International Commission for the Northwest Atlantic Fisheries

Serial No. 3942
(B.g.8)

ICNAF Summ.Doc. 76/VI/36

ANNUAL MEETING - JUNE 1976

Report of Third Meeting of the Environmental Working Group 26-30 April 1976, Szczecin, Poland

Chairman: E.J. Sandeman

The Environmental Working Group was established bollowing a recommendation of the 1974 Annual Meeting (Redbook 1974, page 72), "to suggest a proposal aimed at determining the factors involved in the production of good and poor year-classes in some of the major fisheries in the ICNAF Area". At the first meeting of the Working Group proposals were made for the study of herring stocks in the Gulf of Maine - Georges Bank area and cod on Flemish Cap, in so far as they relate to the terms of reference of the group. At the second meeting these proposals were considered further and, following an extensive review of the data base and progress made during 1974-75, a number of suggestions for augmenting the field research of the Georges Bank - Gulf of Maine coordinated larval surveys program were made and these were summarized in the recommendations. It was considered that the total data base for Flemish Cap still had not been adequately examined and that efforts should be intensified during the ensuing year to develop as complete a data base as possible.

The third meeting of the Working Group was held in Szczecin, Poland during 26-30 April to further review the considerable progress made and examine relevant hypotheses concerning recruitment mechanisms as well as consider such matters as standardization of oceanographic sections, stations and base periods, and standardized formats for exchange of environmental data. The opportunity was also taken to visit

Publ. in ICNAF Redbook 1977: 141-151

the Plankton Sorting Centre at Szczecin, where be observed their standard sorting procedures and quality control. Representatives attended from Canada, Federal Republic of Germany, Poland and USA (Appendix 1).

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

1. Larval Herring Studies for 1975-76 Season.

Following the recommendation (29 (i)) of the previous meeting of the Working Group "that monitoring of larval production should be continued for at least the next two years in the Georges Bank - Gulf of Maine area during the first six months of larval life, using standard methods of sampling and consisting of 4 or 5 cruises between September and December, one cruise in February and one cruise in March", the work done during 1975-76 was examined.

(a) Overview of 1975-76 larval herring survey program.

Dr. Grosslein, as task force leader of the coordinated international herring larval surveys, summarized survey activity during the period September 1975 to April 1976. Four extensive surveys were made over the Georges Bank - Nantucket Shoals region in the September-November period (BELOGORSK, 24 Sept-10 Oct; BELOGORSK, 15-31 Oct; ANTON DOHRN, 31 Oct-15 Nov; ALBATROSS IV, 2-17 Dec). Inshore Western Gulf of Maine was covered once by the U.S. vessel CHALLENGE in early September (4-9 September), and both western and eastern Gulf of Maine was surveyed by DELAWARE II in late September; (23 Sept-2 Oct); the eastern Gulf (i.e. Southwest Nova Scotia) and Bay of Fundy areas were surveyed by E.E. PRINCE in November (5-14 Nov).

Minimum sampling on all the Gulf of Maine surveys included standard Bongo hauls plus temperature profiles and surface salinities; on the DELAWARE II cruise, Nansen casts were also made at some stations for

salinity, nutrients and chlorophyll. For the Georges Bank-Nantucket Shoals region, Bongo and Neuston hauls were made at both standard ICNAF and at extra stations in larval aggregations. Oceanographic coverage for this area was the most complete achieved to date, including TS profiles, nutrients, chlorophyll and oxygen at nearly all standard stations on all cruises. Primary production measurements with ^{14}C were also made at selected stations on the December and February cruise of ALBATROSS IV as well as WIECZNO in April.

A special cruise on DELAWARE II was scheduled in October to attempt following a patch of newly hatched larvae near the HELGOLAND site. Unfortunately, spawning was later than expected and the vessel could not be rescheduled. However, in late October a short cruise was conducted on ALBATROSS IV in the HELGOLAND area, and extrusion of herring larvae.

(b) Reports on and results from spawning studies and/or larval surveys by different countries.

(i) Canada had little to report since the only cruise which took place was in November and to date this has not been completely analyzed. However, results from the survey did give some insight, when combined with sea bed drift data, on larval retention mechanisms in the Bay of Fundy.

(ii) Federal Republic of Germany reported on the numbers of herring larvae caught in the 0.505 mm mesh size Bongo nets during the November 1975 survey of ANTON DOHRN. On Georges Bank total numbers of larvae in 1975 were substantially lower than in 1973 and 1974 but higher than in 1971 and 1972. On Nantucket Shoals the 1975 catches were also substantially below those of 1973 and 1974 but were about the same as in 1971 and 1972. The ratio of larvae <10 mm to those ≥ 10 mm in the Nantucket Shoals area was low in 1971, increased to a maximum in 1973 and then declined again to a low value in 1975. On Georges

Bank the ratio of <10 to ≥10 mm larvae was also highest in 1973, but ratios were about the same in 1971, 1972, 1974 and 1975. The greatest abundande of larvae in both areas was observed in 1973, this being attributed to the strong 1970 year-class spawning for the first time. In addition, it was thought that the high ratio of small to larger larvae in this year might also be related to the initial and possibly later spawning of the 1970 year-class. Hatching success was assumed not to have varied substantially over this period. Discussion highlighted the difficulty of obtaining representative samples of recently hatched herring larvae and the Working Group emphasized the necessity of sampling very close to the bottom if unbiased samples of yolk sac larvae are to be obtained.

Data on larval herring catches made at night during the juvenile herring surveys of R.V. WALTHER HERWIG and R.V. ANTON DOHRN in March 1973-1976 was presented (Res.Doc. 76/VI/79). In 1973 it was found that larvae sampled by their becoming meshed in the knots of the bottom trawl showed a similar size distribution to those caught in the 0.505 mm Bongo.

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

(iv) The USSR vessel BELOGORSK conducted two surveys in autumn 1975 (the first filling in the gap left by WIECZNO) but USSR representatives were not present, and no results were available.

(v) The United States presented distribution maps of larval herring caught in December 1975 and February 1976. In the Nantucket Shoals area in December the length frequency was biomodal, with modes at 10 and 18 mm, and with about twice as many larger larvae. However, as in previous years, this

smaller mode had disappeared by February. One hypothesis discussed was that predation removes the smaller larvae.

The distribution of Georges Bank larvae was essentially unimodal in December with the modal length being ≈ 18 mm. By February these larvae had grown to ≈ 30 mm. Data was presented on the growth and mortality rates on Georges Bank alone between 1973-74 to 1975-76.

Sampling period	Larval abund	% Mort. per day	Mean length /mm/	% Growth per day
13 Dec	5076		15.1	
14 Feb	406	3.93	22.9	
24 Mar			30.1	0.603
13 Dec	7410		16.5	
14 Feb	506	3.87	26.7	
17 Mar			30.0	1.625
9 Dec	1120		17.4	
16 Feb	457	1.27	31.1	
5 Mar			31.6	1.818

As illustrated in the preceeding table, the mortality rate of harring larvae has declined as the growth rate has increased. This fits in well with the theoretical basis of growth and the death models presented by Cushing, Ware and others. The point was raised that the principal mortality of herring larvae was occurring in areas of winter concentrations.

(c) Other aspects of larval herring studies.

Extrusion of larvae through the meshes of the sampling gear is a source of potential bias and the United States reported that although the complete results were still not analysed, an examination of the data from two ALBATROSS cruises showed that for larvae >8 mm, there was no statistically significant difference between the 0.333 mm and 0.505 mm mesh sized nets.

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

Five papers were reviewed in connection with the environmental conditions in the more southern part of the Northeast Atlantic continental shelf. These were Working Paper 76/IV/113 and Res Docs 76/VI/4, 77, 78 and 85.

Standardization of continuous temperature measurements and increased nutrient and chlorophyll sampling were implemented on larval herring cruises during 1975. The Working Group was particularly pleased to note the latter in relationship to their recommendation from last year's meeting (Redbook, 1975, (29(vii)) p. 98) and encouraged participants to continue this important aspect of the work.

Temperature conditions were not significantly different in 1975-76 when compared to the 1971-1973 data throughout the area for all cruises. The relatively cool area on northeastern Georges Bank and east of Nantucket Shoal appear to be semi-permanent features during the Autumn. Temperature gradients lessened in December and nearly isothermal conditions existed in February with mean temperatures for Georges Bank identical to those found in 1974 (9.9°C in December and 5.7°C in February).

Long-term seasonal temperature trends from 1962 to 1972 were determined for the northwestern Atlantic Shelf. These were augmented for the Gulf of Maine and Georges Bank in spring and autumn by bottom temperatures from 1968 to 1975. Both in the Gulf of Maine and Georges Bank a general warming was seen in the spring beginning in 1964. Although different base periods were used, a warming of 2-3°C was observed. The bottom temperature data for the Gulf of Maine indicated that a sudden influx of warm bottom water may have occurred in autumn 1971. However, the autumn data generated considerable discussion because of an apparent divergence between the two sets of data. The cause of the discrepancy

could not be resolved.

A preliminary report was given on data collected on a series of hydrographic sections in the Northeast Channel between Georges and Brown's Banks involving the National Marine Fisheries Service, US Coast Guard, and participants in the ICNAF larval herring cruises. Twenty-one oceanographic sections across Northeast Channel were taken during 1975. Slope water was regularly present in the Northeast Channel, from March through December, and frequently inside the channel sill. Such intermittent observations of warmer, more saline slope water are consistent with a presumed sporadic flow into the Gulf of Maine.

The Working Group noted with satisfaction the increased oceanographic activity and that the important section across the Northeast Channel has been occupied at least once a month throughout the spring of 1976. In keeping with their recommendation of last year (Redbook 1975, 29(v) p. 98) the Working Group welcomed the plans of the United States for deployment of several current meters with temperature sensors on these moorings at the sill of the Northeast Channel. It was hoped that these arrays would be deployed by late August or September and anticipated that measurements would be made over the period of a complete year.

3. Spring Juvenile Surveys and other Studies on Juvenile Herring.

Working Paper No. 76/IV/50 on the 1976 spring trawl surveys was reviewed briefly and it was noted that no age two

herring (1974 year-class) were caught in the Georges Bank and Southern New England regions, the main areas surveyed by both ANTON DOHRN and ERNST HAECKEL. In previous spring surveys significant numbers of age two herring were caught, particularly by WALTHER HERWIG in 1973 and 1974, which suggests that the 1974 year-class may be even weaker than the 1971-73 year-classes. There is still some uncertainty as to the distribution and availability of two-year-olds in the spring, and there are some inconsistencies in the relative strengths of certain year-classes as measured by successive survey abundance indices at different ages (two to four). In particular it was noted that in W. HERWIG spring surveys the ratio of the 1971 to 1972 year-classes was much larger as indicated by catches of 3-year-old herring, than it was for 2-year-oldd herring (see pp. 40-41, Summ.Doc. 76/VI/22); on the other hand ALBATROSS IV survey catches showed relatively smaller differences in the ratios of the 1971 and 1972 year-classes at age 3 (Working Paper 76/IV/50). Also it was noted that the ratios varied somewhat with the area of the survey. Nevertheless, there is a basic pattern of consistence and credibility in the overall ranking of the year-classes based on the spring surveys, which indicated substantially smaller recruitment since the 1970 year-class, and that the 1973 and 1974 year-classes are even weaker than the 1971-1972 year-classes. This pattern does not correlate well with the year-class indices based on numbers of larvae in December. There were four to ten times as many larvae in December of '73 and '74 as in December of '71 and '72 (Res. Doc. 75/112); and yet, as noted in WP 76/IV/50 and the April '76 assessment report, survival to ages two and three as indicated by spring trawl

surveys appears lower for the '73-'74 year-classes than for the '71-'72 year-classes. This implies that the mortality which occurred after December was most important in determining size of these year-classes. The most recent '75-'76 over-winter mortality estimates by Lough (Table in Section A1(b)) showed that the December '75 to February '76 mortality was considerably lower (and larval growth greater) than in the two previous winters. That is, larval abundance in February '76 was about the same order of magnitude as in February '74 and February '75, whereas the larval abundance in December '73, '74, and '75 was in the ratio 5:7:1, respectively. This tends to further confirm the hypothesis that over-winter mortality is critical to year-class success.

The Working Group again noted the need for information on the post-larval and remaining 6 months of the first year of life, but considered it unwise to abandon the monitoring of the fall-winter larval production, growth and survival because some of the factors responsible for variation in over-winter mortality (e.g. growth rate and thus size and robustness of larvae as they enter the winter period) may actually operate during the previous autumn months. The question arose whether some of the vessel time devoted to spring trawl surveys might be diverted to midwater trawl surveys to follow the herring into the post-larval and early juvenile stages. It was concluded that, in spite of the variability in the spring survey indices, they represent the only source of pre-recruit abundance data at age two, and probably the only unbiased estimates of older age

groups as well, by virtue of the controlled sampling procedures. Without these data we would have only VPA data as a consistent basis for correlating larval abundance with year-class strength at older ages, and hence no basis for investigating the question of timing of mortality until year-classes entered the fishery 3 or 4 years later. Also, the Working Group was aware of the fact that the spring surveys are useful for mackerel assessment, and hence could not recommend interruption of the spring surveys without more guidance as to their priorities from the Assessment Subcommittee. It was suggested that it would be desirable to have more information on fishing power differentials between the vessels conducting the spring trawl surveys, in the hope that more accurate abundance indices could be made. However, it was also recognized that fishing power experiments are extremely time-consuming and require a time series just as much as abundance surveys. In view of the available resources, the Working Group does not recommend diversion of ships from current spring surveys for fishing-power comparison. Midwater trawl sampling of post-larval and early juvenile stages should get higher priority if more ship time becomes available.

4. General Plankton Studies.

The Working Group was pleased to note the efforts that have been made towards obtaining a better base for the understanding of zooplankton dynamics with three papers being reviewed under this general topic (Res. Docs. 76/VI/82, 83 & 97).

An examination of the distribution of copepods in the coastal waters of the Western Gulf of Maine in the year 1966

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

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

The Working Group noted with satisfaction first results from the analysis of plankton from .333 mm mesh samples. These results which demonstrated the valuable part that the Plankton sorting centre can plan in the work of the Group, provided a description of the distribution and abundance of zooplankton in the Georges Bank-Gulf of Maine area. The analysis which was based on samples from the larval herring survey of WIECZNO 27 Sept - 18 Oct 1974, provided comparisons between the 10 most dominant taxa in regard to their total biomass contribution. The concentration of copepods in the areas of

larval herring abundance was noted and discussion centered on the mechanisms which might be involved in retaining and concentrating herring larvae and their food organisms with the 100 m contour. Potential predators of herring larvae such as chaetognaths and euphausids were observed throughout the distributional area of the larvae.

5. Progress Toward and Reports on Other Specific Studies (Redbook 1975, Recommendation 29 (viii)).

(a) Diurnal movements - No new information to report.

(b) Establishment of a complete series of known age larvae.

U.S. reported on work being done with the scanning electron microscope. A good correlation was found between apparent daily growth rings on the otolith and the age in days for some species of fish. They are hoping to extend this work during 1976 to herring larvae of known age reared in the laboratory under different environmental conditions.

(c) Monitoring abundance of phytoplankton and zooplankton with Continuous Plankton Recorders.

Use of such instruments would provide useful information on the scale of patchiness of larvae. No new information to report.

(d) Aquisition of further data on egg mortality in relation to egg size and egg quality.

U.S. reported briefly on the Helgoland experiment. In addition to the technical difficulties of the experiment and the problems posed by extreme weather conditions, the herring did not spawn close to the Helgoland habitat.

(e) Analysis of various length measurements on larvae collected by the ICNAF larval herring surveys.

Various length conventions have been used by the participants in measuring larvae collected on the surveys since the beginning of the Cooperative International ICNAF Larval Herring Surveys in 1971. Four different measurements have been used: (i) standard length (snout to base of caudal fin) to nearest mm; (ii) standard length to mm below; (iii) total length to nearest mm; and (iv) total length to mm below. The question as to whether there is a significant difference among the length conventions as they relate to length frequency distributions of larvae was addressed in Res Doc 76/VI/58. The Working Group noted the need for more rigorous and standardized subsampling procedures, as well as the desirability of adjusting basic larval length measurements to standard length, nearest mm, for future analyses of growth and mortality. These problems will be resolved for .333 mm samples all of which will be processed with one set of standard procedures by the Sorting Centre.

6. Review of Plankton Sorting and Archiving Methods at the Sorting Centre.

Dr L. Ejsymont, Director of the Plankton Sorting Centre, provided the Working Group with a review of the organization and operations of the Plankton Sorting and Taxonomic Centre (see Res. Doc. 76/VI/115). He described progress to date in the sorting of plankton samples from the various cruises of the joint ICNAF larval herring surveys and elaborated on the methods which had been established

to date. Present priorities which were established by an Advisory Committee of USA and Polish scientists, regarded the analysis of 0.333 mm mesh samples from the joint ICNAF larval herring cruises from 1971 to 1975 as of the highest priority and the Working Group was pleased to note the progress that had been made to date and particularly the paper which documented the first results of the work (Res.Doc. 76/VI/97). The Working Group noted that in the future the Sorting Centre would be prepared to consider sorting plankton samples other than those of hte joint ICNAF larval herring surveys.

The results of a Workshop convened in March 1976 to measure the variance associated with the subsampling procedures, and to establish standard sorting protocols were reviewed. Papers were presented in relation to counts of zooplankton made at different aliquot levels and with three different splitting devices to measure the variance of subsamples (Res.Doc. 76/VI/81) and on the Interim Sorting Protocol for ICNAF zooplankton samples (Res.Doc. 76/VI/84 + Corrigendum). It was noted that the nomogram method developed by Tschislenko is now being used by the staff of the Sorting Centre to estimate the contribution of the more numberous zooplankters to the total biomass and it is hoped that better methods being developed at the Narragensett Laboratory will be substituted in the next few months. The Working Group expressed its satisfaction at the recommended interim protocols (Res Doc 76/VI/84) and noted that these were open for discussion and possible revision. In particular, it asked that ICNAF scientists carefully examine the taxa list (Res Doc 76/VI/84, attachment 2) to see if other taxa should be added.

A visit to the Plankton Sorting Centre allowed the Working Group to observe the processing of the samples, aliquotting methods, sorting and identification procedures as well as the archiving of representative samples. The Working Group were impressed with the calibre of the staff and the high quality of work being done by the Sorting Centre. There is no doubt that the results will play an important part in improving our understanding of secondary production on Georges Bank. Because knowledge of the Plankton Sorting Centre is largely confined to Polish and US scientists, the Working Group suggested that a general description of the Plankton Sorting Centre and work being done there would be useful to all ICNAF scientists and that it might be possible for the Director to prepare such a document for the Meeting of the Environmental Subcommittee in June (see Res.Doc, 76/VI/115).

7. Status of Data Processing Plans and Progress toward Standardization and Transfer of Time Series Data to the Computer Data Bank.

Dr. Grosslein reported that the time series of 1972-75 data on sorted larvae from the 0.505 mm meshed nets was now within the Woods Hole computer and that a list of computer outputs for distribution to participating scientists will soon be made available. Samples of computer output were examined by the Working Group and although it was planned that the majority of outputs available would be of a standard form, more specialized outputs could be made available if requested. At present, the MARMAP plankton data and oceanographic data are not compatible though it is anticipated that these will be made so during the coming year.

The Working Group discussed the general problem of data availability and the necessity of providing some rights to scientists who collected the data while still recognizing the desirability of opening the data base to other users as quickly as possible. It was generally agreed that a committee would provide the necessary institutional mechanism to accomplish this and at the same time it could highlight analyses needed on various components of the plankton community as well as minimize duplication of analytical effort. Although it was accepted that the U.S.A. should play the lead role in the analysis of the data requiring the use of the computer, the composition or terms of reference of such a committee were not discussed further; however the matter was flagged as one which might be considered at a future meeting of the Working Group.

8. Review and Discussion of Hypotheses on Factors Controlling Success of Year-Classes of Herring.

As an introduction to this topic, Mr. Lett summarized two papers. The first of these (Working Paper 76/IV/101) provided a useful review of the density-dependent and independent processes which may affect recruitment in herring. Discussion ranged over facets of the early life history of herring from the factors which are likely to affect egg production through larval energetics. In particular, it was noted that very little is known about the ecology of juvenile herring following metamorphosis. Unfortunately, this could be one of the important periods in the life history of herring in determining the recruitable year-class sizes. An examination for density dependent l_1 growth, the

length at the laying down of the first annulus, was suggested as a holistic method which might provide some insight into the ecology of herring during this early period. Predation was also discussed as being a further important component of the overall density dependent recruitment mechanism.

In the second paper (Res Doc 76/VI/4) a stochastic model was developed to study the effects of temperature perturbations, predation and competition from mackerel on the recruitment processes and general dynamics of Gulf of St. Lawrence herring. The paper attempted to elucidate some general hypotheses concerning recruitment which could be tested using data gathered from the Georges Bank area. Multivariate statistics were used to determine the structural equations for portions of the life history of herring. Temperature and the abundance of age group 0 mackerel affected the herring growth rate, but neither total herring biomass, total mackerel biomass, nor total pelagic biomass had any measurable effect on the herring growth rate. The growth rate of herring, coupled with adult stock size and environmental effects, mediated through temperature, were the prime determinants of the abundance of larvae < 10 mm. Predation, tempered by the available food density, was discussed as a major population stablizing mechanism and a fine tuning mechanism for year class formation.

The Working Group concluded that the model presented in Res Doc 76/IV/4 could represent a conceptual paradigm of the dynamics of the Georges Bank herring stock and proceeded to examine the assumptions inherent in the model with a view to

the possibility of testing them. The following assumptions were examined.

(a) Egg production is related to the production of the adult stock.

It was concluded that the Georges Bank herring stock in its depleted state would be growing at a maximal rate. Thus, to test this hypothesis, a laboratory experiment was required in which the ration size of herring could be varied to study the effects on fecundity. Since density-dependent growth has never been demonstrated for Atlantic herring, and due to the relatively stable environment in the Georges Bank area, the effects mediated by temperature would be difficult to detect under field conditions, large variations in the annual growth rate of this stock would be unlikely.

At this time, the Working Group felt that they could not recommend that an additional study be undertaken to study egg production but did suggest that the hypothesis be examined at a future date.

(b) The abundance of larvae is directly proportional to the abundance of eggs.

The Working Group noted that there were some rather serious gaps in our knowledge of this stage of the life history and it was desirable to acquire further knowledge on egg mortality in relation to egg size, quality and predation, as well as on environmental variables. For the present, it is assumed that larval survival is directly proportional to the number of eggs spawned. Therefore, predatory rates by haddock and other demersal species must be directly proportional to the

number of eggs spawned. However, it was noted that the haddock population in this area is at a minimum, thus predation on herring eggs by this species may not be that important. It has also been shown that the layering of Atlantic herring eggs does not lead to a substantial mortality, especially in the Georges Bank stock which is at an extremely low level.

The Helgoland experiment was to have conducted time intensive studies on the spawning and density distribution of eggs, subsequent egg survival and hatching success. Due to a late spawning and technical difficulties, this experiment was not able to achieve all the desired objectives. It was noted that experiments of this type, as well as being technically extremely difficult, are also very costly and consequently, the Working Group were unable to recommend that this assumption should be tested at this time. Doubt was even expressed by some whether this could ever be tested.

(c) Density dependent growth cannot be shown in the adult stage of herring, however, it can be demonstrated for juvenile and adult herring.

Density dependent l_1 growth was demonstrated for herring. This relationship was presented in the light of a population stabilizing mechanism by which both year-class size and the length at the end of the first year of life are simultaneously fixed, and remain invariate.

The Working Group agreed that the back calculation of herring scales was a possible fruitful area for future research. In addition to elucidating an important component of the recruitment mechanism, back calculation may itself be

useful as a predictive tool in determining year-class size. Information from back calculation is easily obtained and relatively inexpensive. Since the accuracy of this type of measurement is high, its usefulness as a predictive tool is certainly enhanced.

Back calculation will also provide information on the growth of Georges Bank herring. The growth rates could then be correlated with the biomass of the stock between 1960 and 1975 to determine whether density-dependent growth is observable for the stock in its severely depleted state. Correlation analysis could also be used to test the effects of the densities of other fish biomasses on the growth of herring. Supportive evidence for these correlations could be gained by stomach content analysis of species of fish other than herring, to determine if they are competing with herring.

Environmental effects mediated through temperature have also been shown to alter the growth rate of adult herring. This hypothesis could also be simply tested using the information gained from back calculated herring scales, through correlation analysis.

The Working Group thus recommends:

(i) *that herring scales for the Georges Bank stock be collected and back calculated,*

(ii) *that relationships between* 1_1 *and year-class size from sequential population analysis, between the growth rate of 1+ herring and stock biomass, between the growth rate of 1+ herring and the stock biomass of other species, and between the growth rate of herring and other environmental*

factors, be examined through the use of correlation analysis,

(iii) *that stomach content data be collected from fish caught in commercial and experimental trawls and a suitable midwater trawl be hauled in addition to standard bongos to catch smaller organisms which could compete with herring larvae and juveniles.*

(d) Predation by mackerel and cannibalism by herring are important population control mechanisms.

In the stock-recruitment model presented, predation by mackerel and cannibalism by larger herring were found to be important as a stabilizing mechanism for the herring population. It was also hypothesized that predation on small herring larvae by other types of zooplankton could be an additional important factor. The Working Group, therefore, recommends: *that greater emphasis be placed on surveying for predators. For this a greatly expanded program of stomach analysis would be required and all possible predaters should be included.*

(e) Shifts in the maturity ogive in relation to herring length could be an important population control mechanism.

It is assumed that maturity is a fixed function of length, however, evidence was presented for species other than herring that these ogives can indeed shift. The dramatic effects these shifts can have on egg production were elucidated. Thus, the Working Group recommends *that the maturity data collected through commercial sampling be analysed to study this hypothesis.*

(f) The stock being investigated is well delineated.

It was acknowledged that the delineation of the

Georges Bank spawning stock could be improved. Based on the present sampling scheme there appears to be no basis for improving the delineation of the stock. However, it was also noted that there would have to be a substantial augmentation of the present program tp perform this task. Tagging programs may be forthcoming but this is not certain. The Working Group was firmly of the opinion that greater emphasis should be put into the distribution of juvenile herring in their second six months of life but was unable to commit resources to this program at this time.

(g) Herring larvae can retain themselves in a specific area by varying their depth in response to tidal flow.

A review of the literature indicated that there was a mechanism whereby larval herring could maintain their position in the water column by varying their depth in relation to tidal flow. Temperature, salinity and light were identified as other key environmental variables which would aid larvae in orientating themselves, so they might maintain their position. In addition, there is evidence indicating that larvae in the Bay of Fundy used areas of upwelling to aid them in maintaining their position in the spatial horizontal plane. It has been noted that the over-wintering location of herring larvae on Georges Bank is well defined and that these larvae appear quite efficient at maintaining a relatively constant position.

The Working Group discussed in some detail ways and means of studying the fine structure of the vertical distribution and identifying the processes responsible for larval retention systems. It is apparent, because of the limited

number of research vessels available, that little work could be done towards this goal during the ensuing year. However, the Working Group regarded the study of a larval patch to be of such priority that they should reiterate the recommendation made at their 1975 meeting (Redbook 1975, 29 (vi)) *viz:*

that a special sampling study to follow an isolated patch of larvae on Georges Bank be attempted in 1975 and/or 1976, with a view to identifying the processes responsible for larval loss from the system, and providing information on the fine-scale variations in growth, mortality, dispersion, feeding and vertical distribution, as a basis for evaluating the feasibility of quantitative estimation of these processes and contributing to knowledge of sampling errors inherent in the present data base.

This study should include recording current meters in the path of the drifting larval patch, as well as drifting buoys and/or dye releases to measure Lagrangian and Eulerian advection and dispersion parameters. It was suggested that a useful start might, perhaps, be made by the deployment of one or two meteorological type buoys on the spawning beds to measure temperature, conductivity and currents at the bottom, midwater and surface.

The Working Group were pleased to note that the U.S. attempted a patch experiment in 1975 in connection with the HELGOLAND experiment. Results were disappointing because the timing of the hatching of herring did not coincide with the availability of the research vessel, however, it was gratifying

to note that attempts will again be made to follow a plankton patch during the September-October period in 1976.

9. Plans for the 1976-1977 Field Operations are to continue the plankton-hydrographic sampling basically in the same manner as for the 1975-76 program except for additional emphasis on:

a) attempts to conduct a patch study along the lines outlined in the body of the Working Group Report;

b) possible additional neuston and midwater trawl sampling to extend our knowledge of late spring larval distribution and distribution of juveniles following metamorphosis, as well as samples of larval predators.

more detailed description of both plankton and hydrographic sampling methods will be circulated via ICNAF Circular Letter this summer as was done for the 1975-76 program.

10. Task Force Leader for 1975-76.

The Working Group was unanimous in recommending *that Dr M.D. Grosslein remain as the Cooperative ICNAF Larval Herring Surveys Task Force Leader for 1975-1976.*

B. FLEMISH CAP.

The discussion of Flemish Cap as an area worthy of a Special International Coordinated Study aimed at determining the factors involved in the production of good and poor year-classes of major groundfish stocks in the area was initiated at the previous meeting of the Working Group.

As a follow-up to these initial discussions, a joint study using existing data, to be carried out by one scientist from

the USSR and one from North America, was recommended. Dr. Konstantinov was nominated by the USSR and Dr. Wolford of the U.S. Coast Guard agreed to serve on the joint study.

Unfortunately it was not feasible for Drs. Konstantinov and Wolford to prepare a joint report nor was Dr. Konstantinov able to attend the Working Group meeting. Thus, the deliberations of the Group were necessarily limited.

Dr. Wolford's presentation, which was based principally on Coast Guard data taken in the Flemish Cap area, identified the region as one with relatively stable temperature conditions in near bottom waters around the Cap, and with surface currents (computed from dynamic typography) relatively weak and variable.

Since a large proportion of the data available for the area has been taken by the USSR, but were not yet summarized and available to the Working Group, it became evident that advancement of the Working Group's thinking on the central question before it, in relation to Flemish Cap, was not possible at this time. Accordingly, it was agreed :

1. that we should proceed no further until Dr. Konstantinov's report became available, and full discussion with USSR scientists have taken place;

2. that, only with the full participation of the scientists from the USSR would it be possible to examine the desirability of developing a Flemish Cap proposal, and, providing this is forthcoming, a formal and slightly enlarged Mini-Working Group (including both Drs. Konstantinov and Wolford) might provide a vehicle for further developing this appraisal of Flemish Cap as an area worthy of special international study.

It was further proposed that the chairman should, through the Environmental Subcommittee convey to the U.S. Coast Guard the appreciation of the Working Group for the Coast Guard's continuing support for its works and for Dr. Wolford's valuable contribution to the Group.

C. STANDARDIZATION OF OCENAOGRAPHIC SECTIONS, STATIONS AND BASE PERIODS

1. At the 1975 meeting of STACRES, the standard sections proposed by the Working Group (Redbook 1975, App. V, Annex 1, Section C) were adopted as ICNAF standard oceanographic sections. Dr. Trites agreed to develop proposals for station positions on these standard sections. At that time, the oceanographic data for Georges Bank, Gulf of Maine and Southeast Scotian Shelf areas had not yet been sufficiently examined to enable proposals for specific sections in these areas to be made. Dr. Schlitz (U.S.A.) agreed to examine these areas in order to identify the most appropriate sections and Drs. Trites and Schlitz agreed to develop proposals for the consideration of the Working Group.

(a) Proposals for station positions on standard sections adopted by STACRES, 1975.

A list of proposed stations (positions and approximate depths) was circulated by the secretariat prior to the meeting of the Working Group (Circular Letter 76/25, Appendix II) and the Working Group recommended *that the list of stations proposed in Circular Letter 76/25, Appendix II be adopted as ICNAF standard oceanographic stations.*

(b) Proposals for sections in the South Western Nova Scotian Shelf, Georges Bank, Gulf of Maine and further south.

Proposals submitted by Drs. Schlitz (Res Doc 76/VI/37) and by Dr. Trites were considered and the Working Group agreed

(1) on the location of a section line cutting across Roseway Basin and Baccaro Bank,

(2) on the location of a section line to include Coast Guard A-5 (partial) and extended across Browns Bank to Cape Sable,

(3) that a section should run along 67° W longitude,

(4) that a section should run along 69° W longitude.

(5) that a section should run along 71° W longitude.

It was further agreed that the geographic positions for each of the stations in the foregoing sections, together with approximate bottom depths, should be prepared by Dr. Schlitz and submitted to the Environmental Subcommittee at its forthcoming meeting.

It was agreed that the Chairman of the Working Group should communicate to the U.S. Coast Guard, our continuing interest in having them occupy the Standard Sections as often as possible.

2. Investigation of Base Periods

At previous meetings of the Working Group, it had been recommended that MEDS (Marine Environmental Data Service) should examine the environmental time series in the ICNAF Area specifically to evaluate the possibility of finding useful base periods. Drs. Wilson and Trites (Canada) agreed to do this and working documents were available at the meeting. The MEDS

proposal was stated in Working Document 76/IV/100. While Dr. Trites (Working Document 76/IV/115) supported the MEDS plan, he expressed the view that while the MEDS output would be real value, it would still fall short of the users aspirations. Accordingly, he proposed a complementary approach which would permit the development of "station" averages along the standard sections, for semi-monthly intervals wherever 5 or more stations had been occupied over a 5 or more year period. While it was recognized that this would probably not produce meaningful averages at stations situated in or near the frontal zones, it was felt that for many of the stations the seasonal signal was the dominant signal.

The Working Group agreed that both the MEDS proposals and the complementary approach should be progressed and recommended: *that until further definitive progress is made in developing station averages along standard sections as proposed by Dr Trites ICNAF should adopt the following procedures:*

(a) Base periods for the ICNAF area should be 10 year periods such as 1951 to 1960 inclusively and 1961 to 1970 inclusively.

(b) Anomaly bases should be calculated as the arithmetic mean of the relevant individual means for each year of the base period.

(c) The degree of variability of the anomaly should be indicated by estimating the standard deviation about the base for each anomaly published.

(d) A review of these procedures should be carried out by the Environmental Subcommittee after 3 years, to

assess how the system is working.

(e) In order to help set up the new procedure, the MEDS, as oceanographic data centre for ICNAF, calculate baselines of 10 year means with standard deveiations for areas within the ICNAF area where sufficient data is available.

It was further recommended *that the USSR and Coast Guard Data as well as all available STD data should be incorporated into the data base before the analyses are carried out.*

3. Marine Environmental Data Service

Several members of the Group noted that the data bank was not as complete as it should be. It was agreed that the chairman would explore the problem with MEDS and report back to the Environmental Subcommittee at its next meeting.

4. Atlasses.

Working Group discussed the question of atlasses. It was agreed that careful consideration should be given to the possibility of preparing an atlas for the Georges Bank area utilizing oceanographic data collected on the cooperative ICNAF larval herring survey program. The Group recommended that Dr. Schlitz prepare as soon as possible a detailed outline for a proposed atlas of the Georges Bank area, and that the proposal should include sample products, if possible.

5. ROMBI Forms.

Previously, it was recommended that the ROMBI form be introduced on an experimental basis, in order to evaluate their usefulness. In light of the limited use which has been made of these forms to date, it was agreed that the evaluation

period would need to be extended, before a meaningful appraisal could be made.

6. Salinity Intercomparisons.

Dr. Schlitz reported on the intercomparison experiment conducted on salinity determined from cruises run by 3 ships in the Georges Bank larval herring program. He found salinity differences as high as 0.04 and 0.05. In light of such large differences, it is recommended *that Drs. Schlitz and Wolford examine the salinity measuring problem further, as time permits, and report their findings to the Working Group.*

D OTHER MATTERS

1. While the Working Group recognized and appreciated the important part played by scientists from the USSR and GDR in the Cooperative Larval Herring Program and in the further development of the Flemish Cap proposal, it also expressed deep disappointment of the lack of representation from these countries to support the work of the Group.

The Working Group emphasized the difficulty of holding meaningful discussions and making adequate plans for future work when some of the most important participants were missing. By holding the meeting of the Working Group in Eastern Europe, it had been hoped that greater participation of working scientists from Europe would be forthcoming. The Working Group was now at a loss in knowing how to achieve the greater participation of scientists active in the programs being carried out, and, apart from recommending that the next

meeting be held in Kaliningrad or Rostock, it could only reiterate recommendation (33) of the 1975 Environmental Subcommittee "that all member countries be encouraged to ensure appropriate representation at the working level at subsequent meetings of the Environmental Working Group".

2. Following the conclusion of the Cooperative ICNAF Herring Larval Surveys 1976-77 season, and bearing in mind the recommendation of the 1975 meeting that the Herring Larval Program should continue for at least two further years, it is anticipated that a meeting in May-June 1977 should be one of decision.

It is recommended *that the next meeting of the Working Group be held prior to the 1977 Annual Meeting of the Environmental Subcommittee.*

Appendix 1

List of Participants

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