INTERNATIONAL COMMISSION

FOR THE

NORTHWEST ATLANTIC FISHERIES

REDBOOK 1972, PART I

STANDING COMMITTEE
ON
RESEARCH AND STATISTICS PROCEEDINGS

1972
ANNUAL MEETING

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Dartmouth, N.S., Canada
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NOTE

REDBOOK 1972 is in three parts: PART I (this volume) contains Proceedings of the Standing Committee on Research and Statistics; PART II contains Research Reports by Member Countries for the year 1971; and PART III contains Selected Papers from the 1972 Annual Meeting.

This volume was produced in the Secretariat largely through the efforts of Mrs E.R. Cornford who did the typing and to Messrs G. Moulton and R. Myers who did the multigraphing.

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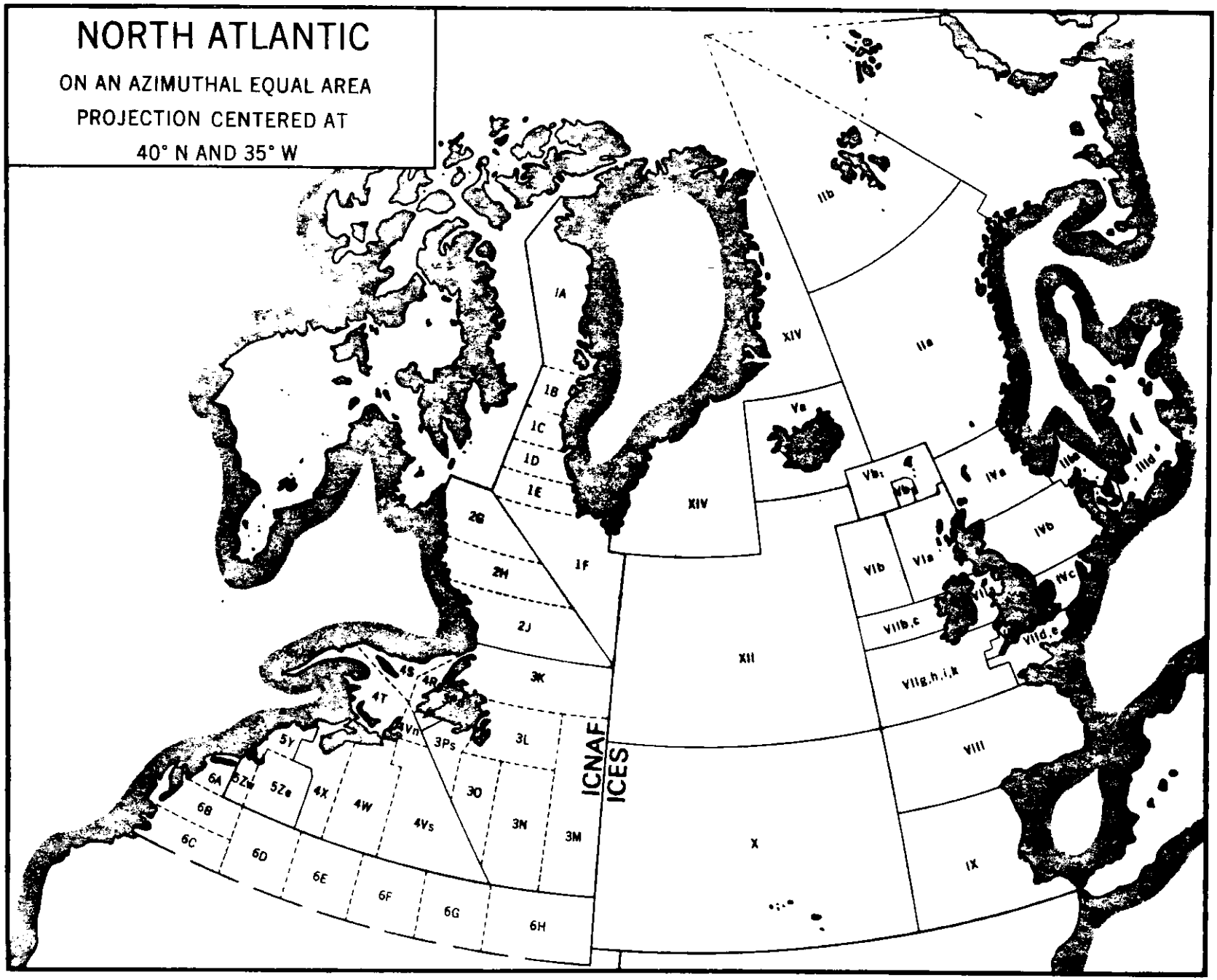
NORTH ATLANTIC
ON AN AZIMUTHAL EQUAL AREA
PROJECTION CENTERED AT
40° N AND 35° W
ICNAF
ICES
1A
1B
1C
1D
1E
1F
2G
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A. SUMMARY REPORT OF PROCEEDINGS OF STACRES

Chairman: A. S. Bogdanov Rapporteur: V. M. Hodder

The Standing Committee on Research and Statistics (STACRES) convened in Washington, D.C., USA, on Thursday, 18 May 1972, and with its various Subcommittees and Working Groups met on each day (except Sunday) to Tuesday, 23 May. A further meeting was held on 1 June to complete consideration of deferred agenda items, to consider future action on tasks referred to STACRES by the Panels at this Annual Meeting, and to approve the STACRES Report. The STACRES Meetings were preceded by a meeting of the Assessments Subcommittee on 16-17 May. The Assessments Subcommittee and the Herring Working Group also met at Rome, Italy, 24-29 January 1972 (Res.Doc. 72/1) and STACRES was convened on 29 January to review the Report of the Herring Working Group, which was considered by the Commission at the Special Meeting on Herring, FAO, Rome, 31 January - 7 February 1972. The ICES/ICNAF Joint Working Group on North Atlantic Salmon met at Dublin, Ireland, 21-24 March 1972 (Res.Doc. 72/32) and the ICES/ICNAF Joint Working Group on North Atlantic Cod Stocks met at Copenhagen, Denmark, 8-14 March 1972 (Res.Doc. 72/33). Items of major importance dealt with at these meetings are summarized below.

1. GROUNDFISH ASSESSMENTS (APP. I)

(a) Fishery Trends

The total nominal catch of 3,200,000 metric tons from the Convention Area in 1971 was about the same as that reported in 1970. An additional 326,000 tons were reported from Statistical Area 6 in 1971, but these latter statistics are as yet very incomplete.

The table below indicates that cod is still the most important species with herring next, and mackerel, redfish, and silver hake following in that order. Nominal catches of cod, herring, plaice, and yellowtail flounder declined from 1970 to 1971, those of mackerel, redfish, and silver hake increased, and haddock remained about the same.

	Nominal catches in 000's metric tons	
Species	1970	1971
Cod	1,152	1,055
Herring	865	733
Mackerel	220	346
Redfish	224	273
Silver hake	223	232
American plaice	115	108
Yellowtail flounder	70	67
Haddock	48	49

(b) Assessments

Cod and herring assessments were emphasized this year, and new assessments for several other species were carried out, including American plaice and yellowtail flounder in Subarea 3, and silver and red hakes in Subareas 5 and 6. The assessments for haddock and yellowtail flounder, now under quota regulation, were updated.

COD

Assessments for all cod stocks are not yet completed, but advice concerning the effects of fishing was provided for major stocks. Because the assessments indicate that almost all of the cod stocks are being fished near the point of maximum sustainable yield, and proposals for regulation of several of the stocks are now before the Commission, the Assessments Subcommittee has provided recommended quotas for 1973 which will achieve the objective of maximizing long run yields. It should be noted, however, that these, in almost all cases, correspond to the maximum effort levels compatible with sustained yields. Reduction of fishing mortality up to 50% would provide, in the long run, nearly the same yields with considerable benefits in terms of increased catch per unit effort.

Stock	1971 Catch	1973 Recommended Catch
Subarea 1	120	102
Div. 2J, 3K-L	450	650
Div. 3N-O	120	70
Div. 3Ps	60	70
Div. 4T-Vn	57	60
Div. 4Vs-W	53	60
Div. 4X	10	0
Div. 5Z	27	35
Div. 2G-H	12	-
Div. 3M	19	-
Div. 3Pn, 4R-S	124	-
Div. 5Y	7	-

The North Atlantic Cod Working Group considered assessments for selected major stocks throughout the area and the interaction between fisheries which occurs because of the mobile fleets. The preliminary results indicate that the same total catch could be taken in the long run by about 50% of the present cod effort. After initial decreases, the catch would recover in about 7 years.

It is now possible to develop further the possible interactions and effects of diversion of fishing effort caused by partial regulation. Further applications must be defined and related to the Commission's requirements.

HADDOCK

Revised assessments indicate that there has been no improvement in recruitment to any of the stocks and that further declines in abundance will probably occur at the 1972 catch levels. It now appears that catches of haddock incidental to other fisheries may be greater than annual surplus production, and it is again recommended that any measure possible to reduce the catch to the lowest possible levels should be taken. The quota in 1971 in Div. 4X of 18,000 tons was nearly reached (17,600 tons) while that in Subarea 5 was slightly exceeded (12,152 tons compared with 12,000 tons).

YELLOWTAIL FLOUNDER

For the stock in Div. 3L-N-O, STACRES noted that the level of F was probably beyond the maximum sustainable yield point in recent years and that the increased landings have been supported by an expanding population. It was concluded that a catch in 1973 of about 50,000 tons would maintain F at current levels if the population keeps expanding at rates observed in the past. A catch less than this is probably desirable, but an exact amount cannot now be estimated.

In Subarea 5 the 1971 catch quota of 13,000 tons west of 69° was exceeded by about 1,900 tons, but east of 69° the catch was about 300 tons less than the quota of 16,000 tons. The recommended quotas for 1973 are the same as 1972 - 10,000 tons west of 69° and 16,000 tons east of 69°.

AMERICAN PLAICE

Assessment of the stocks in Div. 3L and 3N indicates that, to reduce F to more desirable levels and maintain population size in 1973, catches in 1973 should be 32,000 tons and 20,000 tons respectively.

SILVER HAKE

A first assessment of this stock has been completed but further refinements are required. However, in order to achieve maximum yield-per-recruit, the following quotas are required in 1973: 10,000 tons in Div. 5Y, 80,000 tons in Div. 5Ze and 80,000 tons in Div. 5Zw + Subarea 6.

Additional gains in yield-per-recruit of about 8% can be obtained by increasing mesh size from the 33 mm now commonly used on Georges Bank and Southern New England to 52 mm.

RED HAKE

For the stock in Div. 5Zw and Subarea 6, the level of fishing allowable in 1973 for maximum yield-per-recruit has been estimated at 40,000 tons. The stock in Div. 5Ze should have no directed fishing.

HAKES, GENERAL

The present closed area for both hake species define adequately the area of pre-spawning concentrations. Direct biological benefits cannot be ascertained at the present time.

In order that the precision of hake assessments may be increased, STACRES

recommends (1)

that each country fishing the hake stocks in the ICNAF Area supply for the 1973 Mid-Term Meeting the requisite information outlined in the Assessment Subcommittee's Report (App. I).

SCALLOPS

A re-assessment of yield-per-recruit in the light of recent trends toward a lowering of the age of first capture indicates the desirability of introducing conservation measures. Increasing age at first capture from the present 3.5 years to 7 years would increase yield-per-recruit by 50%. Advice on efficiency of methods to accomplish this has been given.

(c) Other Matters

i) The adoption of a 130 minimum mesh size in Subareas 4 and 5 would produce benefits for cod, haddock and yellowtail flounder.

ii) Studies relating to total biomass and fishing effort in Subareas 5 and 6 were reviewed and discussed. Further investigation of effects of fishing on total biomass is encouraged.

iii) Further advice on the definition of objectives of regulation relative to assessment parameters was provided. In general four objectives were defined:

1) Maximizing yield-per-recruit.

2) Optimizing economic returns.

3) Maintaining stock size.

4) Maximizing long term yields.

It will be in many cases necessary to distinguish between these objectives in setting quotas.

2. HERRING ASSESSMENTS (APP. II)

(a) Stock identity, relative size and inter-relationships

The division of herring populations in the ICNAF Area into five major spawning stocks each of which can be conveniently considered as a unit for management purposes still stands.

A revised assessment of the juvenile stocks of the Gulf of Maine (Div. 5Y) and the New Brunswick side of the Bay of Fundy (Div. 4Xb) gave some indication that Div. 4Xb juveniles may not contribute strongly to the adult Div. 5Y stock.

Surveys in early 1972 revealed a wide offshore distribution of juvenile herring (1970 year-class) from Emerald Bank (Div. 4Wb) to south and west of Long Island (Div. 5Zw and Subarea 6). Stock identification and quantitative estimation of these offshore juveniles should receive high priority.

The results of the 1971 international herring larval survey program were encouraging and justify extension and intensification of effort in 1972 and 1973.

(b) Fishery trends

Annual catches corresponding to each of the five major spawning stocks are presented in Table 6 of the Working Group Report (App. II). Catches from the Georges Bank and Gulf of Maine stocks have declined greatly since 1968. The 1971 catch, compared with 1970, was about the same for the Georges Bank stock

(247,000 → 251,000 tons) but less for the Gulf of Maine stock (89,000 → 63,000 tons), the Nova Scotia stock (148,000 → 85,000 tons) and for the Gulf of St. Lawrence stock (316,000 → 264,000 tons). The Banquereau catch increased slightly in 1971 (63,000 → 66,000 tons).

(c) Advice to the Commission on catch levels

No significant changes in the conclusions regarding the status of the stocks (in Div. 4X and part of Div. 4W, 5Y and 5Z and Subarea 6) from those presented in the January 1972 Report resulted, nor in the recommended actions for regulation in 1972.

There was no modification of advice on catch levels for the Nova Scotia stock. Revision of the assessment for the Georges Bank stock resulted in only minor changes in estimates of stock size, numbers in the catch, and fishing mortality rates which do not significantly affect advice on catch levels already given. Assessment on assumptions of higher natural mortality rates than were used in the January 1972 assessment were found to result in a decrease in the recommended catch levels.

An independent assessment of the Georges Bank stock by Polish scientists is underway and results will be presented at the Mid-Term Meeting in January 1973. Revision of the assessment for the Div. 5Y stock included a wider range of assumptions of natural mortality rates but this did not result in modification of the advice given the Commission in January 1972. Based on estimating abundance of the 1972 Div. 5Y adult stock from Div. 5Y juvenile landings, a catch of 23,000 tons in 1972 would maintain spawning stock size.

The effects of 1972 catch limitations on all these stocks and, therefore, on the advice to be given to the Commission in January 1973 will depend on the level of 1972 recruitment and also on assumptions for 1973 recruitment, which cannot be predicted at the present state of our knowledge.

Maintenance of catches of juveniles in all areas at reasonable levels is also required to complement measures applied to adult fisheries.

A summary of maximum and allowable yields follows:

		1972 Quota		
	Maximum sustainable yield	To maintain 1971 stock size	To increase stock size in 1972	To achieve optimum yield per recruit
Georges Bank (Div. 5Z, Subarea 6)				
Long-term av. recruitment	300,000	-	-	-
Recent av. recruitment	130,000	95,000	70,000	70,000
Recruitment reduced 25%		70,000	50,000	-
Gulf of Maine (Div. 5Y, 4Xb)				
Av. recruitment	50,000[1]	23,000[2]	-	28,000
Nova Scotia (Div. 4Xa, 4W)				
Av. recruitment	100,000	60,000	-	?

[1] If all taken as juveniles, harvesting as adults would increase sustainable yield.
[2] Adult fishery.

3. GROUNDFISH SURVEYS (APP. III)

STACRES considered the Report of the Working Group on Coordinated Groundfish Surveys, which reviewed a number of new studies on results of surveys and trawl comparison experiments. New evidence indicated that indices obtained from such surveys are sufficient for assessing major changes in stock size both for individual species and for total groundfish biomass as a whole. The need for more survey activity in Subareas 1-2, standardization of sampling designs in Subareas 1-3, and more complete and systematic analyses of existing data from all areas was emphasized. Noting that a coordinated groundfish survey program has many benefits yet to be fully realized, STACRES

recommends (6)

i) that the stratification schemes, proposed for Subareas 2 and 3 (Res.Doc. 72/60 and 72/125) be used for all surveys in those areas during the next year.

ii) that the Chairman of the Working Group endeavor to establish common sets of sampling strata within each of Subareas 2-6, giving preference to sets where overlap of different surveys occurs and where the best time series exist,

iii) that all member countries conducting surveys attempt to summarize catch-per-haul data in time for use by the Assessment Subcommittee prior to the Mid-Term or Annual Meeting, using the standard format of Res.Doc. 71/128, for the common strata sets referred to in item (ii), and for the following species and Subareas:

Species	Subarea 1	2	3	4	5	6
Cod	x	x	x	x	x	x
Haddock			x	x	x	
Pollock				x	x	
Yellowtail			x	x	x	
Plaice			x	x		
Halibut			x	x	x	
Redfish	x	x	x	x	x	
Red hake					x	x
Silver hake				x	x	x
Grenadier	x	x	x			
Herring			x	x	x	x
Mackerel				x	x	x
Squid				x	x	x

iv) that member countries with time series of survey data make special efforts to complete the data analyses indicated in item (iii) for the entire series, at least in time for the next Annual Meeting, and

v) that the Working Group be re-convened at the next Annual Meeting to evaluate progress.

4. STATISTICS AND SAMPLING (APP. IV)

(a) *Sampling Yearbook*, Vol. 14 for 1969, was issued in October 1971 and Vol. 15 for 1970 in April 1972.

(b) Noting that sampling of the fisheries by member countries is in some cases very inadequate, STACRES

recommends (8)

that the scientific advisers to Panels bring to the attention of the various Panels the important conclusion relative to adequacy of biostatistical data on fisheries contained in the Report of the ICES Liaison Committee to NEAFC, an extract of which is appended to the Report of the Statistics and Sampling Subcommittee (App. IV, page 74).

(c) *Statistical Bulletin*, Vol. 20 for 1970, compiled and produced for the first time by computer processes, was distributed in April 1972. STACRES, noting the need for the expeditious release of this important publication,

recommends (9)

that member countries take all possible steps to avoid serious delays in submitting their statistical data to the Secretariat, as such delays seriously affect the timely release of the Statistical Bulletin.

(d) The problem of the feasibility of obtaining catch and effort data by a more detailed area breakdown than currently used by ICNAF was again considered. Although the collection of such detailed statistics by national offices could present serious difficulties, STACRES, nevertheless,

recommends (13)

that member countries initiate plans for the introduction of more detailed and flexible statistical reporting systems, especially in regard to species subject to management programs involving quota allocations, where more frequent and more detailed statistical reporting will be required for both stock assessments and regulatory purposes (in this connection, STACRES wishes to draw attention to the ICES Liaison Committee's Report to NEAFC).

(e) **On the recommendation of the CWP that minor adjustments be made in the ICNAF GRT categories now used to define classes of fishing units, STACRES**

recommends (15)

that the Secretary of the CWP, in Section 3.4 of the "Notes for the Completion of Statlant 21B Forms", substitute for the present ICNAF GRT categories the following:

ICNAF Code	*GRT Categories*
1	*Not known*
2	*0 - 49.9*
3	*50 - 149.9*
4	*150 - 449.9*
5	*500 - 999.9*
6	*1,000 - 1,999.9*
7	*2,000 and over*

(f) **The 7th Session of the CWP was held at Rome on 10-16 November 1971 and ICNAF was represented by four participants. The Secretary of the CWP reviewed the Report of the 7th Session, and various statistical matters arising from the CWP Report are dealt with in the Report of the Statistics and Sampling Subcommittee.**

STACRES was informed that the 8th Session might be held sometime in 1973 and that ICSEAF (International Commission for the Southeast Atlantic Fisheries) has expressed the wish to participate. Noting that the CWP might become too unwieldy if the number of participants became too large, STACRES, therefore,

recommends (18)

i) that each of the five participating agencies (ICNAF, ICES, ICSEAF, ICCAT, and FAO) appoint not more than three experts to attend the 8th and subsequent sessions,

ii) that ICNAF invite the USA to nominate one participant, and

iii) that the other two participants be the Assistant Executive Secretary and the Chairman of the Statistics and Sampling Subcommittee.

(g) **Various other statistical matters were considered and recommendations made for action by the ICNAF Secretariat or the CWP Secretary.**

5. ENVIRONMENTAL (APP. V)

(a) **The review of environmental conditions in the ICNAF Area in 1971 indicated that in Subareas 1-3 water temperatures were generally lower in 1971 than averages based on the previous 10-15 years and that ice conditions were severe, as in 1969 and 1970. Temperatures were, however, above normal along the southern edge of the Grand Bank and over the Scotian Shelf, but no appreciable changes were noted for the Georges Bank region.**

(b) **The Continuous Plankton Recorder program was discussed, and STACRES**

recommends (19)

that a representative of the UK Institute of Marine Environmental Research be invited to attend the next meeting of the Environmental Subcommittee and to present a review of the Institute's work, including suggestions as to how the material might be summarized annually for greatest use in relation to ICNAF Area fisheries studies (e.g. monthly charts of distribution of various plankton species, plus fish eggs and larvae).

(c) Ice conditions in the northern subareas have been severe since 1969, and it was felt that the Environmental Subcommittee should become better acquainted with ice observation and forecasting techniques and the general availability of this information. STACRES accordingly

recommends (20)

i) that appropriate ice experts and forecasters be invited to participate in the next meeting of the Environmental Subcommittee and that they be asked to prepare formal presentations for discussion, and

ii) that national research reports should contain a section on ice conditions, particularly the concentration and extent of ice cover in the various subareas.

(d) ICNAF will be represented at the forthcoming meeting of the Joint ICES/ICNAF/IOC Coordinating Body for the North Atlantic to be held in conjunction with the 1972 Meeting of ICES.

(e) The ICNAF Special Publication, containing papers presented on Environmental Conditions in the North Atlantic, 1960-69, is in press and will be distributed by late summer 1972.

(f) Noting the need to standardize the hydrographic sections and stations in the Northwest Atlantic, and to establish certain base periods for temperature and salinity anomalies, STACRES

recommends (21)

i) that the ICES/ICNAF/IOC Coordination Body assess a proposed list of standard sections and stations in the ICNAF Area (East Greenland and ICNAF Subarea 6 should be included), and

ii) that the problem of standardization of base periods for temperature and salinity anomalies be also considered, and proposals presented at the 1973 Meeting of the Environmental Subcommittee.

6. GEAR AND SELECTIVITY

(a) In reviewing the 1971 Report of ICES Gear and Behaviour Committee, it was noted that Germany had carried out experiments indicating no significant difference between the selection properties of "extra strong" (R 12000-18000 tex) and "normal" (R 6000-8000 tex) polyamide codends. The stronger codends can be used without topside chafers but they are much more costly than the codends normally used. STACRES noted that such results are encouraging, particularly in regard to the possibility of eliminating the need for topside chafers, and urges that similar experimental work (both in relation to selectivity and economic factors) be carried out by other member countries.

(b) The question of adopting polyamide as a standard for scientific purposes was again considered. It was noted that ICES had adopted a specific polyamide netting yarn as a standard and that a similar decision by ICNAF would be useful in encouraging more and better research, particularly since the present standard (manila) is virtually unobtainable. STACRES therefore

recommends (22)

that polyamide (as defined in ICES Cooperative Research Report, Series A, No. 25, page 50) be adopted as the standard for selectivity experimental work.

(c) A Symposium on Acoustic Methods in Fishery Research will be held at Bergen, Norway, 15-22 June 1973, with Mr Margetts as Convenor. The planning group recently met and prepared a prospectus which is now being distributed. ICNAF has made a financial committment, and STACRES

recommends (23)

that all member countries take an active part in the Symposium on Acoustic Methods on Fishery Research at Bergen, 15-22 June 1973.

(d) Information on trawl material and mesh-size sampling in 1971 could not be documented for this meeting due to the lack of an adequate number of returns (only 6 countries have reported to date, although the returns are due at the Secretariat by 31 March). The importance and necessity of the information was stressed, and STACRES strongly

recommends (24)

that countries make every effort to submit returns on trawl material and mesh-size sampling (ICNAF Stat. Form 4) to the Secretariat for documentation prior to the Annual Meeting.

(e) The Report of ICES/ICNAF Working Group on Selectivity Analysis was published as ICES Cooperative Research Report, Series A, No. 25, 1971.

(f) Res.Docs. 72/5, 72/116 and 72/118 were reviewed. The last two are mainly reviews of past selectivity work on herring and flatfish. Res.Doc. 72/5 on scallop dredge selectivity indicates that most of the escapement occurs through the bottom of the dredge and that many of the escaping scallops are lethally damaged. The need for more intensified research was stressed. The usefulness of further trawl selectivity experiments on herring was questioned because past experiments showed that mortality due to loss of scales may be extremely high, and meshing could be a serious problem.

7. ICES/ICNAF JOINT WORKING PARTY ON NORTH ATLANTIC SALMON

STACRES considered the report of the latest meeting of the ICES/ICNAF Joint Working Party on North Atlantic Salmon (Res.Doc. 72/32) held in Dublin, Ireland, 21-24 March 1972. The Report reviews the latest data on the salmon fisheries at West Greenland, in the Norwegian Sea and in home waters, presents the results of further assessment of the effects of fisheries at West Greenland and in home waters on total and home-waters salmon stocks and catches, and considers plans for future research relevant to the assessment work with special reference to the international tagging experiment at West Greenland in 1972. Items of special relevance to ICNAF are summarized below.

(a) West Greenland fishery

The salmon catch at West Greenland in 1971, at 2,615 tons (provisional data), was about 470 tons greater than in 1970 and the largest catch so far taken in the fishery. As in previous years the catch consisted almost entirely of one-sea-winter salmon which, if not caught and surviving, would return to home waters as two or more sea-winter salmon.

The fishery was again prosecuted by drift-net and set gill-net and, although the catch taken by each gear cannot be determined completely, that taken by drift-nets was almost certainly the greater. The number of non-Greenlandic vessels participating in the drift-net fishery in 1971 (22) was nine fewer than in 1970 (31), but their 1971 catch (1,240 tons) was approximately 350 tons greater. This was considered mainly due to increased fishing power and efficiency of the individual fishing units, resulting in no decrease in the total effective fishing effort despite the decrease in the number of vessels operating, rather than to a substantially greater abundance and/or availability of salmon. It clearly illustrates the limitations of regulations limiting total vessel tonnage as a method of stabilizing effective fishing effort in a fishery in which major technological and other developments affecting fishing power and efficiency are taking place, and indicates the need for detailed studies of future changes in them. Nevertheless the measures introduced prevented the entry of additional tonnage into the fishery.

(b) Origin and destination of salmon at West Greenland

Further recaptures at West Greenland in 1971 of salmon tagged as smolts in home waters, and of recapture in home waters of salmon tagged at West Greenland, together with data from biochemical and serological studies again showed that the salmon stock at West Greenland comprise fish originating from and, if surviving, returning to North American (mainly Canada) and European (mostly Great Britain and Ireland) river systems in about equal proportions. Canadian studies show that different river systems make markedly different contributions to the West Greenland stock. They indicate that only a small proportion of the natural smolt production in rivers entering into the Bay of Fundy contribute to the stock while for other rivers where smolts have been tagged, especially those running into the Gulf of St. Lawrence, the contribution has been substantial. This indicates that the effects of the West Greenland fishery on home-waters stocks and catches may differ markedly between river stocks.

(c) Assessment of effect of West Greenland fishery

Estimates of losses to the combined North American and European home-waters stocks and catches resulting from the West Greenland fishery were made, as in previous years, from an assessment of the changes in total weight (i.e. the resultant of natural mortality and growth) which would have occured in the salmon comprising the West Greenland catch, had they not been caught there, and, if surviving, had returned to home waters in North America or Europe. These gave for a West Greenland catch of around 2,000 tons, as in 1969 and 1970, an estimated loss to the total home-waters stocks in the range 1,100-2,700 tons and to the home-water catches in the range 650-1,600 tons (using upper and lower values of instantaneous natural mortality rate of 0.1 and 0.02 per month respectively). The same general levels of estimated losses were also obtained from a simulation analysis of home-waters and West Greenland catches. Since the West Greenland catch in 1971 was higher than in 1969 and 1970, the estimated losses to the home-water catches from that year were correspondingly somewhat greater. In the absence of accurate measures of the relative contributions of salmon from different countries to the West Greenland stock, it is not possible to estimate with reliability the losses on an individual country basis, but

the available data suggest that they are roughly equally divided between North American (almost entirely Canada) and European (Mainly Great Britain and Ireland) stocks. It must again be stressed that these estimates refer only to the immediate, direct losses of salmon returning to home waters and take no account of any possible effects of the West Greenland fishery on smolt production and hence future recruitment through a decrease in spawning stock size.

The latest information provides no basis for modifying the assessments reported last year, that the West Greenland fishery has resulted in an increase in the total catch (West Greenland plus home waters) of salmon returning to European rivers and, with the possible exception of some Canadian river systems, also those returning to North American rivers.

(d) Home-waters catches

The total catch of salmon plus grilse in 1971 was lower than in 1970 in all the main salmon producing countries, except Norway where it was about the same and Iceland where it was slightly higher. Separate statistics for salmon and grilse catches are available for most countries only for recent years but those for the main European countries show an overall decline in both salmon and grilse catches in the period of 1969-1971 (for details of fluctuations in catches, see Res.Doc. 72/32).

(e) Future research

STACRES noted and approved the plans for the international salmon tagging experiment at West Greenland in 1972 and the arrangements for the analysis of the tag recapture and other data, as summarized in Appendix 3 of Res.Doc. 72/32. It also stressed the importance of the other studies indicated by the Working Party to its assessment work, especially those concerning the relationship between stock and recruitment.

STACRES

recommends (25)

i) that the next meeting of the ICES/ICNAF Joint Working Party on North Atlantic Salmon should take place at Copenhagen, Denmark, for five days during the week beginning 26 March 1973, and

ii) that the Reports of the 1970 and 1971 Meetings of ICES/ICNAF Joint Working Party on North Atlantic Salmon should be combined and published, preferably in the ICES Cooperative Research Report Series.

8. INTERNATIONAL LOGBOOK SYSTEM (ICNAF *REDBOOK* 1971, PART I, APP. III)

STACRES further considered the proposed format for an international logbook and agreed to a slight amendment to the paragraph "Information that should be included..." by changing the wording for the "Catch" information, which now reads "daily totals by species in lbs, kg, ...", to read "daily totals by species and gears in lbs, kg, ...".

STACRES wishes to reiterate its views on the International Logbook System given in its 1971 Annual Meeting Report (ICNAF *Redbook* 1971, Part I, page 5).

9. PROCEDURES FOR PERMISSION FOR FOREIGN RESEARCH VESSELS TO CONDUCT RESEARCH CRUISES UNDER ICNAF INSIDE NATIONAL FISHING LIMITS

Any country intending to conduct research cruises under ICNAF inside the national fishing limits of another country should apply for permission directly through the appropriate channels to the Foreign Affairs Department of the country from which permission is sought with details of the research to be conducted. It is important that application be made well in advance of the period proposed for the operation.

10. COLLABORATION WITH OTHER ORGANIZATIONS

(a) ICNAF participated in the Seventh Session of the CWP (Coordinating Working Party on Atlantic Fisheries Statistics) together with FAO, ICES and ICCAT. This session was held at FAO, Rome, 10-16 November 1971 (Res.Doc. 72/126).

(b) ICNAF participated in the ICES/ICNAF Joint Working Party on North Atlantic Salmon held at Dublin, Ireland, 21-24 March 1972 (Res.Doc. 72/32), and in the ICES/ICNAF Joint Working Group on North Atlantic Cod Stocks held at Copenhagen, Denmark, 8-14 March 1972 (Res.Doc. 72/33).

(c) ICNAF has committed financial support for and will participate in the ICES/ICNAF/IBP Symposium on the Biology of the Seal, to be held at Guelph, Ontario, Canada, 14-17 August 1972.

(d) ICNAF has committed financial support for and will participate in the ICES/FAO/ICNAF Symposium on Acoustic Methods in Fisheries Research, to be held at Bergen, Norway, 15-22 June 1973.

(e) ICNAF expressed interest in the Symposium on the Early Life History of Fish, to be held at Oban, Scotland, 17-23 May 1973, and recognized the relevance of some items in its prospectus to ICNAF's scientific program. However, since ICNAF scientists had played no part in planning the program and in view of the timing of the Symposium (17-23 May 1973), STACRES doubted if ICNAF should co-sponsor the Symposium.

11. TASKS REFERRED FROM PANELS

STACRES took note of the tasks referred to it by the Panels at this Meeting and agreed that they be considered at the next meeting of the Assessment Subcommittee. The particular tasks are (a) the matter of full utilization of regulated species (Comm.Doc. 72/20), (b) the need for more information on and the assessment of such species as mackerel, pollock and squids, (c) the up-to-date assessment of cod stocks in Subarea 1 as a basis for consideration of quota allocation at the next Annual Meeting, and (d) the effects of fishing on total biomass of fish.

12. ADEQUACY OF BIOSTATISTICAL DATA

STACRES noted with approval the recommendation of Panel 1 "that the statistical and catch sampling requirements should be set out by the Chairman of the Scientific Advisers in consultation with the Secretariat and be sent to all Member Countries fishing in the Subarea with the request that they implement their collection and reporting as a matter of high priority". It was agreed that the Secretariat should bring this proposed action to the notice of the Chairman of the Scientific Advisers to other Panels.

13. PUBLICATIONS AND REPORTS

STACRES, having appraised the saving in time and material of reducing and reproducing the originals of manuscripts on 8½" x 11" paper for the research document series,

recommends (26)

i) that the Commission adopt the use of 8½" x 11" size paper for the documents series.

ii) that each document of the document series be identified in the upper right hand corner of the cover page.

iii) that textual material for the document series, when printed on both sides of the paper, be arranged for easy reading when tumbled.

STACRES also

recommends (27)

that the ICNAF Secretariat publish a list of titles and a subject index of the research documents in Part I of the ICNAF Redbook each year

STACRES noted that 37 of the 127 Research Documents presented at this Annual Meeting had been selected (subject to approval by authors) for publication in *Redbook* 1972, Part III, or in ICNAF *Research Bulletin*.

14. FUTURE MEETINGS

(a) Having recognized the need for more time for the preparation and printing of the STACRES report to the Commission, STACRES

recommends (28)

that the STACRES and Commission Meetings be scheduled such that there is an intervening weekend.

(b) Mid-Term Meetings

i) The Assessments Subcommittee will meet at a time and place to be decided but not later than January 1973.

ii) The Herring Working Group will meet in January 1973 (prior to the Mid-Term Commission Meeting on Herring) at a time and place to be decided later.

iii) The ICES/ICNAF Joint Working Party on North Atlantic Salmon will meet at Copenhagen for 5 days in the week beginning 26 March 1973.

(c) Regular Meetings

STACRES and its Subcommittees and Working Groups will meet for several days prior to the 1973 Annual Meeting of the Commission at Copenhagen, Denmark.

15. OFFICERS FOR 1972/73

Chairman of STACRES: Dr A. Bogdanov (USSR)
Chairman of Subcommittee on Assessments: Mr D. Garrod (UK)
Chairman of Subcommittee on Environmental Studies: Dr N. J. Campbell (Canada)
Chairman of Subcommittee on Statistics and Sampling: Mr V. M. Hodder (ICNAF)
Chairman of Working Group on Coordinated Groundfish Surveys: Dr M. D. Grosslein (USA)
Chairman of Working Group on Herring: Mr T. D. Iles (Canada)

Members of Steering and Publications Subcommittee:

USSR, Romania, Poland	- Dr F. Chrzan (Poland)
France, Portugal, Spain	- Mr J. Morice (France, SP)
Iceland, Norway, Italy, Japan	- Mr G. Saetersdal (Norway)
Fed.Rep. Germany, Denmark, UK	- Dr A. Schumacher (Fed.Rep. Germany)
Canada	- Mr A. Fleming (Canada)
USA	- Mr J. A. Posgay (USA)

APPENDIX I - REPORT OF ASSESSMENT SUBCOMMITTEE

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APPENDIX I - REPORT OF ASSESSMENT SUBCOMMITTEE

Chairman: R. C. Hennemuth

Rapporteur: J. A. Posgay

The Subcommittee met at FAO, Rome, Italy on 24-29 January 1972 (Res.Doc. 72/1), and again during 16-22 May 1972 in conjunction with the 1972 Annual Meeting of STACRES held at Washington, D.C., USA. This report covers the groundfish and scallops assessments. Reports of the Working Groups on Herring and Coordinated Groundfish Surveys appear as Appendices II and III.

1. Review of Latest Statistics of Nominal Catches and Fishing Trends in the ICNAF Area

Total nominal catch of all species from the Convention Area was about 3.22 million tons in 1971 (provisional data) compared with about 3.25 million tons in 1970. The cod catch decreased about 10% and herring about 15%. The catch of haddock, silver hake and flounders remained about the same as in 1970, while that of redfish rose by about 15%.

The reported landings from Statistical Area 6 (316,000 tons) were nearly the same as equivalent data for 1970. Mackerel, red hake and squid showed significant increases, while herring dropped by about 25%.

The provisional data on nominal catches in Subareas 1-5 in 1971, with comparable data since 1959, are given in Table 1.

a) Subarea 1

In 1971 the cod catch was 120,000 tons compared with the 1970 catch of 116,000 tons, and the catches in these two years are the lowest recorded in the ICNAF statistics. The 1971 catch is only one-quarter of the peak catch in 1962 and about one-third of the estimated long-term sustainable yield under recruitment as in the 1950's and 1960's.

Fishing activity seems to have decreased further from the low 1970 level, again to a great extent because of extremely bad ice conditions. By far the greatest quantities of cod are taken by trawlers. The tendency of the mobile trawler fleets to fish only on good concentrations during the spawning season has resulted in the maintenance of the catch-per-unit-effort. The fishery occurred mainly in Div. 1C-1F.

Redfish catches remained at a low level of about 3,000 tons. USSR reported a catch of about 4,000 tons of grenadiers, taken mainly in the western part of Div. 1D. The total catch of salmon was 2,615 tons, the highest so far recorded. Catches of prawns increased further to about 10,000 tons taken mainly by Denmark (G) in inshore waters, and they now account for the second highest quantities landed from the Subarea, next to cod.

b) Subarea 2

The fishery is conducted almost entirely by large otter trawlers fishing principally for cod. There is, however, an inshore small boat fishery for cod. The largest cod catch (449,000 tons) was taken in 1968. Since then there has been a consistent decline to 412,000 tons in 1969, 224,000 tons in 1970, and 164,000 tons in 1971. Where catches by non-member countries are available by subarea, they have been included in these figures.

As in 1970, severe ice conditions during the winter-spring fishery in 1971 interfered with otter-trawler operations, and many trawlers moved from the Subarea earlier than in former years. The inshore catch amounted to only 3,000 tons, largely due to the unavailability of cod.

The redfish catch, taken mostly as by-catch, remained at a low level (7,000 tons) in 1971. There was a substantial increase in the catches of other groundfish species above the 1959-70 average of 5,000 tons to 58,000 tons, consisting mainly of roundnose grenadiers.

c) Subarea 3

Provisional statistics for 1971 show total groundfish landings to be slightly below the 1970 level. Cod landings decreased from 529,000 tons in 1970 to 516,000 tons in 1971. The total landings of flounder species remained at approximately the same level as in 1970, about 165,000 tons (a 10,000-ton decrease in plaice was offset by a similar increase in yellowtail). Redfish catches, however, increased by 18,000 tons, mostly in Div. 3N-O-P, to 102,000 tons. There were no significant changes in the catches of the other groundfish species.

Herring landings decreased from 135,000 tons in 1970 to 118,000 tons in 1971. This decrease was

caused partly by lack of significant recruitment to the stocks, which are fished during the winter-spring period in southwest Newfoundland coastal waters.

d) Subarea 4

Total landings of groundfish from Subarea 4 in 1971 dropped slightly to 628,000 tons from a peak catch of 653,000 tons in 1970. Decreases in cod landings, mainly from Div. 4R and 4Vn to 220,000 tons (84% of 1970 landings), and in silver hake landings mainly from Div. 4W to 129,000 tons (76% of 1970 landings) accounted for much of the loss. Increases were recorded for redfish (+19%, to 142,000 tons), flounders, mainly witch but also plaice (+36%, to 56,000 tons), haddock (+12%, to 31,000 tons) and for "other groundfish" (+55%, to 50,000 tons), but these failed to offset the losses. An increase in haddock landings occurred in Div. 4W (43%), which reflects an increase in Canadian effort from the abnormally low levels of 1970 caused by labour troubles in the Canadian fishing industry. The doubling of witch flounder landings was due to the USSR fleet entering the Div. 4W fishery.

There was a substantial decline in 1971 landings of herring to 311,000 tons, which was only 75% of the 1970 catch. The main decreases occurred in Div. 4T (23%), 4W (20%) and 4X (44%), where the 1971 catches were 135,000, 75,000 and 70,000 tons respectively.

e) Subarea 5

The total nominal catch of all species of finfish was 717,000 tons in 1971, an increase over the 1970 catch of 630,000 tons. The total 1971 catch (reported to date) of all species is 808,000 tons. This compares with about 740,000 tons in 1970 and is slightly below the 1969 catch. About 70% of the 1971 increase was accounted for by the nominal catches of two species: the catch of silver hake increased by 46,000 tons to 95,000 tons and the red hake catch was up by 17,000 tons to 28,000 tons. Other species showing a sizeable (5,000-10,000 tons) increase were redfish, mackerel, pollock, and sharks. Most other species had small increases or remained stable. The largest decrease occurred for the yellowtail flounder landings which dropped 12,000 tons to 23,000 tons in 1971. Quota regulations restricted the catch of this species.

The larger landings resulted primarily from greater effort as overall abundance of herring and groundfish were at a lower level. However, silver hake stocks have increased in abundance in recent years in Div. 5Z. The increased catches of pollock and redfish were a result of increased effort on stocks previously not fully harvested.

f) Statistical Area 6

Total nominal catch of finfish (except menhaden) in 1971 was over 300,000 tons compared with 219,000 tons in 1970[1]. Incomplete reports of menhaden and shellfish landings prevent comparisons of the total catch. In view of the preliminary nature of the 1971 fishery statistics available at this time and the lack of non-members' catches other than herring for 1970, the general conclusion is that the total landings in 1970 and 1971 were quite similar. Mackerel increased by 40,000 tons in 1971 to 137,000 tons; red hake increased 7,000 tons to 8,600 tons, and squid increased over 5,000 tons to 6,400 tons. Herring decreased by 8,000 tons to 32,000 tons taken in 1971 and alewife declined by 13,000 tons to an 8,000 ton catch. Most other species showed smaller declines in landings.

[1] Non-member catches for other than herring are not available for 1970.

Table 1. Landings (nominal catches) in '000 metric tons by main species from Subareas 1-5 in 1959-1971.

Sub-area	Species	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969[1]	1970	1971[2]
1	Cod: Trawl	110	101	171	247	244	250	209	188	269	299	123	72	
	Other gears	124	142	174	204	162	100	150	178	161	83	82	44	
	Total	234	243	345	451	406	350	359	366	430	382	205	116	120
	Redfish	33	44	54	61	47	30	19	17	13	9	4	4	3
	Other Groundfish	6	8	15	14	22	29	21	13	11	10	6	11	11
	Total Groundfish	273	295	414	526	475	409	399	396	454	401	215	131	134
	Total Groundfish relative to 1959	100	108	151	193	174	150	146	145	166	147	78	48	49
2	Cod: Trawl	41	171	246	230	191	197	307	313	268	427	401	221	
	Inshore	19	17	19	25	25	16	26	24	27	13	5	2	
	Other gears	-	-	-	+	-	+	-	1	3	9	6	1	
	Total	60	188	265	255	216	213	333	338	298	449	412	224	164
	Redfish	53	83	26	8	6	27	24	14	17	9	6	11	7
	Flounders[3]	+	2	1	+	+	3	8	4	8	11	16	13	14
	Other Groundfish	1	6	4	2	1	2	12	9	4	12	3	3	58
	Total Groundfish	114	279	296	265	223	245	377	365	327	481	437	251	243
	Total Groundfish relative to 1959	100	245	260	232	196	215	331	320	287	422	383	220	213
3	Cod: Trawl	199	231	284	213	272	373	356	368	588	560	387	356	
	Inshore	180	184	136	150	155	144	114	112	102	114	118	103	
	Other gears	46	56	41	26	39	64	28	19	31	60	64	70	
	Total	425	471	461	389	466	581	498	499	721	734	569	529	516
	Haddock	35	67	79	35	15	12	9	10	11	7	5	7	5
	Redfish	246	99	90	61	69	95	112	79	89	54	88	84	102
	Flounders[3]	28	38	32	29	35	56	82	112	158	158	141	167	165
	Other Groundfish	19	17	11	8	7	7	17	11	23	41	18	30	35
	Total Groundfish	753	692	673	522	592	751	718	711	1002	994	821	817	823
	Herring	4	6	4	5	6	3	8	23	79	145	145	135	118
	Other Pelagics	+	+	1	1	1	2	1	1	2	1	2	3	1
	Other Fish	6	7	5	5	6	14	6	7	11	5	13	13	10
	Total Finfish	763	705	683	533	605	770	733	742	1094	1145	981	968	952
	Total Groundfish relative to 1959	100	92	90	69	79	100	95	94	133	132	109	108	109
4	Cod	214	218	212	219	218	229	225	215	194	247	206	262	220
	Haddock	53	46	47	44	51	60	85	66	49	46	42	28	31
	Redfish	42	50	42	43	58	53	68	106	88	104	111	119	142
	Flounders	22	29	29	27	32	36	50	57	43	74	54	43	56
	Silver hake	-	-	-	9	123	81	50	10	2	3	46	169	129
	Other Groundfish	64	63	57	70	104	89	87	87	43	38	34	32	50
	Total Groundfish	395	406	387	412	586	548	565	541	419	512	493	653	628
	Herring	102	105	81	116	112	140	181	236	261	370	422	416	311
	Total Groundfish relative to 1959	100	102	97	104	148	138	143	136	106	129	124	165	158
5	Cod	16	14	18	26	30	29	42	57	42	49	46	38	35
	Haddock	41	46	52	59	60	70	155	127	57	44	25	13	12
	Redfish	15	12	14	14	10	8	8	9	11	7	12	16	20
	Flounders	25	27	29	38	48	58	57	54	49	53	78	55	46
	Silver hake	50	47	43	86	147	220	323	162	101	81	88	49	96
	Other Groundfish	90	42	44	23	69	56	110	138	82	73	107	40	65
	Total Groundfish	237	188	200	246	364	441	695	547	342	307	356	211	274
	Herring 5Y	48	69	27	71	70	28	34	29	35	63	48	259	264
	5Z	-	-	67	152	97	131	40	137	215	364	212		
	Other Pelagics	29	25	17	21	16	8	9	16	21	56	78	119	127
	Other Fish	8	9	11	32	11	28	24	50	26	37	63	46	49
	Total Finfish	322	291	322	522	558	636	802	779	639	827	757	635	714
	Total Groundfish relative to 1959	100	79	84	103	153	186	293	230	144	129	150	89	115

[1] Catches by German Democratic Republic were not allocated by subareas and are not included.
[2] Provisional statistics.
[3] Includes halibut.

2. Cod Assessments

a) Subarea 1 (Res.Doc. 72/19)

Nominal catch in 1970 was approximately 116,000 tons, and preliminary statistics indicate that the 1971 catch was slightly higher at 120,000 tons. German data indicate that effort did not change much between the two years.

As stated in Res.Doc. 72/1 (Report of Mid-Term Assessment Meeting, 1972), it seems necessary to develop assessments separately for Div. 1A-D and Div. 1E-F. This has been attempted at the present meeting using estimates of total numbers landed in 1971 per age-group and area as given below:

Age-group	Numbers landed (000's) 1A-D	1E-F
3	181	6
4	1250	19
5	7809	948
6	6326	2549
7	1737	4097
8	4187	6120
9 and older	2158	2921
Total	23648	16660

Partial recruitment (variation of F with age) is taken as the mean of figures given in the Report of North Atlantic Cod Working Group (Res.Doc. 72/33, Table 15), and F for fully recruited age-groups is considered to be 0.6 in both areas. The greatest uncertainty in the present calculation seems to be connected with mean weight at the various ages which are here taken as:

Age	3	4	5	6	7	8	8+
Mean weight (kg)	0.62	1.18	2.1	2.7	3.0	3.0	5.5

Emigration to East Greenland and Iceland has been included by raising M from 0.20 to 0.35 for age-groups 7 and older in Div. 1E-F according to findings of the North Atlantic Cod Working Group, and recruitment is similarly considered (Res.Doc. 72/33, Table 8), *i.e.* the 1968 year-class is considered to be about three times as abundant as the 1967 and 1969 year-classes.

The new assessments show that, if F is the same in 1972 and 1973 as in 1970/71 (F = 0.6 for fully recruited age-groups), the estimated catches would be as follows:

	1972	1973
1A-D	59,000 tons	61,000 tons
1E-F	38,000 tons	41,000 tons
Total	97,000 tons	102,000 tons

In summary, the abundance of the cod stock at West Greenland is relatively low at present, and with the present prospects for poor recruitment it is likely that even at a level of fishing of F = 0.6 (which is considered to be F_{max}) the annual catches in 1972-75 will be well below the 300,000 tons previously estimated to be about the long-term maximum sustainable yield for this stock.

The rate of recruitment in 1972 of the 1968 year-class seems to be higher in the northern part of the Subarea than in the southern part. At the same time the previous good year-classes (especially

the 1963 year-class), which supported the trawl fishery at southern Greenland in the most recent years are gradually becoming less abundant. Whether this will result in a change in fishing pattern back to the former more even distribution in area and time (which would increase the mortality on younger fish) will to a great extent depend on fishing conditions on other cod stocks (and indeed other fish stocks) and on possible regulation of fishing on such other stocks. It is, therefore, clear that fishing mortality could quickly rise above F_{max} if the catch in 1973 is not limited to 102,000 tons.

b) Divisions 2J-3K-L (Res.Doc. 72/1, 72/2, 72/16, 72/25, 72/108, 72/109)

The total cod catch from these divisions (which accounted for 95% of the catch from this stock in the last 3-4 years) increased from 330,000 tons in 1959 to a level of about 500,000-600,000 tons in 1961-67 and then further increased to a peak of about 784,000 tons in 1968. Since then there has been a decrease to 689,000 tons in 1969, and a sharp decline to 486,000 tons in 1970 and to about 450,000 tons in 1971. The increase in catch in the 1968-69 period was a result of good recruitment from the year-classes of the early 1960's which attracted increased effort to the stock, especially in the northern part of the area. The decline in catch in 1970 and 1971 reflected in part some decrease in effort because of severe ice conditions in the northern part of the area, but the USSR and Polish catch per unit effort decreased and this probably indicates a decrease in abundance because of the entrance of the weaker 1964 and 1965 year-classes.

In 1971, the catch from Div. 2G-H was about 12,000 tons. The catch from these divisions is not included in the assessment although they probably come from the same stock.

In Div. 2J-3K-L the number of fish older than 6 years decreased from about 600 million in 1961-64 to about 320 million in 1969. The 5-6-year-olds of the 1963 year-class which contributed to the peak catches in 1968-69 have now been replaced by those age-groups of the weaker 1964 and 1965 year-classes. However, USSR surveys of young cod in Div. 3K show that improved recruitment should come from the 1966-68 year-classes (see table below), which will all have entered the commercial catches by 1972. There is therefore a prospect of some improvement in stock abundance, provided, of course, that the fishing intensity does not increase at a proportional rate.

Mean number of 3-year-old cod caught per hour trawling by USSR surveys in Div. 3K

Year-class	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
Number	21	11	20	15	36	8	15	27	32	40

Estimates of fishing mortality (F) for ages 7-13 indicated that F fluctuated between 0.3 and 0.6 during 1961-66. The estimate of F in 1967 was 0.56, and in 1968 it was 0.65; both are well beyond that corresponding to maximum yield-per-recruit (0.4). Estimates indicate that F in 1969-70 was also beyond the point of maximum yield-per-recruit, although F in 1970 was probably below that in 1969.

With fishing mortality rate at the level giving the maximum yield-per-recruit (F_{max}), the annual yield from this stock complex in 1973, with average recruitment, would be 600,000 tons. Because better than average recruitment is expected from the 1966-68 year-classes, a fishing mortality equivalent to F_{max} would result in catches of about 650,000 tons in 1973. If fishing mortality in 1973 continues at the 1970 level ($F = 0.55$), 1973 catches will be in the vicinity of 800,000 tons. However, catches in later years would be reduced below the level which could have been held with $F = F_{max}$.

c) Divisions 3N-O

The reduction of the cod catch in Div. 3N-O from the high 1967 level of 222,000 tons to about 120,000 tons in 1971 probably reflects a decreased population as well as a reduction in effort from the unusually high level of 1967. The catch, however, stablized in 1969-71 between 100,000 and 120,000 tons. Since large fluctuations in year-class strength occur in this area, great variability in stock abundance and catches can be expected if the effort were sustained at the present high level.

The 1967 year-class was poor, but USSR and Canadian surveys indicate a rich 1968 year-class. Soviet surveys in May-August 1971 indicate that it will be followed by poorer 1969 and 1970 year-classes. Thus it is possible to expect an increase in cod abundance beginning in 1972 which could lead to an increase in effort in the southern part of Subarea 3 in 1973, as occurred after the entrance to the fishery of the strong 1964 year-class.

However, it is necessary to keep in mind that there is now only one strong year-class which will

comprise 65-70% of the available stock in 1973 according to estimates from Canadian research vessel surveys. This year-class should be conserved to support the fishery during several future years and to provide spawning stock.

It has not been possible to complete an assessment for this stock, but previous estimates of yield-per-recruit indicated that F in the early 1960's was beyond F_{max} by about 30%. Trends in fishing effort in recent years indicate that F is probably higher than that now. It seems clear, therefore, that to reduce F to a level near F_{max}, the catch in 1973 would be about 120,000 tons, but it should probably not exceed 70,000 tons to allow for adequate spawning stock in future years.

d) Division 3Ps (Res.Doc. 72/3)

Landings from the Div. 3Ps cod stock increased from 60,000 tons in 1959 to 84,000 tons in 1961, varied between 47,000 and 52,000 tons in the 1962-65 period, and then increased to between 61,000 and 74,000 tons in 1966-1970. The 1971 catch was about 60,000 tons.

Population numbers of fish aged 3 and older declined from 254 million in 1959 to 145 million in 1963 as a result of recruitment of the fairly poor 1956-60 year-classes. Population numbers increased progressively to 263 million fish by 1967 reflecting improved recruitment from the 1961-64 year-classes.

Fishing mortality on fully recruited age-groups varied between 0.30 and 0.54 during the 1958-68 period. Fishing mortality in 1969 and 1970 was slightly higher than in 1967-68, *i.e.* between 0.50 and 0.60. Maximum yield-per-recruit is obtained at F = 0.30 for this stock. Thus, F was greater than that giving maximum yield-per-recruit in the 1959-68 period and also in 1969-70.

The long-term maximum sustained yield for this stock is about 60,000 tons. However, both USSR and Canadian surveys indicate that the 1968 year-class is an exceptionally large one. Fishing at the 1970 level (F = 0.55) in 1971-73 implies a catch in 1973 of about 100,000 tons, but this increased catch will probably be only of a temporary nature, because a year-class as large as that of 1968 is most unusual.

A fishing mortality of F_{max} in 1973 would result in a catch in that year less than that obtained with the present higher F, but because of the expected good recruitment, the actual catch in 1973 at F_{max} would be close to that in recent years (about 70,000 tons). This level of catch would be maintained over the next few years if fishing mortality rate is kept at F_{max}, becuase the contribution of the strong 1968 year-class will be spread over a longer period than would be the case if the higher level of fishing mortality generated in 1970-71 was applied in 1973. Thus the expected good current recruitment provides the opportunity of reducing fishing mortality to a better level with no transitional drop in total catch.

e) Divisions 4T-Vn (Res.Doc. 72/12)

In this area two stocks are involved: (i) the major stock which inhabits Div. 4T in the summer migrates eastward to Div. 4Vn in December-January where it resides in deep water of 80-150 fm, and moves back into Div. 4T in April-May; and (ii) small inshore stocks in Div. 4Vn, which are independent from the much larger migrating stock, and on which an independent fishery is prosecuted mainly by longline in shallow water less than 50 fm in Div. 4Vn during the summer and autumn.

i) Major migrating stock in Div. 4T-Vn

Landings from this stock declined from a high of 110,000 tons in 1956 to 41,000 tons in 1967, but have since increased, particularly in 1970, to over 64,000 tons, declining in 1971 to about 57,000 tons. In the last decade the bulk of the landings has come from the summer fishery in Div. 4T, prosecuted mainly by Canada. However, the 1970 increase in landings came mainly from the Div. 4Vn winter fishery reflecting increased interest in this fishery, particularly by Spain but also by Portugal and France. Otter trawls were the most important gear in the 1960-70 period, taking 57-77% of the landings. The importance of line catches substantially declined, while that of gillnet catches increased.

From 1960 to 1963, abundance of the stock increased reflecting the recruitment of good 1955-57 year-classes. Subsequent declining abundance resulted from recruitment of the poorer 1958-63 year-classes, whereas increasing abundance from 1967 reflected the recruitment of strong 1964 and 1965 year-classes to the trawl fishery. However, abundance in 1971 declined to the 1968 level, which is about the long-term average for the stock.

Changes in fishing mortality (F) in the period 1960-70 resulted from changes in the intensity of the fishery and were also affected by an increased growth rate which resulted in pro-

gressively earlier recruitment to the trawl fishery. The age of 100% recruitment to the fishery was 7 years in 1960-62 but this had decreased to 5 years in 1966-68. This decrease in age of full recruitment to the fishery resulted from increased fishing mortality on younger age-groups. Declining F on ages 7-10 from 0.60 to 0.25 in 1965-68 reflected reduced effort by trawl and line fisheries, whereas increasing F on ages 11-14 from about 0.30 in 1960 to 0.70 in 1968 reflected the increasing importance of the gillnet fishery which concentrates on older fish.

Thus, the increase in trawl landings from the Div. 4Vn winter fishery in 1970 probably increased mortality only to about F = 0.30 on ages 7-10 as stock abundance also increased. F in 1971 probably increased slightly to 0.30-0.35. This is still lower than the F of 0.35-0.60 on these age-groups in 1960-66.

Because of indications of density-dependent changes in recruitment and production in the 1949-65 period and continuing large changes in growth rate and in the nature of the fishery, we cannot at this time estimate the value of F which will result in optimum yield from the stock. However, current F values on the bulk of the stock are lower than those of the early 1960's which apparently did not have a deleterious effect on stock production. Thus, a moderate increase in fishing effort to a level of F of 0.40-0.45 may provide for a sustainable increase in future production. This is somewhat above the level of F giving the maximum yield-per-recruit in adjacent cod stocks.

At the present level of F and with the expected recruitment of year-classes of average strength, catches will probably decline to about 50,000 tons in 1972 and 1973. If F is increased to 0.40-0.45 in 1973, a catch of about 60,000-65,000 tons can be expected.

ii) Div. 4Vn inshore stocks

The inshore fishery on these minor stocks has been stable over the last 10 years with annual landings of 5,000-6,000 tons. Population abundance and recruitment have not fluctuated greatly, nor has fishing mortality. An average F of about 0.35 is probably close to that giving maximum yield-per-recruit.

f) Divisions 4Vs-W (Res.Doc. 72/111)

Landings from the complex of cod stocks in Div. 4Vs-W have fluctuated between 50,000 and 80,000 tons in the 1960-71 period, the average being 62,000 tons. Size and age compositions of landings varied little throughout the period. Although abundance has been rather stable, there are indications that it was lower in the most recent years, particularly for the older fish.

Fishing mortality (F) has not varied much from the average level of 0.49, which is only slightly above the level of 0.45 giving maximum yield-per-recruit.

The 1966 year-class is among the poorest to enter this fishery in the period studied, and research vessel surveys indicate that the 1967 year-class is even poorer. The 1968 year-class appears to be a good one while first indications are that the 1969 year-class is as poor as those of 1966 and 1967. Since the fishery is based predominately on cod of ages 5 and 6, its success in the next few years will be largely dependent on the strength of the 1968 year-class. It is important that the 1968 year-class be only moderately exploited to prevent a substantial stock decline. Thus, F should not be allowed to increase above the current level, which is approximately that giving maximum yield-per-recruit. This implies a catch in 1973 of 60,000 tons which is about the maximum sustainable yield.

g) Division 4X Offshore

The fishery on the offshore cod stock on Browns and LaHave Banks of Div. 4X (the stock is believed to be independent from the inshore stocks along southwestern Nova Scotia and in the Bay of Fundy) expanded rapidly since 1963 with the introduction of otter trawling, and landings reached 17,600 tons in 1969. However, stock abundance declined markedly in the latter part of the 1963-69 period, declined a further 23% in 1970, but remained at the 1970 level in 1971. Landings declined 50% to about 8,600 tons in 1970, and were about 9,000-10,000 tons in 1971. Research vessel surveys, which show a trend of declining abundance similar to that shown by commercial catch/effort statistics, indicate that pre-recruit year-classes are not strong and thus stock abundance is unlikely to improve in the next few years and may well decline further if the present rate of removal is continued.

Maximum yield-per-recruit from this stock is obtained at F = 0.35, whereas F in the 1965-70 period is estimated to be about 0.70. The yield-per-recruit model predicts that a long-term increase of 10-15% would accrue from a 50% reduction in fishing mortality. At the current very low stock

abundance level and with predicted poor recruitment, a reduction in F of this magnitude implies very low catches, probably somewhat less than 5,000 tons. The present extremely low stock abundance may reduce the probability of good recruitment, and this is a more important reason for severely limiting removals from this stock.

h) Subarea 5 (Res.Doc. 72/115, 72/117)

There are two major stocks of cod in ICNAF Subarea 5, one on Georges Bank (Div. 5Z = 5Ze + Zw) and the other in the Gulf of Maine (Div. 5Y). In the period 1950-1971 landings from the Georges Bank stock rose to near record highs in the mid 1960's and then returned to near the long-term average.

Subarea 5 cod landings ('000 tons)

Year	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Div. 5Y	3.5	2.9	3.2	3.9	4.4	6.0	6.4	8.5	8.2	7.5
Div. 5Z	23.1	27.0	25.2	38.4	52.9	36.2	42.8	37.4	25.1	27.7
Total	26.6	29.9	28.4	42.3	57.3	42.2	49.2	45.9	33.3	35.2

The mean annual catch for the Subarea since 1893 was 32,000 tons. Annual removals above 40,000 tons were not maintained for more than a few years in any period. Approximately 80% of the catch was taken from the Georges Bank stock (Div. 5Z). The catch from the Gulf of Maine stock (Div. 5Y) has been between 2,800 and 8,100 tons during 1952-1971. As assessment is available only for the Div. 5Z stock.

Div. 5Z Cod Assessment. Relative abundance of the stock has been measured on research vessel groundfish surveys since 1963. The abundance was highest in 1963-64, decreased to lowest levels in 1965-66, and has remained steady at intermediate levels since 1967. The catch per day of USA commercial fishing vessels has shown similar trends; however, the recent average of 1.1 is rather lower than the long-term (1931-63) previous average of 1.8. Also, the recent catch per day is biased upward because of more directed fishing.

Div. 5Z cod abundance indices

Year	1963	1964	1965	1966	1967	1968	1969	1970	1971
Survey Cruise (Pounds/tow)	22.4	21.5	11.7	12.3	14.1	17.1	14.6	16.8	15.4
Commercial (Catch/day)	1.8	1.0	0.9	1.1	1.0	1.2	1.2	1.3	1.1

A yield-per-recruit curve has been calculated. The maximum occurs at F = 0.3. The present magnitude of mortality is not yet established.

An estimate of maximum equilibrium yield of 34,600 tons was obtained from a generalized production model based on USA catch and effort data. Catch-per-unit-effort since 1967 have been adjusted to eliminate bias by comparing it with the survey index. The effort corresponding to the maximum is about 30,000 standard units. While the effort in the mid 1960's exceeded this level, 25,000 units were applied in 1971.

The commercial stock size in 1973 was predicted from pre-recruit abundance in 1969-70 as measured by survey cruises. This indicates that the stock should support a catch of 35,000 tons corresponding to an effort of 30,000 units.

i) ICES/ICNAF Working Group on Cod Stocks in the North Atlantic (Res.Doc. 72/33)

The Report of the Working Group integrates assessments for the various cod stocks with estimates of fishing effort and fleet structure through the decade 1960-1970. This shows the progressive increase in the range and mobility of the fleets through technological improvement, which has increased the overall efficiency of the fleets to the level where all the available cod resources can be fully exploited by the fleet deployed on cod in 1970. The present status of the ICNAF stocks has been summarized in Tables 1 and 2 of the Working Group Report. This describes the situation in 1970, but, due to short term changes in the relative abundance of the different resources and their

effect on the distribution of fishing, there will be temporary fluctuations in the level of exploitation of individual resources even if the overall level of fishing effort remains unchanged.

The data assembled were incorporated in a model which permits appraisal of the interaction between fisheries. Preliminary trials show, for example, that considering selected North Atlantic stocks as a single fishery unit using the 1970 ratio of mobile to non-mobile effort and assuming that recent recruitment levels are maintained, the same total catch of cod could be taken by a phased reduction in effort down to 50% of its present level. Such a change would be accompanied by increased stock abundance (catch per unit effort). If part of the displaced effort were redeployed on less heavily exploited species, the total catch of all species by the same fleets could be increased. This conclusion applies to the North Atlantic cod resources as a whole: the effect on individual resources in the ICNAF Area of a 50% reduction would vary, but the results illustrate that the technique is useful. Thus, if regulation of fishing mortality is applied to one or more stocks in the ICNAF Area it is now possible from the model to judge more exactly the effects that the diversion of fishing effort might have on other unregulated cod stocks.

j) Summary of Cod Assessments

The assessments indicate that the major cod stocks are being fished at or above the intensity which would produce the long-term maximum yield (Table 2). Those not assessed are listed in the lower part of the table. For those stocks for which estimates of long-term sustained yield are available (all except Div.4T-4Vn and Div. 4X), the 1971 catch of 830,000 tons was below the estimated long-term yield of 1,130,000 tons because of reduced stock sizes in Subarea 1 and Div. 2J-3K-L. Better recruitment will increase the stock size in Div. 2J-3K-L in the next year, but the higher yields of previous years in Subarea 1 will not be achieved at least until 1976.

The catch for 1973, at the 1970 fishing mortality rate, is estimated at 1,175,000 tons for the major stocks listed in the table (excluding Div. 3N-O and Div. 4X) compared with the corresponding 1971 catch of 767,000 tons. The predicted increase is primarily due to expected recruitment of a good year-class in Div. 2J-3K-L and Div. 3Ps.

It should also be noted that fishing at F_{max} in 1973 would produce a catch very nearly the same as the long-term sustainable yields. This level of catch is the recommended one, except for Div. 3N-O, where the good recruiting year-class is expected to be about 70% of the total population and should be fished at less than F_{max} to provide for future spawning stock.

Table 2. Summary of present state of ICNAF cod stocks.

Stock	Long-term Sustainable Yield[1] ('000 tons)	Fishing Mortality F_{max}[2]	Fishing Mortality F_{1970}	Catch ('000 tons)[3] 1971	Catch ('000 tons)[3] 1973 F at F_{1970}	Catch ('000 tons)[3] 1973 F at F_{max}	Recommended Quotas for 1973 ('000 tons)	Comments
Subarea 1	300	0.6	0.6	120	102	102	102	1971-73 catches below the long-term sustainable yield owing to poor recruitment.
Div. 2J-3K-L	600	0.4	(0.55)	450	825	654	650	Estimates of catch in 1973 the mean of a range of estimates. The fishing (and hence catch) is very sensitive to ice conditions.
Div. 3N-O	(75)	(0.2)	NK	120	NK	120	70	F_{max} for 1963-66 data; no recent information.
Div. 3Ps	60	0.3	0.55	60	110	70	70	Prognosis for 1973 depends critically on the size of the 1968 year-class.
Div. 4T-4Vn	NK	0.4	0.3	57	50	60	60	Projected catch in 1973 based on assuming that stock abundance remains at average level.
Div. 4Vs-4W	60	0.45	0.4	53	60	60	60	Projected catch in 1973 based on assuming that stock abundance remains at average level.
Div. 4X Offshore	NK	0.35	0.8	10	NK	NK	<5	Data not adequate to project 1973 catch, but recent poor recruitment indicates that fishing mortality should be reduced to lowest practical level.
Div. 5Z	35	0.3	NK	27	28	NK	35	Data not adequate to project catch in 1973, but it is expected that 1971 level can be maintained.
Div. 2G-H				12				No assessment.
Div. 3M				19				No assessment.
Div. 3Pn-4R-S				124				No assessment.
Div. 5Y				7				No assessment.

[1] Average recruitment × maximum yield-per-recruit.
[2] Fishing mortality giving maximum yield-per-recruit with the current age at first capture.
[3] Estimate of 1973 catches depend on projection of stock sizes in 1973. They are influenced by F in 1971 and 1972 (they are assumed here to remain at the 1970 level) and on the reliability of future recruitment. Accuracy is probably not better than ±25%.

3. Haddock Assessments

a) Subarea 3

Landings varied between 5,000 and 7,000 tons in 1968-70 and were 5,000 tons in 1971. An estimate of young haddock in Subarea 3 (Shestov, PINRO, USSR) indicated that in 1969, 1970 and 1971 the abundance of 1+, 2+ and 3+ year-old fish was at a low level. Thus in 1972 and 1973 there will be low recruitment to the adult stock and abundance will remain at the present very low level.

For the southern part of Subarea 3 (Grand Bank , Green Bank and St. Pierre Bank) the average catch of 1+, 2+ and 3+ year-old fish per hour of trawling by USSR research vessels was as follows:

Year	1966	1967	1968	1969	1970	1971
No. of fish/hour	30	120	188	26	19	19

The low incidental catches of haddock in fisheries for other species in the area amount to an intensive fishery on the haddock stock itself. Recruitment is highly variable due to natural causes. It is less certain to what extent the present low level of the stock is caused by the fishery itself, but the probability of good recruitment is most certainly reduced at the present low population level. It is important that removals from the stocks be minimized.

b) Division 4V-W

Landings increased 43% from 9,300 tons in 1970 to 13,400 tons in 1971. This reflected an increase in effort as abundance declined a further 15% between the two years. Mortality rate remained at a very high level of F = 0.9-1.2. With the imposition of a catch quota of 4,000 tons in Div. 4W in 1972, landings from the total stock are likely to be about 6,000-7,000 tons in that year.

Research vessel surveys in 1971 confirm that the 1967-1969 year-classes are poor and give a first estimate of the 1970 year-class strength. This year-class appears to be of comparable abundance to those of 1967-69, indicating that recruitment to the fishery will not improve before 1975 (the first significant contribution of a year-class to the fishery is at age 4).

Historical catch data indicate that the Div. 4V-W haddock fishery might maintain a sustained annual catch of 20,000-25,000 tons with normal recruitment. An assessment presented at the 1970 Annual Meeting indicated that the average annual yield of 28,000 tons in the 1958-64 period was obtained at an average F of about 0.5, which is the value giving maximum sustainable yield. Stock size at that time was approximately 78,000 tons.

In 1972, catches are predicted to be about 6,500 tons from an estimated stock of about 19,000 tons, which is relatively low compared with former times. It is expected that this will reduce F from the 1970-71 level to about 0.50, the level giving maximum yield-per-recruit. However, with continuing poor recruitment, stock abundance can be expected to continue its decline, and future catches, if maintained at the 1972 level, will again result in increasing values of F. More importantly, a further decline in stock abundance will continue to reduce the probability of good recruitment. Thus, removals from the stock should be minimal until at least 1975.

For effective management the entire area of distribution of the stock should be regulated, *i.e.* regulation should include Div. 4V as well as Div. 4W. It is likely that by-catches of haddock in other fisheries currently amount to about 4,000 tons in Div. 4V-W. Thus, reduction in removals from the estimated 1972 level of 6,000-7,000 tons is virtually equivalent to closure of the fishery.

Imposition of a closed area regulation during the spawning season of March-May inclusive for the spawning area in Div. 4W would likely be effective in reducing by-catches of haddock. It is apparent however, that this closure would interfere with fisheries for other species in the area. USSR data submitted at this meeting together with Canadian data submitted last year indicate that significant fisheries for cod, flounder and silver hake are prosecuted in the proposed closed area and season. The reported by-catch of haddock in these fisheries varies; in particular, the USSR report indicates that only small quantities of haddock are caught.

c) Division 4X (Res.Doc. 72/21)

The 18,000-ton quota of haddock in Div. 4X was apparently not quite reached in 1971; preliminary statistics indicate landings of 17,600 tons.

Stock abundance, as indicated by USA commercial fleet landings-per-day of 2.6 tons, continued to decline, reaching the lowest level observed in the 1956-71 period. USA survey cruise abundance estimates (Table 3) confirm the decline in abundance in recent years. The young-of-the-year index (Table 4), derived from USA fall surveys, indicates that the 1971 year-class is comparable in strength to that of 1969, both of which are only slightly stronger than the extremely poor year-classes of 1964-68 and 1970. Thus, a significant improvement in recruitment and, hence, stock abundance cannot be expected prior to 1976 at the earliest.

Table 3. Average numbers of fish caught per tow on *Albatross IV* surveys in Div. 4X.

Year	Season	Number per tow	
		Total	Age 4+
1963	summer	104	31
	autumn	193	34
1964	winter	181	45
	summer	147	37
	autumn	44	13
1965	winter	100	22
	summer	86	19
	autumn	55	13
1966	winter	59	9
	autumn	39	14
1967	autumn	37	30
1968	spring	28	25
	autumn	21	14
1969	spring	28	15
	summer	17	9
	autumn	23	5
1970	spring	29	18
	autumn	14	6
1971	spring	23	14
	autumn	25	

Table 4. Browns Bank haddock young-of-year survey cruise index.

Year-class	Index
1962	6.03
1963	37.16
1964	1.10
1965	1.51
1966	1.32
1967	1.10
1968	1.51
1969	3.31
1970	1.03
1971	3.19

Survey cruise data confirm that F in the 1963-70 period was about 0.60, the value used in earlier assessments. This high value of F will probably be reduced, to some extent, by the imposition of a 9,000-ton quota in 1972. However, with continued poor recruitment stock abundance will likely continue to decline. At such low levels of adult stock abundance the probability of good recruitment is almost certainly reduced. Thus, the Commission should give consideration to reducing the catch to the lowest practicable level in order to achieve some recovery of the stock to former levels. Under present exemption regulations, the by-catch under complete closure is estimated to be about 6,000 tons.

d) Subarea 5

The reported catch in 1971 was 12,152 tons compared with the quota of 12,000 tons.

The age-composition of USA landings in 1971 (Table 5) substantiates the prediction of low recruitment for every year-class since 1963. The 1962 and 1963 year-classes accounted for 40% of the number of fish landed by the USA in 1971. In 1970 these two year-classes contributed 65% of the entire year's catch. The growth rate of recent year-classes has apparently increased, causing the age at first capture to be reduced by at least 6 months to age 2. Thus the percentage of 2-year-olds in the catch has increased from essentially zero in 1970 to 27% in 1971. Considering the low spawning stock and that haddock do not spawn until at least three years of age, the increased harvest of two year olds is cause for concern. The preliminary estimate of average age in 1971 was 6.7 years.

Table 5. Age composition of haddock in USA landings from Subarea 5 in 1971.

Age	2	3	4	5	6	7	8	9+	Total
No./thousand	271	45	9	61	54	65	298	197	1,000
No./day fished	151	25	5	34	30	36	116	110	557

The index of abundance calculated from the USA commercial fishery dropped from 2.1 in 1970 to 1.6 in 1971. The index varied between 5 and 6 in the 1962-1966 period.

The 1971 groundfish survey cruise indicates no significant change in the population from 1969 through 1971, although the numbers and pounds-per-tow did decline somewhat between 1970 and 1971. Very few young-of-the-year haddock were caught on the 1971 survey and the young-of-the-year abundance index for 1971 was 1.38 compared with 1.00 in 1970 and 12.6 in 1963.

The estimates of available population and recruitment are given in Table 6. The 1972 quota of 6,000 tons may arrest the decline but would allow only a modest improvement of stock size under the most favourable of assumptions. Significant recovery of stock size, considering current low population and recruitment levels, will occur only with a cessation of fishing. Even then, incidental catches would probably amount to 3,000-4,000 tons.

Table 6. Estimates of available population and recruitment for Subarea 5 haddock (millions of fish).

	1935-1960	1968	1969	1970	1971	1972	1973
Available population (age 2+) including recruits	145	52	27	21	21	20	27
Removals: Total	63	33	15	9	9	4	?
Fishing	41	28	12	6	6	3[a]	?
Natural	22	5	3	3	3	1	?
Recruits (age 2)	54	16	8	9	9	8	11

[a] Under regulation, 2 kg per fish.

4. Yellowtail Assessments

a) Divisions 3L and 3N (Res.Doc. 72/86)

The yellowtail flounder landings from Div. 3L and 3N increased from 3,000 tons in 1965 to 26,000 tons in 1970 and to 32,000 tons in 1971. In addition, about 5,000 tons were landed from Div. 3O in 1971, the first significant catch from this division thus far. Significant amounts of unspecified flounder were reported by some countries in the 1966-69 period and the amounts of yellowtail in these landings have been calculated on the basis of the proportion of yellowtail in the 1970 USSR flounder landings.

Similarities of growth rates and comparison of spring and autumn surveys indicate that the yellowtail in Div. 3L and 3N probably belong to one stock. Estimates based on the 1958-61 year-classes indicate that total mortality (Z) on fully recruited ages averaged about 1.5-1.8 during the 1965-70 period. Although no estimate of M is available for this stock, a range of M of 0.2-0.4 implies F values well beyond the F_{opt} level. At M = 0.4, F would be close to that giving maximum yield-per-recruit and at lower values of M, F would be at or beyond the maximum yield-per-recruit level.

Increases in catch of about 5 times and fishing effort of about 10 times during 1966 to 1970 have not been accompanied by obvious increases in total mortality rate apparently because the abundance and range of distribution of yellowtail have increased at least up to 1968. Thus, the fishing intensity has increased less than fishing effort. However, it is uncertain whether this increase in abundance is still occurring and whether the stock can withstand continued increases in fishing effort without decreaseing yields in the future. Also, since the proposals for regulation of cod

and plaice in this area could result in a deployment of effort to this stock, it seems prudent to prevent drastic increases in fishing effort on this stock. To allow a rate of increase in catches of yellowtail in Div. 3L and 3N in the near future similar to that of previous years implies a catch of 50,000 tons in 1973 (for Div. 3L, N and O).

Yellowtail-plaice mixture in Div. 3L and 3N. Most of the yellowtail-plaice mixture in Div. 3L occurs between 46° and 47° north latitude in depths less than 90 m, where the proportion of yellowtail in the flounder catch may be as high as 50%. North of 47° north latitude and deeper than 90 m, proportions of yellowtail in flounder catches are usually less than 10%, decreasing to practically zero in the northern part of Div. 3L.

In Div. 3N the highest proportion of yellowtail in flounder catches occurs in the region of the Southeast Shoal, where 80-90% of flounder catches is composed of yellowtail. In other areas of Div. 3N, north and south of the Southeast Shoal, a lesser proportion of yellowtail in flounder landings is encountered, usually about 50-60%. It is obvious, therefore, that regulation of these species individually will be difficult.

b) Subarea 5 (Res.Doc. 72/22, 72/23)

The assessment of these stocks has been updated with data obtained from 1971 research survey cruises and preliminary 1971 catch statistics. Predictions through 1973 of the changes in stock status, considering the implications of the quota regulations, have been made. The catches referred to in this section are nominal catches plus discards.

Area west of 69°, Cape Cod-Southern New England

Cape Cod. The catch of the Cape Cod stock in 1971 was 2,300 tons, up 700 tons from 1970. This stock should be capable of supporting this level of harvest in 1973.

Southern New England. The Southern New England stock abundance continued to decline in 1971. The catch per day of the USA commercial vessels decreased from 3.5 tons to 2.9 tons. The landings per day (catch excluding discard of small fish) declined from 2.6 tons to 2.0 tons. USA survey cruise abundance indices declined by 30% (Table 7). Total reported catch for 1971 was 12,600 tons. With the current low population as estimated from survey cruises, this catch would not have reduced F to the desired 0.8 level.

The pre-recruit index from the 1971 survey cruise continued to be low (Table 8). This substantiates last year's conclusion of the Assessment Subcommittee, based on predicted population size from survey cruise data, that a catch of 8,000 tons is necessary in 1972 to reduce F to the desired level.

Table 7. Yellowtail flounder abundance indices from USA survey cruises.

	Southern New England		Georges Bank	
Year	Numbers per tow	Pounds per tow	Numbers per tow	Pounds per tow
1963	50.6	32.1	30.1	22.0
1964	60.8	41.9	22.5	23.4
1965	38.7	28.0	15.0	15.7
1966	50.2	20.8	14.8	6.7
1967	57.7	31.0	18.6	13.0
1968	40.2	22.1	25.6	18.1
1969	54.7	31.7	23.1	15.9
1970	49.5	30.1	16.0	11.6
1971	33.9	21.0	15.3	11.1

Table 8. Indices of pre-recruit (1+) yellowtail flounder abundance Southern New England populations.

Year	Numbers per tow
1963	16.3
1964	18.5
1965	11.7
1966	34.4
1967	19.9
1968	9.0
1969	7.0
1970	8.3
1971	7.7

Length frequencies in USA survey cruise catches in 1971 indicated a further decrease in fish of age 4 and older, which are now at a very low level. This is also shown in the age-composition of the USA commercial landings as follows:

Age composition of yellowtail in USA landings (excluding discards).

Age	2	3	4	5	6	7	8+
No. landed (00s)	6,207	24,761	56,572	28,806	6,902	1,786	252

Recent analysis of age composition of yellowtail flounder in catches of the USA survey cruises from 1963-1969 provides an estimate of total mortality, Z = 1.25. This substantiates earlier findings based on analysis of commercial catch-effort data of a high fishing mortality rate (natural mortality, M = 0.2).

The 1971 quota of 13,000 tons was based on assuming a catch of 2,000 tons from the Cape Cod stock and 11,000 tons from the southern New England stock. The total 1971 catch (including discards) in the area west of 69° was 13,800 tons. If the 1972 Southern New England catch does not exceed the 8,000 ton quota, then the 1973 catch in that area should be held at the 8,000-ton level based on predicted population size. This should not be exceeded as long as recruitment continues at the current low levels. Including the catch of the Cape Cod stock, the 1973 quota may be set at 10,000 tons for the area west of 69°.

Area east of 69°, Georges Bank

Reported catches of 15,700 tons were slightly less than the 1971 quota of 16,000 tons. Catch-per-day in the USA fishery declined from 3.4 tons in 1970 to 2.6 tons in 1971. Landings-per-day declined from 2.5 tons to 2.1 tons. The greater decline in catch-per-day may be due more to changes in fishing practices (*e.g.* larger mesh and market conditions) than a decline in the population of smaller fish.

Survey cruise abundance indices remained about the same in 1971 as in 1970 (Table 7). The length frequencies of survey catches have remained about the same in the period 1963-1971. Pre-recruit (1+) numbers are less in 1971 than in 1970, but the relationship of this index to the future populations on Georges Bank is not yet established. Although the pre-recruit index declined in 1971, the high variability of the index since 1963 means that the observed decline is not of significant magnitude to recommend a reduced quota for 1973.

The age composition data indicate a reasonable proportion of older fish in the USA commercial landings as follows:

Age composition of the USA landings (excluding discards).

Age	2	3	4	5	6	7	8+
No. landed (00s)	1,004	70,670	57,716	21,713	8,591	3,016	2,356

A total mortality rate of 1.0 was estimated from the age composition of 1963-1969 USA survey cruise catch data. This gives an F of 0.8 with natural mortality, M = 0.2. This is lower than the F = 1.0 used in the 1971 assessment, which was obtained from commercial catch-effort data, and thus indicates that the 16,000-ton quota is probably going to be effective in regulating F to a desired 0.8 level.

c) Statistical Area 6

The preliminary catch statistics for Statistical Area 6 indicate an increase in 1971 over 1970 (5,900 tons compared with 4,100 tons). Most of this increase occurred in the area along the border of Div. 5Zw and Statistical Area 6 (71°41'W). Although the relationship between the stocks in the middle Atlantic and in Southern New England has not been clearly defined, when the stock situation is as critical as it is in the latter area, such an increase is cause for concern. If there is a significant intermixing of the fish in these two areas, then increasing fishing in Statistical Area 6 could temper the desired effect of the quota in Southern New England.

5. American Plaice - Divisions 3L and 3N (Res.Doc. 72/14, 72/15, 72/90)

Tagging and growth characteristics indicate that for assessment purposes the American plaice resource of the Grand Banks should be treated as two separate stocks, one in Div. 3L and the other in Div. 3N.

The fishery in Div. 3L is almost entirely Canadian, landings increasing from 15,000 tons in the late 1950's to 25,000 tons in 1965 and then to over 50,000 tons in 1969, and declining to 40,000 tons in 1970

and 38,000 tons in 1971. Increased landings were accompanied by increased fishing mortality rates, F of all age groups having increased from 0.09 in 1955 to about 0.48 for male and 0.28 for female in 1968. Abundance declined by over one-half in the 1956-1971 period. With declining abundance, F for fully recruited age-groups in 1969-70, was 0.7-0.8. The optimum F in Div. 3L is 0.50, which is at a level of about 80% of the maximum yield-per-recruit on the flat-topped yield-per-recruit curve of the stock. This was about the level of F in 1967 when landings were 37,500 tons. Thus to reduce F to a more satisfactory level and to prevent further decline of this stock in 1973, the catch should be about 32,000 tons (assuming recruitment rate to be average).

The Div. 3N stock yielded about 5,000 tons annually in 1954-63. The yield in more recent years (1966-68) contains a proportion calculated from the unspecified flounder landings of some European countries (USSR, Poland) on the basis of the proportion of plaice in 1970 USSR flounder landings. The estimated total landings increased to 35,000 tons in 1966, declined to 15,000 tons in 1969, and increased to about 20,000 tons in 1970 and 23,000 tons in 1971. Fishing mortality of all age-groups increased with increasing landings to about 0.27 in 1966-68. Lower landings in 1969-71 were accompanied by declining stock abundance, but F remained at about the same level in 1969-70 as in 1968. The optimum F in Div. 3N is 0.40 for fully recruited age-groups at a level of about 80% of the maximum yield-per-recruit. This was about the level of F for fully recruited age-groups in 1969, when landings were 15,000 tons. Thus to reduce the level of F to more desirable levels and to prevent further decline of the stock in 1973, the catch from Div. 3N should be about 20,000 tons.

In addition to the fishery for plaice in Div. 3L and 3N, there is a fishery in Div. 30 which yielded 6,000 tons in 1970 and 7,000 tons in 1971.

6. Silver Hake - Subareas 4 and 5 and Statistical Area 6

a) Stock Identification

USSR research studies, based primarily on otolith structure and the relationship of otolith weight to length of fish but with some supporting biochemical evidence, have delineated several separate silver hake stocks in the Northwest Atlantic. These stocks inhabit the Sable Island Bank area (Div. 4W), the Browns Bank area (Div. 4X), Georges Bank and adjacent areas (Div. 5Ze and 5Y), and the Southern New England-Middle Atlantic region (Div. 5Zw and Statistical Area 6). The area off Southern New England (Div. 5Zw) appears to be a region of overlap between the Middle Atlantic and Georges Bank populations, with the former moving into Div. 5Zw in the summer. For assessment purposes, the eastern boundary of the Southern New England stock was considered to be 69°W. Observations of migration patterns, abundance indices from survey cruises, and age structure of commercial and research catches indicate that the inshore Gulf of Maine area (Div. 5Y) has a separate stock also, and this has been considered in the following assessments. Basic assessments for Subarea 5 and Statistical Area 6 were available in a working paper presented to the Assessment Subcommittee by Dr E. Anderson, US Northeast Fisheries Center, Woods Hole.

b) Stock Status

Division 4W. USSR surveys and commercial catch-effort statistics in Div. 4W indicate an increasing population of silver hake from 1969 to 1971. The catch during this period consisted primarily of 3- and 4-year-old fish of the 1966, 1967, 1968 and 1969 year-classes. The 1971 catch (119,000 tons) decreased over that of 1970 (159,000 tons). The percentage age composition of the USSR commercial catch is given for 1971 and, on the average, for 1963-1970 as follows:

Age	1	2	3	4	5	6	7	8	9	Average Age
1971	-	8.8	43.2	36.8	8.8	1.2	0.5	0.5	0.2	3.4
1963-1970 Average	1.7	6.4	30.9	41.3	16.1	3.0	0.5	0.1		3.8

Division 5Y. The 1971 catch in Div. 5Y was 8,400 tons contrasted with 11,100 tons in 1970, continuing a downward trend since 1969. The USA commercial fishery catch-per-effort index has shown a gradual decline since 1957, but have remained relatively constant during 1964-68 as follows:

1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
14	26	20	20	15	20	20	18	16	12	14	10	15	5	3	2

However, a very pronounced drop occurred in 1969 which has continued through 1971. Mean weight-per-tow of silver hake in the USA survey cruises decreased steadily from a high in the autumn of 1963 to a low in 1967 and 1968:

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Spring	-	-	-	-	-	0.1	0.4	0.7	5	4
Autumn	44	10	19	9	3	3	4	5	5	-

Survey indices improved somewhat in 1969-71, with the spring 1972 value decreasing slightly. The marked decline in abundance from 1963 to the present is supported by both the commercial fishery and survey cruise indices, although the marked drop in 1969 in the former series was preceded by a drop in 1967 in the latter. The abundance index of young-of-year fish, based on the 1971 autumn survey cruise, exceeded the previous highest value (1963) in the 1963-1971 series by a factor of almost two.

Age compositions of catch were determined for the 1968-1970 USA autumn survey data. In 1968 fish of ages 4 and 5 predominated, but by 1970 these age-groups were non-existent in the samples. Percent age compositions of the USA commercial landings for 1970 is as follows:

Age	1	2	3	4	5	6	7	8	9	10	Average Age
1970	1.8	13.8	22.9	25.2	13.6	11.2	5.8	3.8	1.0	0.6	4.2

Division 5Z and Statistical Area 6. The nominal catch of silver hake in 1971 was 87,000 tons in Div. 5Z and 7,700 tons in Statistical Area 6, giving a total of 94,700 tons. This is an increase of 43,200 tons over the 1970 catch. Provisional nominal landings by subdivision in 1971 were 55,700 tons in Div. 5Ze, 13,500 tons in Div. 5Zw and 18,000 tons in subdivision not known. The catch statistics are not reported by stocks and a separation could not be made between the Georges Bank and the Southern New England - Middle Atlantic stocks for 1971.

USSR age composition of the catch in Div. 5Z indicate that in 1970 the fishery was dependent primarily on 1- to 5-year-old fish, but 1- and 2-year-olds did not contribute significantly to the catch in 1971. The 1968 year-class is of moderate strength and provided for 32% of the catch in 1971. The percentage age compositions of the USSR commercial catch in Div. 5Z for 1970 and 1971 are as follows:

Age	1	2	3	4	5	6	7	8	9	10	11	Average Age
1970	16.4	13.4	16.2	27.5	16.3	4.0	4.0	1.7	0.3	0.2	-	3.54
1971	1.0	6.9	31.6	32.6	16.3	5.9	2.8	1.7	0.9	0.3	-	4.01

Age composition of the USSR catches in Statistical Area 6 (given below) show that this fishery was supported in 1969 by fish of ages 3 and 4. In 1971, 2- and 3-year-olds made up 31.1% and 37.5% of the catch respectively.

Age	1	2	3	4	5	6	7	8	9	10	Mean Age
1969	-	8.2	40.7	30.1	10.4	3.8	4.4	1.4	0.8	0.2	3.85
1971	3.5	31.1	37.5	17.3	4.2	2.3	2.2	1.3	0.4	0.2	3.14

An attempt was made to estimate age compositions separately for the two stocks for the period 1963-70. The USSR component of the catch was estimated from length frequencies and age-length keys for Statistical Area 6 and Div. 5Z for the period 1963-1967, and for Div. 5Zw + Statistical Area 6 and Div. 5Ze separately for 1968 and 1970. Most of the fish caught in 1963-70 were ages 2 to 5, with ages 3 and 4 being the predominate ones. In 1970, 24 and 28% of the fish from the

Georges Bank and the Southern New England - Middle Atlantic stocks respectively were age 1 fish.

The USA commercial fishery abundance index in the Southern New England - Middle Atlantic stock dropped sharply after 1965, and during 1966-71 averaged 25% of the 1964-65 level.

Stock	Catch-per-effort indices (USA in catch/day, USSR in catch/hr).									
	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Georges Bank (USA)	12	18	2	6	8	1	2	0.2	12	12
Southern New England-Mid-Atlantic (USA)		6	12	12	2	5	3	4	2	3
Both stocks (USSR)	2.2	1.9	2.1	1.7	1.0	1.0	1.0	0.6	0.7	-

USSR catch-per-hour (by BMRT vessels) for both stocks as determined from data in Table 4 of ICNAF *Statistical Bulletins*, declined markedly after 1965 to a level in 1966-68 which was almost 50% of the level in 1962-65; in 1969-70 it was only 35% of the 1962-65 average. In the absence of any USSR study involving a more valid measure of abundance based on catch-per-unit-effort data, the indices presented above are the only ones available to indicate trends in offshore abundance. Both the USA and USSR catch-per-effort changes coincide with marked drops in catch after 1965 and the subsequent levelling off in 1968-70.

Mean catch-per-tow (weight) in USA survey cruises declined sharply on Georges Bank after 1963 and have remained low since then, with the autumn indices declining slightly each year after 1968 (see following table).

		Pounds per tow of silver hake in *Albatross IV* surveys									
		1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Georges Bank:	Spring	-	-	-	-	-	0.6	1	20	2	2
	Autumn	33	5	4	4	6	7	5	5	4	-
S. New England:	Spring	-	-	-	-	-	16	8	4	8	5
	Autumn	12	12	17	8	10	10	5	6	10	-
Mid-Atlantic:	Spring	-	-	-	-	-	3	3	2	3	2
	Autumn	-	-	-	-	2	2	0.3	0.5	0.5	-

Survey catches in the Southern New England - Middle Atlantic area also decreased between 1963 and 1970 but increased somewhat in 1971. These data suggest continued low abundance of silver hake for the Georges Bank area but some improvement in the Southern New England - Middle Atlantic area. The USSR reported that vessels fishing on the southern slope of Georges Bank found good concentrations in 1971 and 1972. Pre-recruit numbers established from USA survey cruises are greater in 1971 than in 1970 for the Southern New England - Middle Atlantic area but are not exceptionally high when compared with earlier values back to 1963.

c) Silver Hake Assessment

Estimates of average annual natural mortality for age-groups 2-4 in 1963-70 (Anderson, 1972 Assessment Working Paper) ranged from 0.3 for the Gulf of Maine stock to 0.5 for the Southern New England - Middle Atlantic stock. USSR scientists indicated that natural mortality may increase with age after spawning particularly on Georges Bank, but that further research is necessary. However, the mortality rates referred to above encompass the age-groups that have supported the fishery. Virtual population estimates of total mortality (Z) increased for ages 3 to 7+ in the Gulf of Maine, and for ages 3 and 4 on Georges Bank and in Southern New England waters. Using an estimate of natural mortality of $M = 0.4$, F for ages 4 to 7+ was 0.55 for the Gulf of Maine stock, 0.85 for Southern New England - Middle Atlantic stock and 1.01 for the Georges Bank stock.

Yield-per-recruit studies indicate that little is to be gained by increasing F above 0.5. If natural mortality is only moderate ($M < 0.4$) for age-groups 2 to 5, increases in F above 0.6 can, in fact, result in a decrease in yield-per-recruit. If natural mortality is high ($M \geq 0.4$), F for maximum yield-per-recruit may be considerably higher than 0.5, but yields for $F > 0.5$ are within 10% of the maximum.

The ages at first capture, required to obtain a maximum yield-per-recruit, range between 2.75 (mean length of 25 cm) and 3.00 (mean length of 27.8 cm) for F ≤0.75. For higher levels of F the yield-per-recruit is maximized at age 3.5 years, but gains by increasing age at first capture beyond 3 years are less than 3%.

Mesh selection studies for silver hake have been published by Jensen and Hennemuth (1966, ICNAF *Research Bulletin* No. 5). They estimated a selection factor of 5.1 for 52-mm nylon mesh and calculated that yield would be increased by 8% if mesh size in the USA Southern New England fishery were raised from the 33 mm currently in use to 52 mm. Almost all fish less than 25 cm would be released by the larger size. With a selection factor of 5.1, a mesh size of 55 mm would give a 50% selection point at age 3 (length 27.8 cm). There may be different selection factors with different gears under differing conditions and further research is necessary to refine these values. However, the present evidence indicates that size at first capture and yield-per-recruit could be increased by increasing mesh size at least to about 52-55 mm.

The establishment of mesh regulations in mixed fisheries (which at least part of the silver hake fishery is) contains practical difficulties. These need to be considered both from the standpoint of fish for which a given mesh would be larger than desired and those for which it would be too small. This applies both to all of the sought-for species in the mixed fishery and those taken only as by-catch.

Maximum sustained yield is estimated at 38,000 tons for the Gulf of Maine stock, using the generalized production model. This value appears reasonable, considering the long-term landings in this fishery, which has fluctuated mainly between 20,000 and 40,000 tons throughout its 30-year history. The 1970 and 1971 catch and effort were on the lower right hand level of the curve indicating moderate fishing on low stock abundance. The generalized production model was also applied to the Southern New England stock, with a resulting maximum sustained yield estimate of 67,000 tons. However, the only available measure of abundance and effort for this stock is based on data for the USA industrial fleet, which is a mixed fishery and catches a very small portion of the total catch from the stock. Thus additional data is needed to refine the approximate measure of catch-per-unit-effort for the Southern New England - Middle Atlantic stock. No adequate measure of catch-per-unit-effort has been provided for the commercial fishery on the Georges Bank stock.

In order to provide further guidelines for quotas, estimates were made of the 1972 population based on survey-cruise abundance indices adjusted by virtual population estimates of fish age 3 and older. Catches estimated for various F values are as follows:

	Estimated 1972 catches (000 tons)			
Stock	F	M = 0.3	M = 0.4	M = 0.5
Gulf of Maine	0.5	8.6	8.3	7.9
	0.6	9.9	9.5	9.1
	0.7	11.1	10.7	10.2
Georges Bank	0.5	14.8	14.1	13.6
	0.6	17.0	16.3	15.6
	0.7	19.0	18.2	17.5
Southern New England - Middle Atlantic	0.5	158.5	152.0	145.6
	0.6	182.2	174.7	167.6
	0.7	203.8	185.3	169.8

In order to extrapolate these estimates to 1973, it has to be assumed that abundance remains constant during 1972. For the Gulf of Maine and Georges Bank stocks the estimates seem reasonable considering generalized production model studies, abundance indices from commercial catch-effort and survey data and historical records. However, the catch estimated for the Southern New England - Middle Atlantic stock is 2 and 3 times higher than the generalized production model value and is also more than the peak catches of about 155,000 tons taken in 1965 and 1966. Considering the historic catch for this stock, it would seem advisable to recommend a value somewhat less than these previous maximum catches. However, because of the difficulty in defining exactly the division of catches between stocks, it is perhaps satisfactory to use the boundary between Div. 5Ze and 5Zw as the dividing line between the Georges Bank and Southern New England - Middle Atlantic stocks and pro-rate the allowable catch on a 50-50 basis. This implies a catch of 80,000 tons for Div. 5Ze and 80,000 tons for Div. 5Zw and Statistical Area 6.

7. Red Hake (Res.Doc. 72/27, 72/28)

A USA fishery for red hake in Subarea 5 and Statistical Area 6 has existed for a long period, but the catch was rather small except in the late 1950's when it rose to about 35,000 tons. An intensive USSR fishery began in 1965. Total catches by all countries for the years 1965-71 are as follows:

Year	1965	1966	1967	1968	1969	1970	1971
Catch (000 tons)	90	114	58	20	55	12	37

USSR studies indicate the existence of two principal stocks. The first inhabits the southeast Georges Bank area (Div. 5Ze) and the second the waters southwest of Cape Cod (Div. 5Zw and Statistical Area 6). The stocks apparently mix at certain times of the year along the border, and for purposes of this assessment the 69°W longitude line was used as the eastern boundary of the southern stock. Anderson and Au (Working Paper presented at the 1972 ICNAF Annual Meeting) provide an assessment of red hake in Subarea 5 and Statistical Area 6. During the winter the stocks may be relatively descrete, occupying areas deeper than 100 m. During the summer the fish make extensive inshore migrations and may well be intermixed in some areas.

The relative abundance of the stocks as estimated from USA trawl surveys since 1963 is as follows:

	Catch-per-tow (pounds) in *Albatross IV* autumn surveys								
Stock	1963	1964	1965	1966	1967	1968	1969	1970	1971
Div. 5Ze	15	5	3	2	1	2	3	1	3
Div. 5Zw	18	10	12	6	6	10	11	9	9
Stat. Area 6	-	-	-	-	0.3	2	1	0.4	0.8
5Zw + 6	-	-	-	-	3	6	6	5	5

The catch-per-tow in the area occupied by a part of the southern stock component (Div. 5Zw) decreased significantly between 1963 and 1967, increased in 1968 and 1969 and then decreased slightly in 1970 and 1971. In the Georges Bank area (Div. 5Ze) the trend in relative stock abundance followed much the same pattern.

In the USA commercial fishery, catch-per-effort indices for the Southern New England - Middle Atlantic stock dropped sharply from a peak in 1964 to a low in 1966. The index improved in 1967 and has remained at about 50% of the 1964 level up to the present time, with a slight improvement in 1971. Both the USA survey cruise and commercial fishery abundance indices indicate similar trends. Although commercial fishery abundance indices are not available for Georges Bank, the precipitous drop in landings after 1966 which continued at a low level up to 1971 together with the drop in the survey cruise abundance index after 1963 and its continued low level indicate the present low abundance of the red hake stock in that area.

Estimates of total mortality (Z), based on USSR commercial fishery and survey data, are as follows for ages 1-5:

	Estimates of Z for red hake from USSR data											
	Age 1		Age 2		Age 3		Age 4		Age 5		Average 3-5	
Stock	Comm.	Res.	Comm.	Res.	Comm.	Res.	Comm.	Res.	Comm.	Res.	Comm.	Res.
Div. 5Ze	-	-	-	-	0.62	0.71	1.34	0.82	1.71	1.29	1.40	1.00
Div. 5Zw - Stat. Area 6	-	0.22	-	0.64	0.59	0.79	1.21	0.94	2.00	1.57	1.27	1.09

The estimated mortality for age 1 fish in the survey catch, Z = 0.22, is assumed to be mostly due to natural mortality. However, because the commercial catches contain significant numbers of 2-year-olds (see age-composition table below), the coefficients for ages 2 to 5 contain increasing proportions of

Z due to fishing mortality. The following age composition data of USSR commercial catches indicate that at least for the years 1969 and 1970 full recruitment to the fishery probably occurs between ages 3 and 4.

Percentage age composition of red hake in Subarea 5, 1969-1971

Year	Age 1	2	3	4	5	6	7	Total (%)	Mean age
1969	3.4	17.5	35.5	35.4	7.6	0.3	-	100.0	3.27
1970	-	2.5	63.8	29.2	4.5	0.3	-	100.0	3.36
1971	0.4	47.7	29.0	14.4	6.9	1.5	0.1	100.0	2.85

If ages 4 and 5 fish are fully recruited and equally vulnerable to the fishery, the average increase in Z of about 0.6 between ages 4 and 5 may reflect an increase in natural mortality. Thus, the upper limit of natural mortality rate is between 0.2 for age 1 fish and about 0.8 for age 5 fish. The total mortality coefficient for fully recruited age-groups (ages 4 and 5) is estimated to be about 1.5.

The stock sizes of red hake, as estimated by USSR from commercial catch and survey cruise data (estimates based on the later in parentheses), together with catches (000 tons), are as follows:

		1965	1966	1967	1968	1969	1970	1971	1972
Div. 5Ze	stock	125	91	62	12	11 (13)	11 (8)	(10)	(24)
	catch	55	40	27	5	5	2		
Div. 5Zw - Stat. Area 6	stock	69	174	72	36	117 (87)	104 (54)	(54)	(51)
	catch	30	74	31	15	50	10		

In some years the fishery removals were a significant part of the stock. The fishery has become more dependent on annual recruitment with the 1969 year-class contributing 48% of the USSR catch by numbers in Subarea 5 in 1972.

Yield-per-recruit estimates were made by Anderson and Au (Working Paper presented at the 1972 ICNAF Annual Meeting) and Richter (1970, *Journal of Ichthyology*, Vol. 10, p. 736-742) for M ranging from 0.3 to 0.8. The curves are extremely flat-topped with very small (<10%) increases in yield achieved for exploitation rates greater than 0.5. Higher rates which achieve maximum yield-per-recruit tend to reduce stock size to perhaps 10% of its original value, and this is a level at which stock recruitment relationships become an important consideration. In general an F of 0.5-0.6 would appear to define a desired maximum level of fishing.

The generalized production model was applied to the stock, utilizing the catch-per-unit-effort data derived from the USA mixed industrial fishery in Southern New England. Maximum sustainable yield estimates ranged from 31,000 to 38,000 tons.

Rickter estimated the yield from a moderate stock size to be between 36,000 and 44,000 tons for F of 0.5. The survey cruise indices indicate a low to moderate population for the Southern New England - Middle Atlantic stock. An extremely low population is indicated for Georges Bank, which stock is presently capable of sustaining only incidental catches. Thus the total catch from Subarea 5 and Statistical Area 6 should be about 40,000 tons in 1973.

8. Other Hake Considerations

a) Silver and Red Hake Closed Areas (Res.Doc. 72/114)

USA survey cruise distribution records for silver and red hake were reviewed in relation to the ICNAF closed area. From the period mid-January through to April the area did encompass the major concentrations of both red and silver hake. There were some hake concentrations somewhat eastward of the closed area in similar depth zones. In addition, there were catches of significant numbers in Statistical Area 6 just west of the ICNAF closed area and shoreward of the area closed by USA-USSR and USA-Polish bilateral agreements. Verbal reports by USSR scientists indicated that the

closed area may be even more inclusive of the winter concentrations if only larger size fish are considered.

b) General Comments on Hake Assessments

The current information available for both silver and red hake does not permit assessments as precise as are required for firm conclusions. In order that the necessary precision be achieved, it is imperative that age-length keys from the exploited stocks be available to the Subcommittee along with relevant length compositions, length-weight data, and appropriate measures of effort and catch by stock. Data should be reported by sufficiently small unit areas (*i.e.* 0.5 degree rectangles) so that they may be adjusted to conform with the latest information on stock structure. All relevant research studies should be presented to the Subcommittee as documents or working papers.

9. Scallops - Division 5Ze

Scallop landings from Subarea 5 reached a peak of 15,600 tons of meats in 1962, after the entry of an extremely abundant year-class to the fishery in 1959, but declined to about 5,600 tons of meats in 1971. Catch-per-hour dragged by the Canadian fleet dropped from 406 pounds in 1961 to 81 pounds in 1971. The USA research vessel index dropped from 93 in 1961 to 45 in 1968.

A dense concentration of 3- and 4-year-old scallops, 80 square miles in extent, was located early in 1970 by the Canadian fleet and was substantially fished out by June 1971. An F of 1.06 for this group of scallops was calculated from research cruise survey data, and it is estimated that incidental mortality to pre-recruits, (<70 mm shell size) which formed half the population in the area, was also high. New recruits were also located in limited areas on the eastern side of Georges Bank in 1971 and 1972, and these were heavily fished. Canadian meat counts which rarely exceeded 40 meats/pound in the early 1960's had reached a maximum of 80 meats/pound in 1970 and maxima of 90 to 120 meats/pound in 1971 and 1972. Despite this, meat counts from grounds outside the area of new recruits remained predominantly below 40 meats/pound. The fishery has thus developed in an unsatisfactory pattern: continuously declining catch-per-unit effort has not discouraged a doubling of fishing effort since 1966, largely because landed price has increased threefold in the same period. As stock density declined, the inducement to fish areas of high density of young scallops has increased, and the age of first recruitment has declined from age 5 to ages 3 and 4 for the Canadian and USA fisheries respectively. The extra labor of shucking small scallops is more than offset by the larger catches in areas where small scallops occur.

Fishing mortality for the whole stock is probably lower than that within the area of new recruits. F of 0.7 was determined from USA research vessel data in 1962, and it is estimated that F has declined by 17% between 1962 and 1971. Hence F for the whole stock in 1971 was probably about 0.6. At this level of fishing mortality, it is calculated that a 50% increase in yield-per-recruit would result from postponing age at first capture from 3.5 years to 6-7 years (14 meats/pound). At the present age at first capture of about 3.5 years (65 meats/pound), it would be necessary to reduce fishing mortality by one-half to achieve an increase in yield-per-recruit of 10%.

An increase in age at first capture to 6-7 years would result in a large immediate decrease in landings. Such an increase should perhaps be approached by progressively raising the size limit. Meanwhile a reduction of fishing effort is desirable in order to prevent a further decline in stock abundance, especially since diversion of fishing from young scallops could increase effort on stocks of older scallops by about 60%, if 1970 and 1971 levels of effort are maintained.

A minimum size limit may be expressed in terms of age, shell size or meat weight (Table 9). Mesh size regulations are not practical for this fishery because of poor selectivity of existing gear. A size limit could be expressed in terms of a minimum shell length of scallops shucked on board vessels but presents obvious difficulties in enforcement. Inspection of meat sizes in the landings seems to be the only practical method of enforcement now available. Such enforcement would direct the vessels from grounds with high density of small scallops or force discards of small scallops that would survive in order to provide for effective benefits.

Table 9. Shell length, age, meat weight and count per pound for Georges Bank scallops.

Shell Length (mm)	Approximate Age (years)	Average* Weight (gm)	No. of meats per pound
80-84.9	4	8.0	56.7
85-89.9	4	9.5	47.2
90-94.9	4	11.3	40.2
95-99.9	5	13.3	34.1
100-104.9	5	15.5	29.4
105-109.9	5-6	17.9	25.5
110-114.9	5-6	20.5	22.1
115-119.9	6	23.4	19.5
120-124.9	6	26.5	17.2
125-129.9	6	29.9	15.2
130-134.9	7	33.5	13.6
135-139.9	8	37.5	12.1
140-144.9	9	41.7	10.9
145-149.9	9	46.3	9.8
150-154.9	9	51.1	8.9
155-159.9	9	56.3	8.1

* Estimated from the equation given by Haynes (1966 ICNAF *Research Bulletin*, No. 3, P. 32-48) for all months combined.

Three ways of defining a sea scallop regulation based on landed meat size were discussed and some comments on the problems associated with each method are as follows:

a) A limit on average meat size in the catch. This measure would allow fishermen to include small scallops in the catch as long as the average meat weight did not fall below the specified limit. Fishermen could spend several days during a 10-14 day trip fishing areas where small scallops abound and the remainder of the trip fishing large scallops. Fairly extensive random sampling of the catch would be necessary to define the average count in the catch with adequate confidence intervals.

b) A limit on average meat size in each bag. After shucking, scallops are packed in cloth bags holding 35-40 pounds and placed on ice in the hold of the vessel. These bags are often off loaded and shipped to retailers without processing, so that they form a convenient unit of the catch. If the regulation were phrased in terms of the maximum count per pound allowed in each bag, the inspecting officer could choose for sampling those bags whose contents obviously exceeded the specified count.

c) Minimum size of meats landed. The prohibition of the landing of meats below a certain size is the most rigorous approach in that it can be directly related to age at first capture. The confidence limits for the shell length/meat weight relationship derived by Haynes (1966) can be used to define the limits of meat size for a given size of shell. This measure would, however, be difficult to enforce because of the large number of meats in the catch (often in excess of 500,000), and because meats of "legal" size scallops might fall below the prescribed limit due to careless cutting of the meats from the shells.

10. Minimum 130 mm Mesh Size

In considering this proposal the Subcommittee concluded that previous studies are still valid. The 130 mm mesh size would provide for increased yield-per-recruit, albeit in some cases very slightly, for cod, haddock and yellowtail flounder in the Convention Area where it is not now in force. Flounders in general would benefit, but assessments for several species have not yet been made.

11. Sustainable Yield of Total Groundfish Resource in Division 5Z (Res.Doc. 72/119).

An attempt was made to assess the change during the last decade in biomass of the total groundfish resource in Div. 5Z, and to estimate the total sustainable yield for the entire groundfish community. Changes in catch-per-haul on USA surveys in Div. 5Z indicated that the biomass of most groundfish species has been reduced by at least 50 percent. This decline was observed for miscellaneous as well as for commercially important species, and this is not surprising in view of the heavy fishing and the relatively non-selective nature of bottom trawls used. However, there is no evidence of a significant increase in biomass of the miscellaneous groundfish species which would be expected to fill ecological niches opened up by reduction in biomass of major species.

Estimates of the maximum sustainable yield (MSY) of the total groundfish resource in Div. 5Z were made by combining estimates for the major species, based on available assessments, with first approximations of sustainable yield for the remaining species. The latter estimates were based on the assumption that the MSY of these species was equivalent to the level of recorded catches which apparently reduced their relative biomass by about 50% from the level of stock size present at the beginning of the last decade. In effect, the stock sizes of miscellaneous species in the early 1960's were treated as if they were virgin stocks, an assumption considered reasonable for purposes of a first approximation.

Summing the MSY's for all groundfish species in the above manner provided a total MSY of 315,000 tons for all groundfish and flounders in Div. 5Z, excluding skates and dogfish. If skates and dogfish were fully exploited, the total MSY might rise by an additional 50,000 tons. This estimate of total MSY of 365,000 tons may be somewhat low depending upon the completeness of nominal catch statistics, particularly for skates. On the other hand, the estimate may be too high depending upon stock recruitment relations. The possibility that stocks may be fished down to levels where recruitment is impaired, as may now be the case for Georges Bank haddock, would of course effect the MSY estimate. At current levels of effort directed primarily at a few major groundfish species, it is quite possible that recruitment might be impaired for many species, thus depressing the productive capacity of the groundfish resource as a whole; and the current rate of research is such that it could be many years before the effects of fishing on all important stocks can be assessed, much less the resolution of the stock-recruitment problem. It is therefore important to improve our measures of total effective effort and to promote better monitoring of the changes in total biomass of groundfish by means of both improved commercial statistics and research vessel surveys.

12. A Preliminary Measure of Total Fishing Effort in Subarea 5 and Statistical Area 6 (Res.Doc. 72/119)

In order to make a preliminary evaluation of the effects of the fishing on the total biomass in Div. 5Z and Statistical Area 6, it was necessary to establish a measure of total effort. Fishing power coefficients were determined for various categories of fishing units based on total catch-per-day of all species, using an analysis of variance technique for a logarithmic linear model. The catch and effort data for all species except menhaden and miscellaneous shellfish were obtained from Tables 4 and 5 of ICNAF *Statistical Bulletin*, Vol. 10-20 (for the years 1960-1970).

Total effort in standard days fished, directed at finfish, was estimated for each year by multiplying the unadjusted effort (days fished) by the fishing power coefficient relative to the standard (USA otter trawler) and by summing over all categories. The results are presented in Table 10. These values clearly illustrate the importance of a standardization procedure for assessing the effort exerted on the fisheries in a particular area. Considering the unadjusted effort data, the effort approximately doubled during the 1960-70 period, while the standardized effort data indicate that effort tripled during the same period.

The Div. 5Z area has an estimated maximum sustainable yield (groundfish, flounders, dogfish and skates) of 365,000 tons. As a first-round working estimate of total sustainable yield of finfish (including herring and mackerel but excluding menhaden) in the Div. 5Z - Statistical Area 6 region an amount of 485,000 tons was added to the Div. 5Z estimate giving a total of 850,000 tons. Landings of 850,000 tons (Table 10) were slightly exceeded in 1965 with an effort of 97,000 standard days fished, but mackerel were not being harvested at that time. If mackerel are not considered, landings of other species almost reached maximum sustainable yields in 1964 at 87,000 standard days fished. (With the 1964 catch-per-day of 8.0 tons, an additional 100,000 tons of mackerel could have been taken with 12,500 days fished, giving a total of 99,500 standard days fished.) The peak effort level in 1969 was 42% more than the 1965-68 average. In 1971 there was a decrease in standardized effort but it was still 23% more than the 1965-68 level. However, the standardized catch/effort decreased in 1969 and 1970, perhaps indicating an overall decrease in the exploited biomass.

All of the estimates presented are first approximations. It is hoped that they will stimulate further discussion and research so that the question of total effort and total biomass relationships can be more adequately considered. This problem is important because it may be impractical to manage many species individually on grounds where they are mixed, and because the inter-specific relations may affect the overall productivity when heavy selective removals of given species occur.

Table 10. Estimate of unadjusted effort, standardized effort, total catch, catch/unadjusted effort, catch/standardized effort for years 1960-1970 in Division 5Z and Statistical Area 6 combined.

Year	Unadjusted Effort	Standardized Effort	Catch	Catch/Unadjusted Effort	Catch/Standardized Effort
1960	41,420	38,257	223,165	5.4	5.8
1961	40,471	36,236	273,050	6.7	7.5
1962	58,304	64,543	470,876	8.1	7.3
1963	64,177	70,696	529,776	8.3	7.5
1964	76,378	86,871	699,139	9.2	8.0
1965	89,591	97,064	887,530	9.9	9.1
1966	69,853	109,565	891,563	12.8	8.1
1967	69,129	77,759	677,848	9.8	8.7
1968	81,870	99,382	833,359	10.2	8.4
1969	117,558	136,487	1,021,941	8.7	7.5
1970	96,589	117,629	787,851	8.2	6.7

13. Advice on Catch Levels (Res.Doc. 72/26)

The scientific results of assessment studies are usually presented as curves relating the average long-term yield to the amount of fishing (fishing effort, or fishing mortality) or to the size at first capture (mesh size). The choice of where to be on these curves is a matter of political or administrative decision to be taken by the Commission. However, some guidance can be given by the Subcommittee, and in setting out the results for different stocks some specific values of fishing mortality or catch have been adopted. The ones generally used have been:

F_{max} = the fishing mortality which will give the maximum yield per recruit;

$F_{0.1}$ = the value of the fishing mortality at which the marginal yield per recruit (*i.e.* the addition to the total yield per recruit resulting from adding an additional unit of mortality) is 10% of the catch per recruit per unit mortality in a very lightly exploited stock. This has been referred to in some documents as F_{opt}.

Replacement catch = that annual catch which will result in the stock abundance at the end of the year being the same as that at the beginning of the year.

In addition there will be some value of the fishing mortality which will give the maximum long-term yield, taking into account the effect on average recruitment. Because of the uncertainties concerning the relation between stock and recruitment, this value of fishing mortality has not been calculated explicitly. However, estimates of the corresponding catch have been presented.

If average recruitment is constant, then F_{max} will also result in the maximum total yield, but it is most unlikely that recruitment will be precisely constant. More probably, at least for reasonably heavily fished stocks, increased fishing will cause some decrease in average recruitment, and the greatest yield will occur at some value of F less than F_{max}.

If the present value of F exceeds F_{max}, the long-term catch will certainly be decreased by increased fishing; if F is less than F_{max} the catch may be increased by more fishing, but not certainly so.

Unless the objective is maximum yield from the stock being considered, irrespective of costs or of the opportunities for increasing catches from alternative stocks, it will be desirable to fish at a level of effort somewhat less than that giving the maximum yield. The choice of the precise point will depend on social and economic factors, but a fairly reasonable guide of where the target level might be in terms of yield per recruit it provided by $F_{0.1}$.

This was chosen on the basis that at this level the net production of an additional vessel will be only one-tenth of that of the first vessel to enter the fishery, and that this is probably the limit of economical operations. Ideally these calculations should be made in terms of total yield, rather than yield per recruit. For most stock-recruitment relations the value of $F_{0.1}$ will occur at a lower point

relative to the maximum on the total yield curve than on the yield-per-recruit curve.

As defined above, $F_{0.1}$ is calculated purely on an economic basis. It occurs to the left of F_{max} to a greater or lesser extent, depending largely on whether the yield falls off slowly or quickly as fishing is decreased from F_{max}. Though the value of fishing mortality giving the maximum total yield is not generally known, it will tend to differ from F_{max} in the same way as does $F_{0.1}$: that is, if the maximum in the yield-per-recruit curve is sharp, then the maximum total yield will probably occur close to F_{max}, but, if the yield-per-recruit curve is flat, the maximum total yield will probably be taken with a fishing mortality considerably less than F_{max}. Thus the F giving the maximum total yield is between $F_{0.1}$ and F_{max}.

APPENDIX II - REPORT OF THE HERRING WORKING GROUP

Chairman: T. D. Iles

Rapporteur: G. H. Winters

The Herring Working Group met on 18-22 May to review and update where necessary the Herring Assessments which were made during the Mid-Term Meeting of the Assessments Subcommittee at FAO, Rome, Italy, 24-29 January 1972 (Res.Doc. 72/1, section IV). Additional information contained in national research reports and other research documents presented at the 1972 Annual Meeting have been considered in updating this Report. However, there were no significant changes in the conclusions regarding the status of the stocks from those presented at the Mid-Term Meeting in January 1972.

1. Stock Identity, Relative Size and Inter-relationships

a) Adult Stage

Evidence presented to the Herring Working Group at this meeting increased our knowledge and understanding of the stock structure and inter-relationships of herring in the ICNAF Area. Figure 1 summarizes the present state of knowledge for the stocks and indicates the boundaries between their spawning areas and the seasonal movements of adults of individual stocks.

The Gulf of St. Lawrence stock occurring in Div. 4RST and 3P, migrates seasonally between the southwestern Gulf of St. Lawrence, where it is fished in the summer, to southwest Newfoundland, where it is fished in autumn and winter. The available evidence indicates that a small but not significant proportion of the stock may move into Div. 4Vn. The Banquereau stock in Div. 4Vs and 4Wa (Chedabucto Bay), fished mainly in the winter both offshore and inshore, probably does not move northward into the Gulf nor southward into the main part of Div. 4W.

Of particular importance are the stocks to the south and west of the Div. 4V-4W boundary (see double lines in Fig. 1). The information available at present indicates that each of the areas A, B and C in Fig. 1 (which correspond to the areas for which proposals on catch limitation were discussed at the Special Commission on Herring, 31 January - 5 February 1972) contains a separate independent spawning stock (*i.e.* the Nova Scotia stock, Gulf of Maine stock and Georges Bank stock respectively).

USSR data confirmed that the herring fished on the Scotian Shelf in Div. 4W in winter are members of the Nova Scotia stock (A in Fig. 1) which spawns in autumn off southern Nova Scotia (Div. 4Xa) and that this stock is distinct from the Banquereau stock. The Georges Bank stock (C in Fig. 1), which includes the herring spawning in the Nantucket Shoals area, moves from its spawning area in Div. 5Ze to the southwest after spawning and the over-wintering concentrations of it are fished in Div. 5Zw and Subarea 6 in the period December-March. The distribution of the Gulf of Maine stock (B in Fig. 1) outside the spawning season is not yet known, but it is possible that some of its members also move south and west after spawning, joining the over-wintering Georges Bank stock in Div. 5Zw and Subarea 6, although US and USSR biochemical and serological data indicate that its members cannot contribute more than 10% of the herring in this area.

In addition to the major groups defined above, small "local" spawning groups are known to occur in areas A, B and C but there is no evidence that their yield potential is significant in relation to that of the major groups.

b) Juvenile Stage

The situation regarding the juvenile stages of these three major stocks is not as clear. Three major juvenile stocks should be involved and the simplest assumption is that the post larval and juvenile stages of each stock are also confined to their respective adult areas. There is evidence that this is so for the Nova Scotia stock. The majority of the late larval stages from this stock occurs in the eastern portion of the Bay of Fundy, where large numbers of larvae were found during several winter surveys in the 1960's. Differences in vertebral counts of the juveniles on the Nova Scotia side and the New Brunswick side of the Bay of Fundy were found. This and other evidence suggests that the Nova Scotia spawning stock does not contribute progeny to the New Brunswick juvenile fishery. This further suggests that the juveniles caught on the New Brunswick side of the Bay of Fundy (Div. 4Xb) and along the coastal Gulf of Maine (Div. 5Y) are derived from, and contribute to, other than the Nova Scotia stock. The stock identity of the juveniles from the Gulf of Maine coast, New Brunswick coast, and the offshore juveniles needs further resolution.

Preliminary USSR data for early 1972 indicates a wide offshore distribution of juvenile herring of the 1970 year-class, extending from Emerald Bank (Div. 4Wb), over Georges Bank (Div. 5Ze) and to the south and west of Long Island (Div. 5Zw and Subarea 6). Estimates of abundance are not

available nor has it been determined if this situation is an unusual one, but there is at least a possibility that the offshore banks are over-wintering areas for juvenile herring.

c) Larval Surveys

At the 1971 ICNAF Annual Meeting it was agreed to carry out a joint survey of larval herring in the Georges Bank - Gulf of Maine areas to delimit the major spawning grounds in these areas, to obtain relative estimates of spawning stock size and to obtain information about larval drift and dispersal. Offshore cruises were made sequentially on a standardized grid pattern, and using standardized gear and methods, during the period 5 September - 17 December 1971 by the following research vessels:

Cryos (France)
Delaware II (USA)
Viandra (USSR)
Walther Herwig (Fed.Rep. Germany)
Albatross IV (USA)

Also, four coastal cruises, using the same standard procedures, were made during the period 9 September - 8 November in the Gulf of Maine from Massachusetts Bay to Machias Bay by the small US research vessel *Rorqual*. A survey in the Bay of Fundy and off southwest Nova Scotia was made in October by the Canadian research vessel *Prince*, but different gear and sampling procedures were used. Preliminary reports for most of these cruises were available at the Mid-Term Assessment Meeting. Certain preliminary qualitative and quantitative results have been obtained.

Qualitative Results. The significant sites of larval production detected in the survey were as follows:

Georges Bank: Spawning was concentrated on the northern edge of the bank; significant numbers of larvae were first detected during the second half of September and small larvae were found until the middle of November. Drift and dispersal were in a southwesterly direction in the clockwise gyre. An additional spawning site was located on the western part of the bank just east of the western arm of the Fundian channel. Spawning occurred here later than on the northern edge. Very few larvae were found outside the 100-m isobath. By December, larvae were widely dispersed over the bank.

Nantucket Shoals: Larvae were detected in significant numbers in this area (west of the Great South Channel) first in early November. Dispersal was apparently southwestward but may also have been in part northeastward across the channel on to Georges Bank. This area has been included with Georges Bank in the quantitative estimates given below.

Nova Scotia: The Trinity Ledge - Lurcher Shoal spawning area was readily detectable in the surveys, with larvae occurring in significant numbers during the second half of September. These larvae were larger than those taken on Georges Bank at the same time. Major drift was northward along the eastern side of the Bay of Fundy.

Southwestern Gulf of Maine: The first concentration of larvae detected in this area was off Cape Elizabeth, Maine, during the latter part of September. Dispersal of this group of larvae was mainly shoreward. Concentrations of larvae in the Jeffreys Ledge - Stellwagen Bank areas were detected about the middle of October with dispersal shoreward. Virtually no larvae were found on the oceanic side of Jeffreys Ledge.

Eastern Section of the Maine Coast: A group of larvae, centered off Frenchman's Bay (near the boundary between central and eastern Maine shown in Fig. 5) was found in the first half of September. This larval group presisted until early November with dispersal inshore and southwestward along the coast. The origin of these larvae is unknown.

Quantitative Estimates. In order to get a relative measure of the size of the spawning stocks in the Georges Bank - Nantucket Shoals and Coastal Gulf of Maine areas the absolute numbers of small larvae (<10 mm) were estimated. As the tow profile used in the surveys did not sample all layers of the water column equally, it was necessary to make the simplifying assumption that most larvae caught were in the upper 40 meters. A theoretical calculation of the volume of water sampled in the upper 40-m section of the tow was made and checked against the mean of values for volumes of water filtered in actual 40-m tows. These values check quite closely and were used to convert the numbers of larvae per tow to numbers of larvae under one square meter. By calculating the size of the surveyed area and taking the mean number of larvae per square meter, estimates of the total number of larvae were obtained (Table 1).

Table 1. Estimated total numbers (x 10^{-9}) of larvae (<10 mm) by cruise and area.

Ship	Date	Georges Bank	Coastal Gulf of Maine
Rorqual (USA)	9 Sept - 16 Sept		9.4
Cryos (France)	10 Sept - 24 Sept	260	
Rorqual (USA)	22 Sept - 1 Oct		15.2
Delaware (USA)	21 Sept - 3 Oct	470	
Viandra (USSR)	9 Oct - 25 Oct	200	
Rorqual (USA)	13 Oct - 25 Oct		130.0
Rorqual (USA)	27 Oct - 8 Nov		1.7
W. Herwig (F. R. Germany)	31 Oct - 12 Nov	420	
Albatross (USA)	2 Dec - 17 Dec	17	

From these estimates a production curve was drawn and a rough measure of the relative numbers of larvae produced in the two areas was obtained by comparing the areas under the production curves. According to this comparison, ten times as many herring larvae were produced on Georges Bank - Nantucket Shoals area in 1971 as were produced in Coastal Gulf of Maine area.

2. Fishery Trends

Tables 2-5 give the herring catches by country and area for the years 1968 to 1971 respectively. The grouping of catches by ICNAF statistical divisions and subdivisions to provide the catch data for the stocks delineated in Fig. 1 is underlined in the row of totals at the bottom of each table. Catches in Subarea 6 are allocated entirely to the Georges Bank stock. These tables provide a more refined and accurate breakdown of catches than presented previously and include up-to-date information on catches by non-member countries. Comprehensive non-member catch data for the period 1966-71 were presented by Dr Ranke of the Sea Fisheries Institute, Rostock.

A summary of catches (all countries combined) for the period 1961-71 is given in Table 6 by subdivisions and by stocks. The total Northwest Atlantic herring catch in 1971 was 729,000 tons, 134,000 tons less than the 1970 catch, and 236,000 tons less than the peak catch of 965,000 tons reported in 1969. The catch in 1971 from the Georges Bank stock (251,000 tons) was slightly greater than that for 1970 (247,000 tons). The catch from the Gulf of Maine stock declined by 30% (89,000 → 63,000 tons), that of the Nova Scotia stock by about 43% (148,000 → 85,000 tons), that of the Gulf of St. Lawrence stock by 16% (316,000 → 264,000 tons), but that of the Banquereau stock increased by 5% (63,000 → 66,000 tons).

The catches from the Nova Scotia, Gulf of Maine (including the New Brunswick juvenile catch), and Georges Bank stocks are shown in Fig. 2. For the Gulf of Maine stock and the Nova Scotia stock, the total catches of juveniles are now available for the first time, and Fig. 3 shows the total catch and the catch of juveniles for each stock over the period 1963-71; for the Gulf of Maine stock the juvenile catch is subdivided into its New Brunswick (Div. 4Xb) and Gulf of Maine (Div. 5Y) components. These data show that, in the fisheries on these stocks during the mid-1960's, the great increase in total catch was made up largely of increases in the catch of adults, particularly from the Nova Scotia stock. Catches of juveniles from the Nova Scotia stock have remained relatively constant, but those of the Gulf of Maine stock have declined steadily since 1968 from more than 100,000 tons to 20,000 tons in 1971. The rate of decline of the catch of juveniles was more rapid than that of the total catch. From 1970 to 1971 the Div. 5Y catch of juveniles declined from 11,000 to 8,000 tons; in the same period the catch of juveniles in Div. 4Xb declined from 30,000 to 12,000 tons (Table 6). A significant proportion of the decline in Div. 4Xb resulted from the application in 1971 of measures restricting the catching of yearling herring (less than about 12 cm) in the New Brunswick purse seine fishery in autumn and winter.

Table 2. Herring landings ('000 tons) by country and area (stock) in 1968. (A = adults, J = juveniles)

Country	Subarea 3	Div. 4RST	Div. 4Vn	Div. 4Vs	Div. 4Wa	Div. 4Wb	Div. 4Xa		Div. 4Xb		Div. 5Y		Div. 5Z	Subarea 6	Total
							A	J	A	J	A	J			
Can(M)	15	103	Ø	-	1	-	130	13	9	75	22	-	14	-	382
Can(N)	130	16	1	-	-	-	-	-	-	-	-	-	-	-	147
Germany (FR)	-	-	3	7	-	-	-	-	-	-	-	-	71	Ø	81
Iceland	-	-	-	-	-	-	-	-	-	-	-	-	Ø	-	Ø
Poland	Ø	-	-	-	-	Ø	-	-	-	-	-	-	64	12	76
Romania	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2
USSR	-	-	-	1	-	2	-	-	-	-	-	-	127	16	146
USA	-	-	-	-	-	-	-	-	-	-	12	29	1	Ø	42
Non-member (GDR)	-	-	-	8	-	-	-	-	-	-	-	-	59	1	68
Non-member (Others)	Ø	-	-	-	-	-	-	-	-	-	-	-	7	-	7
Total	145	119	4	16	1	2	130	13	9	75	34	29	345	29	951
	Gulf of St.Lawrence		Banquereau				Nova Scotia		Gulf of Maine				Georges Bank		

4Wa = Chedabucto Bay area
4Wb = Div. 4W offshore

4Xa = Div. 4X offshore and Nova Scotia inshore
4Xb = New Brunswick side of Bay of Fundy

Table 3. Herring landings ('000 tons) by country and area (stock) in 1969. (A = adults, J = juveniles)

Country	Subarea 3	Div. 4RST	Div. 4Vn	Div. 4Vs	Div. 4Wa	Div. 4Wb	Div. 4Xa		Div. 4Xb		Div. 5Y		Div. 5Z	Subarea 6	Total
							A	J	A	J	A	J			
Can(M)	-	143	Ø	-	28	-	82	11	4	43	10	-	1	-	322
Can(N)	146	15	2	-	Ø	-	-	-	-	-	-	-	-	-	163
Germany (FR)	-	-	9	13	-	Ø	-	-	-	-	11	-	62	-	95
Iceland	-	-	-	-	-	-	-	-	-	-	-	-	13	-	13
Norway	-	-	-	...	-	...	-	-	-	-	...	-	1	-	1
Poland	-	-	-	5	-	-	-	-	-	-	-	-	32	13	50
Romania	-	-	-	-	-	-	-	-	-	-	-	-	Ø	-	Ø
USSR	-	-	-	53	-	12	-	-	-	-	-	-	101	38	204
USA	-	-	-	-	-	-	-	-	-	-	6	23	2	2	33
Non-member (GDR)	-	-	...	36	-	1	-	-	-	-	5	-	41	1	84
Total	146	158	11	107	28	13	82	11	4	43	32	23	253	54	965
	Gulf of St.Lawrence		Banquereau				Nova Scotia		Gulf of Maine				Georges Bank		

4Wa = Chedabucto Bay area
4Wb = Div. 4W offshore

4Xa = Div. 4X offshore and Nova Scotia inshore
4Xb = New Brunswick side of Bay of Fundy

Table 4. Herring landings ('000 tons) by country and area (stock) in 1970. (A = adults, J = juveniles)

Country	Subarea 3	Div. 4RST	Div. 4Vn	Div. 4Vs	Div. 4Wa	Div. 4Wb	Div. 4Xa		Div. 4Xb		Div. 5Y		Div. 5Z	Subarea 6	Total
							A	J	A	J	A	J			
Can(M)	-	161	2	-	29	-	76	12	3	30	18	-	ø	-	331
Can(N)	135	20	3	-	ø	-	-	-	-	-	-	-	-	-	158
Germany (FR)	-	-	2	3	-	ø	-	-	-	-	6	-	82	-	94
Japan	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Poland	-	-	ø	1	-	ø	-	-	-	-	-	-	55	16	72
Romania	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
USSR	-	-	-	13	-	59	ø	-	-	-	-	-	39	22	134
USA	-	-	-	-	-	-	-	-	-	-	18	11	1	1	31
Non-member (GDR)	-	-	-	10	-	ø	-	-	-	-	3	-	27	1	41
Total	135	181	7	27	29	60	76	12	3	30	45	11	207	40	863
	Gulf of St.Lawrence		Banquereau				Nova Scotia		Gulf of Maine				Georges Bank		

4Wa = Chedabucto Bay area
4Wb = Div. 4W offshore

4Xa = Div. 4X offshore and Nova Scotia inshore
4Xb = New Brunswick side of Bay of Fundy

Table 5. Herring landings ('000 tons) by country and area (stock) in 1971. (A = adults, J = juveniles)

Country	Subarea 3	Div. 4RST	Div. 4Vn	Div. 4Vs	Div. 4Wa	Div. 4Wb	Div. 4Xa		Div. 4Xb		Div. 5Y		Div. 5Z	Subarea 6	Total
							A	J	A	J	A	J			
Can(M)	-	132	8	-	53	-	45	10	1	12	15[a]	-	13	-	289
Can(N)	118	14	3	-	1	-	-	-	-	-	-	-	-	-	136
Germany (FR)	-	-	-	-	-	-	-	-	-	-	2	-	55	ø	57
Japan	ø	-	-	-	-	-	1	-	-	-	-	-	2	ø	3
Poland	-	-	-	ø	-	ø	-	-	-	-	-	-	69	11	80
Romania	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
USSR	-	-	-	-	-	29	-	-	-	-	-	-	64	17	110
USA	-	-	-	-	-	-	-	-	-	-	23	8	2	-	33
Non-member (GDR)	-	-	-	1	-	-	-	-	-	-	2	-	15	2	20
Total	118	146	11	1	54	29	46	10	1	12	42	8	221	30	729
	Gulf of St. Lawrence		Banquereau				Nova Scotia		Gulf of Maine				Georges Bank		

[a] Includes an estimated 8,000 tons landed at US ports and not reported in Canadian statistics.

4Wa = Chedabucto Bay area
4Wb = Div. 4W offshore

4Xa = Div. 4X offshore and Nova Scotia inshore
4Xb = New Brunswick side of Bay of Fundy

Table 6. Herring landings ('000 tons) by area (stock), 1961-1971. (A = adults, J = juveniles)

Year	Subarea 3	Div. 4RST	Div. 4Vn	Div. 4Vs	Div. 4Wa	Div. 4Wb	Div. 4Xa A	Div. 4Xa J	Div. 4Xb A	Div. 4Xb J	Div. 5Y A	Div. 5Y J	Div. 5Z	Subarea 6	Total
1961	4	20	←——	3	—→		←——	58	—→		3	23	68	-	179
1962	5	36	←——	12	—→		←——	68	—→		1	69	151	-	342
1963	6	42	1	-	2	3	25	5	4	32	1	67	97	-	285
1964	4	44	Ø	-	2	1	37	12	5	40	8	20	131	-	304
1965	8	49	Ø	-	1	6	65	12	5	44	3	31	41	-	265
1966	23	43	Ø	-	1	2	122	8	6	55	4	24	137	6	431
1967	78	69	Ø	Ø	1	1	128	13	6	50	24	19	216	4	609
1968	145	119	4	16	1	2	130	13	9	75	34	29	345	29	951
1969	146	158	11	107	28	13	82	11	4	43	32	23	253	54	965
1970	135	181	7	27	29	60	76	12	3	30	45	11	207	40	863
1971[a]	118	146	11	1	54	29	46	10	1	12	42	8	221	30	729
Stock	Gulf of St.Lawrence		Banquereau				Nova Scotia		Gulf of Maine				Georges Bank		

[a] Preliminary statistics.

4Wa = Chedabucto Bay area
4Wb = Div. 4W offshore
4Xa = Div. 4X offshore and Nova Scotia inshore
4Xb = New Brunswick side of Bay of Fundy

3. Herring Assessment

a) Division 5Y Herring Assessment

Fishing and Abundance Changes. The traditional USA herring fishery in Div. 5Y has changed greatly in recent years (Table 6). The 1971 juvenile catch (fish of 1-3 years old) is less than one-sixth of that in the period from the late 1940's through the early 1960's. The decrease in abundance of recent year-classes is indicated by the decline in total catch of juveniles and also by other indices of abundance. Figure 4 presents the total catch of stop seines and weirs, and an adjusted index of abundance computed from the catch per effort of selected fishermen from the western Maine juvenile fishery. Stop seine fishermen with catches for 5 years or more (63 fishermen) were used in determining the index of abundance. An analysis of variance procedure was used for estimating relative catches per fisherman (population densities) which were then standardized against 1951. All indices of abundance of juveniles indicate drastic declines, down to about 10%, of the peak year-classes of the 1950's. The last large year-class occurred in 1961. The estimated juvenile catch of 7,500 tons in 1971 in Div. 5Y was the lowest since 1938 and may be contrasted with the average annual catch of 64,000 tons during the 1950's. The similar slope of the total catch of stop seines and weirs and the adjusted index of abundance indicates a fixed fishing intensity, on the average, during the 1960's.

Beginning in 1967 a substantial adult fishery developed in the western portion of the Gulf of Maine. This adult fishery is concentrated on Jeffreys Ledge, Stellwagen Bank and adjacent areas (Fig. 5), while the traditional USA juvenile fishery is limited to the Maine coastline. The age-composition of herring in the adult fishery, as estimated from USA samples, has shown a decline in the abundance of recent year-classes.

The juveniles, occurring inshore along the Maine coast, probably provide the major source of recruitment to the Div. 5Y adult population. The 1964-1967 year-classes were low in abundance, and those of 1968 and 1969 were even smaller (Fig. 4 and Table 6).

The 1960-1963 year-classes contributed greatly to the adult fishery since 1967. The contribution of herring of age 7 and older to this fishery was 29%, 36%, 60%, 53%, and 21% for 1967 to 1971. In 1972, the contribution of these year-classes (1963 and before) to the fishery should be very small and the weak 1968 and 1969 year-classes will be expected to provide a significant proportion of the catch (on the basis of the 1971 age composition - about 25% of the total catch). By 1973,

because the 1964-1967 year-classes will be further reduced in size and because the 1968-1969 year-classes are weak, unless there is good recruitment from the 1970 year-class, adult stock size will have decreased significantly.

It is possible that a portion of the juvenile herring stock found on the west side of the Bay of Fundy in Div. 4X are also part of the Gulf of Maine stock complex. The New Brunswick weir catch which consists mainly of 2-year-old fish has declined drastically since 1968. The 1971 weir catch of 9,500 tons is only about one-fourth of that in 1968.

It may be expected, therefore, that even if the New Brunswick juveniles contribute to the Div. 5Y fishery, by the end of 1972 when the 1960-1963 year-classes will have probably passed through the fishery, the Div. 5Y adult stock will decline even without a fishery.

Estimates of Mortality. Estimates of juvenile fishing mortality were obtained by comparing catches of age 2 herring with the mean stock sizes at age 2 estimated from the adult catches. The number of adults caught are shown in Table 7. A minimum estimate of mean stock size at age 2 was obtained by using Pope's cohort analysis (Res.Doc. 71/116), assuming that the 1962-1965 year-classes are still being fished, 1960-1961 year-classes are not still being fished, and assuming F's of 0.4 and 0.6 in the terminal year of catches (Table 8). The estimates were made according to three assumptions of natural mortality: M constant at 0.2, M constant at 0.3, and M's increasing with age of 0.15, 0.15, 0.15, 0.25, 0.36, 0.47, 0.58, 0.69, 0.81 and 0.92 for ages 2 to 11 respectively.

Table 7. Numbers of herring (000's) by year-classes caught in the Div. 5Y fishery for adults during 1967-1971.

Year Class	Year of Capture					Total
	1967	1968	1969	1970	1971	
1956	359.2					359.2
1957	700.4	1,960.1				2,660.5
1958	736.3	2,412.4	1,684.8			4,833.5
1959	1,412.1	3,166.3	2,603.7	2,666.0		9,848.1
1960	17,582.5	18,387.3	11,027.5	13,774.1	3,733.1	64,504.5
1961	28,669.3	27,974.2	21,123.5	27,992.6	8,461.6	114,221.2
1962	15,895.2	29,280.1	26,617.9	23,344.2	12,692.4	107,829.8
1963	6,336.4	29,458.2	22,475.8	26,942.5	18,440.9	103,653.8
1964	680.7	17,467.2	9,850.1	26,835.0	30,331.6	85,164.6
1965	43.5	17,734.4	6,191.9	18,349.5	42,326.6	84,645.9
1966		563.9	39,044.4	26,369.6	39,134.9	105,112.8
1967			1,722.3	9,326.9	26,117.7	37,166.9
1968				3,419.3	26,639.2	30,058.5
1969					730.1	730.1
Total	72,415.6	148,404.2	142,341.9	179,019.7	208,608.0	750,789.4

Dividing the catch of age 2 herring by the mean stock size provides an estimate of fishing mortality for each year-class under different assumptions of parentage of juvenile populations (Table 8). The catch of age 2 herring is combined for Western and Central Maine, all of Maine, and Maine and New Brunswick. The estimates of F range from 0.3 to 6.4 and are highest for the assumption that the New Brunswick juveniles recruit to the adult Div. 5Y fishery. Even allowing for emigration of New Brunswick juveniles elsewhere than to Div. 5Y, the average of estimates of F in the juvenile fishery are still of the order of 1.0.

Table 8. Estimates of juvenile fishing mortality assuming that all juveniles recruit to the Div. 5Y adult herring fishery. (Juvenile mean stock sizes are calculated according to fishing mortalities (F_T) in the terminal year of catch of 0.4 and 0.6.)

	YEAR CLASS											
	1960		1961		1962		1963		1964		1965	
	F_T		F_T		F_T		F_T		F_T		F_T	
	0.4	0.6	0.4	0.6	0.4	0.6	0.4	0.6	0.4	0.6	0.4	0.6
Estimated mean stock size at age 2 (millions)												
Assuming M=.2	764	761	492	458	461	419	562	505	487	420	489	412
M=.3	1,081	1,069	903	827	776	691	817	726	701	590	504	427
M varies	1,508	1,410	1,177	1,023	774	663	684	598	532	449	476	399
Age 2 catch from western and central Maine (millions)	1738		565		433		558		187		155	
$\hat{F}$ assuming M=.2	2.27	2.28	1.15	1.23	0.94	1.03	0.99	1.10	0.38	0.44	0.32	0.38
M=.3	1.61	1.63	0.63	0.68	0.56	0.63	0.68	0.77	0.27	0.32	0.31	0.36
M varies	1.15	1.23	0.48	0.55	0.56	0.65	0.82	0.93	0.35	0.42	0.33	0.39
Age 2 catch from all of Maine (millions)	2238		772		475		933		292		268	
$\hat{F}$ assuming M=.2	2.93	2.94	1.57	1.69	1.03	1.13	1.66	1.85	0.60	0.70	0.55	0.65
M=.3	2.07	2.09	0.85	0.93	0.61	0.69	1.14	1.29	0.42	0.49	0.53	0.63
M varies	1.48	1.59	0.65	0.75	0.61	0.72	1.36	1.56	0.55	0.65	0.56	0.67
Age 2 catch from Maine and New Brunswick (millions)	3309		1741		2138		2805		2694		2551	
$\hat{F}$ assuming M=.2	4.33	4.35	3.54	3.80	4.64	5.10	4.99	5.55	5.53	6.41	5.22	6.19
M=.3	3.06	3.10	1.93	2.11	2.76	3.09	3.43	3.86	3.84	4.57	5.06	5.97
M varies	2.19	2.35	1.48	1.70	2.76	3.22	4.10	4.69	5.06	6.00	5.36	6.39

Other estimates also indicate that mortality occurring in the Gulf of Maine herring fishery is large. Catch curves of age 2 herring by week, adjusted for moon phase, were used to estimate mortality rates. The original estimates were made for varying amounts of time but the estimates of Z in Table 9 are for a 10-week period in all cases. These estimates are large even assuming that the fishery lasted only 10 weeks. The juvenile herring along the Maine coast are generally taken during June and July, but there is some evidence that the decline in catch during the warm summer months is not entirely due to mortality but, to some degree, to the movement of the herring to deeper water or eastward along the Maine coast. Catch curves would thus over-estimate the total mortality rates.

Despite obvious uncertainties about the reliability of the data, all mortality estimates are large, and the exploitation rate (E) is probably well over 0.65.

Table 9. Estimates of total mortality rates from catch curve analysis of the Maine juvenile fishery for a 10-week period (95 percent confidence intervals in parentheses).

Year	Total Mortality Rate	
	Western Maine	Central Maine
1953	1.50 (1.488 - 1.503)	0.83 (0.829 - 0.836)
1954	1.48 (1.474 - 1.485)	1.18 (1.173 - 1.181)
1955	1.54 (1.528 - 1.541)	1.31 (1.300 - 1.310)
1956	1.74 (1.732 - 1.743)	1.23 (1.225 - 1.231)
1957	2.51 (2.500 - 2.517)	1.16 (1.160 - 1.165)
1958	1.20 (1.200 - 1.207)	0.90 (0.894 - 0.899)
1959	1.99 (1.979 - 2.000)	1.18 (1.176 - 1.184)
1960	1.45 (1.447 - 1.458)	0.78 (0.777 - 0.781)
1961	1.32 (1.311 - 1.325)	0.76 (0.755 - 0.764)
1962	1.59 (1.587 - 1.595)	0.79 (0.785 - 0.788)
1963	1.71 (1.699 - 1.711)	0.93 (0.931 - 0.938)
1964	0.75 (0.744 - 0.750)	0.93 (0.928 - 0.939)
1965	1.04 (1.039 - 1.051)	1.05 (1.049 - 1.056)
1966	0.64 (0.631 - 0.640)	0.91 (0.902 - 0.914)
1967	0.78 (0.778 - 0.789)	0.79 (0.785 - 0.792)

Estimates of Adult Stock Sizes. In order to obtain a rough estimate of the relation of stock size to catch in the adult fishery, the following approximations were made:

1) Juvenile populations were estimated by applying the catch equation separately to the juvenile catch in Div. 5Y and in Div. 5Y plus the New Brunswick side of the Bay of Fundy, assuming conservative estimates of F of 0.6 and 0.8 with an M of 0.2 in the juvenile fishery.

2) Natural mortality rates of M = 0.2 and M = 0.3 were applied over the years to the numbers remaining after the juvenile fishery, to arrive at a year-class size two years later.

The results of these computations are presented in Table 10.

Table 10. Population sizes and removals (millions) from the Gulf of Maine herring stock.

Based on Div. 5Y juvenile catches only

Year-classes	Average age 2 catch (millions)	Age 2 stock size at start of year (millions)	Age 2 fishing mortality rate	Age 2 natural mortality rate	Age 4 stock size at start of year (millions)
1945-1959	917	2,220	.6	.2	605
	917	2,317	.6	.3	507
	917	1,813	.8	.2	335
	917	1,890	.8	.3	277
1960-1963	1,032	2,497	.6	.2	770
	1,032	2,609	.6	.3	650
	1,032	2,040	.8	.2	467
	1,032	2,127	.8	.3	391
1964-1967	296	718	.6	.2	163
	296	748	.6	.3	131
	296	587	.8	.2	76
	296	610	.8	.3	57
1968-1969	186	449	.6	.2	130
	186	470	.6	.3	107
	186	367	.8	.2	77
	186	383	.8	.3	60

Continued

Table 10. Continued

Based on Div. 5Y plus the New Brunswick side of the Bay of Fundy juvenile catches

Year-classes	Average age 2 catch (millions)	Age 2 stock size at start of year (millions)	Age 2 fishing mortality rate	Age 2 natural mortality rate	Age 4 stock size at start of year (millions)
1960-1963	1,904	4,609	.6	.2	1,410
	1,904	4,813	.6	.3	1,279
	1,904	3,764	.8	.2	856
	1,904	3,924	.8	.3	792
1964-1967	1,497	3,624	.6	.2	1,076
	1,497	3,784	.6	.3	1,005
	1,497	2,960	.8	.2	670
	1,497	3,085	.8	.3	623
1968-1969	670	1,624	.6	.2	506
	670	1,694	.6	.3	460
	670	1,326	.8	.2	320
	670	1,381	.8	.3	290

Catch Quotas. From the late 1940's through to the early 1960's the annual sardine catch in Maine averaged 65,000 tons (approximately 1,800 million fish). About 28,000 tons (917 million herring) of this average were age 2 herring caught each year from year-classes 1945 to 1959. In the period from 1962 to 1965, the 1960-1963 year-classes provided an annual catch of 1,000 million of age 2 herring. This increase in annual catch over earlier years was due to the two good year-classes of 1960 and 1961. After these two year-classes passed through the juvenile fishery, the catches of age 2 herring declined sharply and the weaker year-classes 1964-1967 provided annual catches of only 296 million herring. Year-classes 1968-1969 were even weaker producing a catch of only 186 million age 2 fish annually. The fishery on the New Brunswick side of the Bay of Fundy caught an average of 43,000 tons (2,100 million) of herring annually during the years 1963-1965, 62,000 tons (3,400 million) annually in the years 1966-1969, and 23,000 tons (1,400 million) in the years 1970 and 1971. The winter purse seine fishery took about 54% of the catches in recent years. This fishery caught very small herring, about 15-17 months of age, 10-11 cm in total length, and about 15 gm in weight. The New Brunswick weir fishery caught herring a few months older, but also of small size. More juvenile herring have been taken in the New Brunswick purse seine fishery since 1963 (approximately 12,000 million) than adult herring taken from the Georges Bank fishery since 1961 (approximately 9,000 million). This purse seine fishery was virtually eliminated by late 1971 as a result of a size-restriction conservation measure, thereby greatly reducing the fishing mortality on these young herring in Div. 4Xb (Res.Doc. 72/12).

The upper part of Table 10 indicates a rapid decline in abundance of herring at age 4 for the 1964 and younger year-classes compared with the greater abundance of 1945-1963 year-classes, the average abundance of year-classes 1964-1967 for the Div. 5Y juvenile fishery being only 15-20% of that of year-classes 1960-1963. The decline in year-class size in the New Brunswick herring fishery occurred a little later; compared with 1960-1963 year-classes, the decline was 22% for the 1964-1967 year-classes and an additional 55% for the 1968-1969 year-classes.

The average adult catch of herring in Div. 5Y was 110 million fish (25,000 tons) in 1967-1968, and it increased to 161 million fish (36,000 tons) in 1969-1970 and to 209 million (47,000 tons) by 1971. It is obvious that the adult herring catch cannot continue to increase or even to remain at the present level as the stock size declines. A catch of 200 million adult fish under levels of recruitment currently observed in the juvenile fishery is approaching the level whereby the catch may exceed recruitment to the adult fishery. This level of recruitment depends on whether the New Brunswick juvenile herring recruit to the Div. 5Y adult stock. The estimates of mortality rates in Table 8 suggest that only a small proportion of them do so, while probably all of the herring supporting the Maine fishery do recruit to the Div. 5Y fishery for adults. Even if all of the New Brunswick juvenile herring recruit to the Div. 5Y adult fishery, the catches for 1972-74 should not be greater than the current level of 40,000 tons if the spawning stock is to be maintained at its present size due to the very poor 1968 and 1969 year-classes. But, as is indicated above, probably only a small proportion of them do so, and the catch levels for 1972-74 should be substantially less than 40,000 tons. If no New Brunswick juveniles recruit, then the estimated catch for 1972 should be 23,000 tons to maintain the spawning stock size.

At present, therefore, the best judgement would suggest that the 1972 adult catch should not appreciably exceed 23,000 tons. This, if maintained and with juvenile catches at reasonably low levels, would allow good recruiting year-classes to increase the size of the adult stock.

b) Div. 5Z - Statistical Area 6 Herring Assessment

Since 1961 the Georges Bank herring fishery has been supported largely by the 1960 and 1961 year-classes. These very strong year-classes provided 58% of the catch by number from 1964 to 1966 and 24% from 1967 to 1969. Estimates of age composition are based on weighted averages of the available national data. The 1960 year-class finally passed through the fishery in 1971 and the catch of the 1961 year-class was insignificant. There have been no year-classes as strong as those of 1960 and 1961 during the period since the 1961 year-class entered the fishery, a period in which the international herring fishing fleet working in that area grew to a very large size. The overall stock size declined during this period by 75-90% as recruitment failed to replace the losses (Tables 11 and 12).

In 1970 and 1971 the large 1960 and 1961 year-classes did not contribute significantly to the landings and the herring fishery began to take larger quantities of fish of the younger age-groups. In 1967 and 1968, 3- and 4-year-old herring accounted for approximately 8% of the total catch in number. In 1970 and 1971 the frequency had increased to 49%.

Estimates of stock size and fishing mortality from 1967 to 1971 are given in Table 11. For the years 1967-70 these estimates were derived by virtual population analysis, assuming M = 0.2. Such estimates for the year 1971 are not possible, and the fishing mortality in 1971 was therefore estimated by assuming that the proportional change for each age group from 1970 to 1971 was in the same ratio as that observed from 1969 to 1970.

Table 11. Herring stock size and catch (millions), and fishing mortality for Division 5Z.

	Year	Age 9+	9	8	7	6	5	4	3	Total Number	Weight (000 tons)
Stock	1967	20[a]	23[a]	133[a]	1100[a]	1302[a]	891[a]	1322[a]	1128[a]	5919	1271
	1968	13[a]	64[a]	557[a]	839[a]	632[a]	1027[a]	918[a]	1231[a]	5281	1152
	1969	47[a]	152[a]	295[a]	306[a]	537[a]	686[a]	960[a]	1245[a]	4228	877
	1970	35[b]	69[b]	80[b]	188[b]	311[b]	596[b]	978[b]	951[a]	3208	626
	1971	43[b]	19[b]	70[b]	144[b]	243[b]	394[b]	644[b]	745[a]	2322	462
	1972	28[b]	17[b]	69[b]	136[b]	143[b]	147[b]	315[b]	745[c]	1600	310
Catch	1967	10	11	49	379	251	108	61	7	876	219
	1968	7	22	337	433	233	336	72	52	1491	373
	1969	24	110	191	189	278	277	210	46	1324	306
	1970	18	30	52	93	122	270	451	125	1160	247
	1971	22	14	50	104	175	284	275	331	1254	262
										Average	
F	1967		0.74	0.53	0.48	0.24	0.14	0.05	<0.01	0.19[d]	
	1968		0.46	1.10	0.85	0.53	0.45	0.09	0.05	0.44[d]	
	1969		1.61	1.25	1.14	0.85	0.59	0.28	0.04	0.52[d]	
	1970		0.63	1.24	0.79	0.57	0.70	0.71	0.16	0.55[d]	
	1971[e]		0.25	1.20	0.54	0.38	0.81	1.31	0.66	0.72[d]	

[a] Stock size calculated from $CZ/F(1-e^{-Z})$

[b] Stock size calculated from $N_{i+1} = N_i e^{-Z_i}$

[c] Assumed to be the same as for 1971.

[d] The average $\hat{F}$ is weighted over year-classes by stock size in number.

[e] Fishing mortality for 1971 was estimated by assuming the same proportional change in 1971 over 1970 as occurred in 1970 over that of 1969.

Table 12. Results of estimates of the spawning stock of herring population on major spawning grounds on the northern Georges Bank, 1964-1971.

Year	Spawning area km^2	Eggs $10^{-6}kg$	Spawning population $10^{-6}kg$
1964	38.8	427.8	1,180
1965	24.3	299.5	530
1966	19.1	76.5	150
1967	-	-	-
1968	5.7	46.1	130
1969	4.0	25.7	60
1970	1.9	6.9	12
1971	1.9	5.2	11

There is evidence that the natural mortality may be greater than 0.2, especially among the older fish. However, among the younger fish, which now make up the bulk of the stock, the probable upper limit to the natural mortality is 0.4. Using values of M higher than 0.2 in the virtual population analysis would increase the estimate of stock size and decrease the estimated value of the current fishing mortality rate, but not to any significant extent. The recommended quota value would be lower in order to maintain the stock size.

The estimation of recruitment of 3- and 4-year-olds in 1972 is critical to the estimation of production and yield in that year. Two-year-old abundance in 1971 is not known; hence the recruitment of this year-class in 1972 cannot be predicted. The effect of different assumptions about this on yields in 1972 are specified. Age 3 fish have not been completely recruited to the fishery in the past, nor are they expected to be so in 1972. However, the relative catch of age 3 fish in 1971 probably increased significantly over that in previous years. Because of the scarcity of older fish in 1972, the 3-year-old contribution is expected to be relatively greater. The proportional increase in catch from age 3 to age 4 for year-classes 1964 to 1966 has been by a factor of 8.1 on the average. The proportional increase for the 1967 year-class was only 2.2 times indicating that herring at age 3 recruited in a higher proportion in 1970 than in previous years. If there were no change in recruitment patterns, a considerable proportion of age 4 herring in 1971 would have been expected from the 1967 year-class. Since this was not so, the 1967 year-class cannot be regarded as above average in abundance. Similar observations on changes in recruitment pattern were made in two North Sea herring stocks in the 1950's. It follows that the large 1971 catch of the 1968 year-class does not necessarily mean that it is a strong one (although data from the Polish catches show an increase in catch per effort of 3-year-olds in 1971). Evidence from juvenile catches of neighboring stocks (Div. 5Y and 4X) indicates that this year-class was low in abundance. (There has been reasonable agreement in indices of abundance between recruiting year-classes to Georges Bank and year-classes of young herring in Div. 5Y.)

Fishing effort on the Georges Bank herring stock (Div. 5Z and Subarea 6) increased through 1970 as indicated below. The effort data from 1967 through 1970 are total international effort weighted by the fishing power of various sized vessels. Effort data for 1971 were calculated assuming catchability did not increase in 1971 and that the 1968 year-class was not a strong one, indeed below average, in which case the effort must have increased in inverse proportion to the decrease in mean exploited stock size in order to maintain a catch of 251,000 tons. (The figure of 177,500 days will be revised when the full effort data for 1971 are available.)

Year	Catch ('000 tons)	Effort ('000 days)
1967	218.6	31.3
1968	373.4	103.3
1969	305.4	95.8
1970	245.8	122.8
1971	251.0	(177.5)

During the 1967-71 period, the stock size, estimated on the assumption of below average size of the 1968 year-class, declined from 5,919 million to 2,322 million fish. A stock size in 1972 of 1,600 million fish has been projected (Table 11). This represents only 24% of the maximum stock size of 6,605 million fish in 1964. It may be noted that, on the one hand, there are much higher estimates of the total decline in the stock size since 1964 (75-99%, see Tables 11 and 12), and, on the other hand, there was no decrease in catch-per-unit of effort of some fleets from 1970 to 1971. The value for the total decline in stock up to 1972, given in Table 11, is therefore considered reasonable.

The above estimates of stock size in 1972 assumes recruitment of age 3 fish to be the same as in 1971. With the estimated reduction in stock size in 1972, it is possible to return to the level of stock size of 1971 by 1973 only with very large recruitment in 1972. Figure 6 shows the stock size at the beginning of 1973 that would result from various levels of fishing mortality and recruitment in 1972. The fishing mortality used was the average value over age-groups 3-9 weighted by age-group abundance in numbers. It is important to note that values of F estimated in this way are not directly comparable to those usually used with yield-per-recruit curves, because all fish of age-group 3 are not fully recruited. Weighted average fishing mortality of ages 5-9 (the fully recruited age-groups until 1970-71) has been greater than that of ages 3-4. If it is assumed, therefore, that at present age 3 and 4 herring are not fully recruited, an F of 0.5 over ages 5-9 is comparable to an F of 0.3 on ages 3-9 (Fig. 7). Since an F of 0.5 is the maximum that should be allowed on the Georges Bank herring stock to obtain maximum yield-per-recruit, an F of 0.3 on ages 3-9 should be the upper limit under presently estimated recruitment rates of ages 3 and 4. From Fig. 6 it may be determined that this indicates a catch of 70,000 tons in 1972, assuming recruitment of age 3 fish to be at the same level as in 1971. This catch would provide for a slight increase in stock size from 305,000 to 330,000 tons in 1973, regaining 17% of the expected loss in stock size from 1971 to 1972.

This reduction in catch must be made to stop the very sharp decline in stock size that is now taking place. An F of 0.3 in 1972 represents a reduction of 63% in F and implies a reduction of 71% in total catch from 1971. The estimated stock levels are shown in Fig. 6 for 1969 to 1972 under various assumptions for F in 1972.

Merely to arrest the decline in the size of the stock with no provision for any stock increase, an F of 0.44 could be placed on the stock (assuming steady recruitment), which would yield a catch of 95,000 tons in 1972. Such a procedure is not advisable since it does not allow for any rebuilding of the stock and will cause a further decline in stock size if poorer recruitment appears in 1972 and 1973 than in 1971. The catch quota would then have to be revised downward. Even a delay of one year of the implementation of this new low level of catch would mean the stock could be reduced to such a low level that it would require even more severe restrictions to rebuild the stock to the level that existed in 1971.

If M is taken to be 0.3 and the other assumptions hold, to arrest decline in stock size the 1972 catch would be 84,000 tons. If M increases with age the catch quota is similarly reduced (Res. Doc. 72/24).

At a low level of stock size the probability of achieving good recruitment must be diminished. Therefore, to reduce the danger of successive years of poor recruitment and allow the stock to increase, an F of 0.2 is recommended. This would restrict the 1972 catch to 50,000 tons and would, if 1972 recruitment were at the 1971 level, permit the stock to regain 31% of the reduction in stock size during 1971. This would bring the stock back to a size of 350,000 tons at the beginning of 1973, again assuming 1971 recruitment levels in 1973.

Since the current low stock levels mean that the fishery depends greatly on annual recruitment, future determination of allowable yields depends almost entirely on early estimates of recruitment. An overestimate of recruitment by as little as 25% could cause a further significant decline in stock size. Figure 6 shows the effect of recruitment reduced by 25% in 1972 over that of 1971. Under these circumstances, a regulated F of 0.44 would mean a stock decrease of 25,000 tons through 1972.

A 25% reduction in recruitment from the 1971 level requires an F of 0.3 to maintain the 1972 stock level, and this corresponds to a catch of 70,000 tons in 1972. An increase in stock size from the 1972 level can be safely obtained only by achieving an F of 0.2 or less, and this corresponds to a maximum catch of 50,000 tons in 1972.

While estimates of recruitment can be too low or too high, under present circumstances, in which the proportion of 3- or 4-year-old fish taken by the fishery is increasing, overestimates of recruitment are more probable than underestimates. Further, if the Commission acts on an assessment of lower incoming recruitment than is actually the case, the subsequent stock will be greater than expected, and subsequent catches can be increased. If a readjustment of quotas can be done quickly, this procedure will involve no loss and it may even involve some increase in the catch

taken from the initially underestimated year-classes. The Commission should, therefore, act on conservative estimates of the strength of incoming year-classes.

Panel 5 has asked the Standing Committee on Research and Statistics to advise in January 1973 on a catch level for 1973 which will not lead to a further decline in spawning stock size, *i.e.* that will maintain the level at the end of 1972. This level will depend on the level of recruitment during 1972, which cannot be estimated with certainty from 1972 catch age data available by January 1973, because of the uncertainty of the degree of recruitment of year-classes to the spawning stock at age 3. However, preliminary estimates of recruitment using the virtual population method with extrapolated catches, indicate that recruitment in 1972 could be less than the long term average level of about 1,000 million herring, possibly 500-600 million. The stock size to be maintained would then be only about 100,000 tons (Res.Doc. 72/24), about 57% of the stock size at the end of 1971. Therefore the regulating objective set by the Commission for 1973 would result in even lower stock levels than obtained at the beginning of the 1972 regulating period and these are likely to give lower yields than the stock is capable of giving on a sustained basis.[1]

c) Advice to Commission on Catch Levels

At the 1971 meeting the scientists were asked three questions regarding the herring stocks: (a) What is the level of the maximum sustainable yield? (b) What is the current level of the sustainable yield? (c) What should the catches be to initiate a program of rebuilding the stocks?

Because of the uncertainties surrounding certain aspects of herring biology, such as the relation between stock and recruitment, and the large apparently random fluctuation in year-class strength, the concepts of maximum sustainable yield and sustainable yield, which have proved very useful in considering management of seals or whales, are less useful for advice on herring. Fluctuations in year-class strength mean, for example, that when a good year-class enters the fishery the stock will increase in the short term almost irrespective of the amount of fishing. Conversely, the stock will decrease when good year-classes leave the fishery, even if fishing is very light, but the decrease could be catastrophic if catches are too high.

The Herring Working Group has therefore attempted to answer the questions in a slightly different form: (a) What are the average annual catches possible if the stock is maintained at the level giving good recruitment? (b) What values of fishing mortality would be desirable, at an average long-term level, to give a high yield-per-recruit while maintaining a spawning stock large enough to provide a reasonable expectation of good recruitment? What would be the catch quotas necessary in 1972, and later years, to maintain such values of fishing mortality? (c) What would be the changes in spawning stock size following the adoption of the quotas in (b), and what lower quotas would be necessary to restore the stock at different rates?

One explicit estimate of the possible maximum sustainable yield has been made by Anthony (Res. Doc. 72/24), based on the surplus production model, which gives an estimate of a little over 300,000 tons. This may be rather high, since the analysis may be distorted by the presence of the very strong 1960 and 1961 year-classes.

Another estimate of the potential yield, assuming year-classes of the average strength of the 1962 year-class and later ones, is 130,000 tons. Provided that the spawning stock is maintained, year-classes of the 1960 or 1961 strength should occur occasionally, and, depending on their frequency, the yield would be greater. Perhaps a realistic estimate of the potential average long-term yield is around 250,000 tons.

The first estimate of the optimum fishing mortality can be obtained from the yield-per-recruit curve. Given the slow post-recruit growth and relatively high natural mortality, this curve has a flat top with no maximum (Fig. 8). It seems undesirable to increase the effort beyond the left-hand shoulder of the curve, where any increase in yield-per-recruit would be very small compared with the increase in fishing required to catch it. While the limiting position must be somewhat arbitrary, it is suggested that it would at least be at a level of effort no higher than that at which the marginal yield-per-recruit is one-tenth of the marginal yield of the unexploited stock. That is, the point when the net addition to the total catch achieved by an additional vessel is only one-tenth of the yield taken by the first vessel operating in the fishery.

Calculated on this basis for the Georges Bank stock, the limiting value of the fishing mortality (F) is 0.57 for a constant natural mortality (M) of 0.44, and an F of 0.45 for M = 0.35. The

[1] (The Herring Working Group was informed that an independent assessment of the status of the Georges Bank stock is being undertaken by Polish scientists and will be presented at the Mid-Term Meeting of the Herring Working Group in early 1973. This will follow the lines suggested in the Report of Proceedings of the Special Meeting on Herring, January-February 1972 and will be based on assumptions as to size of the 1968 year-class other than those used in this report.)

Working Group therefore concluded that there would be no biological justification for a fishing mortality in excess of approximately 0.5. If a fishing mortality of 0.5 were to be generated in 1972, the catch would be about 70,000 tons, which is an upper limit to the 1972 quota.

This calculation, based on yield-per-recruit, makes no allowance for the effect of the size of the adult stock on subsequent recruitment. The nature of this effect is not known, and it is clear that natural factors are critical in determining whether a good year-class will occur in any particular year. However, if the spawning stock is too low, a good year-class cannot be produced, even when environmental factors are favourable. It is likely that the present very low spawning stock on Georges Bank is considerably smaller than that required to give a high probability of a good year-class occurring when environmental conditions are favourable. A catch of 70,000 tons in 1972 would just maintain the 1971 stock size, although precise calculations are difficult because of uncertainties about the strengths of the year-classes recruiting to the fishery in 1970 and 1971. It is possible that the occurrence of 3- and 4-year-old fish in the catches in 1970 and 1971 gives a fair representation of their relative frequency in the stock. If they do, the recent year-classes are of average strength or higher and a catch of 70,000 tons in 1972 would leave the stock unchanged or at best a little greater. It is more likely, however, that the catch data overestimate their relative strengths, due to a recent increase in the proportion of a year-class recruiting to the fishery at ages 3 and 4, in which case they are no better than average, and the catches in 1972 would have to be no higher than 50,000 tons to ensure that the stocks were not further depleted.

d) Division 4X Herring Assessment

Three different Canadian fisheries occur on herring stocks in Div. 4Xa and 4Wb. The Nova Scotia weir fishery along southeastern shore of Bay of Fundy takes mainly juveniles. An inshore gillnet fishery extends along the Atlantic coast of Nova Scotia and also in the Bay of Fundy. Up to 1971 most of this gillnet catch was taken outside the Bay of Fundy and came from a "local" coastal stock. The purse-seine fishery off southwestern Nova Scotia exploits pre-spawning and spawning herring of the major stocks in Div. 4Xa and 4Wb. All of these fisheries occur from early summer to autumn.

Catches from both the weir and gillnet fisheries have fluctuated very little over the past 10 years, each taking about 10,000 tons annually. Catches from the purse-seine fishery increased rapidly in the mid-1960's, reached a peak of about 120,000 tons in 1967 and 1968 and declined to about 30,000-40,000 tons in 1971. In 1969 an offshore fishery, mainly by USSR, developed on over-wintering concentrations of this stock in Div. 4Wb and a catch of 60,000 tons was reported in 1970. Because of this offshore fishery the total catch of adults from this major stock increased by about 40,000 tons in 1970. Catches of adults from both the Canadian inshore fishery in Div. 4Wa and the offshore fishery in Div. 4Wb declined substantially in 1971.

Both the quality and quantity of data, on which accurate assessment should be based, are much less than are available for the Gulf of Maine and Georges Bank stocks. Canadian purse-seine catches per boat-night had declined by about 45% between 1966 and 1971, but these data were not adjusted for changes in efficienty. It is thought that efficiency may have doubled over the same period. This would indicate a decline in stock abundance to about 30% of the pre-1966 level.

Age-compositions for the period 1965-71 indicate that no great change has occurred in the relative proportions of the older and younger members of the adult stock. Table 13 gives the numbers at each age for the 3rd quarter (Canadian data); for 1970 and 1971 these refer to the spawning area only, but for earlier years they refer to a larger area including other parts of Div. 4X. Table 14 gives, for the same data of Table 13, the numbers and the percentages in two groups - age 6 and older, and age 5 and younger. Mean percentages for each of the periods 1965-68 and 1969-71 are also given. This separation divides the whole period at the time of peak catches in the Canadian fishery. The proportion of younger fish (less than age 6) increased from 54% to 66% between the two periods. USSR data for 1970 and 1971 are also shown in Table 14 and compare reasonably with the Canadian data.

Table 13. Age composition of herring in the Nova Scotia stock (Div. 4Xa and 4Wb).

Year	Number at age (years)							
	3	4	5	6	7	8	9	10+
Canadian Data								
1965	184	931	326	127	16	3	-	-
1966	743	96	254	26	1	-	-	-
1967	339	415	298	255	128	10	-	-
1968	91	42	83	12	11	3	1	-
1969	1,063	80	261	166	168	56	9	-
1970	98	1,021	600	473	319	159	33	3
1971	93	248	487	167	205	74	18	12
USSR Data								
1970	2	10	26	19	24	11	5	2
1971	41	12	20	9	8	5	2	2

Table 14. Composition of herring in Nova Scotia stock (Div. 4Xa and 4Wb) by two age-groups (ages 3-5 and ages 6-10+).

Year	Number by age group		% by age group		Mean %	
	3-5	6-10+	3-5	6-10+	3-5	6-10+
Canadian Data						
1965	1,441	146	90	10	-	-
1966	1,093	27	97	3	-	-
1967	1,052	393	70	30	53	47
1968	377	678	36	64		
1969	1,404	399	72	28		
1970	1,711	987	63	37	66	34
1971	828	476	64	36		
USSR Data						
1970	73	26	74	26	56	42
1971	38	61	38	62		

Recruitment to the Nova Scotia stock varies from year to year but the variability in year-class size is not as great as it is for the Georges Bank stock. The very good year-class of 1966 still contributes substantially to the fishery and is followed by the reasonably sized 1967 year-class. Although historical data is scanty there is no indication of long periods over which recruitment is very low, as is known for the Georges Bank stock and also for the Gulf of St. Lawrence stock. Moreover, there has been no decline in the Nova Scotia juvenile (weir) fishery as there has been on the New Brunswick side of the Bay of Fundy and in the Gulf of Maine.

In recent years total effort in the Canadian purse-seine fishery has declined because of the diversion of boats to other herring fisheries as catch rates fell off from initial high levels. This was certainly true of the 1971 fishery.

While it is not possible to make a full assessment for this stock, the conclusion is that the current status of the Nova Scotia stock is not very far from that giving maximum yield. This would mean that there should certainly be no increase in the fishing mortality rate in 1972.

Based on the observed decline in catch since 1966, a catch in 1972, which is the same in 1971, would probably lead to an increase in fishing mortality (assuming no change in recruitment in

1972) and a decline in stock size. It is believed that this would not lead to a critical situation over a period of one year, but because of uncertainties of recruitment prospects it would be advisable to fix the quota level somewhat below that of the 1971 catch.

The 1971 adult catch was 67,000 tons, and a quota of 60,000-65,000 tons is suggested as that which probably would prevent a stock decline. In doing this, allowance is made for the possibility that provisional Canadian statistics for the 1971 catch from the Nova Scotia stock underestimate the catch by 5,000-10,000 tons, but that approximately this amount of "local" inshore stocks are caught in the Nova Scotia Atlantic coast gillnet fishery.

If an annual catch of some 70,000-80,000 tons represents approximately the average maximum sustained yield for this stock, then it implies that the Nova Scotia stock is rather less than one-third the size of the Georges Bank stock. This is not inconsistent with estimates of the relative size of the area available to larval and post-larval stages of these two stocks.

As in Div. 5Y a fishery on juveniles exists. Therefore, consideration of limitations of adult fisheries must include the possible effects of the juvenile fisheries on adult abundance and yield.

4. ICNAF Herring Research Requirements

a) Tagging Experiment

Although considerable progress has been made in the solution of problems relating to stock identity, much remains to be done if the herring stocks of the Northwest Atlantic are to be managed in a way that realizes their maximum potential. Important information could be gained from a well-planned tagging experiment, and discussion in the Herring Working Group has resulted in the following conclusions:

i) The use of internal metal tags was not practicable at this time because of recovery problems on the offshore vessels which would be expected to catch and process the major part of the returns. Similar problems exist for inshore processing facilities.

ii) While the use of external tags restricts the scope of experiments that can be planned, they could provide valuable information on distribution and migration of adult herring.

iii) The problem most suited for an experiment of this kind concerns the extent to which herring from the Gulf of Maine and Georges Bank stocks mix in Subarea 6 and Div. 5Zw outside the spawning period. This would involve tagging herring caught in Subarea 6 in the winter prior to the pre-spawning and spawning fisheries in the Gulf of Maine and Georges Bank and relying largely on short term returns of tags.

iv) Offshore tagging would be successful only on purse-seined fish, and, because no large scale purse-seine fishery exists in the area, it would be necessary to charter a vessel and crew and, following the example of the recent North Sea herring tagging experiment, hire personnel to carry out the tagging under skilled supervision. In addition, a suitable research vessel would be required in the general area to assist in the tagging operation.

v) While the major aim of such a tagging experiment is limited, the opportunity could be taken to investigate other problems, particularly the effectiveness of other tagging techniques. USA scientists will investigate the possibility of installing tag-detection equipment in plants processing herring caught in Subarea 6 and Div. 5Zw and will submit a report to the Mid-Term Meeting in January 1973. Since juvenile herring have been reported in Div. 5Zw and Subarea 6 in early 1972, provision should possibly be made for inclusion of juvenile herring in tagging experiments.

vi) More detailed information regarding the specific costs and techniques are required, and it is hoped that such information will be made available to the Herring Working Group at the Mid-Term Meeting in January 1973.

b) Larval Surveys

The results of the 1971 *ad hoc* larval survey were promising. However, it became obvious that more closely spaced cruises would be needed in order to obtain accurate larval production estimates and to be able to follow the drift of herring larvae by comparing the distribution of corresponding size groups at respective times. The Herring Working Group therefore

recommends (2)

that the international herring larval survey program in the Gulf of Maine, Georges Bank and Nova

Scotia areas be continued and intensified in 1972.

Bi-weekly surveys are desirable during September to December for the offshore cruises and during September to November for the coastal Gulf of Maine area.

Present commitments indicate that in 1972 the Nova Scotia, Georges Bank, Nantucket Shoals area will be sampled during 9-25 October (USSR), 1-15 November (FRG, *Walther Herwig*) and 1-15 December (USA, *Albatross*). The USSR is requested to sample the eastern part of Georges Bank in September. Since a second cruise in September, October and November is highly desirable, other countries, especially those participating in the herring fisheries in the area (*i.e.* Canada and Poland), should be encouraged to participate in the joint survey in 1972 and following years.

France expects to continue its participation in 1973. Canada is requested to sample the Bay of Fundy and the spawning areas off Nova Scotia during September through December using the standardized methods. The Coastal Gulf of Maine area will be sampled by the USA.

Suggested improvements in sampling methods, given in the Report of the Working Group on Joint Surveys of Larval Herring in the Georges Bank-Gulf of Maine Areas (Res.Doc. 72/123), are recommended to be adopted in the future surveys. A revised station grid system will be prepared in the light of the results from the 1971 and previous surveys. Samples should be sorted as soon as possible after the cruises and the results made available at the Mid-Term Meeting in January so that a final report based on the combined data can be presented at the regular ICNAF Annual Meeting.

c) Juvenile Surveys

A fundamental problem inherent in the management of herring fisheries is the great variability in year-class size and our present inability to estimate the relative abundance of year-classes prior to their full recruitment to the adult stocks. Emphasis should be placed on the immediate development of methods to measure year-class abundance for individual stocks at as early a life-history stage as possible.

The recording of young herring over wide areas of the offshore shelf in 1972 makes it important to investigate the possible significance of these areas as centers of distribution of overwintering juvenile herring. It is understood that USSR will be undertaking further surveys in 1972 and in early 1973. A groundfish survey by USA is planned for March and April 1973, and some additional information could be collected if appropriate sampling gear were available. The Herring Working Group therefore

recommends (3)

that member countries make every effort to carry out surveys for young herring in offshore areas of Emerald Bank, Georges Bank and Subarea 6 in early 1973.

These surveys should have the objective of confirming whether the 1972 distribution represents a regular feature of the life history of herring stocks, of sampling the populations to establish the stock identity of the juvenile populations and carrying out basic experiments to help determine relative abundance estimates. It was agreed that March was the best month for such surveys. Results of any surveys carried out in early 1973 should be made available in preliminary form for consideration at the 1973 Annual Meeting, so that the desirability of extending the scope and extent of offshore young herring surveys can be determined. USSR scientists have indicated that they will try to provide a more detailed analysis of the 1972 surveys for discussion at the Mid-Term Meeting in January 1973.

d) Sampling and Statistics

The quality of fishery statistics and biological sampling data, needed for effective management, depends on the complexity of the measures to be applied. The recommendations in this report represent only the first step toward rational management. Developments and refinements in management procedures will be possible only if parallel improvements are made in the collection and reporting of statistical and biological data. Immediate needs are (1) accurate catch and effort data for each of the subdivisions listed in Tables 5-9; (2) catches, on a monthly basis, expressed in numbers by age-groups in a standard format; and (3) extensive coverage of various maturation stages in all fisheries to determine the degree of recruitment of the various age-groups to the fisheries on spawning stocks. The Herring Working Group therefore

recommends (4)

i) that data for 1972 required for assessment purposes be available to scientists directly involved in assessments of individual stocks not later than 7 January 1973; and

ii) that scientists directly involved in these assessments have the opportunity of meeting to assess and analyze these data sometime immediately prior to the 1973 Mid-Term Meeting.

5. Report of Herring Otolith Exchange Program

At the 1971 Annual Meeting, the St. John's Laboratory of the Fisheries Research Board of Canada agreed to organize and coordinate a program of herring otolith exchange between member countries involved in herring studies in the Convention Area, and at that time Canada, Federal Republic of Germany, France, UK, USSR and USA agreed to participate. A selection of otoliths representing herring stocks from Georges Bank to southwest Newfoundland was circulated and, in addition to age and year-class estimates, participants were requested to provide a description of age definitions, conventions and techniques.

To date these otoliths have been examined by scientists from Canada, Germany, USSR and USA, and the overall results reveal considerable discrepancies in age and year-class estimates between participating countries. These discrepancies arose mainly from difficulties in determining zone counts of older herring, differences in interpreting zone patterns and differences in criteria and conventions for age and year-class assignations. This and previous exchanges have delineated the nature and extent of the problem, and its resolution cannot be accomplished by further exchanges of this type. The Herring Working Group therefore

recommends (5)

i) that a special herring ageing workshop be set up to concentrate on the study of objective criteria for herring age determination and on standardizing methods and conventions. Such a workshop would also consider the usefulness of otolith characteristics and otolith morphometry as a means of stock identification; and

ii) that member countries should make every effort to ensure that individual scientists involved in ageing techniques be allowed to attend.

The St. John's Laboratory has agreed to organize the workshop, which is proposed to take place in early 1973.

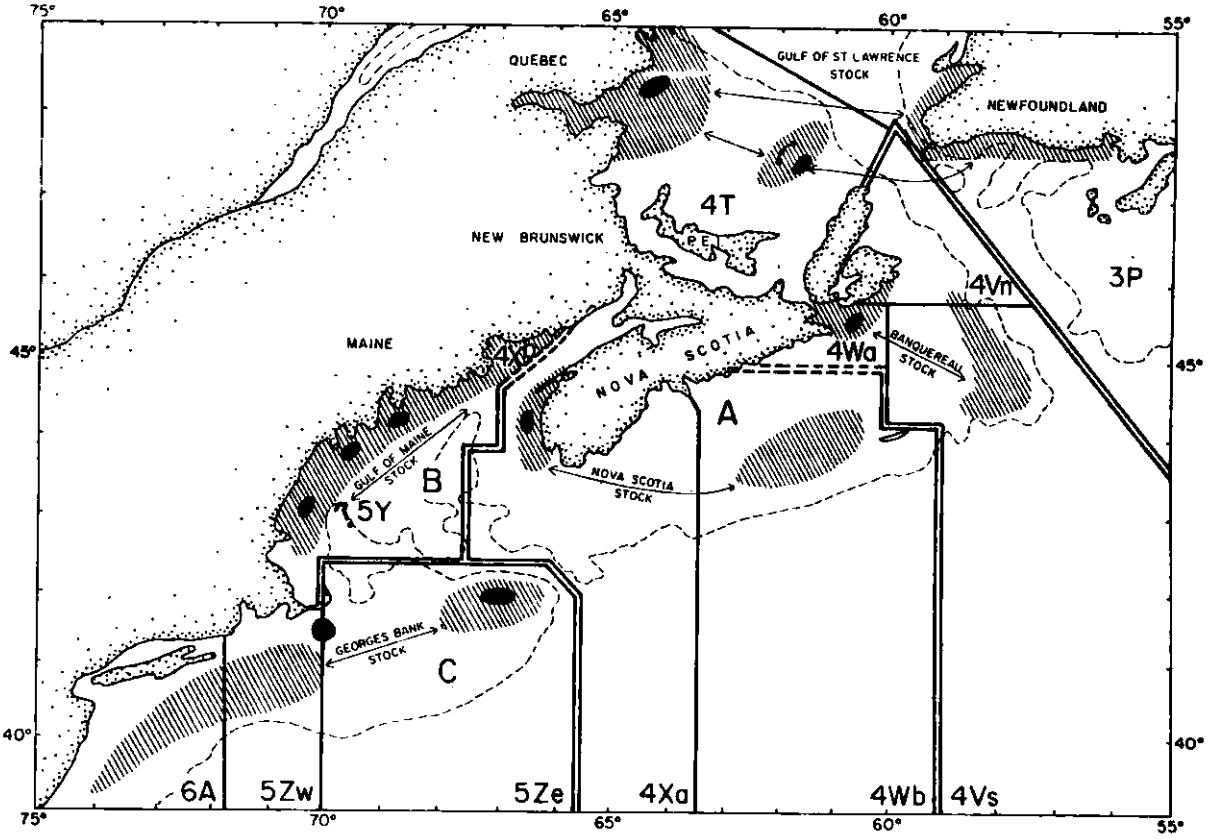

Fig. 1. Herring stock structure in the ICNAF Area (double lines indicate stock boundaries and the solid black areas indicate the general spawning grounds).

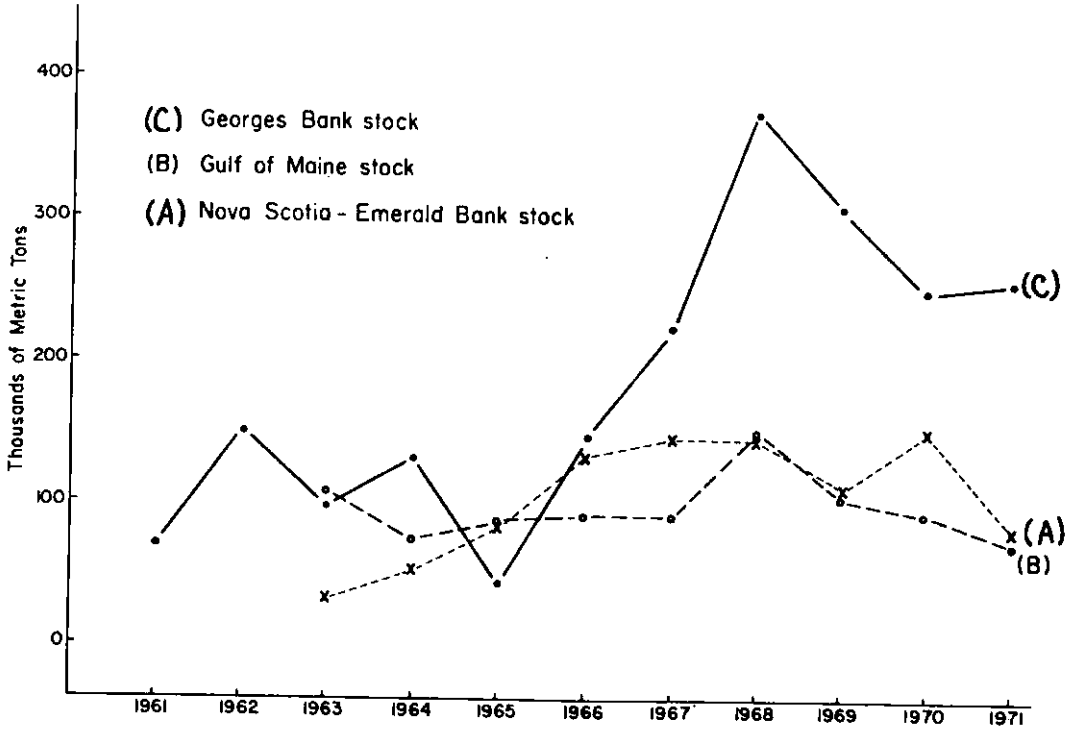

Fig. 2. Herring landings by stocks, 1961-71.

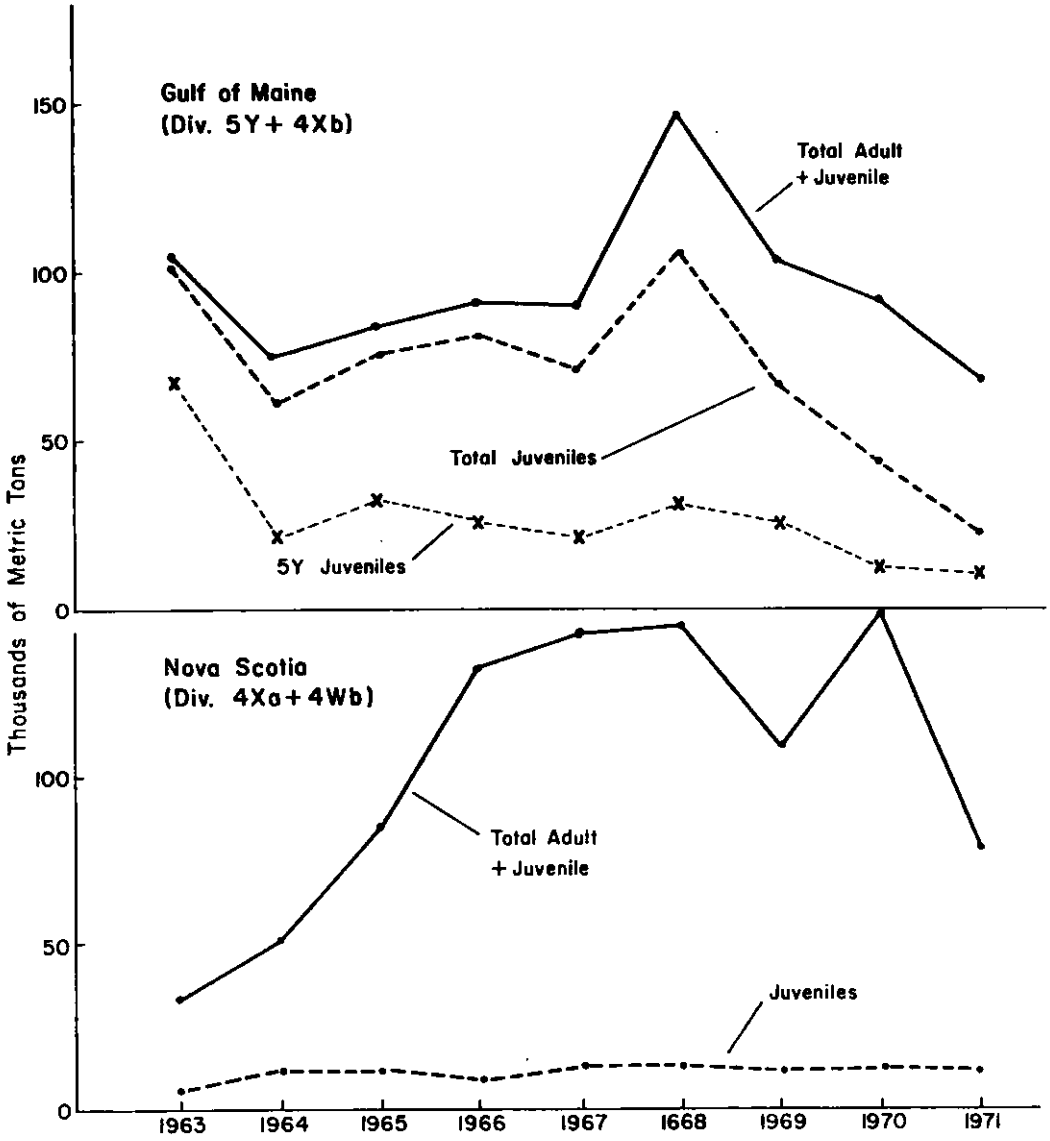

Fig. 3. Gulf of Maine and Nova Scotia landings, showing the juvenile landings relative to the total landings.

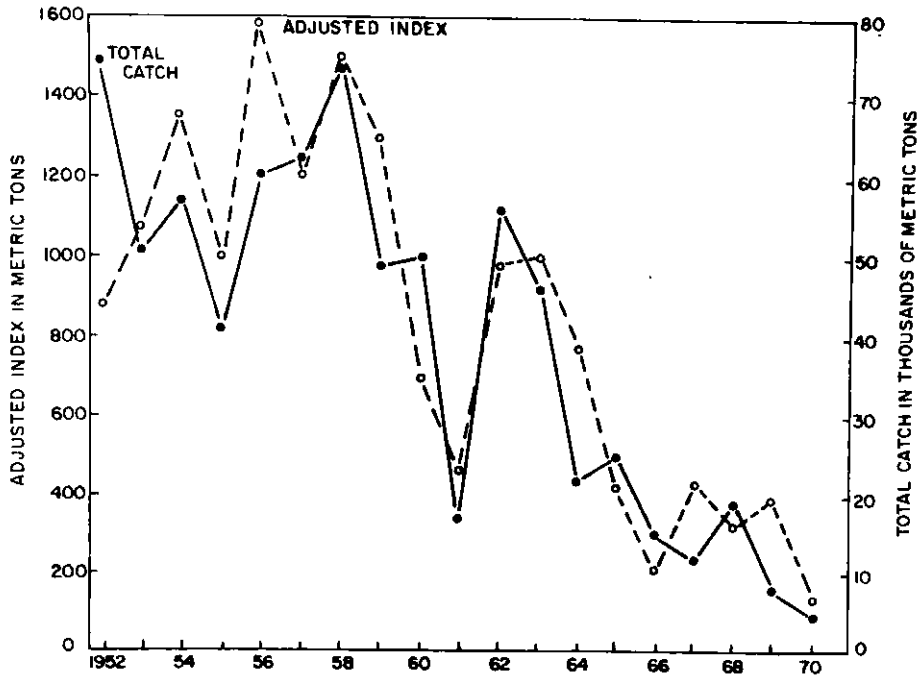

Fig. 4. Abundance indices for Div. 5Y herring: total catch by stop seines and weirs, and adjusted catch-per-man index.

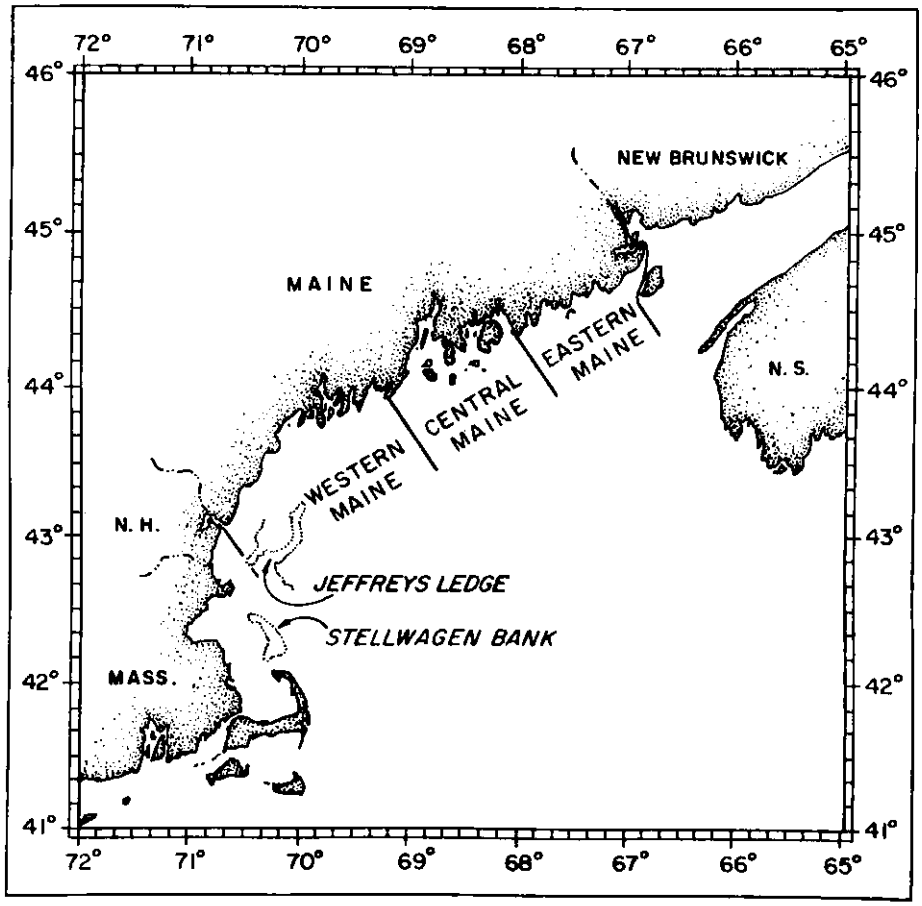

Fig. 5. Map of Gulf of Maine giving place names referred to in the Div. 5Y herring stock assessment.

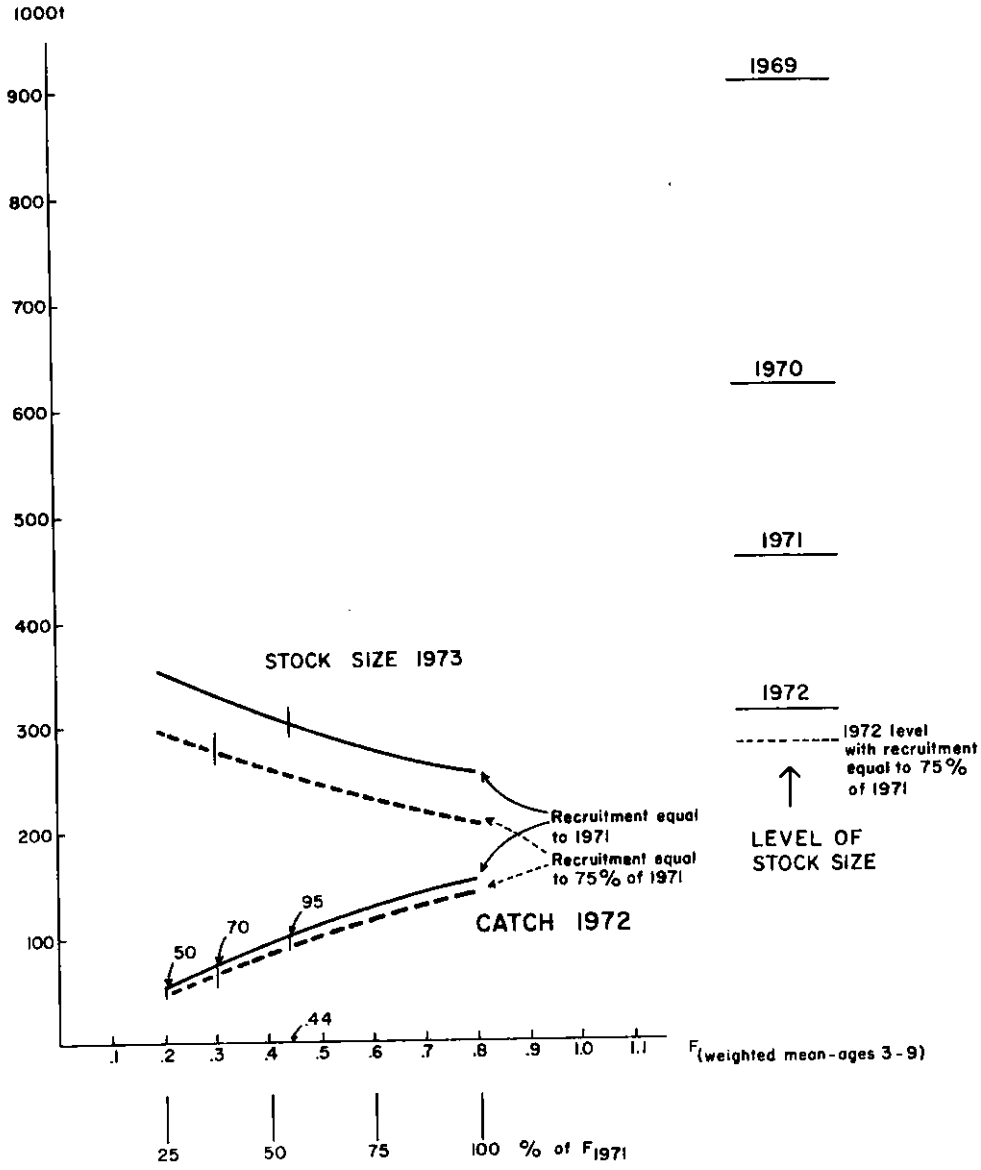

Fig. 6. Georges Bank herring stock sizes in 1973 by levels of catch and fishing mortality in 1972.

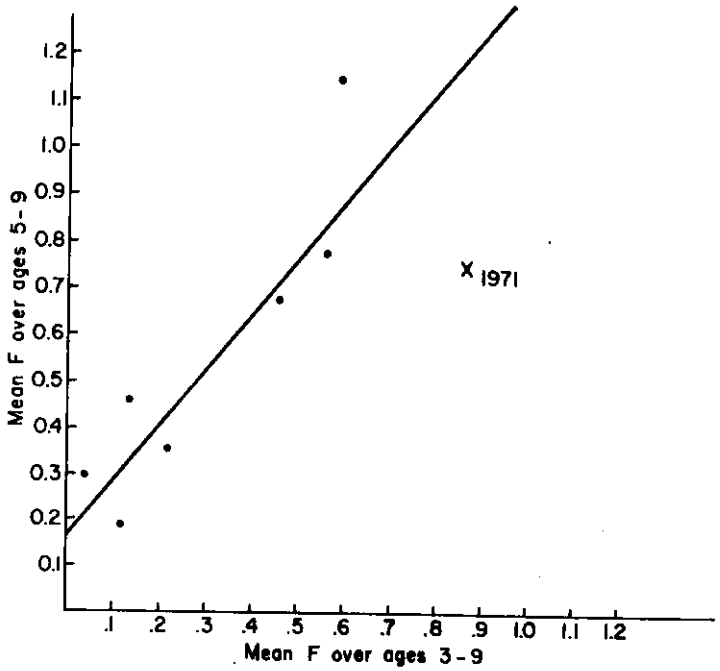
Mean F over ages 5-9
Mean F over ages 3-9
X 1971
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
.1 .2 .3 .4 .5 .6 .7 .8 .9 1.0 1.1 1.2

Fig. 7.

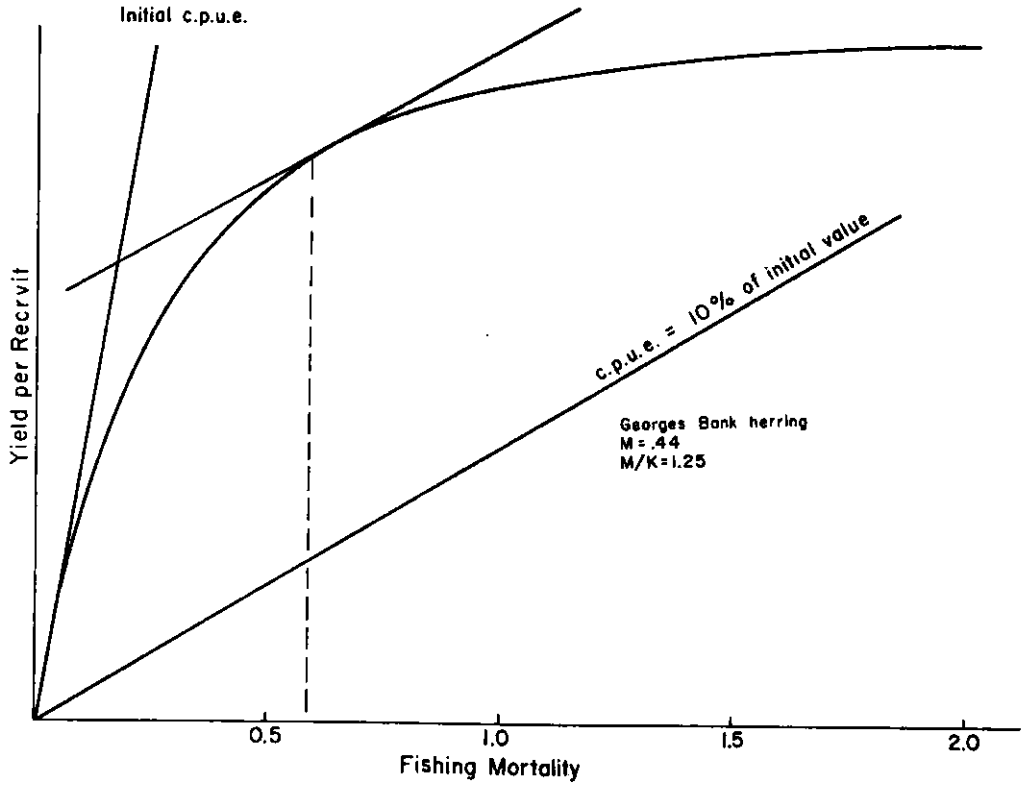
Initial c.p.u.e.
Yield per Recruit
c.p.u.e. = 10% of initial value
Georges Bank herring
M = .44
M/K = 1.25
0.5
1.0
1.5
2.0
Fishing Mortality

Fig. 8.

APPENDIX III - REPORT OF WORKING GROUP ON COORDINATED GROUNDFISH SURVEYS

Chairman: M. D. Grosslein

Rapporteur: E. Anderson

The Working Group met on Monday, 22 May and reviewed new studies completed during the past year on survey methods and results. Mr Garrod (UK) reported on a survey experiment on Faroe Bank which provided a fairly complete description of sources and magnitudes of sampling errors, and he noted that accuracy of the survey abundance indices compared very favourably with the level of accuracy achieved in market sampling (Res.Doc. 72/64). Sampling intensity in the Faroe experiment was about 7 times greater than that of the standard Georges Bank survey by USA (in terms of numbers of hauls-per-unit-area) but coefficients of variation for abundance indices in the Faroe experiment were not much smaller than those observed for the less intensive surveys on Georges Bank. This tends to confirm the analysis of Georges Bank survey data that the point of diminishing returns of statistical precision in relation to sample size is reached with moderate effort, *i.e.* only moderate precision is possible with sampling rates on the order of 1 station per 300 square miles, but substantial improvements in precision require very large increases in sampling intensity.

Dr Grosslein (USA) gave a preliminary evaluation of trawls used for surveys in Subarea 4 by Canada, USA and USSR, and reviewed USA-USSR trawl comparisons in Subarea 5 (Res.Doc. 72/112, 72/134). General advantages of using roller gear were indicated from the standpoint of maintaining consistency of trawling methods over a variety of bottom types as well as reducing gear damage. Fishing power studies of Soviet and USA gear again showed that seemingly slight changes in trawl design and rigging can have major effects on catchability coefficients; and it was noted once again that maintaining strictly standard trawling methods with any given type of gear as well as a consistent sampling design were critical to the reliability of abundance indices derived from research vessel surveys. These comparisons also provided further information on the effect of ground cables on catchability coefficients.

Preliminary total biomass estimates based on surveys in Subarea 4 were discussed. Direct expansion of survey catch-per-haul data for cod and haddock in Div. 4X, 4W and 4V yielded biomass estimates which compared very closely with estimates derived from current assessments (Res.Doc. 72/134). First approximations were also made of total biomass of all groundfish species combined, and these estimates appeared to be consistent with current ideas about catchability coefficients and presumed current fishing rates on groundfish stocks as a whole in Subarea 4. Moreover the estimates were very similar in 1970 and 1971, and this is encouraging at least from the standpoint of precision.

Minimum biomass estimates for selected species were presented for parts of Subarea 3 by Mr Pinhorn (Canada)(Res.Doc. 72/110). Preliminary estimates of cod in Div. 3Ps based on the survey data were roughly one-sixth of the estimate derived from assessment data, but it was noted that cod of pre-recruit sizes (to commercial gear) were very much less available to the survey trawl than were recruited sizes. Other surveys reported on at this meeting provided biomass estimates and/or catch-per-haul statistics for individual species and for all species combined. Although the results are preliminary, a pattern of consistency is emerging which is indeed encouraging as to the feasibility of monitoring relative changes in biomass of all the components of the groundfish community by research vessel surveys (Res.Doc. 72/29, 72/106, 72/119).

An inventory of all survey activity in the ICNAF Area for 1971 and 1972 confirmed the need for more survey work, especially in Subareas 1 and 2 (Res.Doc. 72/120). Significant year-to-year variations in fish distribution present special sampling problems in these Subareas, and discussion centered around ways of utilizing hydrographic and acoustic information for delineating fish aggregations so that more efficient allocation of trawling effort could be achieved. It was noted that new and improved methods of fish detection are needed, not only for improving efficiency of groundfish surveys, but also for development of survey techniques for pelagic fish resources.

Possible ways of improving the utilization of existing survey capability were reviewed. One method is the standardization of sampling designs, and there was general consensus that considerable benefits could be gained by adopting standard sampling areas for the groundfish surveys. Mr Pinhorn (Canada) described a stratification plan for Div. 3Ps, and Dr Messtorf (Fed.Rep. Germany) reviewed a stratification scheme for Subarea 2 (Res.Doc. 72/60, 72/125). It was noted that comparisons of results of surveys by different countries in these areas would be greatly facilitated by using such a set of common sampling areas and would contribute significantly to our understanding of sources of error in the survey abundance indices.

The problem of processing and analysis of survey data was discussed briefly, and the Working Group considered that development of expanded data processing capability by ICNAF could be used to assist with analysis of survey results. However, at the present time, most countries seem to prefer developing their own capability. The Working Group agreed that it is essential to make more complete utilization of the survey data at hand, and that reporting of results in the standard format described in Res.Doc. 71/128 should be attempted for all surveys, and be extended to include all major groundfish species.

It was agreed that the Chairman of the Working Group should correspond with appropriate scientists to establish common strata sets and to coordinate the details of data summaries such as species selection, conventions for recording length, sex, etc.

The Working Group was unanimous in its judgement that even with present resources the coordinated groundfish survey program has considerable potential benefits yet to be fully realized, and therefore urged that its development be energetically continued.

Specifically, the Working Group

recommends (6)

i) that the stratification schemes, proposed for Subareas 2 and 3 (Res.Doc. 72/60 and 72/125), be used for all surveys in those areas during the next year.

ii) that the Chairman of the Working Group endeavor to establish common sets of sampling strata within each of Subareas 2-6, giving preference to sets where overlap of different surveys occurs and where the best time series exist,

iii) that all member countries conducting surveys attempt to summarize catch-per-haul data in time for use by the Assessment Subcommittee prior to the next Mid-Term or Annual Meeting, using the standard format of Res.Doc. 71/128 for the common strata sets referred to in item (ii) and for the following species and Subareas:

	Subarea					
Species	1	2	3	4	5	6
Cod	x	x	x	x	x	x
Haddock			x	x	x	
Pollock				x	x	
Yellowtail			x	x	x	
Plaice			x	x		
Halibut			x	x		
Redfish	x	x	x	x	x	x
Red hake					x	x
Silver hake				x	x	x
Grenadier	x	x	x			
Herring			x	x	x	x
Mackerel				x	x	x
Squid				x	x	x

iv) that member countries with time series of survey data make special efforts to complete the data analyses indicated in item (iii) above for the entire series, at least in time for the next Annual Meeting; and

v) that the Working Group be re-convened at the next Annual Meeting to evaluate progress.

APPENDIX IV - REPORT OF THE STATISTICS AND SAMPLING SUBCOMMITTEE

Chairman: A. W. May

Rapporteurs: L. P. D. Gertenbach (Statistics)
V. M. Hodder (Sampling)

The Subcommittee met during the morning and afternoon of 20 May. The following documents were reviewed: Res.Doc. 72/52, 72/61, 72/63, 72/84, 72/94, 72/95, 72/98, 72/121, 72/122 and 72/124. The Subcommittee also reviewed the ICNAF *Statistical Bulletin* Vol. 20 for 1970, *Sampling Yearbook* Vol. 15 for 1970, and the *Report of the Seventh Session of CWP*, November 1971 (Res.Doc. 72/126).

1. Sampling

a) *Sampling Yearbook*, Vol. 14 for 1969, was issued in October 1971 and Vol. 15 for 1970 was distributed in April 1972.

The Subcommittee concurred that the Sampling Yearbook should be streamlined and the sampling data presented in a form which is more useful to assessment scientists. Various ways of streamlining were suggested, but a decision of the new format would require more detailed consideration than is possible at this meeting. The Subcommittee therefore

recommends (7)

i) that the 1971 data be published as in the past in the Sampling Yearbook Vol. 16 for 1971;

ii) that the Secretariat obtain from scientists involved in ICNAF research, suggestions for improving the presentation of sampling data and prepare some possible formats for consideration at the next Mid-Term Assessment Meeting; and

iii) that a sample copy of the new version (using cod as an example) be prepared as a document for consideration at the 1973 Annual Meeting.

b) A review of information on adequacy of sampling presented in Res.Doc. 72/63 indicated that sampling of the fisheries by member countries is in some cases very inadequate, and this is particularly true for cod. The Subcommittee noted that the statements contained in the ICES Liaison Committee's Report to NEAFC (Res.Doc. 72/34) are equally pertinent to the ICNAF Convention Area. These statements are appended to this report. The Subcommittee accordingly

recommends (8)

that scientific advisers to Panels bring to the attention of the various Panels the important conclusions relative to adequacy of biostatistical data on fisheries contained in the Report of the ICES Liaison Committee to NEAFC, which are considered to be equally appropriate to the ICNAF Area, and which are appended to the Report of the Statistics and Sampling Subcommittee.

c) The reporting and/or publication of sampling and catch/effort statistics in relation to management areas were discussed. This problem at present is relevant to Subarea 5 where the yellowtail management areas do not coincide with the ICNAF Subdivisions 5Ze and 5Zw. The Subcommittee noted that the problem might be solved either (i) by having a separate sampling and statistical series for the management areas, or (ii) by changing the boundary between Subdiv. 5Ze and 5Zw to coincide with the management areas.

The Subcommittee decided that further investigation of the problem was necessary and suggested that United States scientists prepare a document on this problem for the 1973 Annual Meeting.

2. ICNAF Statistical Activities

a) Mr V. M. Hodder, who joined ICNAF on 4 September 1971, as Assistant Executive Secretary, presented his report on the statistical activities of the Secretariat covering the period 1971/72.

b) Statistical tabulations were prepared and submitted in advance of the Mid-Term Meeting of the Assessments Subcommittee, Rome, 24-29 January 1972.

c) The latest *Statistical Bulletin*, Vol. 20, presenting data for the year 1970, was distributed in April 1972. For the first time computer processing was employed to produce the tables in the Statistical Bulletin. The Subcommittee expressed great satisfaction with this significant advance. The Bulletin has been produced and distributed not only at an earlier date but also at a very great saving - Vol. 20 cost less than $1,500 compared with $8,000 for Vol. 19. The need for proof-reading

the tables has been eliminated, thereby reducing significantly the time for mere routine statistical activities. Such time is now being devoted to more advanced work and it is hoped that the dollar savings can be used for additional supporting staff to assist in undertaking statistical analyses.

The Subcommittee noted that Vol. 21 of the *Statistical Bulletin* (for 1971) may be published before the end of 1972 and welcomes this improvement in the expeditious release of this important ICNAF publication. Nevertheless the Subcommittee notes that this depends mainly on timeliness in submission by national reporting offices of the STATLANT 21A and 21B returns.

Noting the need for prompt national reporting and taking into account the CWP's recommendation on this question, the Subcommittee

recommends (9)

that ICNAF cooperate with the other agencies to bring to the attention of the member countries the need to take all possible steps to avoid serious delays in submitting their statistical data to the Secretariat, as such delays adversely affect the distribution dates of future volumes of the Statistical Bulletin.

The Subcommittee, on reviewing Vol. 20 of the ICNAF *Statistical Bulletin*,

recommends (10)

that the Assistant Executive Secretary and the Secretary of the CWP review the List of Northwest Atlantic Species and revise it in time for the publication in Vol. 21 by introducing the following minor changes:

i) deletion of the ICNAF numbers, which have no statistical significance;

ii) introduction of the multi-digit taxonomic codes used in the FAO Yearbook of Fishery Statistics;

iii) the arrangement of the species under "flounders, except halibut", "OG", "PF", "OF" and "SF" Groups taxonomically by Orders, Families and Genera;

iv) the introduction of an entry for Merluccius albidus under the "G" group;

v) the introduction of an entry for "pigfish" under the "OF" group; and

vi) the introduction of a footnote to the effect that the catches of "Silver Hake" (Merluccius bilinearis) could include small quantities of Merluccius albidus.

d) The Subcommittee reviewed Res.Doc. 72/84, prepared by the Secretariat, based on data reported by member countries on ICNAF Stat. Form 4.

Several discrepancies between the data supplied on this form and those published in the *Statistical Bulletin* were noted. To reduce and possibly eliminate such discrepancies, the Subcommittee

recommends (11)

that the Assistant Executive Secretary and the CWP Secretary collaborate in redesigning ICNAF Stat. Form 4.

e) The Subcommittee noted that the effort data by subareas, obtained by means of ICNAF Stat. Form 3, has been tabulated in a more convenient form in Res.Doc. 72/52, and that it is the intention of the Secretariat to reproduce these new tables in the *List of Fishing Vessels for 1971.*

Noting that there is apparently no demand for this kind of effort information, the Subcommittee

recommends (12)

i) the data for 1969, 1970 and 1971 received through ICNAF Stat. Form 3 be reproduced in the List of Fishing Vessels for 1971; and

ii) that the data normally submitted on ICNAF Stat. Form 3 not be requested for 1972 and that the form be discontinued unless there is a strong request for such data at future Annual Meetings.

In making this recommendation, the Subcommittee noted that effort data will be readily and more

expeditiously available in the detailed tables of the *Statistical Bulletin*, which should now be distributed more promptly as a result of the use of ADP procedures.

f) The Subcommittee recalled that in 1971 the question was raised about the feasibility of obtaining catch/effort data on a more detailed area breakdown than the subareas, divisions and subdivisions currently used by ICNAF. The Subcommittee noted the CWP report on the possibility of introducing an area breakdown by rectangles based on latitudes and longitudes. While some participants at the Subcommittee Meeting favoured the introduction, within the not too distant future, of 30' x 30' rectangles, others felt that the collection by national offices of such detailed statistics might at this stage raise serious difficulties. Nevertheless, the Subcommittee

recommends (13)

that member countries initiate plans for the introduction of more detailed and flexible statistical reporting systems, especially in regard to species subject to management programs involving quota allocations where more frequent and more detailed statistical reporting will be required for both stock assessments and regulatory purposes. (In this connection the Subcommittee wishes to draw attention to the ICES Liaison Committee's Report to NEAFC, Res.Doc. 72/34, an extract of which is appended to this report (see page 74)).

3. Reports on Statistical Activities of Other Agencies

a) The Subcommittee noted that, although the *Report of the Seventh Session of the CWP* presented a great deal of information on the statistical activities of ICES and ICNAF in the North Atlantic, it would be most useful to reinstitute the practice of ICES and ICNAF exchanging copies of their annual statistical reports.

Accordingly the Subcommittee

recommends (14)

i) that the ICNAF Secretariat provide ICES with copies of this 1972 ICNAF report as a document for the 1972 meeting of the ICES Statistics Committee;

ii) that ICES be invited by the ICNAF Secretariat to provide for the 1973 meeting of ICNAF copies of the Report of the 1972 ICES Statistics Committee; and

iii) that FAO provide reports of statistical activities of its regional bodies in the Atlantic to all CWP agency members.

4. Report of the 7th Session of the CWP

a) The Secretary of the CWP presented the Report of the 7th Session of the CWP, Rome, 10-16 November 1971 (distributed as Res.Doc. 72/126). ICNAF participants were V. M. Hodder, Assistant Executive Secretary; A. W. May, Chairman ICNAF Subcommittee on Statistics and Sampling; H. A. Wheeland, United States; and K. Løkkegaard, Denmark.

b) The Subcommittee noted that ICNAF has dropped the list of conversion factors from *Statistical Bulletin* (see page 3 of Vol. 20). The need for detailed up-to-date conversion factors is now met by FAO's *Bulletin of Fishery Statistics*, No. 25 (Conversion Factors: North Atlantic Species, 1970). The Subcommittee supports the CWP's recommendation that this FAO Bulletin should be expanded to cover the increasing variety of processed commodities now produced not only on shore but also on floating factories, factory trawlers, etc.

The Subcommittee welcomes FAO's intention to revise the contents of this Bulletin from time to time and to issue improved versions at regular intervals in close collaboration with the interested international agencies and national reporting offices.

c) The CWP Secretary reported that, as soon as final decisions have been reached about the detailed area breakdown of the Western Central Atlantic and the Mediterranean, a Bulletin of Fishery Statistics, containing detailed statistical charts and descriptions for the Atlantic and adjacent seas, will be published.

d) The Subcommittee noted that FAO is continuing to develop a standard coding for the statistical classification of species for the Atlantic and the other oceans and seas and that a report will be issued by FAO as soon as this work has been completed.

e) The CWP at its 7th Session produced a standard classification by GRT divisions and groups to be used for tabulating fishing fleet statistics. This classification could also be used for reporting

effort/catch data by sizes of fishing vessels. Additional details on this matter were presented in Res.Doc. 72/95 and 72/121.

To facilitate the further standardization of inter-agency requests to national reporting offices, the Subcommittee

recommends (15)

that the Secretary of the CWP, in Section 3.4 of the "Notes for the Completion of the STATLANT 21B forms", substitute for the existing ICNAF categories the following:

ICNAF Code[1]	*"Category" Limits (GRT)*	
	lower	*upper*
2	*0*	*49.9*[2]
3	*50*	*149.9*
4	*150*	*499.9*
5	*500*	*999.9*
6	*1,000*	*1,999.9*
7	*2,000*	*and over*

[1] *The code "1" is reserved for cases where the tonnage class cannot be designated.*
[2] *".9" is to be understood as recurring.*

f) The CWP Secretary pointed out that ADP procedures, similar to those used by ICNAF to produce the *List of Vessels for 1971*, could possibly be used to produce a world-wide register of fishing vessels. The Subcommittee noted that the feasibility of producing such an expanded list could now be reconsidered by the CWP in the light of ICNAF's experience with the preparation of the 1971 list.

g) The CWP Secretary reported on the development of the International Standard Statistical Classification of Fishing Gear. Res.Doc. 72/121 presents the ICNAF list of fishing gear in the overall framework of the aforementioned gear classification. To further advance interagency standardization, the Subcommittee

recommends (16)

that the CWP Secretary, in consultation with the Assistant Executive Secretary, in section 3.2 of the "Notes for the completion of Form STATLANT 21B", substitute for the existing ICNAF list a presentation based on the new gear classification.

h) The CWP Secretary reported on the results (Res.Doc. 72/122) of his requests to national offices for comments on the feasibility of not only including "searching time" under "fishing time" (when the latter is expressed in "days fished") but also to report "searching time" separately. The Subcommittee noted that it would be very difficult to obtain from most countries separate data on "searching time", and

recommends (17)

that all countries continue to report "searching time" as part of "fishing time", when the latter is expressed as "days fished".

The Subcommittee noted the CWP's conclusion that there is no alternative to obtaining more detailed nominal catch data from other than biological laboratories. However, for the management of selected fisheries by means of catch allocation, it is necessary to devise special systems for the fast reporting of detailed catch data.

i) The Subcommittee noted that the Secretariats of the various agencies will maintain close collaboration with each other and with the national reporting offices to ensure the prompt reporting of revised versions of preliminary data and incorporation in publications.

k) The Subcommittee was informed that Canada and USA are now reporting their catch/effort data to ICNAF as computer printouts in STATLANT 21B format. This obviates the need for these two countries to complete Form STATLANT 21B. Form STATLANT 21A will continue to be used for reporting summary

catch data by 15 April by all member and non-member countries; while Form STATLANT 21B will continue to be used by all countries, except Canada and the USA.

The CWP Secretary informed the Subcommittee that current investigations to further improve the STATLANT forms and to adapt them to ADP procedures will be continued and that in all these matters there will be close collaboration between him and the Assistant Executive Secretary.

l) The Subcommittee noted that ICSEAF has, at its first session, 24-28 April 1972, Rome, expressed the wish to participate in the activities of the CWP. Both ICCAT and the FAO Committee on Fisheries have already welcomed this. The Subcommittee agrees to ICSEAF's participation in the STATLANT program, as it would greatly facilitate the task of those national offices providing data to ICNAF, ICSEAF and other regional bodies.

m) The Secretary of the CWP informed the Subcommittee that the next (the 8th) session of the CWP might be held in 1973.

n) The Subcommittee indicated that the CWP might become too unwieldy if the number of participants is increased much above the present level, and

recommends (18)

i) that the five participating agencies (ICNAF, ICES, ICSEAF, ICCAT and FAO) each appoint not more than three experts to attend the 8th and subsequent sessions;

ii) that ICNAF invite the USA to nominate one ICNAF participant;

iii) that the other two ICNAF participants be the Assistant Executive Secretary and the Chairman of the Statistics and Sampling Subcommittee.

Extract from ICES Liaison Committee Report to NEAFC, 1972
(see ICNAF Res.Doc. 72/34)

Note on the Communiqué from the Special Meeting at the Level of Ministers

The Liaison Committee has noted that at the NEAFC Special Meeting in Moscow in December 1971, the Ministers agreed on the importance of:

a) extending the range and scope of fisheries research,

b) increasing cooperation in joint scientific programs,

c) improving the supply of statistics by member countries to the scientific bodies concerned.

It wishes to draw the attention of the Commission to some important points which concern ICES in its capacity as the advisory body of NEAFC and which will be considered by the Council at its next Statutory Meeting.

In order to achieve the necessary improvement of the stock assessments, it is essential to greatly improve the coverage, accuracy and speed of reporting of national statistics and to extend substantially the biological sampling programs. In this connection it should be noted that the amount of biological sampling differs considerably between countries and is far from proportional to the quantity of fish caught by the individual countries. Also, the type of data used up till now in assessments must be augmented by other information in order to permit more accurate estimation of stock size and recruitment.

With the rapid changes in the fisheries and with the introduction of catch regulation, the comparability of the present abundance indices will become less and less precise. They are based on long established national patterns of fishing. Closed seasons, closed areas or quotas will disrupt these patterns, making it essential to obtain estimates of stock size independent of catch and effort data, for example by means of acoustic surveys and tagging experiments.

Another essential requirement for management is a reliable estimate of future recruitment to the fishery. For some stocks this is already monitored by means of larval, 0-group and groundfish surveys. These surveys require high investments in time and effort by reasearch vessels. Provisions must be made for considerable increase in such investments and for the expansion of international cooperation in these types of research activities if scientific management of the stocks is to become a reality.

APPENDIX V - REPORT OF ENVIRONMENTAL SUBCOMMITTEE

Chairman: N. J. Campbell

Rapporteur: A. W. May

The Subcommittee met on the morning of 23 May 1972. The following Research Documents were reviewed: 9, 31, 36, 37, 38, 42, 43, 44, 45, 62, 91, 104, 105, 107, 123.

1. Environmental Material in National Research Reports

a) West Greenland

Ice conditions were reported as severe off West Greenland with a long and nearly unbroken extension of storis lying offshore between Cape Farewell and Godthaab in July.

Observations taken in late spring and during the summer and winter months of 1971 revealed cold water conditions and lower mean values of temperature and salinity over the major fishing banks for most of the year. These conditions were clearly shown west of Fylla Bank slope throughout a depth range of 500 meters where temperatures and salinities were respectively 0.67°C and 0.29°/$_{oo}$ lower than for the period of 1950-66. This situation is thought to have developed from severe winter cooling and a strong influx of cold polar water from the East Greenland Current.

b) Labrador Shelf and Grand Banks

Ocenaographic sections and stations were occupied on the Labrador Shelf and Grand Banks region in July, August and November.

The cold water core, temperatures below 0°C, was found to be some 100-150 m thick off Cape Chidley and appears to have extended well down the coast, thinning and narrowing southwards but remaining essentially centered at 125 m depth. Later in the year the lens appears to have been broken off at about 56°N latitude. The cold water core appears to have been much greater and more extensive than for the conditions of 1951-65, more closely resembling the conditions and years with the lowest observed temperature.

In the offshore warmer part of the Labrador Current, temperature conditions were close to the 1951-65 average, reversing the trend set in the previous year. However, on the northern part of the Newfoundland Bank and on the northeastern slope of the Grand Bank, temperature observations were lower than for the period 1957-1971. Along the southern extent of the Grand Bank temperatures were above normal and approached the highest on record shorewards.

Dynamic height charts in Res.Doc. 72/104 clearly show the Labrador Current and its branch moving around the Flemish Cap in a clockwise direction and anticyclonic movements of water in the central part of the Grand Bank and Flemish Cap.

The changing character of the details of these charts from survey to survey is indicative of the origin of anomalies of temperature and salinity in parts of the area; in particular, they show the influxes of Gulf Stream water onto the shallow southern sides of the Grand Banks.

c) Scotian Shelf and Georges Bank

Water temperatures in these areas were generally higher in 1971 than in 1970. Temperatures in the cold intermediate layer in the East Channel area were considerably higher (1.7°C in the spring) than for the summer of 1970. These conditions persisted through to the autumn of the year. No appreciable change in temperatures was recorded in the northern Georges Bank region.

2. Environment and Fisheries

It was noted in the UK research report (Res.Doc. 72/37) that the continuous plankton recorder survey was continued in 1971 on the same basis as in previous years. About 21,000 miles were surveyed in Subareas 1-5. The USA is cooperating in the extension of the survey and is also collaborating with the UK Institute of Marine and Environmental Research in development and assessment of the undulating recorder. In recognition of the importance of this work to fisheries research, the Subcommittee

recommends (19)

that a representative of the UK Institute of Marine and Environmental Research be invited to attend the next meeting of the Subcommittee and to present a review of the Institute's work, including suggestions as to how the material might be summarized annually for greatest use in relation to ICNAF Area fisheries

studies (e.g. monthly charts of distribution of various plankton species, including fish eggs and larvae).

The Subcommittee noted with interest the findings of Soviet scientists concerning low phosphate concentrations over Georges Bank in summer. Similar studies will be carried out in 1972.

In relation to the cold water conditions in the West Greenland area, plankton surveys in 1971 indicated low abundance of plankton, including cod eggs and larvae.

It was noted that ice conditions in the northern subareas have been severe since 1969, including the winter and spring of the current year. It was felt that the Subcommittee should become better acquainted with ice observation and forecasting techniques and the general availability of this information. The Subcommittee, therefore,

recommends (20)

i) that appropriate ice experts and forecasters be invited to participate in the next meeting of the Subcommittee and be asked to prepare formal presentations for discussion; and

ii) that national research reports should include a section on ice conditions, particularly the concentration and extent of ice cover in the various subareas.

It would also be pertinent to the deliberations of the Subcommittee to include charts and descriptions of surface and bottom temperatures in areas where hydrographic observations are made.

3. ICNAF Georges Bank - Gulf of Maine Environmental Survey

The USA, USSR and Canada have collaborated in several experiments to determine the best ways to carry out plankton surveys. Sorting and identification are complete and analyses are proceeding. It was reported that the USA is setting up a major program of plankton surveys (MARMAP) in relation to productivity and abundance of fish stocks. It is anticipated that these surveys will be carried out over the shelves and deep water, and that ships of opportunity will be used.

4. Cooperative Systematic Studies on North Atlantic Oceanography

At the 7th Session of the IOC, a resolution was passed recommending that the Joint ICES/ICNAF/IOC Coordinating Working Group for the North Atlantic meet at the 60th Statutory Meeting of ICES, and consider the present and planned investigations being organized by various intergovernmental and non-governmental bodies in recognition of the need for strengthening the lines of communication between these various bodies and programs. It is intended that ICNAF will be represented.

5. ICES Hydrography Committee Report

The Chairman reviewed a number of recommendations by the ICES Hydrography Committee and highlighted those of potential interest to ICNAF. These included the ICES overflow program, the joint panel on oceanographic stations in the North Sea and the ICES/SCOR study of pollution and its effects on the living resources of the Baltic Sea.

6. Publication of ICNAF Symposium on Environmental Conditions in the North Atlantic, 1960-69

The Executive Secretary reported that this publication is in press and should be distributed by late summer 1972.

7. Contribution to IGOSS

The Chairman and Mr Posgay (USA) reported on recent developments and operational activities of IGOSS, and in particular requested members of the Subcommittee to assess the application of a potential list of products which might have application to fisheries interests, in an effort to bridge the lack of communication concerning the development of oceanographic services of potential interest to fisheries scientists.

8. Polar Ice Research Project

The Subcommittee took note of the resolutions adopted at the International Sea Ice Conference at Reykjavik in May 1971. The Subcommittee does not envisage a major input by ICNAF in organization of such a project, but considers that ICNAF might wish to participate in the project when it becomes operational, in close collaboration with other participating agencies.

9. Review of Standard Sections, Stations and Other Reporting Criteria

It was noted in the 1971 report of this Subcommittee (*Redbook* 1971, Part I, page 81) that there were inconsistencies in the numbering of standard sections and stations for hydrographic purposes. In actual fact there are a large number of sections and stations in the ICNAF Area which are referred to as "standard". Many of these are infrequently occupied, and there is no apparent consistency in annual reporting. The Subcommittee decided to refer the matter to the ICES/ICNAF/IOC Coordinating Working Group for consideration, and

recommends (21)

that the ICES/ICNAF/IOC Coordinating Working Group prepare a proposed list of standard sections and stations in the ICNAF Area for presentation to the 1973 ICNAF Annual Meeting. This list should include proposed standard sections and stations for East Greenland and ICNAF Statistical Area 6.

The Subcommittee also considered the problem of standardization of base periods for temperature and salinity anomalies. Knowledge of the USA MARMAP program would be of relevance to the evaluation of this problem and the USA promised to submit a document in this respect to the ICES/ICNAF/IOC Coordinating Working Group meeting later this year. The Subcommittee accordingly

recommends (21)

that the problem of standardization of base periods for temperature and salinity anomalies be taken up by the ICES/ICNAF/IOC Coordinating Working Group which will meet in conjunction with the 60th Statutory Meeting of ICES later this year and that proposals from the Group be presented to the 1973 Meeting of the Environmental Subcommittee.

C. INDEX OF RECOMMENDATIONS

D. LIST OF RESEARCH DOCUMENTS, 1972 ANNUAL MEETING

Res.Doc. No.	Serial No.	Title	Author
72/1	2707	Report of Mid-Term Meeting of Assessment Sub-committee, 24-29 January 1972	R.C. Hennemuth (Chairman)
72/2 (also ICNAF *SAC No. 72/1 - Revised)	2681	Estimates of natural mortality for ICNAF Division 2J cod	A.T. Pinhorn
72/3 (also ICNAF SAC No. 72/2)	2682	Revised estimates of fishing mortality and stock size for ICNAF Division 2J cod	A.T. Pinhorn
72/4 (also ICNAF SAC No. 72/3 - Revised)	2683	Virtual population assessment of ICNAF Subdivision 3Ps cod, and Appendix	A.T. Pinhorn
72/5 (also ICNAF SAC No. 72/4)	2688	Size selectivity of the Georges Bank offshore dredge and mortality estimate for scallops from the northern edge of Georges in the period June 1970 to 1971	J.F. Caddy
72/6 (also ICNAF SAC No. 72/5)	2689	Some recommendations for conservation of Georges Bank scallop stocks	J.F. Caddy
72/7 (also ICNAF SAC No. 72/6)	2690	Autumnal distribution, abundance and dispersion of larval herring, *Clupea harengus harengus* Linnaeus, along the western coast of the Gulf of Maine in 1971	J.J. Graham, C.W. Davis, S.B. Chenoweth & B.C. Bickford
72/8 (also ICNAF SAC No. 72/7 - Revised)	2691	Preliminary results of Georges Bank - Gulf of Maine ICNAF larval herring cruise, *Delaware II*, 21 September - 4 October 1971	K.A. Honey & S.B. Chenoweth
72/9 (also ICNAF SAC No. 72/8)	2692	Data report - *Albatross IV* cruise 71-7, 2-17 December 1971	J.B. Colton
72/10 (also ICNAF SAC No. 72/9)	2693	The seasonal and area distribution of herring spawning off the southwest Nova Scotia coast as indicated by logbook records	T.D. Iles
72/11 (also ICNAF SAC No. 72/10)	2694	Catch and effort data for the southwest Nova Scotia (4X) purse seine fishery, 1966-1971	T.D. Iles & D.S. Miller
72/12 (also ICNAF SAC No. 72/11)	2695	'Landings' and 'catches' in the Canadian Bay of Fundy herring fisheries, 1963-1971	T.D. Iles
72/13 (also ICNAF SAC No. 72/12 - Revised)	2696	Herring assessment for the Gulf of Maine (ICNAF Division 5Y) stock	V.C. Anthony & B.E. Brown
72/14 (also ICNAF SAC No. 72/13 - Revised)	2698	Assessment of American plaice stocks in ICNAF Divisions 3L and 3N	T.K. Pitt
72/15 (also ICNAF SAC No. 72/14 - Revised)	2699	Estimates of natural mortality coefficients of American plaice	T.K. Pitt
72/16 (also ICNAF SAC No. 72/15 - Revised)	2700	Virtual population assessments of cod in ICNAF Divisions 3K and 3L	R. Wells
72/17 (also ICNAF SAC No. 72/16 - Revised)	2708	Divisions 4V-W haddock: some implications of research vessel survey results	R.G. Halliday

* SAC No. - Special Assessment Contribution to Mid-Term Meeting at FAO, Rome, January 1972.

Res.Doc. No.	Serial No.	Title	Author
72/18 (also ICNAF SAC No. 72/17)	2709	The fishery on the southern Gulf of St. Lawrence cod stock, 1960-70	R.G. Halliday
72/19 (also ICNAF SAC No. 72/18 - Revised)	2710	Recent information of landings, age compositions and future recruitment of Subarea 1 cod	Sv.Aa. Horsted
72/20 (also ICNAF SAC No. 72/19 - Revised)	2711	Biochemical studies on the stock structure of herring in the Gulf of Maine, Georges Bank and adjacent areas	R.D. Lewis & G.J. Ridgway
72/21 (also ICNAF SAC No. 72/20 - Revised)	2712	Division 4X haddock stocks - status report, 1972	E.G. Heyerdahl
72/22 (also ICNAF SAC No. 72/21 - Revised)	2713	Total mortality rates for two groups of yellowtail flounder estimated from survey cruise data from ICNAF Subarea 5	J.A. Penttila & B.E. Brown
72/23 (also ICNAF SAC No. 72/22 - Revised)	2714	Current status of the yellowtail flounder fishery in ICNAF Subarea 5 - January 1972	B.E. Brown
72/24 (also ICNAF SAC No. 72/23 - Revised)	2715	Georges Bank (ICNAF Division 5Z and Subarea 6) herring assessment	A. Schumacher & V.C. Anthony
72/25 (also ICNAF SAC No. 72/24)	2716	The state of cod stocks in the Labrador (Div. 2J) and Newfoundland (Div. 3O) areas in 1971 and the fishery forecast for 1972	A.S. Bogdanov & T.F. Dementieva
72/26 (also ICNAF SAC No. 72/25 - Revised)	2717	Scientific advice on catch levels	J.A. Gulland & L.K. Boerema
72/27 (also ICNAF SAC No. 72/26)	2718	An approximate estimate of the stock abundance of red hake (*Urophycis chuss*) in 1965-1972	V.A. Rikhter
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72/29 (also ICNAF SAC No. 72/28)	2720	Results of trawl survey carried out by the USSR R/V *Argus* in June 1971	A.S. Noskov & V.A. Rikhter
72/30 (also ICNAF SAC No. 72/29)	2721	State of the stock and prospects for the fishery of haddock in the Newfoundland area	V.P. Shestov
72/31	2725	Temperatures and salinities in the eastern Newfoundland area in 1971	W. Templeman
72/32	2785	Report of the ICES/ICNAF Joint Working Party on North Atlantic Salmon, Dublin, 21-24 March 1972	B.B. Parrish (Chairman)
72/33	2784	Report of the ICES/ICNAF Working Group on Cod Stocks in the North Atlantic, Charlottenlund, 8-14 March 1972	D.J. Garrod (Chairman)
72/34	2754	Extracts from ICES Liaison Committee Report to NEAFC, 1972	
72/35	2755	Icelandic Research Report, 1971 - Subarea 3	J. Magnusson
72/36	2764	Canadian Research Report, 1971. A. Subareas 1, 2 and 3 B. Subareas 4 and 5	W. Templeman & A.M. Fleming J.S. Scott

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72/37	2767	UK Research Report, 1971 Subareas 1-3 - A. Status of the fisheries B. Special research studies Subareas 1-5 - Environmental studies	 D.J. Garrod K.A. Pyefinch G.A. Robinson
72/38	2778	Danish Research Report, 1971 - Subarea 1 Part I - Status of fisheries and research studies Part II - Hydrographic conditions	Sv.Aa. Horsted & E. Smidt F. Hermann
72/39	2781	Spanish Research Report, 1971	M.G. Larrañeta & J. Rucabado
72/40	2788	Portuguese Research Report, 1971	Manuel Lima Dias
72/41	2812	Japanese Research Report, 1971	Ikuo Ikeda
72/42	2819	USSR Research Report, 1971	K.G. Konstantinov & A.S. Noskov
72/43	2820	Polish Research Report, 1971	F. Chrzan
72/44	2825	German Research Report, 1971 Part I - Subarea 1 and East Greenland Part II - Subareas 2-5 (except herring) Part III - Subareas 4-6 (herring)	 A. Meyer & W. Lenz J. Messtorff & W. Lenz K. Schubert
72/45	2845	USA Research Report, 1971	
72/46	2857	French Research Report, 1971	M.R. Letaconnoux & J. Morice
72/47 and 72/48		Not Issued	
72/49	2786	Adult salmon recaptures from a 1968 smolt stocking program	B. Tétreault & W. Carter
72/50	2757	Catch and effort statistics for Canadian sealing in the ICNAF Convention Area in 1971	Fisheries Service Dept. of Envir. Ottawa
72/51	2759	Age, length and maturity of adult herring in ICNAF Divisions 5Z, 5Y, 4X and Subarea 6, 1971	H.C. Boyar, F.E. Perkins & R.A. Clifford
72/52	2765	Summary of fishing effort in the ICNAF Convention Area for 1970	Asst. Exec. Sec.
72/53	2768	Age and growth of the American plaice, *Hippoglossoides platessoides*, in ICNAF Subdivision 4Vn	J.P. Minet
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72/55	2771	Observations on herring taken in ICNAF Subareas 4 and 5	Ph. Decamps
72/56	2772	Note on length at sexual maturity of American plaice, *Hippoglossoides platessoides*, on Saint Pierre Bank (ICNAF Subdiv. 3Ps)	J.P. Minet
72/57	2773	Catch statistics for the years 1958-1970 summarized in relation to certain 1972 proposals for quota regulation of cod stocks in Subareas 2, 3, 4 and 5	Asst. Exec. Sec.
72/58	2774	Some notes on the occurrence of larval nematodes in adult herring and mackerel caught in Divisions 6A and 6B of ICNAF Subarea 6	B. Lubieniecki

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72/59	2775	Canadian studies on harp seals in 1971	D.E. Sergeant
72/60	2776	Proposed stratification scheme for ICNAF Subdiv. 3Ps	A.T. Pinhorn
72/61	2777	Notes on distinguishing between the two species of hakes of the Northwest Atlantic, *Merluccius bilinearis* and *Merluccius albidus*	R. L'Herrou
72/62	2779	Distribution of herring larvae on Georges Bank and in the Gulf of Maine in September 1971	R. L'Herrou & D. Briand
72/63	2782	Efficiency of sampling	Asst. Exec. Sec.
72/64	2783	A groundfish survey of Faroe Bank	B.W. Jones & J.G. Pope
72/65 (also ICES/ ICNAF Sal.Doc. 72/1)	2792	Greenland salmon research programme, 1971 - *Adolf Jensen*	W.R. Munro
72/66 (also ICES/ ICNAF Sal.Doc. 72/2)	2793	Scottish salmon catch statistics, 1952-1970	W.R. Munro
72/67 (also ICES/ ICNAF Sal.Doc. 72/3)	2794	Sex ratios of North Esk salmon in relation to age	W.M. Shearer
72/68 (also ICES/ ICNAF Sal.Doc. 72/4)	2795	Summary of salmon parasite investigations 1970-71	J.H.C. Pippy
72/69 (also ICES/ ICNAF Sal.Doc. 72/5)	2796	First estimates of "salmon" versus grilse quantities in Canadian commercial catches, 1969 and 1970	A.W. May & W.H. Lear
72/70 (also ICES/ ICNAF Sal.Doc. 72/6)	2797	Preliminary observations on differences in fishery contributions of hatchery-reared Atlantic salmon (*Salmo salar*) smolts related to stock selection and release location	J.A. Ritter & D.B. Lister
72/71 (also ICES/ ICNAF Sal.Doc. 72/7)	2798	Exploitation of Miramichi Atlantic salmon based on smolts tagged in 1968, 1969 and 1970	G.E. Turner
72/72 (also ICES/ ICNAF Sal.Doc. 72/8)	2799	Percentage of female salmon in the upstream migrations on the River Axe, Devon	Ministry of Agric, Fish. & Food, London
72/73 (also ICES. ICNAF Sal.Doc. 72/9)	2800	Salmon catches for England and Wales	A. Swain
72/74 (also ICES/ ICNAF Sal.Doc. 72/10)	2801	The derivation by analysis of 10-variance of indices of total migrant population size from angling catch returns from the River Wye	A.S. Champion
72/75 (also ICES/ ICNAF Sal.Doc. 72/11)	2802	Geographical and seasonal distribution of the Danish offshore salmon fishery at West Greenland	O. Christensen
72/76 (also ICES/ ICNAF Sal.Doc. 72/12)	2803	The Faroese offshore fishery for salmon at West Greenland, 1971	A. Reinert
72/77 (also ICES/ ICNAF Sal.Doc. 72/13)	2804	The size composition and growth rate of salmon landed in West Greenland during the autumn, 1970	J.Møller Jensen
72/78 (also ICES/ ICNAF Sal.Doc. 72/14)	2805	Grilse/salmon relationship in two Irish rivers	E. Twomey
72/79 (also ICES/ ICNAF Sal.Doc. 72/15)	2806	Catches in 1971 and their seasonal breakdown	E. Twomey
72/80 (also ICES/ ICNAF Sal.Doc. 72/16)	2807	Rates of exploitation in Irish waters	E. Twomey

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72/81 (also ICES/ ICNAF Sal.Doc. 72/17)	2808	Use of scales to determine mainland origin of Atlantic salmon caught in offshore waters	K. A. Mosher
72/82 (also ICES/ ICNAF Sal.Doc. 72/18)	2809	Distant and local exploitation of a Labrador Atlantic salmon population by commercial fisheries	R.F. Peet & J.D. Pratt
72/83 (also ICES/ ICNAF Sal.Doc. 72/19)	2810	Overfishing and depleted stocks of Northwest Miramichi salmon	P.F. Elson
72/84	2787	Summary of information on discards and industrial fish (ICNAF Statistics Form 4) for the year 1970	Asst. Exec. Sec.
72/85	2818	Age analysis of hooded seals in south Greenland	Finn.O. Kapel
72/86	2789	Assessment of yellowtail flounder in ICNAF Divisions 3L and 3N	T.K. Pitt
72/87	2790	Meristic characteristics of Atlantic Herring (*Clupea harengus harengus* L.) stocks in Newfoundland and adjacent waters	L.S. Parsons
72/88	2791	Present status of the southwest Newfoundland herring stocks.	G.H. Winters & L.S. Parsons
72/89 (also ICES/ ICNAF Sal.Doc. 72/20)	2811	Preliminary report of salmon tags of Maine (USA) origin recovered from fisheries in the ICNAF Convention Area during 1971	A.L. Meister
72/90	2813	Nominal catches of American plaice in Divisions 3L and 3N for the years 1960-1970	Asst. Exec. Sec.
72/91	2815	Thermic conditions, catches and biology of the cod of western Greenland	P. Ernst & C. Zukowski
72/92	2816	ICNAF herring otolith exchange 1971-72	L.S. Parsons & G.H. Winters
72/93 (also ICES/ ICNAF Sal.Doc. 72/21)	2817	Gutted weight versus total length of Atlantic salmon at West Greenland	A.W. May & W.H. Lear
72/94	2821	Summary of information on numbers of fishing vessels in the ICNAF Area in 1971	Asst. Exec. Sec.
72/95	2822	Fishing fleet statistics: review of tonnage classes	Asst. Exec. Sec.
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72/97	2824	A comment on the stock and recruitment problem	D.J. Garrod
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72/99	2844	On two types of diurnal vertical migrations of sea fishes	K.G. Konstantinov & T.N. Turuk
72/100	2847	Inter-relationship among Hawke's Bay, southwest Newfoundland and southern Gulf of St. Lawrence herring stocks	G.H. Winters & L.S. Parsons
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72/103	2842	American plaice spawning in the Northwest Atlantic area	M.M. Nevinsky & V.P. Serebryakov

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72/104	2841	Circulation of waters in the south Labrador and Newfoundland areas in 1970-1971	B.P. Kudlo & V.V. Burmakin
72/105	2840	Hydrological conditions in the Labrador and Newfoundland areas in 1971	B.P. Kudlo & V.V. Burmakin
72/106	2832	Preliminary results of a quantitative analysis of commercial fish in Subarea 3 in 1971	A.I. Postolaky
72/107	2833	Abundance fluctuations of fishery stocks of cod and haddock on the Grand Bank of Newfoundland	K.G. Konstantinov
72/108	2839	Catch-per-haul of young cod in ICNAF Divisions 3K and 2J by the research vessel *A.T. Cameron*, 1969-71	R. Wells
72/109	2827	Combined virtual population assessment for ICNAF Divisions 2J, 3K and 3L cod	A.T. Pinhorn & R. Wells
72/110	2836	Biomass estimates for selected commercial species from stratified-random surveys in ICNAF Divisions 3L and 3N, 1971 and 3Ps, 1972	A.T. Pinhorn & T.K. Pitt
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72/113	2829	Review of the current status of the scallop fishery in ICNAF Division 5Z	B.E. Brown, M. Parrack & D.D. Flescher
72/114	2834	Seasonal distribution of red and silver hake in ICNAF Divisions 5Z, 6A and 6B	E.W. Bowman
72/115	2830	Estimates of future abundance levels of cod stocks in ICNAF Subarea 5 based on US research survey cruise indices	E.G. Heyerdahl
72/116	2837	A brief review of herring mesh selection studies	V.C. Anthony
72/117	2831	An assessment of the Georges Bank cod stock (Div. 5Z)	B.E. Brown & E.G. Heyerdahl
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72/119	2835	A preliminary evaluation of the effects of fishing on the total fish biomass, and first approximations of maximum sustainable yield for finfishes, in ICNAF Division 5Z and Subarea 6	
		Part I - Changes in relative biomass of groundfish in Division 5Z as indicated by research vessel surveys, and probable maximum yield of the total groundfish resource	M.D. Grosslein
		Part II - Estimates of total fishing effort and its relation to sustainable yield of finfish	B.E. Brown & J.A. Brennan
72/120	2849	Progress in the ICNAF groundfish survey program, and proposals for coordinated activities in 1972	M.D. Grosslein
72/121	2850	Proposals for revisions of (1) the fishing gear classification and (2) size categories of fishing vessels	Secretary, CWP
72/122	2851	"Searching time" and "fishing time"	Secretary, CWP
72/123	2852	Working Group on Joint Survey of Larval Herring in the Georges Bank-Gulf of Maine areas (ICNAF Subareas 4X, 5Y and 5Z), 9-12 May 1972, Boothbay Harbor, Maine	G.J. Ridgway (Chairman)

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72/124	2853	Nominal catches in the ICNAF Area (Subareas 1-6) in 1971	Asst. Exec. Sec.
72/125	2854	Outline of sampling strata for Subarea 2	J. Messtorff
72/126	2855	Report of the seventh session of the Coordinating Working Party on Atlantic Fishery Statistics, Rome, Italy, 10-16 November 1971	Secretary, CWP
72/127	2858	Catch and effort statistics for Norwegian sealing in front area, Newfoundland in 1971 (revised) and 1972 (provisional)	T. Øritsland
72/128	2859	Status of fisheries and research carried out in Subarea 2 in 1971	A.W. May
72/129	2860	Status of fisheries and research carried out in Subarea 5 in 1971	F.D. McCracken
72/130	2861	Status of fisheries and research carried out in Subarea 3 in 1971	H.A. Cole
72/131	2862	Status of fisheries and research carried out in Subarea 4 in 1971	J.A. Posgay
72/132	2863	Status of fisheries and research carried out in Subarea 1 in 1971	Sv.Aa. Horsted
72/133	2864	Status of harp and hood seal fisheries and research carried out in 1971	A.W. Mansfield
72/134	2865	Preliminary evaluation of trawls used for research vessel surveys by Canada, USA and USSR on the Nova Scotian shelf, and some observations on the resulting biomass estimates	M.D. Grosslein