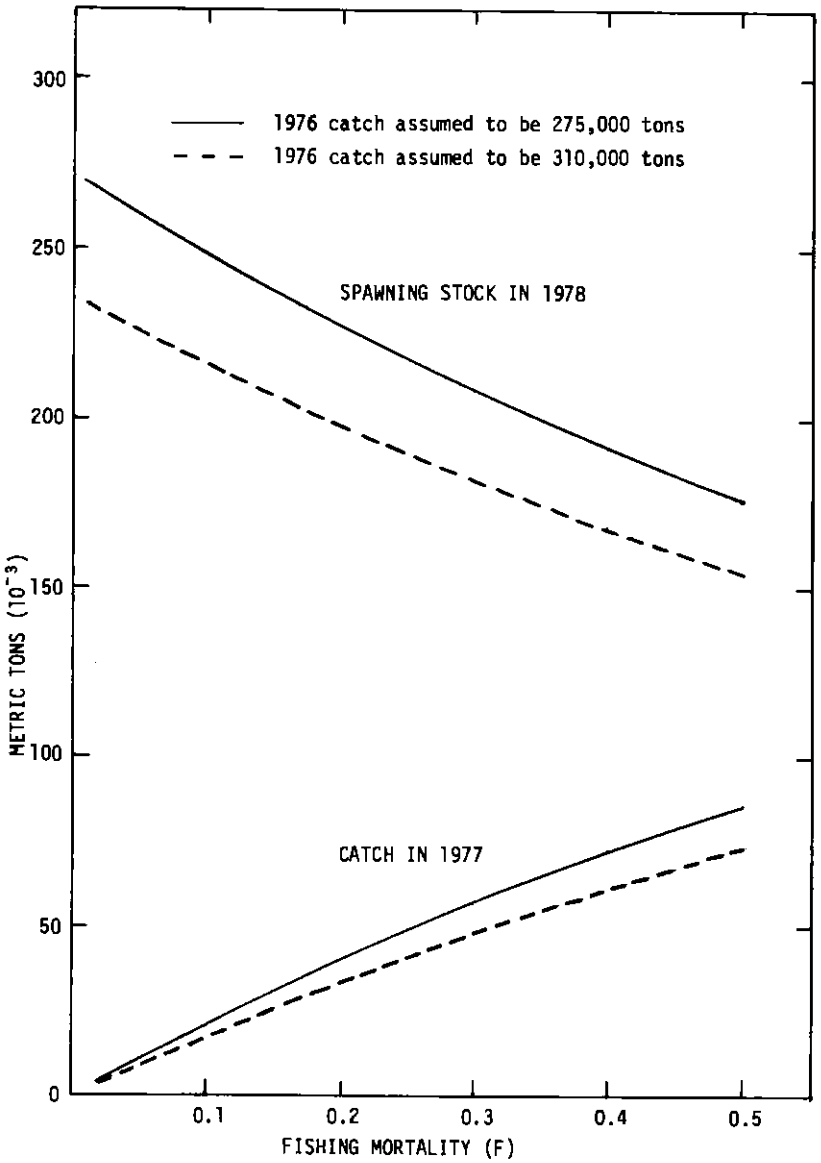

Fig. 2 Mackerel in Subareas 3 to 5 and Stat. Area 6: projected catch in 1977 and spawning stock in 1978 for a range of fishing mortality, assuming two levels of catch in 1976 and the parameters specified for Option 1.

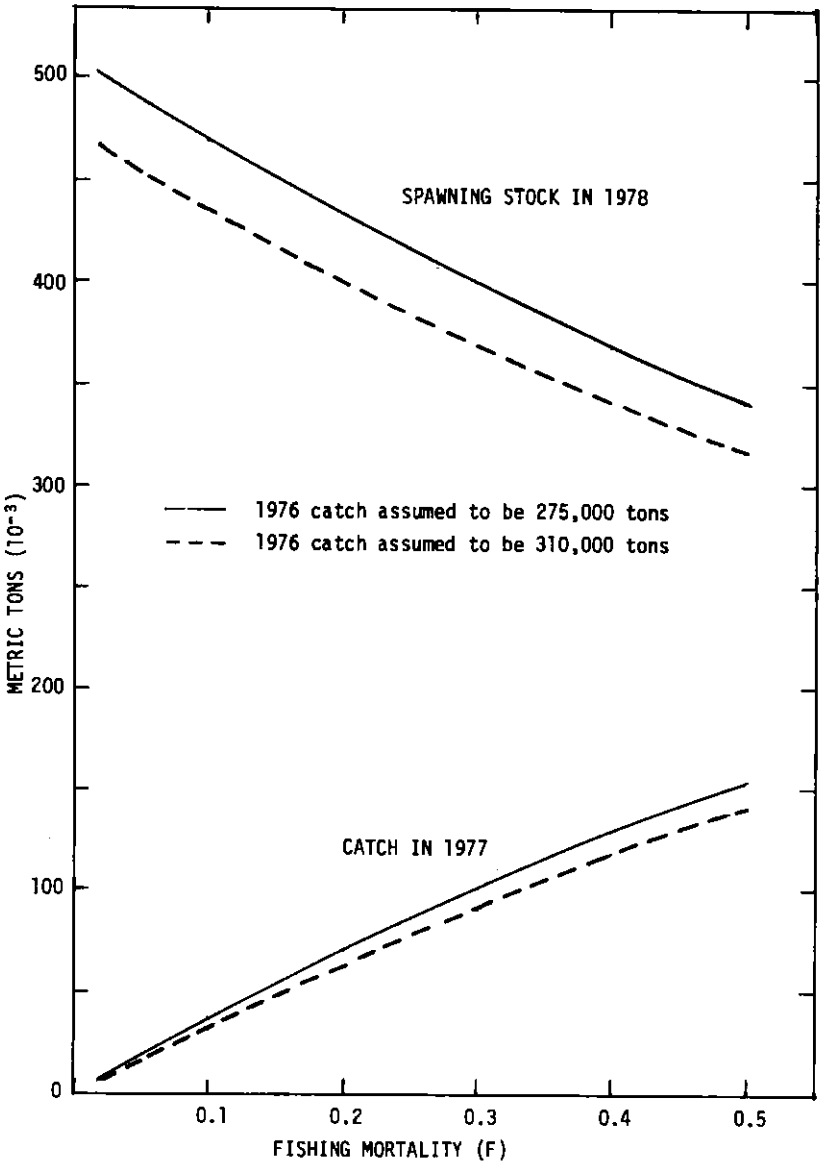

Fig. 3. Mackerel in Subareas 3 to 5 and Stat. Area 6: projected catch in 1977 and spawning stock in 1978 for a range of fishing mortality, assuming two levels of catch in 1976 and the parameters specified for Option 2.

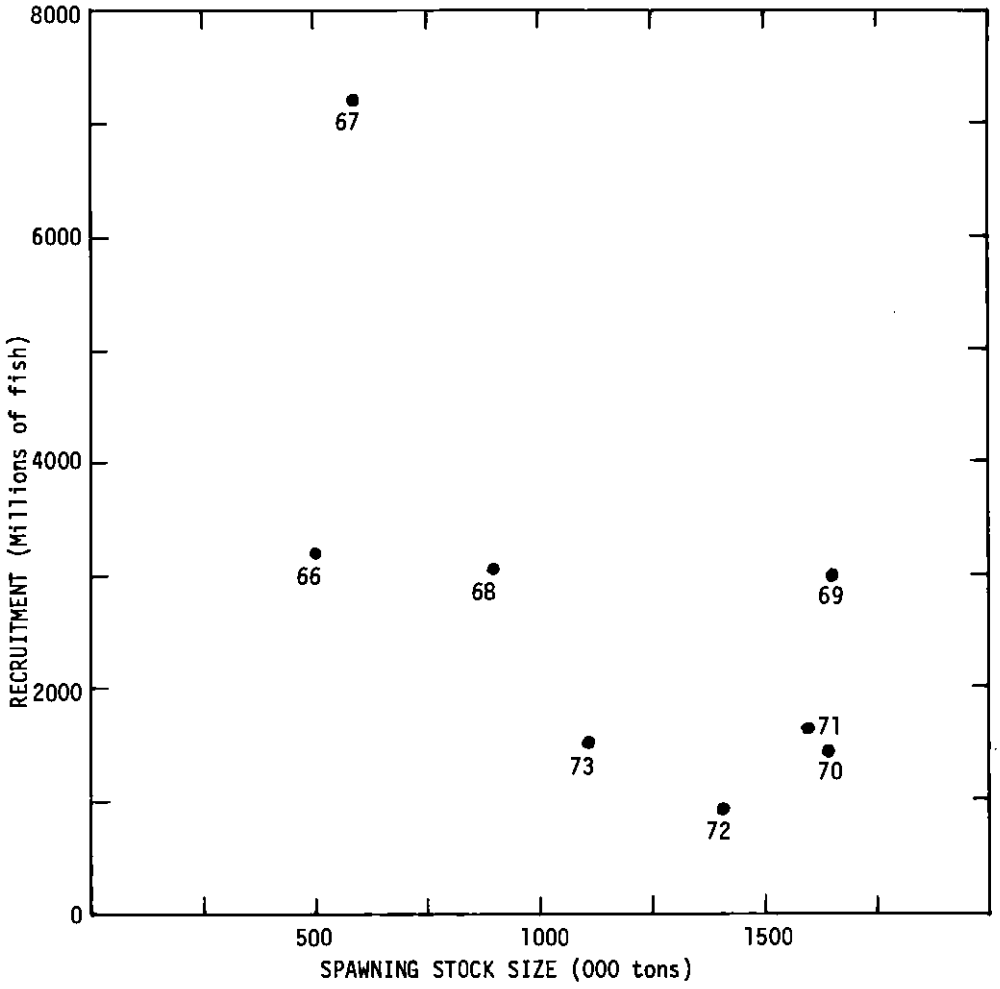

Fig. 4. Mackerel in Subareas 3 to 5 and Stat. Area 6: relationship between recruitment (age 1) and spawning biomass (age 3 and older) for the 1966-73 period. (Spawning biomass for 1968-73 from virtual population analysis, and values for 1966-67 obtained by back-calculation of numbers in later years and the correction of average weights at age by the factor 1.26.)

APPENDIX VIII. REPORT OF STEERING AND PUBLICATIONS SUBCOMMITTEE

Chairman: A. W. May

Rapporteur: V. M. Hodder

The Subcommittee met on 2 June 1976 to consider the items in Section 10 of the STACRES Agenda (see Part E, this volume). All members of the Subcommittee attended except the representative for the country group consisting of Bulgaria, German Democratic Republic, Poland, Romania and USSR.

1. Subcommittee Membership

The Subcommittee concurred with the request that Cuba be included with the group of countries (France, Portugal and Spain) represented at this meeting by Mr. R. H. Letaconnoux (France).

2. Review of STACRES Meeting Agenda and Timetable

The Subcommittee noted that there was at present no difficulty with the scheduling of meetings of STACRES and its Subcommittees and Working Groups, following agreement to hold morning, afternoon and evening sessions during the first 3 days. STACRES finished the major part of its work on 3 June, leaving an additional half-day for the use of Scientific Advisers to Panels which met on 4-5 June 1976.

3. Organization and Operation of STACRES

a) Subcommittees and Working Croups

The Subcommittee agreed to the necessity of continuing the operation of the Statistics and Sampling, Biological Surveys, Assessments, and Environmental Subcommittees, and concurred with the recommendation of the Working Group on Fishing Effort Studies that it be discontinued as further fishing effort studies could be dealt with by other subcommittees (e.g. Assessments or Statistics and Sampling). The Subcommittee noted that the Environmental Working Group had vigorously pursued its objective of initiating studies in the Gulf of Maine and to a lesser extent on Flemish Cap, and agreed that future coordination could be carried out by the Environmental Subcommittee which should hold its main meeting at a time other than the Annual Meeting in order to stimulate greater participation by oceanographers. The Subcommittee would thus need to meet only briefly at the Annual Meeting to update its report prior to its presentation to STACRES.

In view of the studies on ageing that are being conducted in various workshops, the Subcommittee considered that there would likely be a need to set up an *ad hoc* working group on ageing techniques in the near future, and agreed to defer this matter until the next Annual Meeting when reports of workshops planned for late 1976 and early 1977 would be available.

b) Future Status of STACRES

In the light of decisions by Canada and USA to extend coastal state jurisdiction for fisheries management, the Subcommittee discussed the implications of these decisions on the future status of STACRES. It was noted that there would be a need for continued international cooperation in regard to (i) continuation of the STATLANT system of statistical reporting which is coordinated by the CWP (Coordinating Working Party on Atlantic Fishery Statistics) of which ICNAF is a member, (ii) continued implementation of the ICNAF data base in the Secretariat for both fishery catch and effort statistics and biological data, and (iii) continued coordination of research activities. It was also pointed out that STACRES could serve as the forum for discussions of matters relevant to the general problems of fishery science and management in the Northwest Atlantic.

4. Review of ICNAF Publications (Scientific)

a) Publications during 1975/76

The Subcommittee noted that the following publications, related to research and statistics, were issued since the 1975 Annual Meeting:

Special Publication No. 11 (125 p.), containing an index and list of titles of scientific papers published in the Annual Report, Research Bulletin, Special Publications and Redbook, was distributed in July 1975.

Redbook 1975 (127 p.), containing reports of STACRES meetings in January 1975 and May-June 1975, was distributed in August 1975.

Special Publication No. 10 (136 p.), containing contributions to the Symposium (held in May 1974) on Environmental Conditions in the Newfoundland-Grand Bank Area in 1972 and their Effects on Fishery Trends, was distributed in November 1975.

Research Bulletin No. 11 (162 p.), containing 13 scientific papers, was distributed in November 1975.

Statistical Bulletin Vol. 24 (255 p.), containing catch and effort statistics for 1974, was distributed in February 1976.

Sampling Yearbook Vol. 19 (50 p.), containing lists of length and age sampling data for 1974, was distributed in February 1976.

Special Publication No. 9 (51 p.), containing contributions on ice conditions and forecasting techniques presented to the Environmental Subcommittee in May 1973, was distributed in March 1976.

List of Fishing Vessels for 1974 (69 p.) was distributed in March 1976.

Selected Papers No. 1 (193 p.), containing 15 papers selected from research documents presented to various STACRES meetings in 1975, was distributed in April 1976. The Subcommittee welcomed the improved presentation of papers in this volume, in contrast to their presentation previously in Redbook, Part III (discontinued in 1974). It was noted that 50 reprints are supplied free to each author.

Research Bulletin No. 12, to be issued later this year, is at the stage where page proofs will be sent to authors for checking before the end of June.

b) Publication of Reports of Scientific Advisers Meetings in Redbook

In view of the recommendation at the 1975 Annual Meeting for Scientific Advisers to Panels to discuss assessment problems and to update assessments, if necessary, at the Annual Meeting, the Subcommittee noted the need for the reports of scientific advisers to be published in conjunction with the reports of STACRES and its Subcommittees. It was therefore agreed that these reports should be published in the Redbook instead of in the Meeting Proceedings, thus enabling all reports of scientific meetings to be found in the same volume.

c) Status of Working Papers

The Subcommittee again reviewed the status of working papers, to which reference is sometimes required in meeting reports. Since only a few of the working papers need to be referred to, it was agreed (i) that working papers containing extensive material for referencing should be assigned to the Research Document series, and (ii) that, if the amount of material to be referenced is relatively small, the material should be extracted and incorporated directly in the report of the subcommittee or working group.

5. Review of Editorial Policy Relating to Research Bulletin and Selected Papers

The Subcommittee noted that the guidelines recommended at the 1975 Annual Meeting have been put into effect by the Secretariat and that no revisions were proposed at this time. It was pointed out that the tentative arrangement of having the Secretariat act as Editor of Research Bulletin and Selected Papers has significantly increased the workload of the Secretariat and delayed the compilation of the index of ICNAF documents to the extent that it will not likely be finished until 1977. The Subcommittee agreed to the importance of completing the Index and suggested that the Secretariat might consider the use of contingency funds, if available, to obtain additional help in the editing of papers, if a suitable person can be found to do this on a part-time basis.

6. Disposition of 1976 Documents

a) The Subcommittee agreed that the Report of the Working Group on Environmental Studies (Summ. Doc. 76/VI/36) should be published in *Redbook* 1976 as an annex to the Report of the Environmental Subcommittee.

b) The Subcommittee reviewed the research documents and other scientific papers presented to 1976 meetings of STACRES and selected the following for possible publication in *Selected Papers* No. 2, subject to the author's approval with revision as appropriate: Res. Doc. 76/VI/4, 13, 14, 15, 16, 17, 27, 30, 34, 39, 47, 65, 86, 96, 106 + 117; Summ. Doc. 76/VI/13. The Subcommittee noted that the authors of some of these papers may wish to submit their revised manuscripts for possible publication in Research Bulletin.

c) The Subcommittee agreed to the desirability of publishing a comprehensive summary of the proceedings of the seminar, held on 7 June 1976, on the scientific approach to ecosystem management, but noted that only two of the four presentations were accompanied by manuscripts. The Secretariat was requested to contact the Convener (Dr. R. L. Edwards) with regard to the preparation of a summary report for inclusion in *Selected Papers* No. 2. It was also agreed that the seminar paper by J. G. Pope should be invited for inclusion together with the other presentations if the authors submit manuscripts prior to the publication deadline.

7. Other Matters

a) Field Guide for Species Identification

Some members of the Subcommittee expressed the need for a field guide for use on fishing vessels to aid fishermen in the proper identification of species in their catches. Mr. R. C. Hennemuth indicated that such a guide has been developed by USA scientists and he agreed to send copies to the Secretariat to aid in the preparation of a booklet for distribution to member countries upon request.

PART D

REPORTS OF SCIENTIFIC ADVISERS

Annual Meeting - June 1976

CONTENTS

1. REPORT OF SCIENTIFIC ADVISERS TO PANEL 1[1]

Friday, 4 June 1976, 0900 hours

1. The Chairman, Mr. Ø. Ulltang (Norway), opened the meeting which was attended by scientific advisers from all member countries of the Panel except Poland, and by observers from Canada, German Democratic Republic, USA, FAO, ICES and ICSEAF. Mr. B. W. Jones (UK) was appointed rapporteur. The agenda for the meeting of Panel 1 was adopted as the basis for this meeting.

2. Status of Fisheries and Research Carried Out

The Chairman presented his report on the status of fisheries and research carried out in Subarea 1, Statistical Area 0 and the East Greenland area in 1975 (Summ. Doc. 76/VI/39). The report was adopted with a few minor amendments.

3. Conservation Requirements

a) Cod in Subarea 1

The Advisers reviewed the Report of the Assessments Subcommittee (Part C, Appendix I, this volume). After a period of very poor recruitment, the current indication is that the 1973 year-class is somewhat more abundant. Sampling data from 1976 research surveys thus far confirms the assumption of the Assessments Subcommittee that the 1973 year-class will contribute significantly to the catch in 1977 and subsequent years, and to some extent also to the 1976 fishery. The Assessments Subcommittee recommended that the recruiting year-classes should be protected as much as possible to allow the spawning stock to rebuild from its present very low level and also to minimize fishing on these year-classes until they reach a better commercial size. Consequently, it was recommended that the TAC for 1977 should be set at zero. This recommendation was supported by the Scientific Advisers, who also considered whether it was possible to define a minimum size to which the spawning stock should be allowed to rebuild and above which it should subsequently be maintained. This could not be done at present due to an incomplete understanding of the effect of environmental factors on the stock and of the inter-relationship with the cod stocks in the East Greenland area. For these reasons the Advisers point out that, even with a zero TAC in 1977, there is no guarantee that the spawning stock will recover substantially in the near future. However, it was noted that, since the spawning stock is at present at a very low level, any improvement in its size would increase the chances of future recruitment. In this context, it was pointed out that the 1973 year-class seems at present to be the only one to offer the chance of increasing the spawning stock.

The Assessments Subcommittee discussed the report of the ICES Northwestern Working Group (Summ. Doc. 76/VI/7) in regard to the inter-relationships of cod in the West Greenland, East Greenland and Iceland areas and the implications for the management of the fisheries. The Scientific Advisers endorse the views expressed by the Assessments Subcommittee on this subject.

The question of the by-catch of cod in other directed fisheries in Subarea 1 under a zero TAC for cod was discussed, and it was indicated that the other directed fisheries were for Atlantic salmon, shrimp, redfish, Greenland halibut and roundnose grenadier. No by-catch of cod would result from the salmon fishery and the by-catch in the shrimp fishery would depend on the time of the year when the directed fishery for shrimp took place, but in any case it was not considered to be a significant source of by-catch because of the depth differences. The by-catches of cod in the fisheries for redfish, roundnose grenadier and Greenland halibut are considered to be very small.

In regard to the options in Table 3 of the Assessments Subcommittee Report, it was considered that other combinations of catches in 1977 and 1978 might be considered as well as the long-term benefits of the recommended zero TAC in terms of stock recovery. It was pointed out that, because of uncertainties about future recruitment due to strong environmental influences, predictions of catches and stock sizes beyond January 1979 would have no validity. The attention of STACRES was drawn to the fact that with a zero TAC in 1977 an important source of data for stock assessment (i.e. commercial sampling data) would no longer exist.

The USSR reported that an analysis of the effects of environmental factors on the cod stock was in progress and that the results would be presented in the near future.

b) Roundnose Grenadier in Statistical Area 0 and Subarea 1

In previous years, it was only possible to recommend precautionary TACs based on catch statis-

[1] Presented to June 1976 Annual Meeting as Proceedings No. 5, Appendix 1 (Serial No. 3962).

tics. Due to the availability of better data, it was possible this year to make a quantitative assessment of this stock, and the Assessments Subcommittee recommended that the TAC for 1976 should be set at 8,000 tons. This recommendation was endorsed by the Scientific Advisers.

c) Greenland Halibut in Statistical Area 0 and Subarea 1

The Advisers welcomed the study on Greenland halibut by USSR (Res. Doc. 76/VI/109) and also the news that these studies will be continued in the future. They requested that all of the data and detailed descriptions of the methods used should be presented at the next meeting of the Assessments Subcommittee at which Greenland halibut will be discussed. The 1977 TAC of 20,000 tons, recommended by the Assessments Subcommittee, was supported by the Scientific Advisers.

d) Shrimp (*Pandalus borealis*) in Subarea 1

The Advisers welcomed a new study on this species by USSR scientists (Res. Doc. 76/VI/113) and recommended that these data, together with any additional data that might become available, should be discussed more fully at the next meeting of the Assessments Subcommittee at which shrimp will be discussed.

Catches of this species, especially in the offshore fishery, have been increasing very rapidly, and the Assessments Subcommittee recommended that a precautionary TAC for the offshore grounds in 1977 should be set at 26,000 tons with a possible area breakdown of the overall TAC. This recommendation was endorsed by the Scientific Advisers.

Following discussion on the desirability of a mesh size regulation for shrimp, the Scientific Advisers agreed

to recommend to Panel 1

that a minimum mesh size of not less than 40 mm stretched mesh be used in the shrimp fishery in Subarea 1.

4. Future Research Requirements

The Scientific Advisers identified the need for research as follows:

a) Cod

If the TAC is set at zero or at a low level for 1977, the consequent reduction in commercial fishing activity would increase the need for research vessel groundfish surveys to monitor the stock. It was noted that surveys planned for 1976 and 1977 are listed in the Report of the Biological Surveys Subcommittee (see Part C, Appendix II, this volume).

b) Greenland halibut

Studies on trawl codend mesh selection, yield per recruit and additional information on by-catches in the fishery for Greenland halibut are required.

c) Shrimp

Information required involve further observations on density and distribution (horizontal and vertical), mesh selection experiments, data on by-catches taken in both the inshore and offshore fisheries, and studies on predators and predation on shrimp. Denmark reported that shrimp tagging experiments would be extended into the offshore areas. The Advisers endorsed the request of the Assessments Subcommittee that catch and effort data for the shrimp fishery be reported through the STATLANT system.

5. Election of Chairman

Mr. Ø. Ulltang was unanimously re-elected Chairman of Scientific Advisers to Panel 1 for the ensuing year.

6. Time and Place of Next Meeting

It was agreed that the next meeting of Scientific Advisers to Panel 1 would take place prior to the meeting of Panel 1 at the next Annual Meeting.

2. REPORT OF SCIENTIFIC ADVISERS TO PANEL 2[1]

Friday, 4 June 1976, 1315 hours

1. Mr. B. B. Parrish (UK), acting on behalf of the Chairman, Mr. D. J. Garrod (UK), opened the meeting with scientific advisers present from Canada, Cuba, France, Federal Republic of Germany, German Democratic Republic, Norway, Poland, Portugal, Spain, USSR and UK, and observers from Denmark and USA. Dr. T. K. Pitt (Canada) was appointed rapporteur. The agenda for the meeting of Panel 2 was adopted as the basis for this meeting, together with consideration of the conservation requirements for stocks overlapping in Subareas 2 and 3.

2. Status of Fisheries and Research Carried Out

The report on the status of fisheries and research carried out in Subarea 2 during 1975 (Summ. Doc. 76/VI/40) was presented by the Acting Chairman and adopted with minor revisions.

3. Conservation Requirements

a) Cod in Divisions 2G and 2H

The Advisers agreed with the recommendation of the Assessments Subcommittee (Part C, Appendix I, this volume) that the TAC for 1977 should remain at 20,000 tons.

b) Cod in Divisions 2J, 3K and 3L

The Advisers considered the information presented in the report of the Assessments Subcommittee which indicated that a catch at F_{max} of 260,000 tons in 1977 would result in a spawning stock at the end of 1977 of about 600,000 tons, compared to 1,200,000 tons over the 1969-72 period. As a result of poor recruitment of recent year-classes, the spawning stock has progressively decreased in size. A reduction in the fishing mortality in 1977 and subsequent years to the $F_{0.1}$ level would allow the stock to rebuild, with consequential improvement in recruitment prospects. The Advisers accordingly endorsed the Assessments Subcommittee's recommendation that the TAC in 1977 should be set at 160,000 tons, corresponding to fishing at the $F_{0.1}$ level.

c) Witch Flounder in Divisions 2J, 3K and 3L

The Advisers endorsed the recommendation of the Assessments Subcommittee that the TAC for 1977 remain at 17,000 tons, corresponding with fishing at the $F_{0.1}$ level.

d) Redfish in Subarea 2 and Division 3K

The Advisers agreed that the TAC be maintained at 30,000 tons in 1977, the level recommended by the Assessments Subcommittee.

e) American Plaice in Subarea 2 and Division 3K

The Advisers concurred with the recommendation of the Assessments Subcommittee that the TAC for 1977 should be maintained at 8,000 tons, which corresponds to fishing at the $F_{0.1}$ level.

f) Roundnose Grenadier in Subareas 2 and 3

The Advisers considered the information and recommendation of the Assessments Subcommittee, which indicated that, on the basis of a new assessment, the TAC for 1977 should he slightly increased to 35,000 tons from the 1976 level of 32,000 tons, and concurred with the proposal.

g) Greenland Halibut in Subarea 2 and Divisions 3K and 3L

The Advisers agreed that the TAC for 1977 remain at 30,000 tons, as recommended by the Assessments Subcommittee.

h) Capelin in Subareas 2 and 3

The Advisers endorsed the recommendation of the Assessments Subcommittee that the TAC adopted by the Commission at its January 1975 Special Meeting be continued into 1977, with total removals at 500,000 tons for the two subareas as a whole to be allocated as follows: 300,000 tons in Subarea 2 and Div. 3K, and 200,000 tons in Div. 3L, 3N, 3O and Subdiv. 3Ps.

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[1] Presented to June 1976 Annual Meeting as Proceedings No. 6, Appendix I (Serial No. 3963).

4. Future Research Requirements

a) Capelin

The Advisers stressed the need for member countries to provide detailed and up-to-date information on the capelin fishery in Subareas 2 and 3, together with information on biology and population dynamics, for consideration of the adequacy of current management measures at the April 1977 Meeting of the Asssessments Subcommittee. Several countries indicated that research was in progress as follows:

i) Canada. Current research on capelin is summarized in Res. Doc. 76/VI/120, which includes the delineation of capelin stocks using meristic characters, acoustic surveys to estimate capelin biomass in Div. 2J, 3K, 3N and 3O, biological migrations of spawning capelin, and completion of the study on adult and larval capelin in the Gulf of St. Lawrence. The view was expressed that it might take some time to properly understand not only the ecology of capelin but also its inter-relation with other species.

ii) Federal Republic of Germany. Information will be collected on the occurrence of capelin in the stomachs of cod and other species during the course of groundfish surveys in Div. 2J and 3K.

iii) Norway. In addition to sampling the commercial capelin catches, tagging experiments will be conducted in Div. 3N during the summer of 1976 to obtain information on the migrations of the adults and to estimate spawning stock size.

iv) USSR. In addition to commercial catch sampling, acoustic and fishing surveys will be conducted in Div. 3N and 3O in June and in Div. 3K and 3L in the autumn of 1976 to provide further stock size estimates.

The Advisers stressed the importance of having the results of as many of these studies as possible presented as research documents to the April 1976 Meeting of the Asssessments Subcommittee. The importance of capelin as food for cod and other resources was noted and the Advisers agreed that this must be taken into account in providing advice on management of the capelin stocks. Research should, therefore, be directed to the predatory relationships involving capelin. Mr. Ulltang (Norway) agreed to provide, for the 1977 meeting of the Assessments Subcommittee, information on changes in the capelin fishery and stock in the Barents Sea.

b) Groundfish Surveys and Sampling

The Advisers drew attention to the need for more sampling data and extended groundfish surveys in the subarea. In this respect, they endorsed the recommendations of the Biological Surveys and the Statistics and Sampling Subcommittees. Dr. Messtorff (FRG) drew attention to the participation of a Canadian scientist in a research cruise by the Federal Republic of Germany in 1976 and hoped that it would be possible to continue this cooperation in 1977.

c) Ageing Workshop on Cod

The Advisers endorsed the recommendation of STACRES that a further ageing workshop on cod in Div. 2J, 3K and 3L should take place in January 1977.

5. Other Business

A paper dealing with the growth of yellowtail flounder (Res. Doc. 76/VI/91) was presented by the adviser from France.

6. Election of Chairman

Mr. E. C. Lopez-Veiga (Spain) was elected Chairman of Scientific Advisers to Panel 2 for the ensuing year.

7. Time and Place of Next Meeting

The Advisers agreed that its next meeting should be held prior to the meeting of Panel 2 at the 1977 Annual Meeting.

3. REPORT OF SCIENTIFIC ADVISERS TO PANEL 3[1]

Friday, 4 June 1976, 1530 hours

1. The Chairman, Mr. B. B. Parrish (UK), opened the meeting with secientific advisers present from Canada, Cuba, Denmark, France, German Democratic Republic, Japan, Norway, Poland, Portugal, Spain, USSR, UK and USA, and observers from Federal Republic of Germany and FAO. Mr. L. S. Parsons (Canada) was appointed rapporteur. The agenda for the meeting of Panel 3 was adopted as the basis for this meeting.

2. Status of Fisheries and Research Carried Out

The Chairman presented a report on the status of fisheries and research carried out in Subarea 3 during 1975 (Summ. Doc. 76/VI/44). The report was adopted, after minor amendment, for presentation to the Panel.

3. Conservation Requirements

The Scientific Advisers agreed that their consideration of stocks subject to quota regulation should be confined to those stocks listed in the Panel 3 agenda, with the exception of capelin and stocks overlapping in Subareas 2 and 3, these having been dealt with in the meeting of Scientific Advisers to Panel 2. Similarly, the stocks overlapping in Subareas 3 and 4 were considered by the Scientific Advisers to Panel 4. The Scientific Advisers reviewed the report of the Assessments Subcommittee (Part C, Appendix I, this volume), which contains the latest assessment of the fish stocks subject to quota regulation in Subarea 3, with clarification as appropriate provided by the Chairman of the Subcommittee (Mr. A. T. Pinhorn). After discussion, the Advisers endorsed all of the 1977 TACs as recommended by the Subcommittee as follows:

Species	Stock area	1976 TAC (metric tons)	Recommended 1977 TAC (metric tons)
Cod	3M	40,000	25,000
	3NO	43,000	30,000
	3Ps	47,500	32,000
Redfish	3M	16,000	16,000
	3LN	20,000	16,000
	3O	16,000	16,000
	3P	18,000	18,000
American plaice	3M	2,000	2,000
	3LNO	47,000	47,000
	3Ps	8,000	6,000
Yellowtail	3LNO	9,000	12,000
Witch	3NO	10,000	10,000
	3Ps	3,000	3,000
Capelin*	2+3K	160,000+	300,000
	3L	45,000+	
	3NO	126,000+	200,000
	3Ps	9,000+	

* See Report of Scientific Advisers to Panel 2.

The Panel's attention is drawn particularly to the reductions in the recommended TACs for 1977 for cod in Div. 3M, Div. 3NO, and Subdiv. 3Ps, for redfish in Div. 3LN, and for American plaice in Subdiv. 3Ps. For all of the other stocks, the recommended 1977 TACs are the same as in the 1976 regulations, except for a small increase in the TAC for yellowtail in Div. 3LNO. Specific comments on certain stocks are detailed below.

a) Cod in Division 3M

With regard to the recommended reduction in the TAC from 1976 to 1977, the Advisers noted that, although the results of a further assessment had confirmed earlier estimates that the long-term

[1] Presented to 1976 Annual Meeting as Proceedings No. 7, Appendix I (Serial No. 3964).

maximum sustainable yield was about 40,000 tons, the available information supports the view that the stock was in a depressed state with catches in recent years below the equilibrium curve, and that it is now composed mainly of smaller and younger cod, as in the neighbouring cod stocks. It was noted that catches in the last three years had been substantially less than the annual TAC of 40,000 tons. Catch rate data indicated a downward trend in stock abundance since 1963 with some improvement in 1974. A reduction in the TAC to 25,000 tons for 1977, corresponding to the average level of catches in the last three years, would allow the relatively strong 1973 year-class to contribute more effectively to rebuilding the stock.

b) Cod in Divisions 3N and 3O

Although it has not been possible to update the assessment made last year because of the lack of sampling data, the most recent information indicated that this stock was also in a depressed condition with fishing mortality in 1974 and 1975 beyond the F_{max} level. The continued decline in catch rate up to 1974 suggests that the stock was at a low level of abundance, with the biomass in 1974 estimated to have been about 60% of that in the 1960's. Catches in recent years have fallen substantially short of the TACs. In view of the lack of sampling data and the fact that the stock is known to be in a depressed state, the Assessments Subcommittee recommended a substantial reduction in the 1977 TAC in order to protect the stock. The Panel's attention is drawn to the continued lack of sampling data and the Advisers stress the need for member countries fishing this stock to increase their sampling activity.

The Advisers reviewed Res. Doc. 76/VI/108 which provides information on a significant relationship between the numbers of pre-recruit age-groups in USSR trawl surveys in the southern Grand Bank area and subsequent commercial fishery yields. The data indicated that, owing to the relatively low abundance of recent year-classes, increased fishery yields could not be expected in the immediate future. The analyses suggested that environmental conditions were the chief determinant of relative year-class strength. The Advisers concluded that these results do not necessitate a change in the Assessments Subcommittee's advice on the TAC for 1977.

c) Cod in Subdivision 3Ps

The reduction in the recommended TAC from 47,500 tons in 1976 to 32,000 tons in 1977 can be considered as one of the cases involving a change in the management objective from fishing at F_{max} or F_{MSY} to fishing at the lower $F_{0.1}$ level.

d) Redfish in Divisions 3L and 3N

The Advisers noted that the reduced TAC (from 20,000 tons in 1976 to 16,000 tons in 1977) was recommended by the Assessments Subcommittee in order to reduce the fishing mortality and allow for the rebuilding of the stock, following fishing in recent years at levels higher than F_{max}. There was some discussion as to whether the redfish caught by pelagic trawl in this area belong to a different stock from those taken by the traditional bottom trawl. It was noted that redfish normally exhibit extensive vertical migration and the view was expressed by some advisers that the midwater trawl fishery was exploiting the same stock of redfish as the bottom trawl. It was also noted that the Assessments Subcommittee, in making its recommendation for a reduced TAC, had assumed that the same stock complex is being fished by both gears.

4. Research Requirements

a) Capelin

The Advisers noted the research plans of member countries as given in the Report of Scientific Advisers to Panel 2. They further noted that a major review of the status of the capelin stocks would be necessary in 1977 and endorsed the recommendation of the Scientific Advisers to Panel 2 that member countries fishing capelin in Subareas 2 and 3 make every effort to assemble and analyze data on all aspects of capelin biology, stock abundance, and its role in the ecosystem, including the possible effects of the fishery for capelin upon its predators such as cod and marine mammals, in preparation for the April 1977 Meeting of the Assessments Subcommittee.

b) Redfish

In view of the present uncertainty about the identity of the redfish stocks fished by bottom and midwater trawls in Div. 3L and 3N, the Advisers endorsed the recommendation of the Assessments Subcommittee that priority be given to species-stock identification studies for redfish in this area. The Panel's attention is drawn to the fact that no commercial length or age data have been provided for redfish caught in this area during 1967-74, despite the high catches of 1971-73, and that sampling data were available for only a small component of this fishery in 1975. The Canadian adviser briefly reviewed the work underway at the Biological Station in St. John's, Newfoundland, aimed at further delineating the species-stock inter-relationships of redfish in the

area from Labrador to southern Newfoundland. These studies include both biochemical and morphological investigations, and it is anticipated that some preliminary results will be available at the next Annual Meeting. The USSR adviser noted the extensive work of Dr. Barsukov and Dr. Zakharov on the systematics of North Atlantic redfish. He indicated that every effort would be made to provide material on the composition of redfish catches by bottom and midwater trawls in order to assist in the determination of whether these fisheries are exploiting the same stock and/or species as a basis for improved stock assessment.

c) Other Studies

The Advisers endorsed the recommendations of the Environmental Subcommittee with respect to a special study of the Flemish Cap area and urged the cooperation of member countries in providing analyses of past data as the basis for the planning of future initiatives in this area. They welcomed the plans for trawl surveys in Subarea 3 as outlined in the Report of the Biological Surveys Subcommittee. They regretted the continuing inadequacies in length and age sampling for the various stocks under quota regulation, as indicated in the Report of the Statistics and Sampling Subcommittee and documented at the present meeting, and stressed again the need for adequate sampling of catches and the collection and reporting of discards statistics and sampling data for all fisheries in the subarea, in conformity with the objectives and procedures of STACRES. The Advisers noted the results of the ageing workshop on cod held in the autumn of 1975, and endorsed the recommendation of STACRES that a further ageing workshop on cod in Div. 2J+3KL should take place in January 1977.

5. Other Business

The Advisers noted that advice on the groundfish effort limitation measures in force for Subareas 2, 3 and 4 had been provided by STACRES in a general manner and that this subject would not need to be specifically considered at this meeting of Advisers to Panel 3.

6. Election of Chairman

Mr. B. B. Parrish (UK) was re-elected Chairman of Scientific Advisers to Panel 3 for the ensuing year.

7. Time and Place of Next Meeting

The Advisers agreed that the next meeting would be held prior to the meeting of Panel 3 at the next Annual Meeting.

4. REPORT OF SCIENTIFIC ADVISERS TO PANEL 4[1]

Saturday, 5 June 1976, 0900 hours

1. The Chairman, Mr. R. C. Hennemuth (USA), opened the meeting with scientific advisers present from Canada, Cuba, Denmark, France, Federal Republic of Germany, Japan, Poland, Portugal, Spain, USSR and USA, and observers from UK, FAO and ICSEAF. Dr. M. D. Grosslein (USA) was appointed rapporteur. The agenda for the meeting of Panel 4 was adopted as the basis for discussions on the status of the stocks and conservation measures for Subarea 4 in 1977, including the short-finned squid (*Illex illecebrosus*) in Subareas 2 to 4.

2. Status of Fisheries and Research Carried Out

Dr. R. G. Halliday (Canada) presented a review of the general status of the fisheries and research carried out in Subarea 4 in 1975 (Summ. Doc. 76/VI/43). The Advisers' attention was drawn to specific studies on the major species, particularly on cod (Res. Doc. 76/VI/46, 74), redfish (Res. Doc. 76/VI/25, 90), squid (Res. Doc. 76/VI/3, 65), herring (Res. Doc. 76/VI/21, 22, 45, 48), mackerel (Res. Doc. 76/VI/49, 52, 107, 110, 111) and silver hake (Res. Doc. 76/VI/57, 59, 98 + Addendum). In addition, studies on hydrography and plankton were briefly reviewed.

3. Conservation Requirements

a) Cod in Division 4T and Subdivision 4Vn (Jan-Apr)

A new assessment of the southern Gulf of St. Lawrence cod stock was presented, in which a substantial decline in abundance is indicated by catch per effort indices for several categories of Canadian otter trawlers. For the 26-50 GRT class, the decline for the 1950-75 period was about one order of magnitude, and from 1971 to 1975 it was about 50%. Since this vessel category has accounted for a relatively small proportion of the catch in recent years, the question was raised whether these indices were representative. However, significant declines were also observed in the catch per unit effort of two other vessel categories, these being greater than the research vessel survey abundance indices which decreased by 30% from 1971 to 1975. Further evidence pointing to a significant decrease in biomass include (i) the increase in growth rate to an all-time high, (ii) the maturing of cod at a substantially younger age and smaller size, and (iii) the large size of cod at the end of their first year of life (ℓ_1), implying low competition and low recruitment.

The new data provided a much higher starting value of fishing mortality for VPA calculations ($F = 0.88$, in contrast to $F = 0.45$ used in the previous assessment). Using the higher value of F, the estimated spawning stock size in 1975 (58,000 tons of cod aged 4 and older) was substantially lower than that calculated in the previous assessments (83,000 tons). Assuming a catch of 30,000 tons in 1976, the spawning stock size in 1976 is estimated to have declined to about 32,000 tons, compared with the estimate of 72,000 tons in the previous assessment. Thus the present level of stock appears to be far below the total biomass level of 150,000 tons which is thought desirable to ensure a stable long-term fishery.

Under the present management regime, the stock will continue to decline, even if fishing mortality is greatly reduced on young cod in the winter fishery. The Advisers stressed the importance of reducing the partial recruitment of immature cod to as low a level as possible and recognized that the only way to ensure the rebuilding of the spawning stock at the present time is to minimize removals. Therefore, the advice of the Assessments Subcommittee from its April 1976 Meeting, i.e. that the TAC for 1977 be set at zero to ensure an increase in spawning stock as soon as possible, is even more valid now than previously.

The Advisers agreed that further catch projections be performed, using different assumptions on 1975 stock size and mean weight-at-age from those used in the earlier assessment, and that these projections be appended to this Report of Scientific Advisers for the guidance of the Panel (see Appendix I).

b) Cod in Subdivision 4Vn (May-Dec)

Catches in both the offshore and inshore fisheries have declined significantly in recent years, and stock abundance appears to have declined as well. Considering the serious condition of adjacent cod stocks (in 4Vn (Jan-Apr) + 4T and in 4VsW), which probably contribute in part to the catch in Subdiv. 4Vn during the summer and autumn, the Advisers endorsed the recommendation of the Assessments Subcommittee that the TAC for 1977 be set at 3,500 tons to ensure that no in-

[1] Presented to 1976 Annual Meeting as Proceedings No. 8, Appendix I and Addendum (Serial No. 3965).

crease in exploitation will occur on the Subdiv. 4Vn stock.

c) Cod in Subdivision 4Vs and Division 4W

This stock has declined rapidly in recent years due primarily to poor recruitment from the 1971 to 1973 year-classes. It was estimated that the by-catches of ages 1 and 2 cod of about 4,000 tons annually in the silver hake fishery could explain the reduced recruitment of cod in recent years. The rebuilding of this stock to the desired level of 200,000 tons is contingent upon higher recruitment levels than have been observed in the 1970's. Therefore, it is of primary importance to determine the magnitude of the by-catches of ages 1 and 2 cod. It was noted that by-catches of 10,000 tons would eliminate the stock.

The 1976 TAC of 30,000 tons corresponds to fishing at F in the range of 0.8-0.9. Fishing at F_{max} (0.35) in 1977 would yield a catch of 12,500 tons, and fishing at $F_{0.1}$ (0.2) would give 7,500 tons, assuming no by-catch of young cod. If a by-catch of 4,000 tons is assumed, fishing at $F_{0.1}$ in 1977 would produce a catch of 7,000 tons and provide for increasing the spawning stock. The Advisers therefore agreed to the recommended TAC of 7,000 tons for 1977.

d) Cod in Division 4X (offshore)

The 1976 TAC of 4,000 tons, corresponding to fishing at F = 0.30, is expected to allow some increase in the stock size. Yield-per-recruit calculations indicate that F_{max} = 0.35 and $F_{0.1}$ = 0.25, and projections for 1977 at these F levels indicate catches of 5,500 tons and 4,000 tons respectively and allow for increases in stock size. If the $F_{0.1}$ level is adopted and recruitment is maintained at current levels, the stock size would be expected to recover to 20,000 tons in 1977. The Advisers agreed that the 1976 TAC of 4,000 tons should be maintained for 1977.

e) Haddock in Divisions 4V and 4W

The biomass of this stock is at a very low level, and the Assessments Subcommittee recommended that the 1977 TAC be zero, with every effort being made to minimize by-catches to allow for stock rebuilding. A TAC of 2,000 tons was set for 1976 to allow for by-catch. If the 1974 year-class is stronger than other recent year-classes, the by-catch will likely increase in 1976 and 1977. The Advisers endorsed the recommendation of the Assessments Subcommittee that the level of by-catch should not exceed 2,000 tons in 1977 and that member countries make additional efforts to prevent an increase above this level.

f) Haddock in Division 4X

The present objective is to rebuild the spawning stock (at 45,000 tons in 1975) to a level of at least 80,000 tons. Under present regulations, there can be no directed fishery for haddock but allowance is made for unavoidable by-catch of 15,000 tons. The maintenance of a catch of 15,000 tons will result in a decline in spawning stock from the 1976 level to about 39,000 tons in 1978. The Advisers therefore recommends that the TAC for 1977 be set at zero and stressed the importance of keeping removals to the lowest possible level.

g) Redfish in Divisions 4V, 4W and 4X

On the basis of yield-per-recruit calculations and the assumption that the stock size in 1977 will be comparable to the average level in 1971-74, fishing at F_{max} (0.18) in 1977 would produce a catch of 22,000 tons while fishing at $F_{0.1}$ (0.10) would yield 16,000 tons. General production analyses suggest that the catch in 1977 would be about 26,000 tons, if fishing is conducted at F_{MSY}. Given the uncertainties about recruitment in 1976 and 1977 and the fact that recruiting year-classes are being harvested at a smaller size, the Advisers agreed with the Assessments Subcommittee in recommending a TAC of 20,000 tons for 1977, noting again that the harvesting of redfish less than 20 cm in length results in significant loss in yield per recruit.

h) Pollock in Divisions 4V, 4W and 4X and Subarea 5

The Advisers noted that the Assessments Subcommittee had reviewed the question of stock delineation in Subareas 4 and 5. Although the presence of local spawning stocks in Subarea 4 would provide some biological basis for apportioning the TAC between different areas, the information available is not considered sufficient to do this at present.

Estimates of fishing mortality indicate that F has increased beyond the F_{max} (0.4) level (at M = 0.2) since 1973. Trawl surveys by USA indicate a declining trend in abundance, and the Canadian commercial index dropped sharply in 1975. Also, the surveys show that the 1972-74 year-classes are weaker than those of 1968, 1969 and 1971, and consequently the recruitment

prospects for 1977 are less favourable than during the 1968-73 period. If it is assumed that F = 0.5 in 1975, the 1975 catch of 39,000 tons resulted in a stock size of 120,000 tons in 1976. Assuming a modest decline in stock size to 100,000 tons in 1977, fishing at F_{max} (0.40) would yield a catch of 30,000 tons in 1977, and fishing at $F_{0.1}$ (0.24) would allow a catch of 20,000 tons. Although no information is available on the effects of such fishing activity on stock size, it is considered that fishing at F_{max} in 1977 would probably result in a lower stock size in 1978 than in 1975. The Advisers agreed with the Assessments Subcommittee's recommendation for a 1977 TAC of 20,000 tons.

i) American Plaice, Witch and Yellowtail in Divisions 4V, 4W and 4X

The 1976 TAC of 28,000 tons for these three species was reduced from the level of 32,000 tons in 1975, because the assessment in 1975 indicated over-exploitation of American plaice in Div. 4W and a substantial decline in yellowtail abundance. The catch in 1975 was about 23,000 tons, somewhat less than the TAC for that year. Although there was some indication of a small increase in abundance in 1975 based on commercial and survey abundance indices, the Assessments Subcommittee did not consider this as sufficient evidence to warrant changing its previous conclusion on the status of these species and recommended that the TAC for 1977 should be maintained at 28,000 tons. The Advisers agreed with this advice.

j) Argentine in Divisions 4V, 4W and 4X

Catches were relatively low in 1971-73, averaging less than 5,000 tons. The initial TAC for 1974 of 25,000 tons was set above the estimated MSY level to allow for the harvesting of accumulated biomass from the lightly-exploited populations, and this level of TAC was maintained for 1975 and 1976. New data on age and growth were available this year but there is still insufficient information for an adequate assessment of the potential yield of this stock. Nevertheless, if catches in 1976 should approach the TAC level of 25,000 tons, it is likely that the stock will be reduced substantially below the relatively unexploited level of 1973. In view of the uncertainty regarding the status of this stock, the Advisers endorsed the recommendation of the Assessments Subcommittee that the 1977 TAC should be reduced to 20,000 tons. If the information for an adequate assessment of this stock is not soon forthcoming, the TAC for subsequent years should be further reduced to guard against the possibility of over-exploitation.

k) Silver Hake in Divisions 4V, 4W and 4X

The 1976 TAC was set at 100,000 tons. A Canadian assessment indicated that the 1977 catch should be 63,000 tons for fishing at F_{max} = 0.7 with M = 0.4. A USSR assessment estimated the 1977 catch to be in the range of 124,000-229,000 tons, assuming F_{opt} = 0.7 with M = 0.5 and M = 0.8. The difference between the catch projections resulted mainly from disagreement regarding the size of year-classes, the age composition of catches and growth and mortality rates.

A major problem in assessing this stock has been disagreement over ageing. The results from an ageing workshop in April 1976 did not resolve this problem. The USSR data show a higher proportion of older fish in the catch than do the Canadian data. However, the Assessments Subcommittee recommended a 1977 TAC of 63,000 tons with objections by scientists from USSR, German Democratic Republic and Cuba.

A new assessment was presented by USA (Res. Doc. 76/VI/98 + Addendum) which attempted to clarify assumptions on recruitment levels made in the USSR assessment. The new analysis indicated that the predicted high catch for 1977 of 125,000 tons or more was dependent on the assumption of strong 1973, 1974 and 1975 year-classes and, in particular, on the assumption that the 1974 year-class was as large as the strongest year-class on record. The USA analysis showed that the 1974 year-class was weak relative to the strong year-classes of the late 1960's, and that, if the 1975 year-class is assumed to be of medium strength, the TAC for 1977 would be even less (32,000 to 49,000 tons) than that advised by the Assessments Subcommittee on the basis of the Canadian assessment (63,000 tons). The Advisers proposed no change in the Subcommittee's recommendation of 63,000 tons as the TAC for 1977.

The USSR scientists disagreed with the Canadian and USA assessments, noting that the former did not take into account the USSR research vessel surveys which they consider to be the only reliable information on 1972-74 year-class strength. These surveys indicated the 1974 year-class to be very strong, the 1972 and 1973 year-classes to be of average strength and the 1975 year-class to be poor. The USSR scientists indicated that they view their assessment of allowable catch for 1977 as being conservative.

ℓ) Squid-*Illex* in Subareas 2 to 4

The relationship of *Illex* found in Subareas 2 to 4 to those found in Subarea 5 and Stat. Area 6

is not well understood, and there is still considerable uncertainty about the actual harvest in recent years and the parameters used in the preliminary assessments, including the stock size. Thus the Assessments Subcommittee recommended pre-emptive quotas in order to regulate the orderly development of the fishery. About 17,000 tons were taken in Subareas 2 to 4 in 1975. The Advisers endorsed the recommended 1977 TAC for Subareas 2 to 4 of 25,000 tons, noting from some additional information that the 25,000 tons is considered a maximum for the TAC. The Advisers indicated that the TAC should be allocated to ensure that the 1977 catch does not exceed 25,000 tons until further information on the status of the stock becomes available.

m) Herring in Divisions 4V, 4W and 4X

The Commission has set TACs for management areas that differ from those recommended by STACRES at the 1975 Annual Meeting, at the January 1976 Special Meeting and again at this 1976 Annual Meeting. At present, the fishery in Div. 4V is managed on a seasonal basis in conjunction with that in Div. 4V(a), whereas STACRES recommended that the fishery in Div. 4W(a) be combined with that in Div. 4XW(b) for management, thus leaving the fishery in Div. 4V to be managed separately on a seasonal basis (July to June). The Advisers noted that the Assessments Subcommittee had reviewed the most recent information available on all of these fisheries and documented the rather complicated changes that would be required in the TACs to reflect the recommended changes in stock delineation.

The additional data available for the Div. 4V (seasonal) fishery were insufficient to warrant changing the previous STACRES recommendation for a TAC of 11,000 tons for 1976/77 or to revise this recommendation of 11,000 tons for 1977/78. New information for the Div. 4WX fisheries was presented to the Assessments Subcommittee in April 1976, including an analysis of the Canadian 1975/76 winter fishery in Div. 4W(a), revisions to historical catch data for 1975 and previous years for Div. 4XW(b), and re-evaluation of the size of the 1973 year-class. Since the fishery commences in November in Div. 4W(a), the assessment is based on a fishing season from 1 November to 31 October. Stock sizes, catches and fishing mortalities were calculated using the revised estimate of the strength of the 1973 year-class (assumed to be 1.5 billion fish at age 2), natural mortality (M) of 0.1, and F-values consistent with the previously agreed management strategy of fishing at F = 0.35 in 1976.

The catch projection indicated that the TAC for Div. 4WX in April-October 1976 should be set at 92,500 tons. If the Commission wishes to set a TAC for Div. 4XW(b) only, as in previous practice, it should be 89,200 tons for 1976, slightly higher than that recommended from the previous assessment. The higher level of TAC reflects the most recent estimate of the size of the 1973 year-class, which is about 50% higher than the earlier estimate, and the associated increase in the estimate of the inshore catch to 15,000 tons. The TAC of 92,500 tons for Div. 4WX during April-October 1976 corresponds to a total TAC for the 1975/76 season (1 Nov 1975-31 Oct 1976) of 129,000 tons, of which 37,100 tons have already been taken in Div. 4WX during the 1975/76 season. With the revised estimate of recruitment of age 2 herring, as indicated above, the stock size at the beginning of the 1976/77 season (1 November 1976) will be 454,000 tons (age 4 and older). Yield-per-recruit calculations indicate that $F_{0.1}$ is about 0.30. Fishing at this level of F and assuming the 1975 year-class to be at the conventional recruitment level of 750 million fish at age 2, a TAC of 109,000 tons is predicted for Div. 4WX for the 1976/77 season (Nov 1976-Oct 1977). If the Commission retains the previous management regime, the 1977 TAC for Div. 4XW(b) should be set at 84,000 tons (including 15,000 tons estimated for inshore catches) and the 1977/78 TAC for Div. 4VW(a) should be set at 33,500 tons.

A detailed breakdown of TACs by season and stock for each of the two options is presented in the Report of the Assessments Subcommittee (Part C, Appendix I, this volume). Option 1 reflects the changes recommended by STACRES and the Assessments Subcommittee based on the improved knowledge of stock relationships, and Option 2 gives the projection of TACs if the Commission continues to manage the fisheries on the basis of the current regime.

4. Research Requirements

a) International Herring Tagging Program

The Advisers support the plans approved by STACRES for this important research program which is designed to clarify the inter-mixture of herring stocks in Subareas 4 and 5 and Stat. Area 6.

b) By-catch Data

The need for data on by-catches was again reiterated, particularly with regard to the by-catch of young cod in the silver hake fishery. By-catch data could be simulated from research vessel surveys, but ideally the sampling should be done on commercial vessels. It was noted

that this type of research could be carried out through the scientific observer program, but it would have to be implemented immediately if it were to cover the 1976 fishery. It was emphasized again that significant yield could be reclaimed by reducing by-catch.

c) Improved Sampling and Catch Statistics

The need for better sampling and improved breakdown of catch statistics was once again emphasized. In particular, the squid catches need to be separated for the two genera, *Illex* and *Loligo*. Also, the minimum age-length sampling should be initiated for a number of stocks, argentine being cited as an example. The general philosophy was reiterated of imposing more severe pre-emptive quotas if adequate sampling data are not forthcoming.

5. Election of Chairman

Dr. G. H. Winters (Canada) was unanimously elected Chairman of Scientific Advisers to Panel 4 for the ensuing year.

6. Time and Place of Next Meeting

The Advisers agreed that the next meeting would be held prior to the meeting of Panel 4 at the next Annual Meeting.

APPENDIX I. FURTHER CATCH PROJECTIONS FOR SOUTHERN GULF OF ST. LAWRENCE COD STOCK

1. Cod in Division 4T and Subdivision 4Vn (Jan-Apr)

At the suggestion of the Chairman, the Scientific Advisers to Panel 4 agreed that further catch projections should be performed using different assumptions as to the 1975 stock size and mean weight-at-age than those used in an earlier assessment and that these projections should be appended to the Report of Scientific Advisers for the guidance of the Panel.

a) Projection No. 1

Regression of fishing effort and mortality gives an estimated F of 0.88 on fully recruited age-groups in 1975 with a catch of 39,000 tons. The stock size of age 3+ cod at the beginning of 1975 is estimated to have been about 79,500 tons, and the residual stock size at the end of the year is estimated at 29,000 tons (Table 1). The 1976 TAC of 30,000 tons is expected to be taken with the same partial recruitment values as pertained in 1975, which implies that F will increase to a level of 1.31. Removal of 30,000 tons in 1976 will reduce the residual stock size at the end of the year to 16,000 tons. This assumes that the 1973 year-class will contain 25.0 million fish at age 3 as predicted by regression of length at age 1 on year-class size from cohort analysis. The calculations for 1977 assume the same size for the 1974 year-class at age 3.

Table 1. Stock size and catch projections for the southern Gulf of St. Lawrence cod stock, assuming high partial recruitment at ages 4 and 5; alternate catch projection are given for different quotas in 1977. (Stock sizes and catches are numbers × 10^{-3}.)

Age	Mean weight (kg)	Partial recruitment	1975		1976		1977			
			Stock size	Catch	Stock size	Catch	Stock size	Catch	Catch	Catch
3	0.45	0.19	15,121	2,116	25,145	5,059	25,145	3,664	2,118	986
4	0.75	1.00	18,402	9,902	10,474	7,092	16,036	8,872	6,045	3,028
5	1.19	1.00	11,329	6,096	6,249	4,232	2,303	1,274	868	435
6	1.78	1.00	4,367	2,350	3,847	2,605	1,374	760	518	260
7	2.30	1.00	5,897	3,173	1,483	1,004	846	468	319	160
8	2.62	1.00	2,323	1,250	2,002	1,356	326	180	123	62
9	2.99	1.00	1,920	1,033	789	534	440	244	166	83
10	3.63	1.00	1,371	738	652	441	173	96	66	33
11	4.23	1.00	1,061	571	465	315	143	79	54	27
12	6.75	1.00	210	113	360	243	102	57	39	19
13	9.26	1.00	87	46	71	48	79	44	30	15
14	6.44	1.00	74	40	30	20	16	9	6	3
15	6.55	1.00	9	5	25	17	7	4	2	1
Fishing mortality (F)				0.88		1.31		0.92	0.51	0.23
Catch (tons)				40,056		30,000		15,000	10,000	5,000
Stock biomass (age 3+) at end of year (tons)				29,392		16,216		15,655	20,503	24,521

Projections for 1977 at two different patterns of partial recruitment are essentially the same except for the level of F on fully recruited age-groups (Tables 1 and 2). The benefits of a lower partial recruitment on age-groups 4 and 5 would be accrued in subsequent years through a more rapid increase in stock size at equivalent levels of catch. A catch of 15,000 tons in 1977 would maintain the residual stock size at the level of 1976, whereas catches below this level would result in some increase in stock size.

b) Projection No. 2

Lesser declines in stock abundance are suggested by research vessel indices and some commercial indices than that used in the first projection. These imply that the stock size at the beginning of 1975 was about 100,000 tons rather than 79,500 tons. In this second case (Table 3), the fishing mortality in 1975 is estimated at F = 0.61 and the residual stock at the end of 1975 is about 47,000 tons. A catch of 30,000 tons in 1976 will generate an F of 0.66 and a residual stock of about 36,000 tons. A projected catch of 15,000 tons in 1977 will allow the residual stock to remain at, or marginally above, the 1976 level.

c) Discussion

The management objective is to increase the spawning biomass to, and maintain it at, the level of 100,000 to 150,000 tons, at which level the productivity of the stock is maximized. While the stock sizes projected above do not represent spawning stock sizes, it is apparent that, under all options, the predicted stock sizes for 1977 are substantially below the desired level. Thus, the additional calculations do not change the advice on the status of the stock from earlier calculations that were reviewed by the Advisers at the present meeting.

Table 2. Stock size and catch projections for southern Gulf of St. Lawrence cod stock, assuming low partial recruitment at ages 4 and 5; alternate catch projections are given for varying quotas in 1977. (Stock sizes and catches are numbers × 10^{-3}.)

Age	Mean weight (kg)	Partial recruitment	1977 Stock size	1977 Catch	1977 Catch	1977 Catch
3	0.45	0.12	25,145	3,187	1,846	825
4	0.75	0.58	16,036	7,593	4,901	2,378
5	1.19	0.88	2,303	1,419	973	496
6	1.78	1.00	1,374	907	636	331
7	2.30	1.00	846	559	392	204
8	2.62	1.00	326	215	151	79
9	2.99	1.00	440	291	204	106
10	3.63	1.00	173	114	80	42
11	4.23	1.00	143	94	66	34
12	6.75	1.00	102	67	47	25
13	9.26	1.00	79	52	36	19
14	6.44	1.00	16	11	7	4
15	6.55	1.00	7	5	3	2
Fishing mortality (F)				1.25	0.70	0.31
Catch (tons)				15,000	10,000	5,000
Stock biomass (age 3+) at end of year (tons)				15,673	20,066	24,522

Table 3. Stock size and catch projections for southern Gulf of St. Lawrence cod stock, assuming high partial recruitment at ages 4 and 5. (Stock sizes and catches are numbers × 10^{-3}.)

Age	Mean weight (kg)	Partial recruitment	1975 Stock size	1975 Catch	1976 Stock size	1976 Catch	1977 Stock size	1977 Catch
3	0.45	0.19	19,001	1,880	25,145	2,688	25,145	1,559
4	0.75	1.00	23,124	9,633	13,862	6,131	18,164	5,150
5	1.19	1.00	14,236	5,931	10,317	4,563	5,871	1,665
6	1.78	1.00	5,487	2,286	6,352	2,809	4,370	1,239
7	2.30	1.00	7,410	3,087	2,448	1,803	2,690	763
8	2.62	1.00	2,919	1,216	3,306	1,462	1,037	294
9	2.99	1.00	2,413	1,005	1,302	576	1,400	397
10	3.63	1.00	1,722	717	1,077	476	551	156
11	4.23	1.00	1,333	555	768	340	456	129
12	6.75	1.00	263	110	595	263	325	92
13	9.26	1.00	140	58	117	52	252	71
14	6.44	1.00	93	39	63	28	50	14
15	6.55	1.00	11	5	42	18	27	8
Fishing mortality (F)				0.61		0.66		0.37
Catch (tons)				39,000		30,000		15,000
Stock biomass (age 3+) at end of year (tons)				47,102		35,747		37,085

5. REPORT OF SCIENTIFIC ADVISERS TO PANEL 5[1]

Saturday, 5 June 1976, 1430 hours
Tuesday, 15 June 1976, 1400 hours

1. The Chairman, Dr. R. G. Halliday (Canada), opened the meeting with representatives from Canada, Cuba, France, Federal Republic of Germany, German Democratic Republic, Japan, Poland, Spain, USSR and USA, and observers from Denmark, Norway, UK and FAO. Dr. W. T. Stobo (Canada) was appointed rapporteur. The provisional agenda for the meeting of Panel 5 was adopted, with minor revision, as the basis for discussion at this meeting of Scientific Advisers.

2. Status of Fisheries and Research Carried Out

The report on the status of fisheries and research carried out in Subarea 5 and Stat. Area 6 during 1975 (Summ. Doc. 76/VI/42) was presented and approved with minor revisions. Several advisers questioned the value of this type of report. It was noted that few advisers actually used the report, although considerable effort is expended in preparing it. The Advisers to Panel 5 request that the Panel comment on the value and need for such a report for future meetings.

3. Consideration of New Documentation

Several documents, which were not available at the April 1976 Meeting of the Assessments Subcommittee, were presented for discussion. Those related to conservation requirements were considered under the appropriate items in this report. Others of a more general nature were noted as follows: Res. Doc. 76/VI/65 and 87 deal with the distribution and biological characteristics of squid (*Illex* and *Loligo*) on the Scotian Shelf and Georges Bank. Res. Doc. 76/VI/102 deals with the management regime necessary for the total ecosyatem, including conceptual models which must be developed, and provides summaries of the status and knowledge of the stocks. Res. Doc. 76/VI/104 and 118 discuss the results and applicability of research vessel survey data as indices of year-class abundance for pelagic stocks. Res. Doc. 76/VI/121 describes and analyzes some aspects of inter-specific competition between herring and mackerel. The Advisers noted that studies such as the last mentioned are urgently required to properly manage interacting species or stocks, but that they are as yet not sufficiently quantified to allow adjustments in management strategies.

4. Conservation Requirements

The Advisers reviewed the recommendations of the Assessments Subcommittee (Part C, Appendix I, this volume) with regard to the 1977 TACs for Subarea 5 and Stat. Area 6 and agreed to endorse these recommendations (Table 1). Appropriate comments on each stock follow.

a) Cod in Division 5Y

The 1976 TAC of 8,000 tons will generate a fishing mortality of about 0.5, considerably in excess of F_{max} (0.30) and $F_{0.1}$ (0.18). Fishing at levels of F_{max} and $F_{0.1}$ in 1977 would result in catches of 5,000 tons and 3,200 tons respectively, if recruitment remains stable. It is noted, however, that these F levels refer only to the catches in the commercial fishery, with the assumption of no interaction between stocks supporting the commercial and the sport fisheries. The Advisers agreed that the TAC for 1977 should be reduced to 3,200 tons in order to reduce the fishing mortality to the $F_{0.1}$ level.

b) Cod in Division 5Z

The 1976 TAC was set at 35,000 tons, which level was considered to be near the MSY. Preliminary analysis now indicates that catches averaging 26,500 tons during 1970–74 generated fishing mortality exceeding the F_{max} level. If recruitment remains stable, fishing at F_{max} (0.30) or $F_{0.1}$ (0.18) in 1977 would result in catches of 24,000 tons or 15,000 tons respectively. The Advisers agreed that fishing mortality should be reduced to the $F_{0.1}$ level and that the 1977 TAC should be set at 15,000 tons.

c) Haddock in Subarea 5

The 1976 TAC for by-catch only, with no directed fishery, was set at 6,000 tons. Although recruitment prospects have marginally improved, the by-catch problem was considered to be a serious hindrance to the recovery of this stock. It was noted that, with improved recruitment, by-catches would be expected to increase, thereby delaying stock rebuilding. The Advisers therefore recommend that removals in 1977 be kept at the lowest possible level; acknowledging that unavoidable by-catches will occur, every possible measure to reduce the by-catch should be employed.

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[1] Presented to 1976 Annual Meeting as Proceedings No. 9, Appendix I (Serial No. 3966).

Table 1. Subarea 5 and Statistical Area 6: TACs for 1976 and recommended TACs for 1977.

Species	Stock area	1976 TAC (metric tons)	Recommended 1977 TAC (metric tons)
Cod	5Y	8,000	3,200
	5Z	35,000	15,000
Haddock	5	6,000[1]	0
Redfish	5	17,000	9,000
Silver hake	5Y	10,000	5,000
	5Ze	50,000	70,000
	5Zw+6	43,000	50,000
Red hake	5Ze	26,000	16,000
	5Zw+6	16,000	28,000
Pollock	4VWX+5	55,000	20,000
Yellowtail	5(E69°)	16,000	7,000
	5(W69°)+6	4,000[1]	0
Flounders (except yellowtail)	5+6	20,000	20,000
Herring	5Y(adults)	7,000	0
	5Z+6	60,000	50,000
Mackerel	3+4	56,000	...[2]
	5+6	254,000	
Other finfish[3]	5+6	150,000	150,000[4]
Squid - *Illex*	5+6	30,000	30,000
- *Loligo*	5+6	44,000	44,000
Overall 2nd tier[5]	5+6	650,000	500,000[6]

[1] TAC for by-catch with no directed fishery.
[2] TAC re-assessed at Annual Meeting and resulted in a range from zero to 250,000 tons which could not be resolved.
[3] Excludes all TAC species and also menhaden, billfishes, tunas and large sharks other than dogfish.
[4] Within this TAC, upper catch limits are recommended for the following species: 20,000 tons of argentine, 40,000 tons of dogfish, 18,000 tons of butterfish, and 10,000 tons (including inshore fishery) of river herrings (*Alosa pseudoharengus* and *A. aestivalis*).
[5] Includes all finfish species (except menhaden, billfishes, tunas and large sharks) and squids.
[6] To be reconsidered by Scientific Advisers after the TAC for mackerel and most species allocations have been determined.

d) Redfish in Subarea 5

The 1976 TAC was set at 17,000 tons. Projection from the equilibrium yield model indicates that fishing at a level of effort associated with F_{MSY} in 1977 would produce a catch of only 10,000 tons, substantially below the long-term MSY estimate of 17,000 tons. The Advisers therefore recommend that the 1977 TAC be set at 9,000 tons to ensure control of fishing mortality at a level below F_{MSY}.

e) Silver Hake in Division 5Y

The 1977 TAC of 10,000 tons, if utilized, will generate a fishing mortality of 0.55. If fishing is conducted in 1977 at the $F_{0.1}$ level (0.30), a catch of 5,000 tons will be taken. Survey data indicate that the 1971-75 year-classes were strong and have resulted in an increase in stock size. However, the recovery of the adult stock to former levels has been hindered by the discarding of under-sized silver hake. In order to rebuild the stock, a TAC of 5,000 tons is recommended for 1977.

f) Silver Hake in Subdivision 5Ze

The 1976 TAC of 50,000 tons, if taken, will generate a fishing mortality in the range of 0.20-

0.25. The F_{max} level is estimated to be about 0.40-0.50 and $F_{0.1}$ is about 0.30. Survey data indicate strong 1971-75 year-classes, which have caused the stock biomass to increase substantially. Fishing at $F_{0.1}$ in 1977 will produce a catch of 70,000 tons, and the Advisers agreed that the TAC should be increased to this level for 1977.

g) Silver Hake in Subdivision 5Zw and Statistical Area 6

The 1976 TAC of 43,000 tons, if taken, will generate a fishing mortality of 0.26-0.31, somewhat below F_{max} (0.45) but about at the $F_{0.1}$ level (0.30). Commercial catch per effort data and survey indices indicate an increase in stock abundance in 1975 and the production of good year-classes during 1971-75. Fishing at the level of effort associated with $F_{0.1}$ will result in a catch of 50,000 tons, which is the level of TAC recommended for 1977.

h) Red Hake in Subdivision 5Ze

The 1976 TAC was set at 26,000 tons. Survey data indicate large 1973 and 1974 year-classes with a resultant sharp increase in stock size. Yield-per-recruit studies indicate that F_{max} is 0.70 and $F_{0.1}$ is 0.35. A virtual population analysis was also presented with an estimate of 0.70 as the optimal F. Fishing at F = 0.70 in 1977 will result in a catch of 20,000 tons while fishing at $F_{0.1}$ will produce a catch of 12,000 tons. Noting the uncertainty in the most recent assessment with respect to the optimal F but considering that the stock appears to have increased, the Advisers agreed to recommend a TAC of 16,000 tons for 1977.

i) Red Hake in Subdivision 5Zw and Statistical Area 6

The 1976 TAC was set at 16,000 tons. Survey data indicate that the 1973 year-class is very large and that the stock size in 1975 was larger than the previously low levels. As for the Subdiv. 5Ze stock, yield-per-recruit studies indicate F_{max} = 0.70 and $F_{0.1}$ = 0.35, with another estimate of the optimal F at 0.70. If fishing is conducted at effort levels associated with F_{max} or $F_{0.1}$ in 1977, the resultant catches will be 35,000 tons or 20,000 tons respectively. Given the uncertainty about the validity of existing assessments and about the effects of fishing at either the F_{max} or the $F_{0.1}$ level on stock size, the Advisers agreed to recommend a TAC of 28,000 tons for 1977, a catch which will be taken at a level of F in the range of estimates for $F_{0.1}$ and F_{max}.

j) Pollock in Subarea 5

The 1976 TAC was set at 55,000 tons for Div. 4VWX and Subarea 5 combined. The stock question was reviewed and it was concluded that the assumption of a single major stock in Subareas 4 and 5 was still valid and a single assessment made. Estimates of fishing mortality from research survey and commercial data indicate that F has been beyond the level of F_{max} since 1973. Recruitment prospects are not favourable for 1977. Fishing at F_{max} = 0.40 or $F_{0.1}$ = 0.24 in 1977 would result in catches of 30,000 tons or 20,000 tons respectively. Fishing at F_{max} in 1977 would probably result in a lower stock size in 1978, and the Advisers therefore recommend that the 1977 TAC be set at 20,000 tons. There is some biological information to indicate that the TAC should be allocated between the subareas, but there is no present scientific basis to determine the proportions.

k) Yellowtail Flounder in Subarea 5 (East of 69°)

The 1976 TAC of 16,000 tons, if taken, will generate a fishing mortality of 0.80 on age 3 and older fish and an F of 0.40 on age 2 fish. Commercial catch per effort data and survey indices indicate a decline in stock biomass with relatively poor recruitment prospects for 1976 and 1977. It is noted that large catches of age 2 fish were taken in 1975, although mesh regulations, intended to conserve this age-group, were in effect. Fishing at F_{max} (0.80) or at $F_{0.1}$ (0.40) in 1977 will result in catches of 12,400 tons or 7,000 tons respectively. In view of the state of this stock, a 1977 TAC of 7,000 tons is recommended, which should allow the stock to rebuild by about 10% in 1977.

ℓ) Yellowtail Flounder in Subarea 5 (West of 69°) and Statistical Area 6

The 1976 TAC for by-catch only, with no directed fishery, was set at 4,000 tons. The condition of the stocks in this area continues to be poor with commercial abundance indices continuing to decline in 1975. By-catches in 1976, if they remain at recent levels, are expected to generate a fishing mortality in excess of 1.0, whereas $F_{0.1}$ is 0.40. The Advisers agreed to recommend that the 1977 TAC should be set at zero and that every possible measure should be taken to reduce by-catches.

m) Flounders (except Yellowtail) in Subarea 5 and Statistical Area 6

The 1976 TAC was set at 20,000 tons. No significant change was observed in the abundance of this group of species between 1974 and 1975. However, a declining trend was recently observed in the survey data and in the commercial catches, and it was noted that there are substantial unreported catches in the sport fishery for summer and winter flounders. The Advisers recommend that the 1977 TAC be maintained at 20,000 tons, but, in view of the recently observed declining trends, every effort should be made to reduce the by-catches of these species in fisheries using small-meshed gears.

n) Mackerel in Subarea 5 and Statistical Area 6

The status of the mackerel stocks has been extensively reviewed both at the April 1976 Meeting of the Assessments Subcommittee and at the 1976 Annual Meeting of STACRES, without a reconciliation of the differences in scientific opinion as to the state of the stocks or the TACs for 1977, nor could a resolution of the problem be achieved at this meeting of Scientific Advisers. A number of opinions exists as to the critical parameters used in the assessments to determine a TAC for 1977, resulting in a range of catch projections from zero to 250,000 tons. Having no additional advice to give, the Advisers refer the Panel to the extensive discussions in the reports of STACRES and its Assessments Subcommittee (Part C, this volume).

o) Herring in Division 5Y

The 1976 TAC was set at 7,000 tons. The state of this stock continues to be poor. The most recent assessment was made using two estimates for the size of the 1973 year-class, and, if the 1976 TAC is fully taken, the adult stock size will be in the range of 56,000-60,000 tons at the beginning of 1977 (the minimum stock size constraint agreed to in 1973 was 60,000 tons). Using either assumption as to the size of the recruiting 1973 year-class, fishing at $F_{0.1}$ (0.38) in 1977 would reduce the stock size at the start of 1978 to a level well below the minimum stock size constraint. Even a zero TAC in 1977 would only increase the stock to 61,000-65,000 tons, depending on the size of the 1973 year-class. The Advisers therefore recommend a TAC of zero for 1977.

p) Herring in Division 5Z and Statistical Area 6

The 1976 TAC was set at 60,000 tons. The state of this stock continues to be poor, as there is no indication of any good year-classes having entered the fishery since the large 1970 year-class. In 1976, the Commission agreed to establish a level of catch which will enable the adult stock size to be maintained at a level of at least 225,000 tons, and that the TAC will be set at 60,000 tons or less per year until such time as the adult stock reaches the level of 500,000 tons. The assessment was carried out using two assumptions as to the size of the 1973 year-class, and, if fishing is conducted at the level of $F_{0.1}$ (0.38) in 1977, the resultant catch would be about 56,000-64,000 tons, and the stock size at the beginning of 1978 would be at the minimum constraint level of 225,000 tons. The Advisers agreed to recommend a TAC of 50,000 tons for 1977 to allow for some rebuilding of the stock. It was noted, however, that recent additional analyses of research vessel survey data give cause for some concern that the assumed sizes for the 1971 and 1972 year-classes may be too optimistic. If this is so, stock rebuilding will not occur in 1977 with a catch of 50,000 tons, and the Commission may thus wish to set the 1977 TAC below 50,000 tons in order to ensure that some rebuilding of the stock does occur.

q) Squid-*Illex* in Subarea 5 and Statistical Area 6

The 1976 TAC for this area was set at 30,000 tons. Preliminary estimates of stock size indicate that the biomass of *Illex* is about 110,000 tons in the Scotian Shelf to Southern New England areas. Yield-per-recruit and stock-recruitment considerations indicate that removals of about 40% of the stock biomass would be acceptable. In the absence of more reliable estimates of stock size and in view of the continuing problem of not having complete catch statistics available for *Illex* and *Loligo* separately, the Advisers recommend that pre-emptive quotas be maintained and that TACs be set separately for Subareas 2 to 4 on the one hand and Subarea 5 and Stat. Area 6 on the other, in order to prevent fishing effort from being directed largely to one or the other of the stock complex. Therefore, the 1977 TAC for the entire stock complex should be maintained at 55,000 tons, partitioned such that the 1977 TACs are 25,000 tons in Subareas 2 to 4 and 30,000 tons in Subarea 5 and Stat. Area 6.

r) Squid-*Loligo* in Subarea 5 and Statistical Area 6

Estimates of stock size from assessments and from survey data for 1972-75 indicate that the biomass of *Loligo* is about 83,000-89,000 tons. Yield-per-recruit and stock-recruitment studies indicate that removals of about 40% of the stock biomass would be acceptable. Indices from USA

research surveys indicate an increase in abundance through 1975, but on the basis of Japanese analyses there appears to be no significant change in stock abundance in recent years. The Advisers therefore recommend that the 1977 TAC be maintained at 44,000 tons.

s) Other Finfish in Subarea 5 and Statistical Area 6

The 1976 TAC was set at 150,000 tons. The total nominal catch of this group of species has declined from 132,000 tons in 1974 to 119,000 tons in 1975. Within this group, the most notable declines from 1974 to 1975 occurred for argentine (20,000 to 1,400 tons), butterfish (13,000 to 10,000 tons), sculpins (2,800 to 170 tons) and ocean pout (37,000 to 300 tons). Although no new assessments were available for any of the species in this group, there is a potential for development of intensive directed fisheries for particular species and upper catch limits are thus recommended for certain species in 1977 with monthly reporting of catches. The Advisers recommend a 1977 TAC of 150,000 tons for the "other finfish" group, with specific upper catch limits for the following species: 20,000 tons for argentine, 40,000 tons for dogfishes, 18,000 tons for butterfish, and 10,000 tons (including inshore fishery) for river herrings (*Alosa pseudoharengus* and *A. aestivalis*). The reduction of the TAC for argentine from the 25,000 tons recommended by the Assessments Subcommittee to 20,000 tons is based on the reduction of the TAC in Div. 4VWX for 1977, the probable inter-relationships between stocks, and the high catches in recent years coupled with a large decline in catch from 1974 to 1975. In the case of river herrings, it was noted that catches, catch rates and the proportion of older fish in the catches have decreased markedly since the advent of the offshore fishery. The catch limit of 10,000 tons is therefore recommended as a precautionary TAC for inshore catches, with every effort being made to keep offshore catches to a minimum.

t) Overall Second-tier TAC in Subarea 5 and Statistical Area 6

The overall TAC for all finfish and squids in 1976 was set at 650,000 tons. The application of linear programming techniques to TAC allocations, in order to determine the effects of by-catches on national catches, indicates an overall TAC of 80-85% of the summed TACs, assuming 1974 levels of by-catches. The summed TACs, used in the analysis, total 500,000 tons, under the assumption of a zero TAC for mackerel in 1977. If the mackerel TAC is not zero, re-analysis will be necessary, since there would be a mackerel fishery with associated by-catches instead of the 1977 mackerel catches being by-catches in other fisheries. The level of the overall second-tier TAC (500,000 tons less some proportion for by-catch) cannot be resolved until the mackerel TAC for 1977 is decided and national allocations determined for the major species.

During the Panel 5 meeting on 15 June, the question of the mackerel TAC was discussed but no agreement could be reached. However, Panel 5 requested the Scientific Advisers to provide advice on the level of the second-tier TAC in Subarea 5 and Statistical Area 6, using four different assumptions as to the level of the mackerel catch in 1977: 0, 55,000, 115,000 and 250,000 tons. The Advisers agreed that the individual TACs as recommended by the Assessments Subcommittee (Part C, Appendix I, this volume) should be used as the basis for the second-tier TAC, since these were recommended on a biological basis. The Advisers noted that the second-tier TAC was adopted by the Commission (i) to allow for recovery of the total biomass from the reduced level in recent years to a level giving the maximal or some optimal yield in a fairly short period of time, and (ii) to compensate for by-catch mortality. The Advisers therefore agreed to consider these two problems separately. With regard to the problem of biomass recovery, Table 2 shows that, if the mackerel TAC is set at 0, 55,000, 115,000, or 250,000 tons, the sum of the TACs for all stocks in Subarea 5 and Statistical Area 6 is 505,000, 560,000, 620,000 or 755,000 tons respectively. If the Panel should adopt either a TAC of zero or 55,000 tons for mackerel, it recognizes that the mackerel stock is in a severly depleted condition, and the Advisers agreed to recommend that the second-tier TAC, to allow for recovery of both mackerel and all other stocks, should be 500,000 tons if the mackerel TAC is zero and 530,000 tons if the mackerel TAC is 55,000 tons. If the Panel should adopt a TAC of 115,000 tons for mackerel, it is then agreeing that the mackerel stock is in a fairly good condition, and consequently the second-tier TAC should be 620,000 tons (the sum of the individual TACs) to allow for rebuilding of the total biomass. If the Panel adopts 250,000 tons as the mackerel TAC, it is recognizing that the mackerel stock is in a healthy condition, but, since the Commission agreed at the September 1975 Special Meeting that the level of 650,000 tons is the appropriate TAC for rebuilding the total biomass in seven years, the second-tier TAC for 1977 for rebuilding the total biomass in the case of a 250,000 ton TAC for mackerel should be 650,000 tons (giving recovery in six years) and not 755,000 tons which is the sum of the TACs (Table 2).

In regard to the second question of the downward adjustment necessary to account for the by-catch problem, the calculated second-tier TACs based on the 1974 by-catch ratios (which requires a reduction of 19%) are 410,000, 450,000, 500,000 and 610,000 tons for mackerel TACs of 0, 55,000, 115,000 and 250,000 tons respectively. After considerable discussion, it was agreed that regulations introduced by the Commission and efforts by member countries to reduce by-catches have

resulted in an improvement in the by-catch problem since 1974. Although the level of this improvement could not be precisely determined, it was agreed that the by-catch problem has probably improved by about 50%. Therefore, a reduction of about 10% in the sums of the TACs to account for the by-catch problem (corresponding to the mackerel TACs of 0, 55,000 and 115,000 tons) results in second-tier TACs of 450,000, 500,000 and 550,000 tons respectively. Since a 10% reduction in the sum of TACs of 755,000 tons (for a mackerel TAC of 250,000 tons) is greater than the previously agreed 650,000-ton second-tier TAC to allow for biomass rebuilding, the recommended second-tier TAC in this case is 650,000 tons (Table 2 and Fig. 1), this in effect being a reduction of 14% from the sum of the TACs. Second-tier TACs, calculated on the basis of applying 1974 by-catch ratios for bottom fisheries and pelagic fisheries separately, taking into consideration the different by-catch ratios in bottom and pelagic fisheries, and allowing for a 50% improvement in bottom fishing by-catch ratios, are almost identical to those derived by the above method.

Table 2. Summary of second-tier TAC calculations for Subarea 5 and Statistical Area 6 in 1977.

Level of TAC for mackerel	Sum of the recommended species TACs	Second-tier TAC which would allow biomass recovery	Second-tier TAC adjusted for 1974 by-catch ratios (19% reduction)	Second-tier TAC assuming a 50% improvement in by-catch ratios from 1974[1]
0	505,000	500,000	410,000	450,000[2]
55,000	560,000	530,000	450,000	500,000
115,000	620,000	620,000	500,000	550,000
250,000	755,000	650,000	610,000	650,000

[1] In recommending these second-tier TAC levels, the Advisers note that, without knowledge of national allocations for 1977 and the by-catch situation in 1975, there must remain uncertainty with respect to the by-catch situation in 1977.

[2] Theoretical level only, as the actual value depends on by-catch allowance for mackerel.

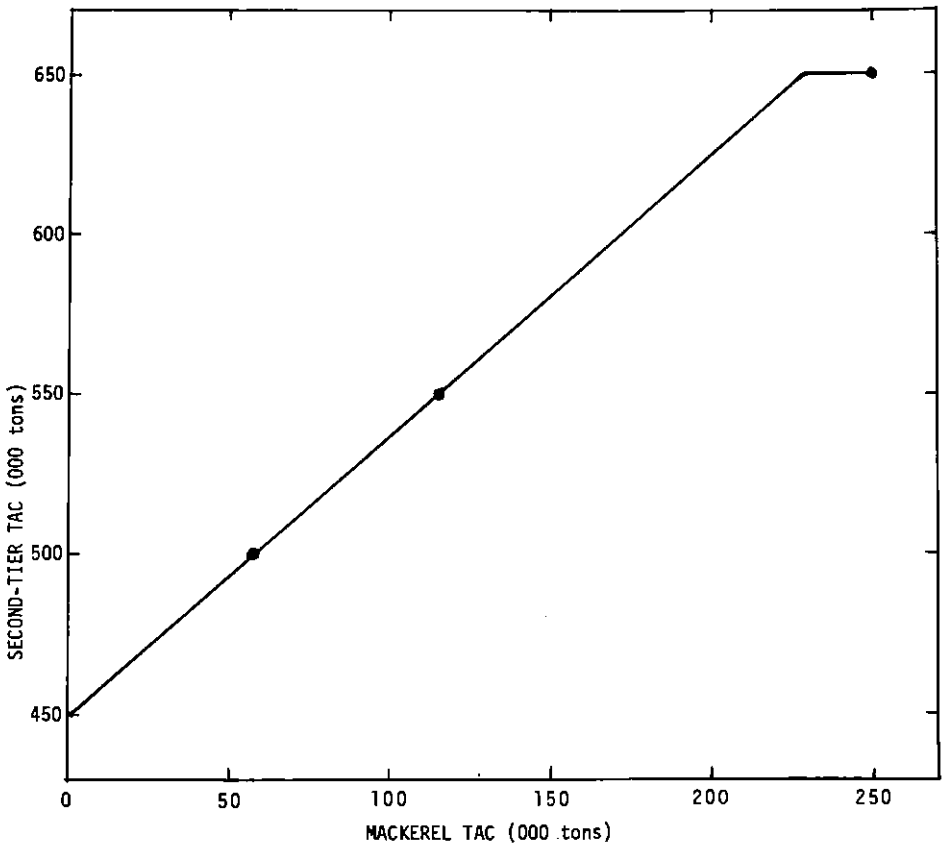

Fig. 1. Plot of second-tier TAC for various levels of mackerel TAC in Subarea 5 and Statistical Area 6, allowing for interpolation of second-tier TACs for values of mackerel TAC between zero and 250,000 tons.

The Advisers noted that a mackerel catch of zero (as distinct from a TAC of zero) is unrealistic, since some allowance for by-catch has to be taken into account to prevent interference with fisheries for other species in which mackerel occurs as a by-catch. The quantity allowed for mackerel by-catch greatly affects linear programming results and hence the appropriate level of the second-tier TAC. Thus, the second-tier TAC level of 450,000 (Fig. 1), which corresponds to a zero TAC for mackerel, is a theoretical value only.

u) Scallops in Division 5Z

The Advisers noted that the question of size limits was thoroughly reviewed in 1972. Since no change in the biological parameters has been observed, the previous advice on this subject is still valid. The recommended size limit (expressed as meat count per pound) was substantially below the regulation adopted by the Panel, and, considering that catches have increased, a reconsideration of the previous size limit proposal is warranted. However, the Advisers had no new information to consider at this time.

v) Menhaden in Statistical Area 6

The Advisers have no advice for the Panel at this time on means of minimizing by-catches of menhaden without interference with fisheries conducted for regulated species.

w) Seasonal Closures for Subarea 5 and Statistical Area 6

The Advisers have no new information which would allow them to formulate further advice on this matter. The Panel is referred, however, to a paper by Grosslein and Bowman (*Redbook* 1973, Part III) which contains information on species distribution from research vessel surveys and includes areas of species overlap.

x) Gear Regulations

The Advisers have no advice to give on this matter at this time.

5. Future Research Requirements

The Advisers endorse the proposals for the International Herring Tagging Experiment, noting that the bi-weekly reporting of herring catch and effort data are requested in conjunction with the reporting of tag returns. The Advisers agreed with the research programs recommended to STACRES by the Biological Surveys and Environmental Subcommittees and recommend that member countries support these programs. In view of the current important results of initiatives in modelling species interactions, the Advisers recommend an expansion of research along these lines, including studies on feeding, competition and predation. The Advisers noted that the reporting of catch and effort statistics by 30' × 30' unit areas has been approved by the Commission and member countries are urged to implement the system as soon as possible. With reference to the ICNAF sampling data base, the Advisers support the proposal for implementing this program as soon as possible, with plans to be worked out by a meeting of a small group of specified national consultants to be held at the Secretariat in advance of the next Annual Meeting, and request the Panel to give consideration to this item.

6. Election of Chairman

Dr. R. G. Halliday (Canada) was unanimously re-elected Chairman for 1976/77.

7. Time and Place of Next Meeting

It was agreed that the next meeting of Scientific Advisers to Panel 5 should be held prior to the next meeting of Panel 5.

6. REPORT OF SCIENTIFIC ADVISERS TO PANEL A (SEALS)

Ottawa, Canada, 17-19 November 1975

1. In the absence of Dr. A. W. Manfield, Dr. M. A. Bigg (Canada) was requested to serve as Chairman of the meeting, and Dr. G. H. Winters (Canada) was appointed rapporteur. Representatives attended from Canada (M. A. Bigg, P. Brodie, C. K. Capstick, D. M. Lavigne, P. F. Lett, A. W. May, B. S. Muir, W. E. Ricker, K. Ronald, D. E. Sergeant, G. H. Winters), Denmark (Sv. Aa. Horsted, F. O. Kapel), and Norway (R. Benjaminsen, T. Øritsland, Ø. Ulltang). The agenda, as proposed by the Chairman, was adopted without revision (see Part E, this volume). During the course of the discussions, the Advisers reviewed 6 working papers and the following research documents: Res. Doc. 75/XII/141 + Addenda 1 and 2; 142, 143, 144, 145 (Rev.), 146 (Rev.), 147 and 148.

2. Conservation of Harp Seals

a) Results of Research in 1975

Canada reported on the results of 1975 studies relating to photographic aerial surveys of whelping harp seals in the Gulf and Front areas, ultra-violet sensing results, marking of pups in the Gulf, and analysis of age frequencies from shore-based fisheries (Res. Doc. 75/XII/142, 144). Aerial and ultra-violet photographic surveys indicated a level of production of 46,000 pups in the Gulf and about 141,000 at the Front for a combined production in 1975 of about 187,000 pups, a decrease since 1972 of 12.5% per annum. Catches of young seals in 1975 were 140,629, of which 7,550 were taken in the Gulf. Analyses of tagging studies indicated a poor representation of the 1969-71 year-classea with catches in excess of 200,000 annually and strong representation of the 1972-73 year-classes following the imposition of the quota of 150,000 seals.

In addition to the research results presented to the Advisers at the 1975 Annual Meeting (Proc. No. 12, Appendix I), Norway presented additional data on age composition analyses and adjusted estimates of year-class survival, mortality and production, which confirmed similar analyses presented in Res. Doc. 75/121.

Denmark presented a working paper on the breakdown of harp seal catches at West Greenland during 1954-74, which indicated a relationahip between survival of pups in the Gulf and Front areas and subsequent 0-group catches at West Greenland during the following summer.

b) Mortality Estimates

Information on levels of total and natural mortality since the early 1960's were provided, based on a variety of methods. Cohort analysis, utilizing effort data (Res. Doc. 75/XII/145, 148), indicated a level of Z = 0.24 and M = 0.20 for age-groups 1+; analysis of catch curves indicated a range of mortality estimates from Z = 0.26 and M = 0.21 for adult seals (sexes combined) (Res. Doc. 75/XII/143) to Z = 0.09 for breeding adult females (working paper by T. Benjaminsen and T. Øritsland). After considerable discussion, it was felt that variability and bias in catch and age composition, hunting effort and recruitment were the main confounding factors in the wide range of estimates and a small working group was established to compute revised estimates of mortality incorporating appropriate adjustments for the above factors. The results of the analyses for adult males are as follows:

Sampling year	Age group	Z	Mean Z	Rate of change in recruitment	Total Z	Estimated hunting mortality	Natural mortality (m)
1973 1974	6-13 7-14	0.138 0.008	0.073	0.137	0.210	0.057	0.153
1969-74	8-21	0.073		0.020	0.093	0.040	0.050

The range of estimates of Z and M, calculated in this manner, were considered too large to be acceptable with confidence. Consequently, an alternative method of calculating mortality was considered involving levels of Z which provide estimates of breeding stock within the limits considered probably in 1975, starting from an estimate of breeding stock in 1967. The breeding stock estimates of Table 1 are based on the following assumptions:

i) Total mortality (Z) is constant over the various age-groups and years.

ii) The whelping age is 6 years.

iii) The breeding stock (age 6 and older) in 1967 was equal to 359,000 females, as calculated by functional regression of survival on pup catches.

The breeding stock estimates over a range of Z (Table 1) were variously considered acceptable under the assumptions made, depending on interpretations of information relating to estimates of pup production (and hence breeding stock) in 1975.

Table 1. Estimates of the breeding stock of harp seals for the period 1967-75, using a range of values of Z and the assumptions as indicated in the text.

	Estimates of breeding stock (thousands) for F-values					
	0.13	0.14	0.15	0.16	0.17	0.18
1967	359	359	359	359	359	359
1968	371	365	359	353	347	342
1969	370	358	348	338	328	319
1970	353	338	325	312	299	287
1971	338	320	305	289	274	261
1972	339	318	300	281	264	249
1973	323	300	280	260	243	227
1974	303	278	257	237	220	204
1975	315	287	262	240	220	202

c) Estimates of Production in 1975

The Advisers could not agree as to the most accurate level of pup production in 1975.

Results from Canadian aerial surveys, both black-and-white and ultra-violet photography, in 1975 indicated a pup production of 46,000 in the Gulf (ultra-violet) and 141,000 at the Front (black-and-white), for a combined total of 187,000 pups. Estimates of pup production at the Front by Canadian Fisheries Officer T. Curran indicated a level of 150,000 with a maximum of 165,000. Based on a production of 50,000 in the Gulf, the ratio of adults in the Gulf to those at the Front in 1975 (1:3) also indicates a level of production at the Front of about 150,000 making a total of 200,000 for both areas.

Total pup kill in 1975 was 140,000, of which 133,000 were taken at the Front. Observations by Norwegian sealers and a Norwegian observer suggest that escapement at the Front was good in 1975; this was indicated by the period in which the white-coat kill preference were fulfilled by the Norwegian fleet with a good escapement of white coats, and by the high daily kill rate of beaters experienced by the Norwegian fleet during the last three days of the hunt in the area of approximately 80 × 60 nautical mfles east of Grey Islands (Res. Doc. 75/120). Canadian sealing statistics indicate that 23,000 beaters were taken by landsmen at the Front during April and greater part of May. The degree of variability associated with aerial surveys was also pointed out, particularly in relation to probable under-estimates of production by this method. Thus, estimates of production at the Front in 1975 may have been considerably higher than indicated by aerial surveys, and a range of 200,000-250,000 was suggested as alternative estimates.

d) Advice on Catch Levels in 1976

The differences in scientific opinion on the level of pup production (and breeding stock) in 1975 precludes definitive advice on catch levels for 1976. However, the breeding stock estimates for 1975 over the range Z in Table 1 represent the range of scientific opinion relating to probable levels of pup production in 1975. It was considered appropriate to provide a series of calculations illustrating the effects on future pup production and breeding stock under alternative estimates of mortality and 1975 breeding stock contained in Table 1. These are given in Table 2.

e) Required Future Research on Harp Seals

Additional studies from recent biological material to establish maturity ogives were considered an important need. The bias resulting from small samples, the problem of obtaining samples at the Front, and the time lag in response of females to population fluctuations were discussed, and a sample of 200 females was considered as a minimum sample for such a study.

On-ice control of any aerial survey by black-and-white or ultra-violet photography was considered necessary, in particular on the Front ice. Norway expressed an interest to participate in any *ad hoc* study at the Front, but, for economic reasons, studies off Newfoundland would be conducted in alternate years. It was agreed that a cooperative research effort be made towards the construction of a systems simulation of the Northwest Atlantic harp seal population on the available data to assist in future harp seal assessments as well as to provide some insight into their community dynamics.

Table 2. Characteristics of the harp seal stock, based on a range of F-values and the breeding stock estimates from Table 1.

1	2	3	4	5	6	7	8	9
Z	A	R	1967 pups	1975 pups	Catch 1976	Long-term trend	Minimum pups	Year to minimum
0.21	0.189	0.142	359	-	0	-	0	
0.19	0.173	0.160	359	184	0	-	0	
0.18	0.165	0.170	359	202	0	±	125	1982
					50	-	0	
0.17	0.156	0.180	359	220	0	+	153	1982
					50	-	0	
0.16	0.148	0.191	359	240	0	+	185	1982
					50	+	185	1982
					100	-	0	
0.15	0.139	0.203	359	262	0	+	222	1978
					50	+	222	1978
					100	...[1]	...[1]	...[1]
0.14	0.131	0.216	359	287	0	+	255	1978
					50	+	255	1978
					100	+	255	1978
					150	-	0	
0.13	0.122	0.229	359	315	0	+	293	1978
					50	+	293	1978
					100	+	293	1978
					150	+	293	1978
					200	±	0	

[1] To be computed for the Eighth Special Commission Meeting, January 1976.

Notes Relevant to Table 2

Column 1. Instantaneous total mortality rate Z of seals from age 1 onward; this is mainly natural mortality, but it includes hunting mortality on seals older than age 0.

Column 2. Annual actual mortality rate; $A = 1 - e^{-Z}$.

Column 3. Computed fraction of all pups surviving the age 0 kill that become pup-producing females at age 6; $R = e^{-6Z}/2$.

Column 4. Assumed number of pups produced in 1967.

Column 5. Computed number of pups produced in 1975.

Column 6. Annual level of catch (all ages) in 1976 and later years, used in the computation. Of these, 84% are considered to be pups, and the rest older ages.

Column 7. Final trend of the computed population: + = continually increasing; - = continually decreasing; and ± = very slow increase or decrease.

Column 8. The level to which the number of pups produced will decline, based on recruitment in 1975.

Column 9. The year of minimum pup production.

The computations are started from the initial conditions as follows (numbers in thousands):

Year	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Pup production	406	399	384	387	367	360	359								
Pup kill	160	207	260	266	183	251	278	156	233	217	211	117	98	115	127
Pup survivors	246	192	124	121	184	109	81								

The pup survivors in each year are multiplied by R and added to the female breeding stock 6 years later. The number of producing females (= pup production) in each year is multiplied by A and the result subtracted from the number present to give the number surviving at the start of the following year. After 1975, trial pup kill strategies are used as follows, as far as appropriate: 0, 42,000, 84,000, 126,000, 168,000. No adjustments have been made for increases or decreases in survival rate of bedlamers or adults because of the different numbers caught under different kill strategies.

3. Conservation of Hooded Seals

a) Population Status

A Canadian re-assessment (Res. Doc. 75/XII/147) of hooded seal production from regression analyses of survival index on pup catch indicated a somewhat lower pup production (26,200) than the initial Norwegian estimates (32,000) using older age-groups (Res. Doc. 75/122).

b) Recommendation for TAC in 1976

The Advisers agreed to defer advice on the 1976 TAC level until the next meeting in Bergen, Norway, in December 1975.

c) Future Research

The Advisers agreed that future research efforts should be intensified towards providing better information on stratified sampling of the kill and extending the aerial reconnaissance northward to include Davis Strait.

4. Time and Place of Next Meeting

The Advisers noted that the next meeting of Panel A was scheduled to be held at the Fisheries Directorate, Bergen, Norway, on 12 December 1975, and agreed to hold the next meeting of Scientific Advisers on 9-10 December 1975 at the Institute of Marine Research, Bergen, Norway.

7. REPORT OF SCIENTIFIC ADVISERS TO PANEL A (SEALS)

Bergen, Norway, 9-10 December 1975

1. The meeting was convened by the Chairman, Dr. A. W. Mansfield (Canada), and Prof. K. Ronald (Canada) was appointed rapporteur. Representatives attended from Canada (P. F. Lett, A. W. Mansfield, B. S. Muir, K. Ronald, D. W. Sergeant, G. H. Winters), Denmark (Sv. Aa. Horsted, F. O. Kapel), and Norway (T. Benjaminsen, B. Bergfiødt, I. Christensen, T. Øritsland, Ø. Ulltang). The agenda, as proposed by the Chairman, was adopted with minor revision (see Part E, this volume). During the course of the discussions, the Advisers reviewed three working papers and the following research documents: Res. Doc. 75/XII/149, 150, 151.

2. Review of Report of Scientific Advisers from November 1975 Meeting (Part D, Section 6, this volume)

a) Hooded Seals

i) Population Status

The Norwegian estimate of the pup population in 1968 at 32,000 (Res. Doc. 75/122) and the Canadian re-assessment at 26,200 (Res. Doc. 75/XII/147), which were discussed at the Ottawa meeting, were reconsidered, together with data on long-term fluctuations in seal hunting in Greenland. After much discussion on the availability of hooded seals and the possible contribution of the Davis Strait herds to the catch at the Front, the Advisers were able to agree on a figure of 30,000 pups as the likely production in 1968. This figure, obtained from the functional regression of year-class survival on pup catch, was taken as the basis for calculating the production in 1975, using the best estimates of mortality available. A mean total mortality (Z) of 0.22 for adults, obtained from 1971-74 catch curves, was used to derive a natural mortality (M) of 0.11. When applied to the 30,000 pups produced in 1968, an adult female population of 37,935 is estimated for 1975. Correcting for infertile females (5%), the sustainable yield is estimated at 13,500 pups if the mean age of sexual maturity is assumed to be 4 years, and 9,600 pups if the mean age is assumed to be 5 years. Total allowable catches would then be 23,800 seals, including 10,300 adults, or 16,500 seals, including 6,900 adults.

ii) Recommendation for Total Allowable Catch (TAC)

The Advisers concluded that, although these estimates were higher than the present TAC, it would be prudent not to change the TAC until firmer data on mortality rates, especially for immatures, and on recruitment has been acquired. The Advisers therefore recommends to Panel A that the TAC for hooded seals remain unchanged in 1976 at 15,100.

iii) Future Research

Canada and Norway will collect from the Front area more jaw samples for age analysis in order to improve estimates of natural mortality.

Canada will continue the marking of hooded seals in the Gulf of St. Lawrence and will make another attempt to survey the patch of hooded seals in Davis Strait. It is hoped that the Canadian Forces will supply a long-range reconnaissance aircraft for this task, and, should the patch be located, a second aircraft from the Canada Centre for Remote Sensing will be used to obtain an estimate of the population, using the ultra-violet technique recently developed at the University of Guelph (Res. Doc. 75/XII/144).

Denmark will continue age analysis of the catches in West Greenland, which make up 15-20% of the total number of hooded seals taken in the ICNAF Area.

Canada and Denmark agreed to exchange recent information on ice distribution and movements in Davis Strait in order to look for recurring patterns which might determine the distribution of hooded seals.

Norway intends to devote most of its research on hooded seals to studies on the moulting herds in Denmark Strait (outside the ICNAF Area), as it is felt that the information gained would provide useful insights into factors affecting the herd at the Front.

b) Harp Seals

i) Population Status

The Advisers reviewed the report of the Ottawa meeting (Part D, Section 6, this volume)

but did not discuss the implications of that report in view of the new calculations and evidence presented at the present meeting in two research documents (Res. Doc. 75/XII/150, 151) and in three working papers (T. Øritsland and T. Benjaminsen; G. H. Winters; and F. O. Kapel).

No discussion of Res. Doc. 75/XII/149 took place since it was essentially a critique of an earlier document (Res. Doc. 75/XII/148) which has now been superseded. As at the Ottawa meeting, the Advisers were still unable to agree unanimously on a figure for the total allowable catch owing to inherent uncertainties in the data, especially the estimates of the pup population in 1975 and the mortality rates of both immature and adult females. The 1976 TACs based on the present catch composition, for various estimates of pup population, are indicated as follows:

Reference	Estimated pup population (in thousands)			
	290	270	260	220
Benjaminsen, T.	180[1]	167[2]		
Winters, G. H.			127	104
Res. Doc. 75/XII/151			110[3]	90[3]

[1] Best estimate (M = 0.13 for immatures and M = 0.10 for adult females).
[2] Conservative estimate.
[3] Estimates using M = 0.11.

ii) Recommendation for TAC

In view of the wide variation in estimates of TAC, the Advisers were unable to reach a unanimous decision on the level of catch to be taken in 1976. However, the majority felt that, due to insufficient evidence, they could not recommend a change from the 1975 TAC of 150,000 seals (excluding Greenland and the Canadian Arctic).

iii) Future Research

The greatest inadequacies in the data in order of importance were considered to be (1) estimates of pup production in the Gulf and at the Front, especially in the latter area; and (2) estimates of natural mortality of immature and adult females. Future research by Canada, Denmark and Norway will be aimed at improving these estimates. A cooperative effort should also be made to develop a systems simulation of Northwest Atlantic harp seal populations to assist in future management.

3. Time and Place of Next Meeting

The Advisers stressed the difficulty of providing new information, based on the current year's sealing season, by the time of the Annual Meeting and recommended that the next meeting be held in the fall of 1976. It was suggested that the week following the ICES Annual Meeting in Copenhagen, Denmark, would be a suitable time and locale.

PART E

CONTENTS

1. AGENDA FOR STACRES MEETINGS

SEVENTH SPECIAL COMMISSION MEETING - SEPTEMBER 1975

1. Opening (Chairman: A. W. May)
   (a) Appointment of rapporteur
   (b) Adoption of agenda
   (c) Plan of work
2. General discussion on implications to philosophy of "Remit to STACRES for Special Meeting" (see Part A, Appendix II, this volume)
3. Assessments (Chairman: A. T. Pinhorn)
   (a) Deferred stocks
      i) Cod (3NO, 3Ps, 4Vn(Jan-Apr)+4T, 4VsW)
      ii) Redfish (3P, 4VWX)
   (b) Review of estimates of potential yield of the groundfish resources in Subareas 2 to 4 in comparison with estimates based on individual resources (Res. Doc. 75/43 and 75/55 with revised addendum)
   (c) Further consideration of finfish and squids within the second-tier overall TAC for Subarea 5 and Statistical Area 6
4. Reports
   (a) Consideration and adoption of Assessments Subcommittee Report
   (b) Adoption of STACRES Report
5. Adjournment

EIGHTH SPECIAL COMMISSION MEETING - JANUARY 1976

1. Opening (Chairman: A. W. May)
   (a) Appointment of rapporteur
   (b) Adoption of agenda
   (c) Plan of work
2. Herring conservation in Subareas 4 and 5 and Statistical Area 6
   (a) Herring (4VW(a), 4XW(b), 5Y, 5Z+6)
3. Herring and mackerel size limits
   (a) Herring in Subareas 4 and 5
   (b) Mackerel in Subareas 3 to 5 and Statistical Area 6
4. Review of information requested by the Commission regarding implementation of effort reduction in Subareas 2 to 4 for 1976 (Proposal (1) from the Seventh Special Meeting, September 1975; Circular Letter 75/60, page 21)
5. Other business
6. Reports
   (a) Consideration of Working Group Reports
   (b) Adoption of STACRES Report
7. Adjournment

ANNUAL MEETING - MAY JUNE 1976

1. Opening (Chairman: A. W. May)
   (a) Appointment of rapporteur
   (b) Adoption of agenda
   (c) Plan of work

2. Assessments (Chairman: A. T. Pinhorn)

(The items listed below were considered by the Assessments Subcommittee in April 1976, Summ. Doc. 76/VI/22)

(a) Review of catch statistics and fishing activity in 1975
(b) Review of abundance indices for 1975
(c) Stock assessments (TACs for 1977)

i) Cod (1, 2GH, 2J+3KL, 3M, 3NO, 3Ps, 4Vn(Jan-Apr)+4T, 4Vn(May-Dec), 4VsW, 4X(offshore), 5Y, 5Z)
ii) Haddock (4VW, 4X, 5)
iii) Redfish (2+3K, 3M, 3LN, 3O, 3P, 4VWX, 5)
iv) Silver hake (4VWX, 5Y, 5Ze, 5Zw+6)
v) Red hake (5Ze, 5Zw+6)
vi) Pollock (4VWX, 5) (Summ. Doc. 76/VI/2, p. 53)
vii) American plaice (2+3K, 3LNO, 3M, 3Ps)
viii) Witch flounder (2J+3KL, 3NO, 3Ps)
ix) Yellowtail flounder (3LNO, 5(E69°), 5(W69°)+6)
x) Greenland halibut (0+1, 2+3KL)
xi) American plaice, witch and yellowtail (4VWX)
xii) Flounders except yellowtail (5+6)
xiii) Roundnose grenadier (0+1, 2+3)
xiv) Herring (4VW(a), 4XW(b), 5Y, 5Z+6, with options for 4V, 4WX)
xv) Mackerel (3+4, 5+6)
xvi) Argentine (4VWX)
xvii) Capelin (2+3K, 3L, 3Ps)
xviii) Other finfish (5+6)
xix) Squid-*Illex* (3+4, 5+6)
xx) Squid-*Loligo* (5+6)
xxi) Shrimp (1) (Comm. Doc. 76/VI/20)
xxii) Alewife (5+6) (Comm. Doc. 76/VI/19)

(d) Overall TAC for finfish and squids in Subarea 5 + Stat. Area 6
(e) Overall effort in Subareas 2 to 4
(f) Other matters

i) Draft report of ageing workshop on cod (Summ. Doc. 76/VI/13)
ii) Report of Northwestern Working Group of ICES re cod stocks at Greenland (Summ. Doc. 76/VI/7)
iii) Management options (Comm. Doc. 76/VI/22)

3. Biological Surveys (Chairman: J. Messtorff)

(a) Review of survey activity in 1975
(b) Proposed survey activity in 1976
(c) Processing facilities for survey work (ICNAF Secretariat?)
(d) Editing of manual on ICNAF groundfish surveys
(e) Hydroacoustic surveys
(f) Review of matters resulting from April 1976 Meeting of ICNAF Environmental Working Group at Szczecin, Poland
(g) Other matters

4. Statistics and Sampling (Chairman: Sv.Aa. Horsted)

(a) CWP report and statistical activities of other regional agencies
(b) ICNAF statistical report, 1975/76

i) Statistical Bulletin, Vol. 24 for 1974
ii) Advance monthly statistics for selected species, 1975
iii) Statistics on discards
iv) Adequacy of national reporting of fishery statistics
v) Review of STATLANT and other statistical forms

(c) ICNAF report on sampling, 1975/76

i) Sampling Yearbook, Vol. 19 for 1974
ii) Adequacy of sampling and/or reporting national sampling data
iii) Early requirement for sampling data
iv) Review of sampling forms and deadlines
v) Report on special sampling project

(d) List of Vessels for 1974
(e) International scientific observer program
(f) Review of papers relevant to sampling methology
(g) Other matters

5. Environmental (Chairman: H.W. Hill)

   (a) Report of Working Group on Coordinated Environmental Studies (E.J. Sandeman, Convener)

      i) Research project for Gulf of Maine-Georges Bank area (related to herring)
      ii) Research project for Flemish Cap (related to cod and redfish)
      iii) Standardization of oceanographic data and sections
      iv) Data products required of MEDS

   (b) Progress report on Gdynia plankton sorting center
   (c) Marine Environmental Data Service (MEDS)

      i) Progress report for 1975-76
      ii) Data products presently produced and envisaged
      iii) Nomination of national data exchange representatives
      iv) Experimental use of ROMBI forms

   (d) Review of environmental conditions during 1975
   (e) Continuous Plankton Recorder results for 1975
   (f) Progress on weather and ice reporting by fishing vessels (SHRED)
   (g) Other matters

6. *Ad hoc* Working Group of Fishing Effort Studies (Convener: R.C. Hennemuth)

   (a) Brief review of Working Group Report from 1975 Annual Meeting (Redbook 1975, p. 83)
   (b) Review of papers (submitted per request of Working Group at 1975 Annual Meeting) on:

      i) Qualitative studies or quantitative data on changes in gear and operating factors that occurred during 1971-75, related to vessel types
      ii) Analytical studies on Div. 5Z Pilot Study data

   (c) Review of other fishing effort studies reported
   (d) Open discussion of problems being encountered by individual countries in implementing fishing effort restrictions in Subarea 2 to 4, 1976 (Comm. Doc. 76/I/1 and Addenda), and alternative suggestion for achieving the same reduction in fishing mortality
   (e) Final evaluation of Div. 5Z catch and effort data submitted by vessel and 30-minute square, on a daily basis.
   (f) Future fishing effort studies
   (g) Other matters

7. Ageing Techniques and Validation Studies

   (a) Report of Ageing workshop on cod, held at Vigo, Spain, October 1975 (Summ. Doc. 76/VI/13)
   (b) Report of Ageing Workshop on silver hake, held at Dartmouth, Canada, April 1976 (Summ. Doc. 76/VI/21)
   (c) Review of papers on validation studies
   (d) Need for further workshops and/or otolith exchange programs
   (e) Other matters

8. Gear and Selectivity

   (a) Trawl materials and mesh size sampling for 1975
   (b) Consideration of recent selectivity studies
   (c) Other matters

9. Cooperative Research Projects

   (a) Status of publication of results of Greenland salmon tagging experiment
   (b) Status of publication of papers presented at Symposium on Acoustic Methods in Fishery Research

10. Steering and Publications (Chairman: A. W. May)

   (a) Membership on Suhcommittee
   (b) Review of meeting agenda and timetable
   (c) Organization and operation of STACRES
   (d) Review of ICNAF publications
   (e) Review of editorial policy relating to Research Bulletin and Selected Papers
   (f) Consideration of 1976 Research Documents for Selected Papers No. 2
   (g) Other matters

11. Other Matters

    (a) Menhaden by-catch problem (Comm. Doc. 76/VI/26)
    (b) Species mix in Subarea 5 and Statistical Area 6 re proposed seasonal closure (Comm. Doc. 76/VI/27)

12. Mid-Year Meetings

13. Arrangements for 1977 Annual Meeting of STACRES

14. Election of Officers

15. Adjournment

2. AGENDA FOR MEETINGS OF SCIENTIFIC ADVISERS TO PANEL A (SEALS)

SPECIAL MEETING OF ADVISERS - NOVEMBER 1975

1. Opening

    (a) Election of Chairman (*pro-tem*)
    (b) Appointment of rapporteur
    (c) Adoption of agenda

2. Harp seals

    (a) Population status
    (b) Recommendation for total allowable catch in 1976
    (c) Future research

3. Hooded seals
    (a) Population status
    (b) Recommendation for total allowable catch in 1976
    (c) Future research

4. Other business

5 Approval of report of this meeting

6. Time and place of next meeting

7. Adjournment

SPECIAL MEETING OF ADVISERS - DECEMBER 1975

1. Opening (Chairman: A. W. Mansfield)

    (a) Appointment of rapporteur
    (b) Adoption of agenda

2. Review of Report of Special Meeting of Scientific Advisers, Ottawa, Canada, 17-19 November 1975 (Summ. Doc. 75/XII/47)

    (a) Hooded seals
    (b) Harp seals

3. Other business

4. Approval of Scientific Advisers Report

5. Time and place of next meeting

6. Adjournment

3. LIST OF STACRES RECOMMENDATIONS

4. LISTS OF SUMMARY AND RESEARCH DOCUMENTS - 1975 (CONTINUED)[1]

SUMMARY DOCUMENTS

Sum. Doc. No.	Serial No.	
75/XII/47	3722	ICNAF. Report of Scientific Advisers to Panel A (Seals), Ottawa, Canada, 17-19 November 1975 (7 pages).

RESEARCH DOCUMENTS

Res. Doc. No.	Serial No.	
75/IX/124	3675	Garrod, D. J. Specified stock size as an objective for the management of single stocks (6 pages).
75/IX/125	3676	Horwood, J. W. Interactive fisheries: a two-species Schaefer model (8 pages).
75/IX/126	3677	Pope, J. G. The application of mixed fisheries theory to the cod and redfish stocks of Subarea 2 and Division 3K (13 pages).
75/IX/127	3678	Pope, J. G. The effect of biological interactions on the theory of mixed fisheries (12 pages).
75/IX/128	3679	Garrod, D. J. Resource management, its objectives and implementation (12 pages).
75/IX/129	3680	Cushing, D. H. On the Canadian proposal to restrict fishing effort (5 pages).
75/IX/130	3681	Maurer, R. A preliminary description of some important feeding relationships (15 pages).
75/IX/131	3682	Walter, G. G. Non-equilibrium regulation of fisheries (16 pages).
75/IX/132	3684	Brennan, J. A., B. E. Brown, and J. E. Palmer. Effects of increased vessel efficiency on effort regulation (5 pages) + Addendum (1 page).
75/IX/133	3685	Pope, J. G., and O. C. Harris. The South African pilchard fishery and anchovy stock complex: an example of the effects of biological interactions between species on management strategy (9 pages).
75/IX/134	3687	Doubleday, W. G. Environmental fluctuations and fisheries management (15 pages).
75/IX/135	3688	Mayo, R. K., and D. S. Miller. A preliminary assessment of the redfish, *Sebastes marinus* (L.), in ICNAF Divisions 4V, 4W and 4X (15 pages).
75/IX/136	3689	Halliday, R. G. Eastern Scotian Shelf cod (ICNAF Division 4VsW): a reconstruction of possible events in the fishery in 1958 to 1974 and a re-estimation of potential yield (23 pages).
75/IX/137	3690	Parsons, L. S., and D. G. Parsons. Status of Division 3P redfish (12 pages).
75/IX/138	3691	Ulltang, Ø. Some aspects of fishing patterns in relation to fishery management (22 pages).
75/IX/139	3692	Clark, S. H., and B. E. Brown. Changes in biomass of finfish and squid from the Gulf of Maine to Cape Hatteras, 1963-1974, as determined from research vessel survey data (18 pages).
75/IX/140	3693	Lett, P. F., and W. G. Doubleday. A system simulation to determine the implications of fluctuations in recruitment on management policies of fish stocks with special reference to Gulf of St. Lawrence cod (53 pages).
75/XII/141	3714	Ronald K., and C. K. Capstick. Harp seal survival as predicted by a modification of Allen'a model (24 pages) + Addenda 1 and 2 (11 pages).

[1] These 1975 documents were issued after *Redbook* 1975 was published.

75/XII/142	3715	Sergeant, D. E. Results of research on harp seals in 1975 with an estimate of production (6 pages).
75/XII/143	3716	Ricker, W. E. Mortality and production of harp seals, with reference to a paper of Benjaminsen and Øritsland (1975) (41 pages).
75/XII/144	3717	Lavigne, D. M., S. Innes, K. Kalpakis, and K. Ronald. An aerial census of western Atlantic harp seals (*Pagophilus groenlandicus*) using ultra-violet photography (10 pages).
75/XII/145 (Rev.)	3718	Lett, P. F., and D. M. Lavigne. The impact of current management policies on stocks of western Atlantic harp seals, *pagophilus groenlandicus* (22 pages).
75/XII/146 (Rev.)	3719	Muir, B. S. Consideration of present management regime for harp seals in relation to recent scientific analysis (3 pages).
75/XII/147	3720	Sergeant, D. E. Comments on new estimates of production and sustainable yield of harp and hooded seals (5 pages).
75/XII/148	3721	Lett, P. F., and D. M. Lavigne. The estimation of natural mortality for the harp seal (*pagophilus groenlandicus*) (13 pages).
75/XII/149	3727	Ulltang, Ø. Comments on an attempt by P. F. Lett and D. M. Lavigne to estimate mortality for northwestern Atlantic harp seals from catch and effort data (8 pages).
75/XII/150	3728	Lavigne, D. M. Harp seal, *Pagophilus groenlandicus*, production in the western Atlantic during March 1975 (3 pages).
75/XII/151	3729	Ronald, K., and C. K. Capstick. A further review of Allen, Ronald, Captstick harp seal model, based on data from Scientific Advisers Meeting held at Ottawa in November 1975 (8 pages).

5. LISTS OF SUMMARY AND RESEARCH DOCUMENTS - 1976

SUMMARY DOCUMENTS

Sum. Doc. No.	Serial No.	
76/I/1	3723	ICNAF. Report of Meetings of Standing Committee on Research and Statistics (STACRES), Seventh Special Commission Meeting, September 1975 (14 pages).
76/I/2	3776	ICNAF. Proceedings of Seventh Special Commission Meeting, Montreal, Canada, 22-28 September 1975 (72 pages).
76/VI/3	3730	ICNAF. Report of Special Meeting of Panel A (Seals), Bergen, Norway, 12 December 1975 (16 pages).
76/VI/4	3759	NEAFC. Northeast Atlantic Fisheries Commission Mid-term Meeting, November 1975: press notice (4 pages).
76/VI/5	3764	ICNAF. Report of Standing Committee on Research and Statistics (STACRES), Eighth Special Commission Meeting, January 1976 (32 pages).
76/VI/6	3884	ICNAF. Proceedings of Eighth Special Commission Meeting, FAO, Rome, Italy, 21-26 January 1976 (78 pages).
76/VI/7	3829	ICES. Report of Northwestern Working Group, Charlottenlund, Denmark, 8-12 March 1976 (63 pages).
76/VI/8	3765	ICNAF Secretariat. Stock records for some species considered at 1975 assessment meetings (30 pages).
76/VI/9	3766	ICNAF Secretariat. Revised catch and effort statistics for Japan 1967-69 (3 pages).
76/VI/10	3773	ICNAF Secretariat. Historical catches of TAC species by stock area and country for the period 1965-74 (67 pages).
76/VI/11	3774	ICNAF Secretariat. Nominal catches of finfish species and squids in Subarea 5 and Statistical Area 6, 1965-74 (10 pages).
76/VI/12	3790	Jones, B. W. U. K. research report, 1975 (2 pages).
76/VI/13	3783	ICNAF. Report of Ageing Workshop on cod, held at Vigo, Spain, 20-25 October 1975 (42 pages) + Addendum (32 pages) + Revised Text (7 pages).
76/VI/14	3793	Sato, T. Japanese research report, 1975 (4 pages).
76/VI/15	3794	Touron, J., A. Vazquez, and J. R. Fuertes. Spanish research report, 1975 (6 pages).
76/VI/16	3813	Posgay, J. A. United States research report, 1975 (16 pages).
76/VI/17	3814	Paciorkowski, A., and E. Stanek. Polish research report, 1975 (20 pages).
76/VI/18	3815	Schultz, H., and L. Danke. GDR research report, 1975 (10 pages).
76/VI/19	3816	Ulltang, Ø., and T. Øritsland. Norwegian research report, 1975 (3 pages) + Addendum (2 pages).
76/VI/20	3844	Konstantinov, K. G., and A. S. Noskov. USSR research report, 1975 (34 pages).
76/VI/21 (2nd Rev.)	3850	ICNAF. Report of silver hake ageing workshop, Dartmouth, Canada, 1-3 April 1976 (6 pages).
76/VI/22	3865	ICNAF. Report of Assessments Subcommittee, April 1976 (53 pages) + Corrigendum (2 pages) + Addenda 1 and 2 (7 pages).
76/VI/23	3866	Fleming, A. M., and J. S. Scott. Canadian research report, 1975 (11 pages) + Corrigendum (1 page).

76/VI/24	3869	ICNAF Secretariat. Sealing statistics for the Northwest Atlantic, 1975 (2 pages).
76/VI/25	3870	ICES. Report of ICES Statistical Committee, October 1975 (4 pages).
76/VI/26	3871	ICNAF Secretariat. Extracts from resolutions passed at the 1975 ICES Meeting relevant to the research and statistical activities of ICNAF (2 pages).
76/VI/27	3878	ICNAF Secretariat. The ICNAF Sampling Program: need for standardized guidelines (8 pages).
76/VI/28	3879	ICNAF Secretariat. Tagging activities reported by member countries for 1975 (8 pages).
76/VI/29	3905	ICNAF Secretariat. Statistics on discards, 1974 (11 pages).
76/VI/30	3906	NEAFC. Northeast Atlantic Fisheries Commission Mid-term Meeting, April 1976: press notice (4 pages).
76/VI/31	3907	Meyer, A., J. Messtorff, and H. Dornheim. Federal Republic of Germany research report, 1975 (19 pages).
76/VI/32	3908	Horsted, Sv. Aa., and F. Hermann. Denmark (Greenland) research report, 1975 (17 pages).
76/VI/33	3918	ICNAF Secretariat. Adequacy of sampling for TAC stocks, 1974 (13 pages).
76/VI/34	3919	ICNAF Secretariat. 1975 Supplement to List of Fishing Vessels for 1974 (16 pages) + Addendum (12 pages).
76/VI/35 (Rev.)	3923	ICNAF Secretariat. Provisional nominal catches in the Northwest Atlantic, 1975 (57 pages).
76/VI/36	3942	ICNAF. Report of third meeting of the Environmental Working Group 26-30 April 1976, Szczecin, Poland (32 pages).
76/VI/37	3943	Portugal, M. L., A. M. Tavares, M. Lima Dias, and M. de Lourdes M. Godinho. Portuguese research report, 1975 (14 pages).
76/VI/38	3948	Chevalier, R. French research report, 1975 (6 pages).
76/VI/39 (Rev.)	3954	Ulltang, Ø. Status of fisheries and research carried out in Subarea 1, Statistical Area 0 and off East Greenland in 1975 (10 pages).
76/VI/40 (Rev.)	3955	Pitt, T. K. Status of fisheries and research carried out in Subarea 2 in 1975 (5 pages).
76/VI/41	3956	ICNAF Secretariat. Nominal catches (1965-74) by country and stock area, with TACs and allocations (1973-76) for species and stocks proposed for regulation in 1976 (138 pages).
76/VI/42 (Rev.)	3957	Tibbetts, A. M., and S. H. Clark. Status of fisheries and research carried out in Subarea 5 and Statistical Area 6 in 1975 (10 pages).
76/VI/43 (Rev.)	3958	Halliday, R. G. Status of the fisheries and research carried out in Subarea 4 in 1975 (9 pages).
76/VI/44 (Rev.)	3959	Parrish, B. B. Status of fisheries and research carried out in Subarea 3 in 1975 (9 pages).
76/VI/45	4000	ICNAF Secretariat. Summary of Trawl Materials and mesh size sampling, 1975 (6 pages).
76/VI/46	4001	NEAFC. Northeast Atlantic Fisheries Commission, Fourteenth Annual Meeting, July 1976: press notice (4 pages).

RESEARCH DOCUMENTS

Res. Doc. No.	Serial No.	
76/I/1	3732	Soldat, V. T. Distribution of herring from the Nova Scotia Shelf (13 pages).
76/VI/2	3760	Karaulovsky, V. P., and I. K. Sigaev. Long-term variations in heat content of the waters on the Northwest Atlantic Shelf (9 pages).
76/VI/3	3762	Tourón, J. Distribution and abundance of *Illex illecebrossus* (LeSueur) in Subareas 3 and 4: results of an exploratory cruise (15 pages).
76/VI/4	3763	Lett, P. F., and A. C. Kohler. Recruitment: a problem of multispecies interaction and environmental perturbation, with special reference to Gulf of St. Lawrence herring (*Clupea harengus* L.) (40 pages).
76/VI/5	3769	MEDS, Ottawa, Canada. Monthly distributions of oceanographic stations in the ICNAF Area, 1950-1959 (146 pages).
76/VI/6	3770	MEDS, Ottawa, Canada. Monthly summaries of oceanographic stations in the ICNAF Area, 1950-1973 (23 pages).
76/VI/7	3771	Huyer, A., and A. Verney. Temperature, salinity and sigma-t at Station 27 (47° 33'N, 52°35'W), 1950-1959 (45 pages).
76/VI/8	3777	Rikhter, V. A., and V. N. Efanov. On one of the approaches to estimation of natural mortality to fish populations (12 pages).
76/VI/9	3778	Labarta, E. Observations on the capelin fishery of the Grand Banks, Newfoundland, June-July 1975 (11 pages).
76/VI/10	3779	Lozow, J. B., and J. B. Suomala Jr. A short note on hydro-acoustical echo signal components and their effect on fish target density estimations (5 pages).
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76/VI/22	3802	Stobo, W. T. The Canadian herring fishery in Division 4V (2 pages).

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76/VI/27	3807	Borrmann, H. Preliminary stock assessments of roundnose grenadier in ICNAF Subareas 0+1 and 2+3 (12 pages) + Corrigendum (1 page).
76/VI/28	3808	Koch, H. A contribution on the methodics of age determination in roundnose grenadier (*Coryphaenoides rupestris* Gunn) (3 pages).
76/VI/29	3809	Anderson, E. D. Recruitment estimates for the mackerel stock in ICNAF Subarea 3, 4 and 5 and Statistical Area 6, based on US research vessel spring trawl surveys, 1968-75, with implications for assessment (8 pages) + Addendum (4 pages).
76/VI/30	3810	Sissenwine, M. P., and A. M. Tibbetts. Simulating the effect of fishing on squid (*Loligo* and *Illex*) populations off the northeastern United States (18 pages).
76/VI/31	3811	Sissenwine, M. P. A review of stock size estimates of squid (*Loligo* and *Illex*) in Subarea 5 and Statistical Area 6 (5 pages).
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76/VI/100	3922	Doubleday, W. G. Report on Special Sampling Project for cod in Divisions 2J+3KL, mackerel in Subareas 3-5 and Statistical Area 6, and silver hake in Subareas 4-5 and Statistical Area 6 (5 pages).
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76/VI/122	3979	Anthony, V.C. The effect on stock size from various assumptions of year-class strengths for the Division 5Z and Statistical Area 6 herring stock (7 pages).

6. PARTICIPANTS IN SCIENTIFIC MEETINGS HELD DURING 1975/76

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