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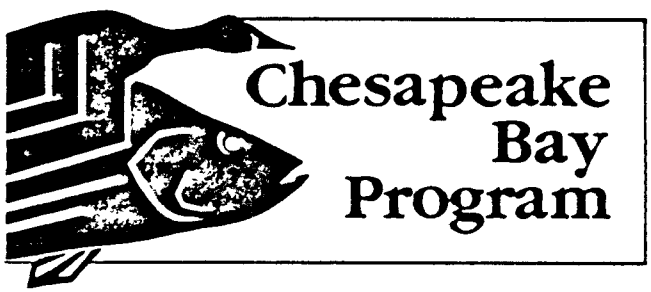
Ichthyoplankton Monitoring and Research on the Chesapeake Bay

Proceedings of a Consensus Workshop



Ichthyoplankton Monitoring and Research on the Chesapeake Bay

Proceedings of a Consensus Workshop
December 5, 1989
Baltimore, Maryland

April 1990

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CONTENTS

SUMMARY

Ichthyoplankton monitoring and research were discussed as a means to 1) assess fish resources, 2) detect trends in abundance, 3) link trends to water quality or habitat criteria, and 4) gain understanding of early life dynamics that can be related to recruitment variability. Long-term ichthyoplankton monitoring carried out on appropriate temporal-spatial scales, may be used to estimate adult spawning biomasses, to define spawning seasons and areas, and reveal trends that may occur over time as a result of changes in spawning behavior or habitat alteration. Although monitoring may not identify mechanisms causing changes in abundance, especially if the causes are complex species interactions or fishing, it is can relate spawning occurrence, distribution and intensity to water quality and habitat criteria.

In the context of the Chesapeake Bay Monitoring Program, few species could be surveyed effectively by ichthyoplankton monitoring. Bay anchovy, naked goby, and possibly hogchoker, are widely distributed, have protracted spawning seasons, and are potentially abundant enough to be assessed by present plankton monitoring efforts. Anadromous fishes cannot be monitored effectively under the present schedule and effort. Routine monitoring is unlikely to provide useful information about recruitment variability and should not be carried out specifically for this purpose. Selected, archived Bay Program plankton samples should be analyzed to evaluate the present monitoring plan's ability to obtain ichthyoplankton data. This effort should be undertaken before deciding to include ichthyoplankton in the Bay Monitoring Program.

Research, including modeling, that is based on testable hypotheses and which focuses on understanding mechanisms that affect mortality and growth during early life is valuable to investigate early life dynamics and recruitment variability, especially if coordinated with studies on older life stages and environmental factors. Research should be carried out at appropriate temporal-spatial scales. Each proposed project must stand on its own merit and alternative approaches should be considered.

Alternative approaches sometimes may be more effective and less costly than ichthyoplankton monitoring or research to achieve similar objectives. For example, juvenile abundance surveys and other fishery-independent surveys, when supplemented with analyses of stock dynamics, are valuable components of a fishery management program. Some fishery-dependent approaches, such as virtual population analysis, provide a posteriori estimates of abundance and recruitment variability when age-specific catches are available. Alternative approaches often do not provide estimates of initial egg numbers, early life survival rates, or specific environmental conditions in early life when highest mortality occurs. The alternative approaches may provide information immediately useful for fishery management while process-oriented ichthyoplankton research is important to shape long-term management strategies in the Chesapeake Bay.

INTRODUCTION

Objectives of the 1987 Chesapeake Bay Agreement include protection, restoration, and enhancement of living resources in the Bay. Subcommittees on Living Resources and on Monitoring have been charged to develop and implement the means to attain goals and achieve objectives (Chesapeake Executive Council, 1988a). In this regard, an extensive Baywide monitoring program has been underway for several years to collect long-term data on habitat, water quality and living resources (Magnien 1987; Heasly et al. 1989). With respect to fisheries, although stock assessments and fishery management plans for some exploited species are included in the Bay Program activities (Chesapeake Executive Council 1988b, 1988c), ichthyoplankton monitoring is not included. The Workshop was held to discuss possible benefits of ichthyoplankton monitoring and, more generally, the role of research on fish early life stages in assessing Chesapeake Bay fish resources.

The fluctuations in recruitment and abundance of fish stocks are caused primarily by variable survival during the early life stages and by the intensity of fishing on the recruited stock. A full understanding of the mechanisms, processes and interactions that cause extreme fluctuations, and sometimes declines, in abundance can only be achieved through long-term research and management of fish resources (Houde 1987). A National Research Council evaluation of the Chesapeake Bay Monitoring Program (National Research Council 1988), while generally laudatory, criticized the Program for its apparent lack of emphasis on living resources (i.e. fish stocks). Discussions in the workshop focused on the possible benefits of ichthyoplankton monitoring to understand effects of water quality, plankton abundances, and environmental variability on fish spawning. The more difficult problem of determining whether ichthyoplankton research can lead to an understanding of recruitment

variability and its causes also was discussed, keeping in mind that alternative approaches, which do not depend upon ichthyoplankton sampling, might be more appropriate in some instances to achieve the objective.

Organization of the Workshop

The Workshop was convened at the request of the Chesapeake Bay Living Resources Subcommittee. Preliminary discussions between Dr. Michael Hirshfield (Maryland DNR) and Dr. Edward Houde (University of Maryland, Chesapeake Biological Laboratory) resulted in a workshop proposal being submitted to Maryland DNR by the University's Center for Environmental and Estuarine Studies (Appendix A). Twenty-two participants, including eight invited experts (Appendix B), attended the workshop, which was held on 5 December 1989 in Baltimore, Maryland. Dr. Houde was the convener of the Workshop. He and Dr. Hirshfield had developed a list of issues and topics (Appendix C), and a list of questions (Appendix D) to be addressed in the workshop.

The agenda (Appendix E) included a leadoff plenary session in the morning that provided participants with background information on Chesapeake Bay fisheries, past and ongoing ichthyoplankton monitoring/research, fishery-independent stock assessment activities and an overview of the Chesapeake Bay Monitoring Program. Invited experts provided information and discussed their experiences on early life studies or stock assessments on other life stages. Three working groups (Appendix F) met separately in the afternoon to discuss and develop recommendations in three general areas:

° Group I. Reproductive Success, Spawning Areas and Times, Environmental and Habitat Criteria.

° Group II. Egg Production and Spawner Biomass Estimates, Trends in Species Abundances, Indices of Community Structure.

° Group III. Causes of Mortality, Early Life Stage Dynamics and Recruitment Predictions.

A summary of discussions and recommendations by each Group was presented in a closing plenary session. Consensus views and alternative approaches are stressed in the report.

RECOMMENDATIONS

Recommendations are made under two subheadings, Monitoring and Research. Participants recognized that these two activities are not always distinct or easily separated. Long time series, if derived from data collected at appropriate time and space scales, can be used to develop hypotheses, undertake modeling, and carry out analyses on effects of environmental variables. An important question faced by the workshop was whether ichthyoplankton monitoring could be carried out successfully in the context of the present Chesapeake Bay Monitoring Program.

Monitoring

Monitoring of fish eggs and larvae for species that are abundant, widely distributed, and have a protracted spawning season may provide useful information in the context of present Chesapeake Bay monitoring efforts. Because Baywide monitoring is scheduled only once each 20 days at a relatively few stations, spawning areas and times are not sampled accurately or precisely for most Bay species. Exceptions may include the bay anchovy Anchoa mitchilli, the naked goby, Gobiosoma bosci, and hogchoker, Trinectes maculatus. Correlative information on eggs and small larvae of these species that links

abundances with water quality, environmental parameters and other plankton organisms could be used to examine long-term trends in abundance, timing of spawning and shifts in spawning areas. Observed changes in abundance, based solely on ichthyoplankton but without knowledge of adult abundances, may attribute such changes to water quality or environmental factors when predator-prey relationships or effects of fishing actually were the primary causes. Accordingly, care must be taken in interpreting abundance changes that could be detected by ichthyoplankton monitoring.

The species that are good candidates for monitoring in the Chesapeake Bay Program are small, unexploited by man, and often not surveyed in fishery-independent stock assessments. Their eggs (anchovy and hogchoker) and small larvae (all three species) are vulnerable to standard plankton sampling gears and can be sampled effectively. Ichthyoplankton of selected species may be one of a suite of indicators in a monitoring program. Long-term surveys of ichthyoplankton may provide an index of trends in spawning biomass, although accuracy and precision are not likely to be high because of the temporal/spatial compromises incorporated into the Baywide monitoring plan. Ichthyoplankton, along with other plankton organisms, can be used to monitor the forage base available to pelagic consumers and may serve a role in delineating habitat quality or trends in eutrophication, although the relative scarcity of fish eggs and larvae in the plankton lowers their value in this context as accurate or precise indicators, compared to more abundant plankton organisms.

The present monitoring schedule and efforts in the Bay are not adequate to survey the spawning areas and times of anadromous fishes. If anadromous ichthyoplankton were to be monitored in the Bay Program, intensive sampling must be directed to specific areas and concentrated in the April-May time period when these species spawn. However, it is not certain that the benefits

to fishery management of such an approach would be greater than those derived from abundance monitoring of other life stages. It was clear to most participants that, if monitoring of anadromous ichthyoplankton were carried out at appropriate time and space scales, egg production and spawner biomass estimates could be derived. Because egg production is an index of adult stock, it can be used as a measure of management success. It was recognized that intensive monitoring of anadromous ichthyoplankton in selected spawning areas might define the environmental conditions that led to eventual juvenile year-class abundances that are assessed by seine surveys in Maryland and Virginia tributaries.

In some marine ecosystems, fish species diversity and fish community structure can be determined via ichthyoplankton monitoring. But, this approach cannot be used in the Chesapeake Bay where many valuable species are recruited as juveniles from spawning that occurred in the ocean (e.g. menhaden, spot, croaker, bluefish).

Ichthyoplankton monitoring by itself should not be expected to contribute significantly to recruitment predictions for Chesapeake Bay fish stocks. Process-oriented research may serve such a role but routine monitoring will not serve that purpose.

Alternatives to ichthyoplankton monitoring that accomplish similar objectives include both fishery-dependent and independent approaches. Virtual Population Analysis on exploited species for which age-specific catch data are available can provide age-specific abundance estimates, including numbers of recruits. The VPA analysis cannot provide a recruitment estimate until a year-class has been fished for two or more years and also is not effective for short-lived species or those not subject to exploitation. Young-of-the-year indices (e.g. striped bass juvenile seine survey) can monitor prerecruit abun-

dances at a life stage when relative abundance of the current year-class is fixed. Trawling surveys or other fishery-independent surveys of juveniles and adults can monitor trends in abundance of many fish stocks. The alternative methods may not succeed in linking abundances at the life stage being monitored to habitat criteria or environmental influences experienced during the egg and larvae stages, especially if juvenile and adult habitat differs from that of eggs and larvae.

It was the consensus of workshop participants that selected, archived plankton samples from the Bay Monitoring Program be examined and analyzed for ichthyoplankton to determine if the sampling design is adequate to evaluate abundances and spatio-temporal distributions of selected species. The quality of data, including precision of abundance estimates for candidate species (e.g. bay anchovy, naked goby, hogchoker, perhaps a few others) needs to be determined. Results of this proposed evaluation should be incorporated into any decision on whether to include ichthyoplankton in future monitoring activities. The preliminary evaluation also should estimate the costs of removing, identifying and measuring ichthyoplankton, as well as analyzing data.

Research

The consensus of the workshop was that ichthyoplankton research has a role in studies of the Chesapeake Bay ecosystem and in fisheries management. However, there was no blanket endorsement for such studies. Proposed research projects on early life stages of fishes must stand on their own merits and be considered on a project-by-project basis. Ichthyoplankton research alone generally is not sufficient to assess fish stocks or provide the information on stock dynamics that is needed to manage populations. However, process-oriented studies on ichthyoplankton were recommended, in which functions and

mechanisms are studied that affect growth, mortality, and production of early life stages. This type of research can tie early life population dynamics to dynamics of older life stages. It serves a purpose in predicting recruitment or developing models to do so, particularly in defining effects of the environment, including contaminants, on survival of early life stages.

Participants emphasized that ichthyoplankton research should be based on testable hypotheses that potentially can be falsified. Process-oriented studies generally should be species-specific and must be carried out at appropriate time and space scales. Community-level studies may be feasible under certain circumstances (e.g. anadromous species complex) to provide information on mechanisms that influence the recruitment process. When possible, early life history research and modeling should be linked with studies on spawning stock dynamics and environmental influences. Both long and short-term research may have roles but the focus should be on processes and mechanisms. Workshop participants recognized that long-term monitoring studies that depend entirely on correlations to interpret environmental or stock-dependent effects, while potentially misleading on their own, may have value in model development and research program design.

The Chesapeake Bay Monitoring Program is accumulating data on the Bay and its tributaries that can be supportive of ichthyoplankton research. Data on hydrography, water quality, river flows, sediments and biological characterizations are available. At present much of this data is being collected on time and space scales that are inappropriate for early life studies of anadromous species, but supportive data may have value in recruitment-process research on forage species such as bay anchovy or naked goby.

Workshop participants recognized that alternative approaches sometimes may be more effective and less costly than ichthyoplankton research in

providing knowledge of fish stock dynamics, assessment and recruitment. Young-of-the-year (i.e. juvenile) surveys on anadromous species are extremely valuable to predict future year-class strengths, and through birth-date analysis can provide some knowledge of environmental conditions encountered by survivors during the earliest life stages. Birth-date analyses are not a complete alternative method of recruitment analysis but are a useful component of such analyses. For species that enter the Bay as juveniles (e.g. menhaden, some sciaenids), egg and larval studies within the Bay are not possible, while assessments on juvenile stages may be quite effective in determining stock dynamics of these fishes once they are recruited. Although juvenile assessments, and models based upon these life stages, provide important information on the dynamics of the stocks and year-class strength, they examine only the survivors of the recruitment process. Thus, they do not give estimates of initial numbers of eggs or larvae and their survival rates. Consequently, they provide only limited knowledge of the specific environmental effects and habitat conditions encountered by eggs and larvae. The alternative approaches often do provide immediate information to guide fishery management. Process-oriented ichthyoplankton research can reveal mechanisms that influence early life dynamics and, as such, has a role in development of long-term management strategies in the Chesapeake Bay.

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APPENDIX A

The University of Maryland System
Center for Environmental & Estuarine Studies
Chesapeake Biological Laboratory
Solomons, MD 20688-0038

ICHTHYOPLANKTON MONITORING AND RESEARCH ON THE CHESAPEAKE BAY: A WORKSHOP

Proposal To

Maryland Department of Natural Resources
Tidewater Administration
Tawes State Office Building
580 Taylor Avenue
Annapolis, Maryland 21401

By

Edward D. Houde, Professor
(301) 326-4281

Project Duration: 4 months
Requested Funding Period: 6 Nov. 1989 - 5 March 1990
Budget Request: $ 5,968

Kenneth R. Tenore, Head of Laboratory
Chesapeake Biological Laboratory

Thomas C. Malone, Acting Director
Center for Environmental and
Estuarine Studies

A workshop to address ichthyoplankton monitoring and research in the Chesapeake Bay is proposed, to be held at the Lord Baltimore Hotel in Baltimore, Maryland on 5 December 1989. The Maryland Department of Natural Resources has requested advice and recommendations on the need to monitor fish early life stages in the Bay and its tributaries, and more generally on the benefits of early-life-stage studies in the context of environmental, water quality and fisheries management concerns.

Specific questions and topics/issues to be discussed by workshop participants are attached (Appendix B). The listed questions and issues are not exclusive. Experts have been invited to participate and to provide a critical evaluation of the benefits and costs of ichthyoplankton/monitoring research. Not all of the participants are ichthyoplankton researchers. Some in fact have questioned the usefulness of ichthyoplankton monitoring and research as tools to enhance management or to improve understanding of environmental effects on fishery resources.

Eight participants will be invited. Most already have expressed a strong interest in the proposed workshop in telephone or personal conversations. They are:

G. Laurence - NMFS, Northeast Fisheries Center, Narragansett, R.I.

V. Crecco - Connecticut Department of Environmental Protection, Waterford, CT

D. Hoss - NMFS, Southeast Fisheries Center, Beaufort, N.C.

P. Rago - U.S. Fish and Wildlife Service, Kearneysville, W.VA

J. Olney - Virginia Institute of Marine Science, Gloucester Point, VA

W. Smith - NMFS, Northeast Fisheries Center, Sandy Hook, N.J.

W. Richkus - VERSAR Corporation, Columbia, MD

E. Setzler-Hamilton - Center for Environmental & Estuarine Studies, Chesapeake Biological Laboratory, Solomons, MD

Additional participants from State of Maryland agencies and the University of Maryland Center for Environmental and Estuarine Studies are anticipated. The total number of workshop participants should not exceed 20.

It is proposed that the workshop be held in the Inner Harbor area, Baltimore, at the Lord Baltimore Hotel. The one-day workshop will provide an opportunity to discuss each issue and to make recommendations when possible. Recommendations will be summarized in a workshop report, to be delivered in draft form to Maryland DNR by 10 February 1990.

Travel support is requested for participants. It is anticipated that airfares will be required for four participants. Hotel accommodations will be required for eight invitees and the convener. Two days per diem support is requested for each of the eight invited participants. Other items that are budgeted include 0.5 man-months secretarial salary support, motor vehicles to provide travel support for CBL participants, funds to produce a workshop report, and clerical/secretarial supplies and materials. A small "miscellaneous" budget category is included to cover any unanticipated costs. The Chesapeake Biological Laboratory and CEES will not charge indirect costs on the workshop contract.

Workshop Product

A draft report will be delivered to Maryland DNR by 10 February 1990. The final report will be issued as a Coastal and Environmental Policy Program (CEPP) document through the Chesapeake Biological Laboratory.

APPENDIX B

Ichthyoplankton Workshop Attendees

*Ray S. Birdsong	Old Dominion University	(804) 683-3595
*Victor A. Crecco	Connecticut DEP	(203) 443-0166
Louis Rugolo	MD DNR	(301) 974-3782
Harry T. Hornick	MD DNR	(301) 974-2241
Phil Jones	MD DNR	(301) 974-3782
Michael Hirshfield	MD DNR	(301) 974-3782
Fred Jacobs	Coastal Environmental Services	(301) 684-3324
*John E. Olney	VA Institute of Marine Science	(804) 642-7334
Patsy Heasly	EPA-CBLO	(301) 266-6873
Steve Jordan	MD DNR	(301) 974-3767
Jim Uphoff	MD DNR	(301) 974-3767
*William A. Richkus	VERSAR, Inc.	(301) 964-9200
*Paul Rago	U.S. Fish & Wildlife Service	(304) 725-8461
Rob Magnien	MD Dept. of Environment	(301) 631-3681
*Donald Hoss	NMFS, Beaufort Lab., N.C.	(919) 728-8746
*Geoffrey C. Laurence	NMFS, NEFC, Narragansett, R.I.	(401) 782-3200
*Eileen M. Setzler-Hamilton	CBL	(301) 326-4281
James H. Cowan, Jr.	CBL	(301) 326-4281
Edward S. Rutherford	CBL	(301) 326-4281
Colleen E. Zastrow	CBL	(301) 326-4281
Letty C. Fernandez (Secreatrial Support)	CBL	(301) 326-4281
**Edward D. Houde	CBL	(301) 326-4281

*Invited Experts
**Convener

APPENDIX C

Issues and Topics to be Addressed at the Workshop

1. Egg Production Estimates
2. Spawner Biomass Estimates
3. Long-term Trends in Species Abundance
4. Definition of Spawning Areas and Times, and Changes over Time
5. Defining Spawning Success and Relating to Environmental Factors
6. Recruitment Predictions
7. Indices of Community Structure
8. Determination of Environmental and Habitat Criteria for Reproductive Success
9. Causes of Mortality of Early Life Stages

APPENDIX D

Questions to be Addressed at the Workshop

1. Why monitor ichthyoplankton? What questions could be answered?
2. What useful indices can we obtain?
3. When is ichthyoplankton monitoring better than that on other life stages of fishes?
4. Can we define critical habitats and environmental parameters from ichthyoplankton monitoring?
5. Is the lack of an ichthyoplankton monitoring component in the Chesapeake Bay Monitoring Program a serious omission?
6. What can be gained from ichthyoplankton research as opposed to monitoring?
7. How long must we monitor ichthyoplankton to achieve goals?
8. When and on what time scales should we monitor ichthyoplankton?
9. For what kinds of species will ichthyoplankton monitoring be most effective?
10. Is ichthyoplankton surveying or monitoring cost-effective?
11. What research questions on estuarine and anadromous species can be addressed effectively by ichthyoplankton studies?
12. Are there research needs separate from monitoring needs with respect to Chesapeake Bay ichthyoplankton programs?

APPENDIX E

ICHTHYOPLANKTON WORKSHOP

Lord Baltimore Hotel
Baltimore, Maryland

Tuesday, 5 December 1989

AGENDA

09:00	Introductions and Welcome	E. Houde
09:05	Objectives and Goals	E. Houde
09:15	Ichthyoplankton Research and Monitoring in the Maryland Chesapeake Bay	M. Hirshfield
09:30	Ichthyoplankton Research and Monitoring in the Virginia Chesapeake Bay	R. Birdsong/J. Olney/ F. Hoffman
09:45	Chesapeake Bay Stock Assessment Committee (CBSAC), Fishery-Independent Assessments	M. Hirshfield (or designee)
09:55	Chesapeake Bay Monitoring Program	R. Magnien
10:15	Comments and Discussion	
10:30	Break	
10:45	Plenary Discussion -- Issues/Topics	
12:00	Lunch (catered Deli Lunch)	
1:00	Group Discussions (Three Working Groups meet separately and develop recommendations)	
3:15	Break	
3:30	Plenary Discussion and Recommendations	
4:30	Adjourn	

APPENDIX F

Working Groups

Group I. Reproductive Success, Spawning Areas and Times, Environmental and Habitat Criteria.

Donald Hoss (Chair), Eileen Setzler-Hamilton, William Richkus, Fred Jacobs, Steve Jordan, Michael Hirshfield and Patricia Heasly.

Group II. Egg Production and Spawner Biomass Estimates, Trends in Species Abundances, Indices of Community Structure.

Paul Rago (Chair), Raymond Birdsong, Colleen Zastrow, John Olney, Harry Hornick and Robert Magnien.

Group III. Causes of Mortality, Early Life Stage Dynamics and Recruitment Predictions.

Geoffrey Laurence (Chair), Victor Crecco, Phillip Jones, James Uphoff, Louis Rugolo and James Cowan.