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NATIONAL MARINE FISHERIES SERVICE
NORTHEAST FISHERIES CENTER
WOODS HOLE, MASSACHUSETTS

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CENTER DIRECTORATE

Fisheries Utilization

The 25th Atlantic Fisheries Technological Conference (AFTC) was held in St. John's, Newfoundland, during 17-20 August. Attendees from the Resource Utilization Division/Gloucester Laboratory were Bob Learson, Fred King, Joe Licciardello, Joe Mendelsohn, and Ron Lundstrom. Papers presented at this conference included: "Energy Productivity Index of Fish Processing Operations in New England," by P. J. Amaria and R. J. Learson; "Nomenclature Problems in Describing Fish," by F. J. King et al.; "Texture Toughening and Enzymatic Formaldehyde Production in Frozen-Stored Red Hake," by R. C. Lundstrom et al.; and "Utilization of Bluefish," by J. J. Licciardello et al.

The main theme of this year's conference was fish quality. The Canadian government took the opportunity to announce its broad-based quality enhancement programs involving vessel certification, dockside grading, and quality standards for fishery products. Other main topics included harvesting and processing cost escalation, and the impact of offshore oil and gas development on Canadian fisheries.

Bob Learson, Fred King, and Joe Licciardello also participated as members of the AFTC Executive Committee. Ron Lundstrom was elected to the Committee for a 3-yr term replacing Joe Licciardello.

Special Scientific and Technical Projects

Construction continued on the Woods Hole pier. Two mooring dolphins were completed this month and all main pier stringers and beams were emplaced.

A report (Comm. Mem. 1980/K:24) for the International Council for the Exploration of the Sea (ICES) on the "Size Selection of Sea Scallops by an Offshore Scallop Survey Dredge" was completed by Fred Serchuk and Ronald Smolowitz.

Preparations were made for the upcoming second leg of the surf clam - ocean quahog cruise which is to be a joint cruise with the Canadians. Changes were made to the electrohydraulic dredge system to remedy problems identified on Leg I.

A report was prepared for the NMFS Engineering Advisory Panel identifying all engineering research and development activities underway at NEFC.

RESOURCE ASSESSMENT DIVISION

Resource Surveys Investigation

In August much of the Investigation's personnel time was spent preparing for, or at sea, conducting the summer bottom trawl and the surf clam - ocean quahog surveys. On the NOAA R/V Delaware II from 28 July to 8 August, Malcolm Silverman was Chief Scientist with Evelyn Howe and Steve Seldon participating. During the same period on the NOAA R/V Albatross IV, 29 July to 8 August, Henry Jensen was Chief Scientist with Donald Flescher and Eva Montiero participating. Linda Despres was Chief Scientist with Elizabeth Bevacqua and Steve Seldon participating on the last leg of the summer bottom trawl survey on Albatross IV during 12-22 August. The last 3½ days of this cruise were spent conducting an experiment to determine the day-night availability of the northern shrimp to our trawl gear. The first leg of the surf clam - ocean quahog survey was conducted on board the Delaware II during 18-28 August with Charles Byrne as Chief Scientist with Andy Thoms and Dennis Hansford participating.

The 1980 sea scallop survey data have been processed and are on tape.

Tom Azarovitz, Chuck Byrne, Linda Despres, Eva Montiero, and Elizabeth Bevacqua continued to work on a final report to the US Bureau of Land Management summarizing historic trawl data.

Tom Azarovitz worked with Canadian biologists on developing a cooperative survey of ocean quahogs on the Nova Scotian shelf. A preliminary survey is planned for September.

Elizabeth Bevacqua has adapted a computer plot program for use in the plotting of cruise station position and catch data. These coastal maps, which have computer-generated shore and depth contour lines, will replace the hand-plotted charts used in the past.

Jim Crossen and Jack Suomala (Charles Stark Draper Laboratories, Inc.) conducted target-strength measurements on 6 and 7 August at the Office of Naval Research's Underwater Sound Reference Division in Orlando, Florida. Measurements of target strength in a frequency range of 10-150 kHz were made on aluminum and steel spheres (51-120 mm). Results of these measurements, USRD Report #630, will be presented at the next meeting of the ICES Fish Capture Subcommittee, which deals with calibration procedures.

Fishery Biology Investigation

Ambrose Jearld continued to work on a study of surf clam age and growth problems off the Delmarva Peninsula. A presentation of the study is to be delivered at the annual meeting of the American Fisheries Society in late September in Louisville, Kentucky. Ambrose participated in writing the Current Year Task Plan for the Resource Assessment Division and prepared a FY 1980 report on research and development activities conducted by the Investigation for the NEFC's fiscal year report to the Atlantic States Marine Fisheries Commission. He also met with Brad Brown, Fred Serchuk, John Ropes, and Steve Muraswski to develop a plan of action to initiate joint American-Canadian studies on shellfish.

On 15 August, Ambrose participated in a 1-day cruise aboard the Delaware II designed to test equipment for sampling shellfish. Aboard this cruise, Ambrose and Brad Brown met with Terry Rowell and Tissa Amaratunga of the Canadian Plant and Invertebrate Research Group, Ltd., to discuss potential joint research projects on shellfish.

Ambrose met with Louise Dery and Paul Scarlett of the New Jersey Department of Environmental Protection to discuss the final content and format of the report on the summer flounder age and growth workshop held at the Woods Hole Laboratory. Also, Ambrose conducted a 2-day aging workshop on surf clams. Workshop participants were: Dr. Thomas Hopkins and Steve Morrison of the University of Maryland Eastern Shore, and Maurice Crawford, Maureen Griffin, and Mark Costa of this Investigation.

Shellfish

Maurice Crawford aged sea scallops from commercial samples landed at Portland, Maine, and from the Gulf of Maine. Maureen Griffin continued growth analyses of commercial landings of surf clams at Ocean City, Maryland, and sample data assembled by the University of Maryland Eastern Shore. Relative to the latter, a workshop was conducted with the contractor, Dr. T. Hopkins of the University of Maryland Eastern

Shore, during 12-14 August. Independent observations of chondrophore specimens were made by Crawford, Griffin, and Hopkins for a comparison of results. Live age and growth determinations were in agreement between the observers for many specimens, but, in some specimens, split growth lines or the inability to define the first annulus resulted in disagreements. Maureen Griffin provided insight into the problem of resolving split growth lines. She observed that by following the lines back into the chondrophore from its concave surface a single coalesced line could be found. In chondrophores not showing a clear first annulus, a few specimen preparations had missed the critical umbo of the shell and in others that were sectioned properly definitely no first annulus was present. Mark Costa demonstrated how he has been able to process consistently chondrophores to obtain sections containing the umbo portion and allow for observation of the first annulus. It was suggested during the workshop that a birthdate of 1 October would be routinely used in analyses of surf clam age and growth, and that photographic prints of chondrophores would be used by all investigators aging surf clams. The investigators at the University of Maryland had made microscopic observations of chondrophore sections, but as was decided during the workshop, this increases the resolution of shell depositional lines other than age lines and adds a confusing dimension to age determinations.

From earlier correspondence with Dr. C. N. Shuster of the Federal Energy Regulatory Commission about obtaining needed data on the occurrence of horseshoe crabs on the North American continental shelf, instructions for making shell outline measurements and for gathering observations on maturity were prepared and a field data sheet was revised. These were used during the 18-28 August surf clam and ocean quahog survey cruise. A total of 48 horseshoe crabs were taken at 18 stations.

The manuscript "Size and Age at Sexual Maturity of Ocean Quahogs, Arctica islandica Linne, from a Deep Oceanic Site," by J. W. Ropes and S. A. Murawski, was completed. Copies were sent for inclusion in the upcoming meeting of the ICES Shellfish Committee in October.

Age and Growth

Judy Penttila checked aging work done by the Atlantic cod age reader for the Massachusetts Division of Marine Fisheries, Doris Jimenez. Cod age samples from the spring bottom trawl survey, Delaware II Cruise No. DE 80-02 and Albatross IV Cruise No. AL 80-03, were checked for accuracy. Agreement on ages between Judy and Doris was 89.83% for the 590 samples of cod otoliths from the spring survey. Of the 60 otoliths disagreed upon, Doris aged 1 (1.67%) as 1-yr older than Judy's age, 49 (81.67%) as 1-yr younger, 8 (13.33%) as 2-yr younger, and 2 (3.33%) as 3-yr younger. Judy also checked and corrected the cod age sample summaries for the fall 1979 and spring 1980 survey cruises and also completed the age sample expanded summaries for the 1979 fall survey data.

Vi Gifford completed aging third and fourth quarter 1971 commercial samples of redfish.

Kris Andrade has completed aging first and second quarter commercial samples of pollock, and has started aging third quarter commercial samples of haddock. Wally Morse from the Sandy Hook Laboratory requested age and growth summaries of spring haddock from Georges Bank from 1968 to 1980.

Finfish

In August, Brenda Fields completed age determinations of 1980 spring and summer bottom trawl survey summer flounder scale samples. She also began aging 1980 commercial samples.

Louise Dery completed aging 1980 spring bottom trawl survey Atlantic herring and began processing 1979 and 1980 survey alewife samples. A sample of 140 summer flounder collected from the Mid-Atlantic States was processed for scales, otoliths, and fin rays as part of a special study comparing size at age I and II, and scale growth patterns, among summer flounder from various inshore areas. Progress was also made on a summer flounder workshop report (workshop held 19-20 May 1980 at the Woods Hole Laboratory).

Fishery Assessment Investigation

Staff

Work continued on preparing material for the status of the stocks report. Frank Almeida completed assessments for silver and red hake. Steve Murawski continued to update assessments of surf clams and ocean quahogs. Thurston Burns and Mike Fogarty continued assessment work on the American lobster for inclusion in the Lobster Management Plan. Ralph Mayo progressed in his analysis of the status of scup populations. Emma Henderson continued teaching a course in standard assessment techniques and reviewing available software packages for assessment use. Ralph Mayo participated in the summer bottom trawl survey aboard the Albatross IV and Mike Fogarty participated aboard the Delaware II. Mike Fogarty completed a review of a chapter on "Fishery Biology of Lobsters and Crayfish" for inclusion in a new book, Biology of the Crustacea.

Senior Assessment Scientists

Brad Brown continued to work on establishing a Marine Section for the American Fisheries Society and was elected Chairman of the new Section. Brad has been developing a panel discussion on "The Fishery Conservation and Management Act of 1976 -- Realization vs. Expectations," to be held at the upcoming American Fisheries Society meeting in Louisville, Kentucky, and is exploring the possibility of publishing the proceedings of the session. Brad coordinated discussions with assessment staff involving formulation of optimum yield and on definition of overfishing for the national standards. Work continued on planning American-Soviet joint fishery research for 1981. Brad, Mike Sissenwine, and Tom Azarovitz have been involved in planning a cooperative US-Canada ocean quahog research program. Mike and Tom continued to work on the design of the proposed survey. Steve Clark supervised assessment work on haddock, pollock, northern shrimp, white hake, Atlantic wolffish, winter flounder, scup, cusk, redfish, alewives, and blueback herring. Emory Anderson completed assessment work on Atlantic mackerel, and prepared sections for bluefish, Atlantic mackerel, and pelagic sharks for inclusion in the status of the stocks report. Work continued on preparing a matrix chart outlining the status of knowledge for fishery management for each of the species currently being studied by the Investigation. Fred Serchuk participated in a surf clam - ocean quahog gear experiment. Vaughn Anthony coauthored a paper with Gordon Waring on estimating Atlantic herring spawning stock biomass and egg production for the Georges Bank - Gulf of Maine region for presentation at the upcoming meetings of the Northwest Atlantic Fisheries Organization (NAFO) in September in St. John's, Newfoundland.

Steve Clark completed revisions of a review and assessment paper written with Bill Overholtz and Dick Hennemuth on Georges Bank - Gulf of Maine haddock for submission to the NAFO Research Bulletin.

University and Research Institute Interactions

Electric organs from Atlantic torpedo collected on bottom trawl surveys were frozen for Dr. John Cohen of Harvard Medical School to be used for isolation of nerve transmitter proteins.

Whole witch flounder were frozen for Dr. Michael Ross of the University of Massachusetts.

American plaice scales and otoliths were saved for Loretta Sullivan of the University of Rhode Island for age and growth studies.

Various fish otoliths were saved for Richard Brodeur of Oregon State University for a guide to otoliths he is developing.

Spiny dogfish were measured by sex for Jack Musick and Jim Colvocoresses of the Virginia Institute of Marine Science as part of a Sea Grant study.

Wood samples were preserved and saved live for Dr. Carl Berg of Harvard University.

Dichelopandalus shrimp and goosefish stomachs were preserved for Dr. Earl Weidner of Louisiana State University for examination in a life cycle study of a microsporidian.

Yellowtail flounder were frozen for Salvatore Testeverde of the University of New Hampshire and NMFS.

Fred Serchuk presented two seminars on fish population dynamics and fishery management under extended jurisdiction at the Cornell University - University of New Hampshire Isles of Shoals Marine Laboratory.

Mike Sissenwine met with Woods Hole Oceanographic Institution staff to discuss cooperative research programs on ecosystem processes and modeling.

Brad Brown, Mike Sissenwine, Ambrose Jearld, Jr., and Tom Azarovitz met with Canadian scientists to discuss proposed joint ocean quahog research.

A meeting was held with USSR scientists to plan possible joint work on Atlantic herring tagging and distributional studies for Illex squid, pollock, Atlantic saury, lanternfish, and summer flounder.

Emory Anderson met with visiting Japanese scientists to discuss assessment work.

Meetings, Talks, Visitors, and Publicity

On 7 August, Brad Brown attended a meeting of the National Marine Educators Association and accepted a position on the Committee for Involvement of Women and Minorities in Marine Education.

On 12 August, Brad Brown and Mike Sissenwine met with New England Fishery Management Council (NEFMC) staff to discuss formulas for specifying optimum yield.

On 12 August, Steve Clark chaired a session of the Northern Shrimp Scientific Committee in Gloucester, Massachusetts.

On 13 and 14 August, Emory Anderson attended a meeting of the Mid-Atlantic Fishery Management Council in Philadelphia.

On 14 August, Brad Brown, Marv Grosslein, and Jon Gibson met with representatives of the Massachusetts Audubon Society to provide input into a narrative concerning the impacts on fish of oil exploration on Georges Bank.

Donald Flescher furnished and manned a NMFS exhibit at New Bedford's seafood festival, SEA FAIR '80, on 16 and 17 August.

On 19 August, Emory Anderson participated in an Inter-Council shark meeting in Philadelphia to discuss the status of pelagic shark assessment needs.

Thurston Burns and Mike Fogarty attended a meeting of the Lobster Plan Development Team in Saugus, Massachusetts.

On 20 August, Mike Sissenwine attended a meeting of the NEFMC Groundfish Oversight Committee in Peabody, Massachusetts.

On 25 August, Mike Sissenwine met with Joe Mueller of the NMFS Northeast Regional Office to discuss economic analysis of the yellowtail flounder fishery.

On 27 and 28 August, Vaughn Anthony attended a meeting of the NEFMC in Rockport, Maine.

On 28 and 29 August, Brad Brown conferred with Frank Riley to discuss the transfer of the Statistics Branch from the Northeast Regional Office to the NEFC.

Publications

Brown, B. E. Why we count fish. Underwat. Natur. (A)

Hennemuth, R. C.; Palmer, J. E.; Brown, B. E. A statistical description of recruitment in 18 selected fish stocks. Northw. Atl. Fish. Organ. Res. Bull. (S)

Murawski, S. A.; Serchuk, F. M. A perspective on bivalve resources off the northeast coast of the United States. Underwat. Natur. (A)

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Almeida, F. A. Silver hake: on the question of stock definition. Woods Hole Lab. Ref. Doc. No. 80-26;1980.

Murawski, S. A.; Ropes, J.W.; Serchuk, F. M. Growth studies of the ocean quahog, Arctica islandica. Int. Counc. Explor. Sea, Comm. Mem. 1980/K:38;1980. 24 p.

Serchuk, F. M.; Smolowitz, R. J. Size selection of sea scallops by an offshore scallop survey dredge. Int. Counc. Explor. Sea, Comm. Mem. 1980/K:24;1980. 38 p.

MANNED UNDERSEA RESEARCH AND TECHNOLOGY PROGRAM

This report covers MURT activities from April through August 1980.

Pigeon Hill

The summer (July) 1980 revisitation and documentation of epibenthic communities at the Ocean Pulse station on Pigeon Hill on Jeffreys Ledge in the Gulf of Maine was accomplished in cooperation with diver scientists from the University of New Hampshire and Southeastern Massachusetts University. Specific, pre-marked, horizontal and vertical transects were rephotographed. Several species of attached and semimobile fauna and flora were sampled for pollutant analysis (hydrocarbons, trace metals, and polychlorinated biphenyls). Colonization substrates (artificial) were collected for faunal and floral analysis. Previously scraped 0.25 m² areas were rephotographed to define further the recolonization rates on rock substrates.

Disruptively collected samples (0.25 m^2) were taken for "ground truth" determinations and comparisons (calibration) with photographic documentation.

Ken Pecci and Charles Gross traveled to the University of New Hampshire to confer with Dr. Larry Harris, Jon Witman, and Alan Hulbert on progress, manuscript preparation, and overall coordination of our Ocean Pulse, diver-oriented studies.

Georges Bank and Submarine Canyons

Approximately 4 wk of manned submersible operations were devoted to research at six site-specific locations on Georges Bank and Lydonia Canyon and three generalized locations in Oceanographer Canyon. This in-situ research was directed at both Ocean Pulse and resource assessment objectives. In general, the Georges Bank and Georges Bank submarine canyon efforts were designed to establish pre-drilling baselines for macrobenthic fauna and their habitats (shelters). Twenty-five dives totalling 62 hr of bottom time were logged to depths of 1000 m, accomplishing the following tasks:

- (1) We established four long-term monitoring stations to relate animal-bound and substrate-bound levels of pollutants to absolute abundance, community structure, and behavior of macrobenthic fauna (American lobsters, jonah crabs, tilefish, ocean pout, conger eel, hakes, black-belly rosefish, flounders, skates, goosefish, cusk, sea scallops, anemones, starfish, etc.). These site-specific stations are marked with 5-yr, 37 kHz pingers permitting revisitation and high-resolution studies. The other stations have received, basically, the same research attention, but are not marked with pingers; highly accurate LORAN C fixes should permit reasonably accurate revisitation. The pinger stations are located in the center of the proposed drilling area (Georges Bank) and downstream in Lydonia Canyon (head of canyon and on west wall). Those stations without pingers are located on the east and west wall and within the axis of Oceanographer Canyon.
- (2) Between 800 and 1000 pictures (35 mm, color) were taken of the sea floor and its associated fauna along 600-yd transects running north, south, east, and west from the station-marking pinger. The photographs were calibrated quantitatively for length and width of the field of view.
- (3) Samples of the surface substrate (2-3 cm) and associated macrobenthic fauna (i.e., American lobsters, jonah crabs, sea scallops, starfish, and tilefish) were collected and immediately frozen in freezer bags for later pollutant analyses. Berried lobsters were also collected for egg examination.
- (4) Lockout diving was conducted at 100 m on Georges Bank to collect surface sediments after conventional box corers failed to operate properly. Lockout diving proved to be very effective for finite sample collection and will be used in the future.
- (5) Additional observations, photographic documentation, and sample collection were conducted at a 1977 drill site on Georges Bank.

- (6) Submersible-operated box-core sediment samples were collected at an area called the "Mud Patch," 60 nautical miles south of Nantucket Island. The Mud Patch is a relatively large area characterized by finely grained sediments and is theorized to be the "recipient area" of much of the finely grained particulates that "break free" of the Georges Bank gyre. This activity of box-core calibration was conducted in cooperation with Dr. Fred Grassle of the Woods Hole Oceanographic Institution.
- (7) Extensive observations and photographic documentation were accomplished on the abundance, population structure, and general ecology of the tilefish at Lydonia and Oceanographer Canyons. This activity was in cooperation with Rutgers University and Harbor Branch Foundation in Fort Pierce, Florida.
- (8) Captain Gary Brown, an offshore lobster fisherman and skipper of the F/V Sea Fever, was given a dive to observe areas of the sea floor he had been fishing for 7 yr.

Significant advances, from an operations point of view, were realized during the first and second cruises with the Harbor Branch Foundation dive system, the R/V Johnson, and the submersible R/V Johnson Sea-Link. For example, the mother ship could track the submersible (range and bearing) with impressive (± 10 m) accuracy, the submersible could measure linear distance traversed over the bottom, and could detect -- at a distance of hundreds of meters -- features (man-made and naturally occurring) through its sonar system. A highly sophisticated hydraulic arm and sampling devices permitted very definitive, site-specific sampling. Scientific productivity was increased significantly because of "state-of-the-art" capabilities of the dive system.

Contracts

A contract was awarded to Cambridge Analytical Associates in Watertown, Massachusetts, to conduct pollutant analyses on samples of fauna and flora from Pigeon Hill and from Georges Bank and its canyons. These samples are being analyzed at this time. A second contract was awarded to Colortek of Boston, Massachusetts, for developing 8000 ft of 35-mm film. This film was developed and gives us an extensive record of ocean floor types and associated fauna. Analysis of these films has begun.

Cooperative Undersea Research

Dick Cooper is coordinating a proposal for a cooperative undersea research program proposed for FY 1981 between the NEFC, Southeast Fisheries Center, Harbor Branch Foundation, US Geological Survey, and SECURE (Southeast Consortium for Research Efforts). Major emphasis is placed in assisting the Southeast Fisheries Center in developing manned submersible capabilities to address low and high-profile live bottom fishery assessment and calibrating existing survey techniques (e.g., longline, traps, gill net). MURT will train several principal investigators from the Southeast Fisheries Center in scientific studies using manned submersibles.

University National Oceanographic Laboratory System - Submersible Requirements

A study to define national requirements for manned submersibles has been completed. The report presents areas of marine research where academia and government have, and are likely to have, priority interests and/or responsibilities over the next 20 yr. The study was conducted in two phases, one dealing with shallow water (continental shelf and slope) requirements, the other with deep water. Dick Cooper chaired the shallow water study group.

National Underwater Laboratory System II (NULS-II)

Dick Cooper chaired the final review process of NULS II proposals. Three universities will receive a total of \$1.2 million to begin programs of undersea research aimed at solving regional and national marine problems. Funding support comes from NOAA's Undersea Research Program. The University of Southern California, University of Hawaii, and the University of North Carolina are the recipients.

Miscellaneous Diving Activities

Cliff Newell and Roger Clifford are serving as Diving Officers in a NOAA-academia sponsored program of studying the impact of walrus feeding on benthic communities in the Bering Sea. They have completed the redesign and fabrication of a surface manifold system for the diving bell - helium oxide air system.

Publications

Cooper, R. A.; Uzman, J. R. Ecology of juvenile and adult American lobsters, Homarus americanus, and European lobsters, Homarus gammarus. Cobb, S. J.; Phillips, B. F., eds. Biology of lobsters. Academic Press;1980:Ch. 7.
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Meyer, T. L.; Cooper, R. A.; Pecci, K. J. Underwater observations on the performance and the environmental effects of a hydraulic dredge in a high clam density area off southwestern Long Island, N.Y. Fish. Bull. (US). (S)

Valentine, P.C.; Uzman, J. R.; Cooper, R. A. Geology and biology of Oceanographer Canyon. Mar. Geol. (A)

Reports

Valentine, P. C.; Uzman, J. R.; Cooper, R. A. Geological and biological observations in Oceanographer Canyon - descriptions of dives aboard the research submersible Alvin (1967, 1978) and Nekton Gamma (1974). US Geol. Surv. Open-File Rep. 80-76;1980. 36 p.

Witman, J.; Hulbert, A.; Harris, L.; Pecci, K.; McCarthy, K.; Cooper, R. Community structure of the macrobenthos of Pigeon Hill in the Gulf of Maine: a baseline report from the Ocean Pulse monitoring program. Ocean Pulse Tech. Rep.;1980.

MARINE ECOSYSTEMS DIVISION

Larval Fish Dynamics Investigation

Experimental Studies

Much time was spent this month on work-up and compilation of data from the striped bass study. We are taking a preliminary look at the data in preparation for a meeting with US Fish and Wildlife Service personnel to prioritize research for Atlantic cod and haddock larvae caught during the spring MARMAP survey (Soviet R/V Evrika Cruise No. 80-01) were analyzed for RNA, DNA, and protein content. Some problems were encountered with preservation of these samples.

Further analysis of data from studies of haddock, winter flounder, and summer flounder reared at several temperatures is showing some interesting relationships between temperature, growth rate, RNA-DNA ratio, and age. Winter flounder larvae reared at the higher temperatures (10°C) showed accelerating growth rate with age while larvae reared at lower temperatures (5°C) had a more or less constant growth rate. The RNA-DNA ratio of larvae reared at higher temperatures also increased with age. We have now been able to demonstrate a positive linear relationship between RNA-DNA ratio and growth rate in the larvae of Atlantic cod, summer flounder, and winter flounder, and have enough data to look at the relationship in striped bass.

Plankton samples from the spring in-situ environmental chamber experiment in the Pettaquamscutt Estuary were processed. Sorting of the microdistribution samples from the Evrika Cruise No. 80-02 was continued.

Thomas Halavik and Geoffrey Laurence attended a symposium on "Enclosed Marine Experimental Ecosystems."

Population Processes

The Population Processes Team (Greg Lough, George Bolz, Dave Potter, Roz Cohen and Janet Murphy) prepared eight papers and other supporting materials this month for the Larval Herring Task Force at the NAFO Scientific Meeting during 3-13 September 1980 in St. Johns, Newfoundland. These reports included materials on nearly all aspects of the International Commission for the Northwest Atlantic Fisheries (ICNAF) larval Atlantic herring time series: abundance, growth, mortality, morphological condition factors, prey selection, and vertical distribution, as well as reports on the status of data and computer processing for the 0.333-mm mesh net time series and including the 1978 larval Atlantic herring patch study. One of the papers dealing with a growth model for larval herring based on otolith increments also was submitted as a 1980 ICES document. Nancy Lyons has been producing computer distribution plots of larval herring prey from the 0.333-mm mesh net zooplankton, and Cabell Davis has been helping Roz Cohen determine mesh selectivity of the 0.165-mm mesh samples in order to calculate prey selectivity indices for larval herring from the ICNAF time series. Janet Murphy has been working on editing the copepod identification guide, on larval herring condition and gut-content data report, and on identification of copepod nauplii from a series of water bottle samples collected during the 1978 larval Atlantic herring patch study. Janet terminated her summer appointment on 29 August to return to school. Bea Hess has been processing larval herring gut data, primarily from the MOCNESS (multiple opening-closing net and environmental sensing system) vertical collection series during the 1978 patch study.

Greg Lough traveled with Robert Marak, Kenneth Sherman, Robert Edwards, and Helen Mustafa to a meeting at Scripps Institute of Oceanography (SIO) to plan NOAA/NMFS's participation in the First International BIOMASS Experiment (FIBEX). Based on this meeting, Greg prepared a document describing a two-phase study involving an acoustical survey of krill conducted jointly with scientists of the SIO R/V Melville and a 7-day krill patch study on the Soviet R/V Odysee in the Atlantic sector of the Southern Ocean during January-March 1981. Greg Lough, Hal Merry, and Robert Marak held several meetings with Dr. P. H. Wiebe and Al Morton of the Woods Hole Oceanographic Institution (WHOI) to acquire a MOCNESS 10 for krill sampling in the FIBEX program. Greg Lough and Hal Merry spent considerable time making purchase orders for the MOCNESS 10 for krill sampling in the FIBEX program, and for conducting cable and additional gear and equipment. Hal Merry also repaired two General Oceanics meter blocks for MARMAP surveys and spent Labor Day weekend helping Jim Crossen hook up the clam dredge for the Delaware II survey.

Micronekton Investigation

The Micronekton Investigation was given the task of preparing for the US participation in FIBEX, to be carried out during January and February 1981. As a result of a meeting at SIO, we will be cooperating with SIO scientists aboard the Melville. Four NMFS scientists will be participating on each leg (1 mo) of the cruise. Hydro-acoustic studies to determine krill abundance and net sampling for "sea truth", as well as other studies, will be carried out. On completion of the second leg we will join with other ships for an 8-day krill "patch" study. Plans to work cooperatively (six US scientists) with the USSR on the Odysee to carry out similar operations are being investigated. Considerable effort has gone into the acquisition of "full spectrum" sampling gear as well as the support equipment to carry out the studies in the Antarctic. The difficult logistic problems have also required considerable time and effort.

Benthic Dynamics Investigation

A series of five ICES documents were completed this month that all deal with different aspects of fish feeding and digestion. This effort included joint work between the Ecosystem Dynamics Investigation (i.e., Marv Grosslein, Mike Pennington, Wendell Hahm), the Woods Hole Laboratory Automatic Data Processing (ADP) Unit (i.e., Barbara North), the Benthic Dynamics Investigation (i.e., Richard Langton, Ray Bowman), and the University of Rhode Island (i.e., Ted and Ann Durbin).

In the Woods Hole Laboratory's research aquarium, John Hacunda has made progress in the study of digestion in juvenile white hake, the fish respond well to lab conditions and are currently being used in an experiment with several prey including squid.

Progress is being made on data analysis of several of our "special cruises." Fish food habits data collected as part of an intensive study of Jeffreys Ledge (Gulf of Maine) are currently being listed while data collected on fish as part of the 1978 larval Atlantic herring patch study are being prepared for keypunching. Routine work-up of the fish stomachs collected on bottom trawl survey cruises is also going well; 1977 data are being keypunched and our contractee is beginning analysis of the 1979 samples.

Jim Towns has spent several weeks at sea on a bottom trawl survey, Albatross IV Cruise No. AL 80-08, and has been involved in helping to reorganize the benthic sorting lab.

Rich Langton spent a week at sea on the Woods Hole Oceanographic Institution's R/V Lulu and dove in the DSRV Alvin as part of a biological/geological study of the head of Oceanographer Canyon.

The final figures for the bivalve report were photographed. With this task completed the report should be ready for submission within the next month. In addition to work on the bivalve report, Roger Theroux has been busy translating abstracts of various ICES documents into French and building the benthic lab sorting table. Roger and Bob Kaminski have also been evaluating the extent of our unprocessed polychaete samples.

Ray Bowman made a few minor revisions and then resubmitted the paper on the food of some juvenile groundfish that was accepted for publication in Fishery Bulletin last month. Ray also completed a preliminary analysis of the food of silver hake from the 1973-76 data base.

Ecosystem Dynamics Investigation

The month of August was devoted to preparation of papers for ICES and NAFO. Ed Cohen prepared an ICES paper on comparisons of energy flow on Georges Bank and in the North Sea; it is based on the original energy budget paper, but incorporates new information on zooplankton biomass and grazing rates. Also, Ed revised the paper on primary production levels on Georges Bank and submitted it to Nature. Wendell Hahm and Rich Langton described feeding selectivities of fishes and Mike Pennington worked on two ICES papers -- one on a growth model for larval Atlantic herring and one on variability of stomach-content data for fishes. Finally Ted and Ann Durbin of the University of Rhode Island (URI) prepared two ICES documents -- on digestion rates in fishes and on a model for estimating daily rations in Atlantic cod and silver hake in cooperation with the Ecosystem Dynamics and Benthic Dynamics Investigations at the Woods Hole Laboratory.

Marv Grosslein concentrated on preparations for the NAFO Larval Herring Task Force meeting to be held in September at St. John's, Newfoundland. Numerous documents and working papers have been prepared (authors include R. Lough, R. Cohen, C. Davis, G. Bolz, D. Potter, W. Smith, K. Sherman, S. Grimm, V. Anthony, G. Waring, R. Schlitz, R. Wright, E. Cohen, and M. Grosslein). The Task Force will review these and other papers to continue its evaluation of the data base and status of knowledge on herring recruitment.

Wendell Hahm began work on a program documentation report for GEORGE, the multispecies model developed at NEFC. He also collaborated with James Kirkley (NEFC economist) and Ira Sohn (New York University Institute of Economic Analysis) on development of a combined bioeconomic model consisting of GEORGE linked to an input-output economic model. The bioeconomic model will be used to evaluate different fishing strategies under realistic biological constraints.

Nancy Lyon has assisted several investigators in the Division at the Woods Hole Laboratory with various computer programming problems -- notably plots for haddock fecundity studies, plots of zooplankton data for the larval herring series, and data for the food chain studies.

Ichthyoplankton Investigation

The second part of our summer MARMAP I survey was successfully completed on Evrika, closing out our fourth consecutive year of intensive survey activities. During the fiscal year we completed seven surveys in coastal waters between Cape

Hatteras and Nova Scotia. Preliminary analyses of our FY 1980 ichthyoplankton samples reveal two interesting developments. First, the abundance of American sand lance larvae during winter 1980 was drastically reduced from the record high level observed in 1979 when the average station abundance reached 417 larvae per 10 m² of surface area. In 1980 the average was 64 larvae per 10 m² of surface area. Despite this decline, they continued to dominate numerically the February and March ichthyoplankton collections and the center of their distribution remained off Southern New England in the vicinity of Nantucket Shoals. Second, the abundance of haddock larvae on Georges Bank during the spring appeared to be much higher than during any of the previous 3 yr.

We were privileged to have two visiting scientists from the Morski Instytut Rybacki in Szczecin, Poland, with us at the Sandy Hook Laboratory for most of the month. Mss. Margaret Adamus and Maria Baranowski arrived on 11 August for a 4-wk period. They are working on identification of marine fish eggs under the guidance of Peter Berrien, Doris Finan, and Cindy Fahay.

Fishery Oceanography Investigation

Preparation of scientific papers and other reports occupied much of the Investigation's time in August. Five papers were completed; five others are in various stages of preparation.

Completed papers include three for the 1980 Statutory Meeting of ICES: (1) a paper by Ann Dorkins on the mean alongshore flow measured during the Nantucket Shoals flux experiment, including a comparison of geostrophic and measured transports; (2) a paper on "Northeast Channel Flow and the Georges Bank Nutrient Budget," by Steve Ramp, Ron Schlitz, and Red Wright; and (3) a paper on "The Mean Circulation on Georges Bank as Measured by Moored Current Meters," by Ron Schlitz and several other authors from WHOI, US Geological Survey, and EG&G Environmental Consultants, Inc. In addition, the paper by Ed Cohen and Red Wright on "Primary Productivity on Georges Bank" has been revised and submitted to Nature.

Ron Kirschner's manual on MARMAP hydrography was issued as a Woods Hole Laboratory Reference Document. Dan Patanjo's paper comparing expendable bathythermograph (XBT) and thermometer data on MARMAP cruises, and Kathy Bush's paper on volumes and surface areas in the shelf-slope region are nearly ready for release in the same series. Cindy Chappell has typed all the tables for Kathy's paper.

Ron Schlitz has completed a revised draft of his paper on upwelling mechanisms along the northern edge of Georges Bank and the implications for nutrient replenishment on the Bank. Gil Dering has completed a first draft of a paper describing the data handling system he and Ron Schlitz (and others) have developed based on the Tectronix Graphics Terminal. And Tom Laughton is working on his volumetric temperature-salinity census of the Gulf of Maine.

Another principal effort during the month has been renovation and refinishing of our current-meter marker buoys. Derek Sutton, Tom Laughton, and Bob Buckman have done most of that work, with sandblasting provided by contract. Derek has also designed new radar reflectors and battery cases for the marker buoys and has arranged to have them manufactured.

Plotting of data continues. Sam Nickerson has completed bottom salinity plots for all MARMAP cruises since 1977 and has read XBT traces from Delaware II Cruise No. DE 80-05 and Albatross IV Cruise No. AL 80-08. Bob Buckman has drawn temperature sections for three Ship-of-Opportunity Program runs across the Gulf of Maine and also drafted several figures for the ICES papers. He, Dan Patanjo, and Jim King have also continued drafting vertical sections of temperature, salinity, and oxygen for MARMAP

transects. Jim has also produced computer plots for thermometer corrections for all our recently calibrated reversing thermometers.

Red Wright and Ron Schlitz took part in the SEBEX workshop at WHOI, with the objective of designing a series of remote sensing experiments in the Nantucket Shoals region. Red also worked with Marv Grosslein and Greg Lough to prepare for the Larval Herring Task Force session at the NAFO meeting in St. John's, Newfoundland, and discussed a proposed series of cruises investigating the natural history and migratory habits of the short-finned squid, also in preparation for the NAFO meetings.

Plankton Ecology Investigation

Image Analysis

Jeff Hansen of the Florida Institute of Technology completed a report on the silhouette photography method including a library of photographs of 19 major groups and 18 species which routinely dominate MARMAP plankton samples. These enhanced, permanent records will be used as an input media for the pattern recognition group at URI. In addition, Jeff has completed a series of silhouette photos of live plankton taken off Block Island which will be analyzed for spacing, orientation, and grey-scale information.

Ray Maurer and Jeff Hansen attended a Bausch and Lomb, Inc. (B&L), demonstration of the FAS-II pattern-recognition system on 2 August at the Marine Biological Laboratory in Woods Hole. Improvements in the system include a more sensitive video scanner (Chalnicon) which allows for greater grey-scale separation and facilitates thresholding over a field of up to 30 individual plankters. Counting, sizing, and discrimination functions were demonstrated using both stained preserved plankton and silhouette photos.

Following the review and recommendations of Dr. Marc Berman (URI), the B&L image system at the Narragansett Laboratory is being interfaced to the URI computer facilities. Marc has also expanded the HP-9825 programs to store counts and length-frequency data on magnetic tape cartridges and to allow the operator to enter an identification code as the counts and measurements are being recorded.

Ray Maurer and Bill Felch submitted a Narragansett Laboratory Reference Document, "Automated Zooplankton Processing Data Report I: Length Frequencies of Dominant Species from Georges Bank MARMAP Surveys, Spring 1977-78." Over 20 000 specimens were measured using the Image Analysis System. For the first time, seasonal and areal patterns in the structure of plankton populations can be detected over a broad geographic area using a semiautomatic electronic system.

Primary and Secondary Production

The sorting of plankton-pump samples from Evrika Cruise No. 80-02 by Paul Fofanoff and Bob Halpin is nearly complete. Data from these samples will provide information on the abundance and the species and life history stage composition of microzooplankton on Georges Bank in the area of the high larval haddock densities observed this spring. Joe Kane has been looking at larval haddock gut contents from opening/closing nets from the same cruise. So far the results indicate a high ingestion rate of invertebrate eggs with nauplii and adult Pseudocalanus also frequent in the stomachs. Jack Green has completed calculations of gut contents of Calanus finmarchicus using a modification of the Mackas and Bohrer technique. Gut contents are in the range of 0.7 - 11.0 μ g of pigment per animal with the highest values

occurring between 1800 hr and midnight between 5 and 35 m of depth. These values agree well with Dagg and Grill's values for Centropages typicus in the New York Bight and with Boyd et al. for copepods off Peru as reported in the most recent issue of Limnology and Oceanography.

Donna Busch met with Soviet scientists from the Evrika on 11 and 12 August to exchange data and discuss plans for possible future cooperative research. NEFC contributed a long list of data reports to the exchange, one of which included a summary of primary productivity measurements made during MARMAP surveys (Soviet R/V Belogorsk Cruises No.'s 79-01, 79-03, and 79-05) by Jay O'Reilly and Donna Busch.

Donna also prepared phytoplankton samples and a sample inventory list for the collections made on Evrika Cruise No. 80-06 which will be sent to Stefan Grimm's laboratory in Gdynia, Poland.

Biostatistics

The following master files were created to hold station and net tow data: EV80-01, WI79-03, and DN78-03. Ichthyoplankton data were merged into the following master files: DN78-03, BE79-03, and WI79-03. Zooplankton data were merged into the following master files: WI78-04, DN78-03, AL78-15, AL78-13, RE76-01, WI74-01, and AL74-13. Zooplankton logs for Polish R/V Wieczno Cruise No. 79-03 were received from Poland and sent to Sandy Hook for keypunching.

Contour maps of zooplankton wet-displacement volumes and of density of major copepod taxa were produced by Lorrie Sullivan and Steve Eldridge. Cindy Jones and Steve Eldridge produced Fagers and Univariate statistics for all zooplankton taxa in four areas, Middle Atlantic Bight, Southern New England, Georges Bank, and Gulf of Maine, during 12 surveys during 1978 and 1979. Tom Plichta ran several statistical analyses testing the significance of differences in zooplankton densities between surveys, areas, and years.

Meetings, Talks, Visitors, and Publicity

As part of the national recognition of NOAA's first decade, the Narragansett Laboratory held an open house on 20 August. The members of the staff described four research programs to the public:

- (1) Studies of the recruitment processes with demonstrations of ecological influences on growth and survival of fish larvae including Atlantic cod, haddock, flounders, and Atlantic herring, species which are important to the New England community.
- (2) Studies of plankton showing the linkages in energy transfer from phytoplankton to zooplankton to fish.
- (3) Oceanographic studies showing the use of long-term information on temperatures, currents, and frontal movements on the abundance of fish stocks in the Northwest Atlantic. Traditional physical oceanographic measurements of temperature, salinity, depth, chlorophyll, and oxygen will be described along with new applications of remote sensing technology of surface temperature and oceanic fronts of the continental shelf and slope.

- (4) Oceanic gamefish studies presenting new information on the distribution and abundance of sharks and swordfish. Description will be given of age and growth, food consumption requirements, and the impact of annual migrations of these large predators on the stocks of smaller fish (e.g., bluefish, Atlantic mackerel, squids, and Atlantic herring).

Dr. Takita, a Japanese scientist from the University of Nakasaki discussed plankton research with the staff at Narragansett on 18 August.

On 26 August, Jim Griffin and Marty McClure (URI) and Ken Sherman met regarding remote sensing and the acquisition of a trailer to house satellite receiving equipment for the Ocean Division of the Northeast Regional Remote Sensing System.

On 21 August, Ken Sherman and Bob Marak traveled to Woods Hole to discuss 1981 joint work with USSR scientists aboard Evrika.

Donna Busch attended the Career Development Workshop in Providence, Rhode Island.

Publications

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Reports

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RESOURCE UTILIZATION DIVISION

Fisheries Engineering Investigation

The squid ring cutter was tested successfully. Some slight modifications are necessary along with the installation of several extra cutting blades to accommodate larger squid.

The steel necessary for fabricating a new Dutch beam trawl beam has been received. Work on this will commence shortly.

Data sheets for labor and energy productivity have been received from a large fish processing company in the region. These will be tabulated and summarized to obtain an operational efficiency index of current methods.

Four members of the Fisheries Engineering Investigation left for Mississippi on 10 August to bring the research-vessel-to-be Gloria Michelle to the Gloucester Laboratory. She is expected to be here by the first week in September.

Efforts are continuing to let the architectural and engineering contract for the solar energy project.

Engineering Assistance to Other NEFC Programs

Dan Baker and Al Blott spent a week at the Woods Hole Laboratory rigging the Delaware II with the equipment for clam dredging. This included fitting and installing the new lower door. Additionally, new blade edges are being fabricated.

The August trip in cooperation with the Atlantic Environmental Group for obtaining XBT readings and seawater samples on the M/V Marine Evangeline was completed by Dan Baker.

Safety inspections of each of the laboratories in the region have been completed. Reports to each laboratory and the NEFC are being written.

Resource Development and Improvement Investigation

Squid Processing

The skinning efficiency and production rate of a Model 600s Townsend membrane skinner to skin squid were determined using thawed short-finned squid. These squid had been eviscerated and the tails were removed.

Skin removal percentage was:

- 100% skin removal in 47% of the squid;
- 90-95% skin removal in 38% of the squid;
- 80-89% skin removal in 6% of the squid;
- 70-79% skin removal in 0% of the squid;
- 60-69% skin removal in 6% of the squid;
- 50-59% skin removal in 0% of the squid; and
- below 50% skin removal in 3% of the squid.

Production rate in this experiment was about 153 lb/hr. In all, the machine performed well. The amount of skin left on the squid could easily be removed by on-line inspectors. Production rate was limited by the use of the wooden paddles used to push the squid into the skinning blade.

Blue Crab

A storage study is in progress on vacuum-packed and air-packed blue crab meat. After 11 days of refrigerated storage, there are no differences in the organoleptic quality of the meats in both packs.

Nutrition

Blue crab and Jonah crab meats were prepared for fatty acid and cholesterol analyses. Half of the products were canned and the other half were frozen at -5°F. Blue crabs, Jonah crabs, surf clams (frozen since January 1980), and blue mussels (frozen since July 1980) were worked up for gas chromatographic analyses using our new methodology. Proximates have also been completed on all of these samples.

The manuscript for the collaborative study to identify crab species has been completed and sent to the Association of Official Analytical Chemists for review.

Product Quality, Safety, and Standards Investigation

Product Quality

A taste test was conducted on canned bluefish after 3 mo of storage. The overall sensory score for cooked fillets packed in either tomato sauce or oil, or for raw fillets packed in oil, was approximately 7 (= like moderately), which was the same average score received at the beginning of storage.

Only after 19 days of storage on ice was the taste panel able to detect ammonia in gutted dogfish. At that time, too, the pH increased from 6.3 to 7.4, and TMA-nitrogen rose to 9 mg/100 g from a previous level of about 3 mg/100 g. Attempts to monitor ammonia content with the Orion electrode were not successful. Accumulation of chemical scale on the electrode required a standard curve to be made each day the electrode was to be used.

A clear Plexiglass window has been installed in the Kramer Shear Press testing cell so that sample behavior can be observed during shearing tests. This should help us correlate inflections on the force-distance curve with the deformation of the sample during testing. Without this modification, it is difficult to interpret the curves with respect to shear, compression, extrusion, and yield point of the material.

Kurt Wilhelm has assembled some notes on the use of the computer to organize, statistically analyze, and plot the data derived from our experiments.

Kurt, assisted by Steve Kelleher, a graduate student from Cornell University, in devising a method to measure the effect of steam pasteurization on the texture of fresh Atlantic cod. A modified Kramer Shear Cell was found suitable for this purpose.

Product Safety

This month was devoted exclusively to the work-up and analysis for polychlorinated biphenyls of muscle and gonad samples of striped bass from the NMFS Tiburon Laboratory.

Product Standardization

The "U.S. General Standards for Grades of Shrimp" was published in the Federal Register of Tuesday, 5 August 1980, as an "Advance Notice of Proposed Rulemaking." This standard covers all forms of shrimp except breaded. Comments are due on or before 1 October 1980.

A draft of an expanded "U.S. Standards for Grades of Frozen Fried Fish Portions" was transmitted to the Central Office for publication.

We are continuing to assist in the selection of species for the fish nomenclature project of the US Army's Natick (Massachusetts) Laboratories. Through the cooperation of Don Mahar of the NMFS National Seafood Quality and Inspection Laboratory in Pascagoula, Mississippi, samples of large and small-sized red snapper were supplied for the Natick study.

Copies of the interim commercial item description for canned tuna and canned salmon were sent to the US Department of Commerce (USDC) inspection offices and technological laboratories, to government-user agencies, and to the canned tuna and salmon industries. To date, there has been only a 12% response, mostly positive.

University Contacts

Al Blott lectured at Fitchburg (Massachusetts) State College on fishing gear for the 1980 Professional Development Workshop for Occupational/Vocational Educators.

The Fisheries Engineering Investigation has arranged with the University of Massachusetts Marine Station in Gloucester to tie up temporarily the Gloria Michelle when she arrives.

We provided reprints of isoelectric focusing (IEF) species identification papers and a photo of authentic IEF patterns to Dr. Righetti of the University of Milano (Italy) and NASA's Marshall Space Flight Center, who is preparing a review paper on applications of IEF to analysis of food proteins.

We made arrangements for Dr. Leamson, Assistant Professor of Biology at Southern Massachusetts University, to spend a few days at the Gloucester Laboratory to learn IEF methodology.

Technical Assistance

Information and technical assistance were given in the following areas: sanitation; obtaining 35-mm slides of fishing vessels; building codes for fish plants; fishery publications; disposal of sodium waste; sodium tripolyphosphate use; preparation of dogfish, squid, and cownose ray; eels; USDC grade standards; pot-buoy release mechanisms; fish traps; hydraulic clam dredging; energy consumption in fishing.

operations; influence of ambient water temperature on fish quality; new lobster pot concepts; energy efficient vessel design; salting of fish; fish packaging; storage of fish in modified atmospheres; products from minced silver hake; tempura batter for fish; picking conchs; squid fishing; mechanically sizing squid; squid processing; moisture analysis of salt fish; preparation of fish blocks; sardines; fish meal processors; installation of fish smoking equipment; and weight loss of shrimp during distribution.

Meetings, Talks, Visitors, and Publicity

Meetings

Bob Learson, Fred King, Joe Licciardello, Joe Mendelsohn, and Ron Lundstrom attended the 25th Atlantic Fisheries Technological Conference in St. John's, Newfoundland. Joe Licciardello gave a paper on "Utilization of Bluefish" and Ron gave one on "Textural Toughening and Enzymatic Formaldehyde Production in Frozen Stored Red Hake." Ron was elected to the AFTC Executive Committee as one of the two New England members.

Perry Lane attended the monthly meeting of the New England Fisheries Steering Committee. He also met with John Hurst of the Maine Department of Marine Resources and the manager of a Maine fish processing plant to discuss methods of improving plant sanitation. At the request of the Central Office, Perry served as a member of a board to review proposals for a national fish consumption survey.

Visitors

Dr. Patricia Davison of the National Institute of Fisheries of Montevideo, Uruguay, visited the Gloucester Laboratory to discuss the Division's research activities and visit local fish processors.

A group of students from the Gloucester Fishermen's Museum toured the Gloucester Laboratory.

Training

Judi Krzynowek and Kate Wiggin attended a seminar on the progress of analysis using capillary columns in gas chromatography work, given by Hewlett-Packard in Lexington, Massachusetts.

Kate Wiggin attended a US Office of Personnel Management course-seminar about career women.

Don Gadbois spent 2 days with Steve Bingham of the NMFS Charleston (South Carolina) Laboratory on the familiarization and uses of the Texas Instrument Omni 800-820 KSR terminal. Time was also spent on selecting the proper format to enter polychlorinated biphenyl data.

Kurt Wilhelm attended a 1-wk summer course at the Massachusetts Institute of Technology, "Food Rheology," which covered the fundamental aspects of food texture and its measurement.

Butty Tuhkunen attended a 3-day course on Career Opportunities for Women Employees.

Publicity

On 7 August, the Gloucester Laboratory held an open house. This was part of a week-long series of events being held as the Cape Ann Week of the Coast celebration. Approximately 200 visitors to the Laboratory had an opportunity to visit our facilities and try some products prepared from underutilized species.

Joe Carver and Perry Lane staffed a Gloucester Laboratory display at the New Bedford Seafair '80. They gave out some 400 samples of marinated squid during the 2-day event.

Publications

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DIVISION OF ENVIRONMENTAL ASSESSMENT

Behavior of Marine Fishes and Invertebrates Investigation

Work on the feeding behavior of juvenile red hake is continuing as part of an overall study, supported in part by US Environmental Protection Agency (EPA) funding, of the behavior and ecological requirements of juvenile hake. Currently we are analyzing data from a series of experiments designed to examine how the feeding behavior of the species relates to a habitat in which food might be a limiting factor i.e., patchiness in the distribution of prey species.

This situation was simulated in the lab by depriving individual hake (TL: 86-100 mm) of food for periods of 6, 18, 24, and over 40 hr followed by the introduction of a standard ration of 50 amphipods, a natural prey for juvenile red hake. The fish were then observed, recording minute-by-minute the number of amphipods ingested. Results to date show that while meal size increased with the period of deprivation, the time taken to consume the meal was independent of the deprivation period. Typically at all four deprivation levels, the fish consumed the major portion of the meal within the first 3 min of feeding and became satiated within 6-9 min. These results appear to indicate that red hake of this size are opportunistic feeders, enabling them rapidly to utilize patches of food. In addition, this particular strategy also appears to be selectively advantageous by reducing an individual's time away from cover and its vulnerability to predation.

Biological Oceanography of Stressed Environments Investigation

Seabed Metabolism

In August 1980, an intense investigation of Newark, Raritan, and Sandy Hook Bays, including the Kills around Staten Island, was completed by Bill Phoel and Steve Spina. Data from this study will be used to assess the impact of the polluted waters on the oxygen consumption rates of the estuarine sediments. Additionally, the study sought to compare two accepted techniques for the measurement of seabed metabolism: (1) the Pamatmat multiple corer, and (2) the in-situ dome system. The former is operated from a large floating platform while the latter requires implacement upon

the bottom by SCUBA divers. Data from this investigation will be analyzed in the coming months.

Total Plankton Respiration

As part of the Chesapeake/Delaware Bay and Plume study (Superflux), Jim Thomas and Craig Robertson are presently analyzing total plankton respiration rate data collected from 26 stations within the Chesapeake plume during the June 1980 cruise. Preliminary examination of the data suggests that the highest rates of respiration appear to occur on the seaward edge of the plume and not in the plume itself. Also, highest rates for the area occur just east of the Chesapeake Bay mouth and decrease with increasing distance from the Bay mouth - Cape Henry area. The major influence of the plume, with regard to plankton respiration, does not appear to extend as far south as North Carolina.

Additional analysis is presently being performed to attempt to establish possible links between respiration and other data collected simultaneously.

Phytoplankton Growth Potential

Algal bioassay of 12 samples was completed. To streamline the assay procedure, counting was reduced from three main counts during incubation to two. The apparent complexity of the chemical water quality influencing phytoplankton growth in Northeast Monitoring Program (NEMP) strata suggested thus far by these studies is illustrated by results from two of the above samples. In an outer shelf sample, metals most critically limited growth; nitrogen, which is most commonly the scarcest nutrient in coastal waters, was rivaled by phosphorus for secondary growth limitation. In a mid-shelf sample, the classical situation of nitrogen limitation prevailed. Another important difference between the two is that the mid-shelf sample was much more generally fertile than the outer shelf sample.

Preparations were made for the September NEMP cruise. Starting with this cruise, two additional stations will be sampled for bioassay studies, the New Bedford, Massachusetts, polychlorinated biphenyl site and Deepwater Dumpsite (DWD) 106.

Phytoplankton Community Structure

Myra Cohn and Harold Marshall (Old Dominion University) are presently assembling their phytoplankton data from the Belogorsk Cruise No. 78-03 for the continental shelf waters of the northeastern US for data processing. Upon completion, lists of all phytoplankton found by both investigators will be produced for this cruise. Listings will indicate cell concentrations, species diversity, equitability, salinity, station locations, and additional cruise data. The data will be incorporated into a NOAA Technical Report. Harold Marshall and Myra Cohn will meet in mid September at the Sandy Hook Laboratory to work on this report.

An article on clam digger's itch by Myra Cohn and Donna Blaszczak (Underwater Naturalist, 1976, vol. 9(4)) was used entirely as the reference material for a column called "View Outdoors" by Pete McClain which appeared in the Sunday, 24 August 1980, edition of the "Asbury Park (New Jersey) Press."

Samples from the Evrika Cruise No. 80-06 were received and processed (118 vials). Plans are being made to collect samples during the NEMP biological-effects-monitoring cruise in September.

Remote Sensing

On 19 and 20 August 1980, a NEMP/Ocean Pulse meeting was held at Easton, Maryland, to review the Chesapeake/Delaware Bay and Plume study (Superflux). Fifty-one individuals from three federal agencies and five universities participated. The agencies and institutions represented included NOAA, NASA, EPA, Old Dominion University, Virginia Institute of Marine Science, Chesapeake Bay Institute, University of Delaware, and the University of Miami. At the meeting data were presented by those who had participated in the March and June 1980 Superflux and plans for the future were discussed. Of particular interest was the mention of a symposium being planned for December 1980.

Coastal Ecosystems Investigation

Dave Radosh, Jennifer Kennedy, Florence Wood, Marie Cheung, and Bob Reid (Chief Scientist) participated in the 28 July - 6 August NOAA R/V Kelez cruise to monitor contaminants in sediments and biota of the New York Bight and Long Island Sound. We collected samples for benthic microflora, meiofauna, and macrofauna, sediment grain size, and contaminant contents (heavy metals, polychlorinated biphenyls (PCB's), polynuclear aromatic hydrocarbons (PNA's), and coprostanol, the latter a sterol indicative of sewage disposal) at up to 54 stations. Collecting adequate numbers of target finfish and shellfish species from "contaminated" and "uncontaminated" areas was more difficult. Numbers of rock crabs, windowpane, and winter flounder obtained from the Bight and Sound are probably sufficient to describe areal patterns of contaminant distributions in these species. Data for American lobsters and sea scallops will be patchier, since few scallops were found in the Bight apex, and few lobsters were collected further offshore. We only obtained two specimens of the final target species, summer flounder, so red hake (fairly common both inshore and offshore) was substituted. Bob Reid delivered the Kelez samples to analytical labs and discussed processing of the samples on 19 and 20 August (sediment PCB's, PNA's, and coprostanol to ERCO in Cambridge, Massachusetts; other sediment samples to GEOMET in Woodbury, Long Island, New York; benthic macrofauna to the University of New Hampshire; and resource specimens for organic contaminant analyses to our Gloucester Laboratory.

Clyde MacKenzie and others deployed trays of relatively contaminated and uncontaminated sediments at several sites in the inner New York Bight, to examine effects of sediment quality on setting of larval surf clams. Our group also cooperated extensively with the New Jersey Marine Sciences Consortium in using divers to deploy bags of blue mussels around the Bight's dredge-spoil disposal area to determine uptake of contaminants, particularly PCB's.

Benthic Energetics

Again, much of this month's efforts went into preparing for the three Ocean Pulse cruises scheduled for the remainder of the year. Dorothy Jeffress completed her transitional training and she and Janice Ward continued work on determining the benthic biomass distribution in the New York Bight apex. Frank Steimle developed appropriate ADP formats to input all the calorimetric data he has produced since 1972. These formats allow him to produce data in several different commonly used units of caloric equivalency so that comparisons with other studies would be simple. He has also developed input formats to develop an inventory, based on data available in the literature, of calorimetric equivalencies for aquatic organisms.

When this inventory is established, it will allow for rapid retrieval of calorimetric data for species or groups where data are available; this will be beneficial in quickly developing or refining energy budget estimates for management and research purposes.

Work continued to progress on several manuscripts including those dealing with: the feeding habits of fish collected around artificial reefs, a summary of 2-yr of Ocean Pulse hydrographic data, a benthic survey of Block Island Sound, a preliminary study of the calorimetry of shark livers, and the development of shark condition indices. Janice Ward and Frank Steimle are currently addressing editorial comments on an atlas of distributions and life histories of common New York Bight apex benthic invertebrates.

University and Research Institute Relations

During this month the New Jersey Marine Sciences Consortium made use of equipment and expertise in the benthic energetics lab to further their study of a local salt marsh. Frank Steimle made arrangements with the New Jersey Department of Environmental Protection so that they would collect dissolved oxygen and temperature data off central New Jersey in August to monitor the adequacy of NOAA dissolved oxygen (DO) depletion predictions. They located an area of low DO southeast of Atlantic City; this was predicted and doesn't appear to be a problem; other areas they examined had satisfactory DO levels.

Environmental Chemistry Investigation

Ammonium-nitrogen concentration was measured in approximately 950 seawater samples collected during the recent MARMAP survey (Evrika Cruise No. 80-06) and the Ocean Pulse/NEMP survey (Albatross IV Cruise No. AL 80-07). Al Matte and Ruth Waldhauer renovated the iron and urea analytical channels and colorimeters of our Auto Technicon Analyzer II so that these two analyses could be made on selected seawater samples. Ruth Waldhauer instructed Steve Spina (Biological Oceanography of Stressed Environments Investigation) in analyses of ammonium concentrations in seabed cores. Andrew Draxler, Steve Spina, and Bill Phoel will be measuring the flux of ammonium and other nutrients (along with seabed oxygen consumption) in seabed cores collected during the September Ocean Pulse survey.

Salinities collected during the aforementioned Ocean Pulse survey were analyzed on the Guildline Salinometer and coded on computer entry formats.

We began analyses for heavy metals in seabed sediments sampled during the Ocean Pulse surveys, Advance Cruise No. 79-01 and Albatross IV Cruise No. AL 79-07. Samples of sediment, rock crab, winter flounder, windowpane, red hake, American lobster, and sea scallop were collected at polluted and relatively cleaner areas of the New York Bight during the August NEMP survey aboard the Kelez. These samples will be analyzed for heavy metal and hydrocarbon concentrations. Vincent Zdanowicz, Wendy Stephenson, Jay O'Reilly, and Robert Reid selected representative samples for hydrocarbon analyses. These were sent to our Gloucester Laboratory.

Phytoplankton biomass (i.e., chlorophyll-a concentration) was measured at 159 stations (2917 measurements) sampled during the July-August MARMAP survey on Evrika. During the July Ocean Pulse survey on Albatross IV, chlorophyll-a concentrations were highest off the mouths of the Raritan-Hudson, Chesapeake, and Delaware estuaries, along the Long Island coast, and over the center of Georges Bank. Highest chlorophyll-a concentrations were observed off Narragansett Bay (4.5 mg/m^3). Areas away from estuarine influence, mid shelf, and shelf break, were generally lower in phytoplankton biomass.

Jay O'Reilly and Steve Esser (New Jersey Marine Sciences Consortium) continued to monitor large netplankton (>0.053 mm) populations (*C. tripos*, etc.) through double, oblique tow collections made in the New York Bight during the MARMAP survey on Evrika.

Primary productivity samples (phytoplankton organic carbon production) collected during Albatross IV Cruises No.'s AL 79-11, AL 79-13, and AL 80-02, and Evrika Cruise No. 80-01 have been counted on our Packard Liquid Scintillation counter, and the activities have been coded along with ancillary field data on computer data entry formats. Phytoplankton productivity measurements made during Albatross IV Cruise No. AL 79-10, an Ocean Pulse survey, have been calculated and the computer output is currently being proofed. All primary productivity data collected in 1978 and 1979 have been proofed against computerized chlorophyll records and against nutrient data field logs to ensure internal consistency of information on date, station, and sampling depths. This will facilitate computer program intercomparisons among these three measurements (productivity/biomass ratios, etc.).

Jay O'Reilly and Ruth Waldhauer worked with Frank Steimle to complete a data report titled "Hydrographic Data, Ocean Pulse Environmental Monitoring Surveys, April 1978 through April 1980." The report contains information on water temperature, salinity, sigma-t, DO, percent oxygen saturation, in-situ pH, and total alkalinity.

Physiological Effects of Pollutant Stress Investigation

Physioecology

Exposure of the F₁ and F₂ generations of the limpet Crepidula sp. to silver continued this month. With the very warm weather we have experienced, tank temperatures have risen sharply. Aquaria temperatures at the beginning of the month were 19°C and are now 24°C. This very high temperature has curtailed egg production by Crepidula. At the beginning of the month there were 7-8 releases per day, but now we are observing very few releases.

Work continued with American oyster eggs exposed to mercury at different regimes. The oysters are reluctant to spawn and the quality of the gametes has been poor.

Three 48-hr bioassays to determine the effect of PCB Aroclor 1254 dissolved in acetone on oyster embryos were performed in July and August. Results indicated that a concentration of at least 100 ppb was required to produce the minimal effect on oyster embryos. This low toxicity information differs from that of other previous studies which indicate that Aroclor 1254 affects various marine organisms at concentrations as low as 10 ppb. The results of spectrophotometric determination of PCB levels in seawater test beakers are still being awaited before any conclusions can properly be made.

William Kramer, a computer programmer of Input-Output Computer Services, Inc., met with us to discuss the installation of four programs on the DEC-10 computer in Waltham, Massachusetts, as part of the NEFC software system. One program, an LC50 program, is now operational; it computes LC50 and its confidence limits in three different ways (i.e., moving average, probit, and binomial). Test runs using old bioassay data are now being performed. A second program, BOX2, which performs detailed statistical analysis of multifactorial studies and plots three-dimensional response graphs, will soon be installed on the DEC-10 computer.

Physiological Effects

The work of a summer employee on the scanning electron microscope (SEM) was completed this month. A tissue-preparation outline was assembled for flounder, crab, lobster, and bivalve gills, the animals we are studying in the Ocean Pulse Program. In addition, a reference collection of SEM photomicrographs was assembled as a basis for further work with these species.

Measurements are continuing on feeding and respiratory studies of bay scallops at different water-flow conditions. We are now initiating round-the-clock measurements because scallop activity varies considerably with the time the animals are held in the flowing-water respirometers.

Work continued on measurements of sodium, potassium, calcium, and osmolality in the plasma of animals collected on previous Ocean Pulse cruises. August sampling of the three Long Island Sound stations was delayed by repairs to our R/V Shang Wheeler, but should be completed by the end of the month. Preparations are being made for the September Ocean Pulse cruise on the Albatross IV.

Biochemical Effects

Bench work this month completed the analyses of all the scallops experimentally exposed to cadmium or silver for 30 or 60 days. Analysis of the seven paired data sets is underway. Some time was also spent in preparing for next week's Ocean Pulse survey, Albatross IV Cruise No. AL 80-09.

With Physiological Effects personnel, we finished the manuscript reporting on the blue mussel field study performed in collaboration with EPA's Narragansett Laboratory.

Anaerobic Bacteriology/Metabolism

Activities the past 2 mo were directed toward the preparation and participation in two cruises: the first leg of an Ocean Pulse survey, Albatross IV Cruise No. AL 80-07, and the first annual NEMP survey, Kelez Cruise No. KE 80-07 & 08 in the New York Bight, which also included sampling of the Ocean Pulse stations in the New York Bight apex.

Sediments and waters were obtained for bacteriological analysis for our index species from 10 stations on the Ocean Pulse cruise. On the New York Bight monitoring cruise, sediments were taken from 43 stations for fecal coliform analysis. Target animal species (lobsters, scallops, and crabs) were obtained from stressed and non-stressed areas for coliform, fecal coliform (E. coli), Salmonella sp., fecal streptococcus (Klebsiella sp.), Vibrio sp., and C. perfringens analysis. Data have not been completely compiled. As expected, fecal coliforms were detected in sediments from the sewage sludge area and some inshore areas. Offshore area sediments were free of fecal coliforms. C. perfringens was detected in more sediment samples than were fecal coliforms. The select bacterial pathogens have been detected in the animal species examined. Confirmation tests of the bacterial isolates cultured aboard ship are being done in the lab. Correlation of the presence of bacteria with the areas studied has not been completed. Identification of isolates, at least to the presumptive stage, is needed first. As in the case of the sediments, C. perfringens is being detected in more animal species than the other indicator bacteria.

Meetings, Talks, Visitors, and Publicity

On 6 August, Dr. John Pearce participated in a midday seminar with Mr. Robin Zimmer of the New Jersey Marine Sciences Consortium. Mr. Zimmer and Dr. Pearce discussed problems of marine pollution in the Raritan Bay, New York Bight area.

On Thursday, 7 August, Dr. Pearce presented a seminar to the EPA's Drafting Committee for a National Study on Estuaries. The seminar also involved Dr. John Costlow of the Duke University Marine Laboratory, Dr. Eugene Cronin of the Chesapeake Bay Consortium, and others. Dr. Pearce presented an historical resume of the deteriorating water quality in major East Coast estuaries with particular emphasis on the results of recent investigation.

Bob Reid discussed Sandy Hook Laboratory programs with 25 French high school students on 12 August.

During 19-21 August, Dr. Pearce chaired a meeting of the NEMP Management Team at the Tidewater Inn in Easton, Maryland. Frank Steimle and Jim Thomas also attended the meeting. The first portion of the meeting involved reviews of ongoing work being conducted under the Superflux program. Investigators from Old Dominion University, the Virginia Institute of Marine Science, NASA, and others, talked about results of recent measurements done in conjunction with remote sensing. In addition, there were several presentations based on current work being done in pathobiology and benthic ecology. The last day of the meeting was taken up with NEMP business, including vessel scheduling for FY 1981.

On Thursday, 28 August, Dr. Pearce participated in an Advisory Council meeting of the American Littoral Society. The Council reviewed the efforts of the past year and discussed future environmental activities and the future direction of the Society. It was also announced that the annual meeting of the Society would be held in Woods Hole and would involve a tour of the facilities and research vessels at the Woods Hole Laboratory.

Publications

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Starr, R.; Steimle, F. Temporal development of physical characteristics. In: Oxygen depletion and associated benthic mortalities in the New York Bight, 1976. NOAA Prof. Pap. No. 11;1980:17-50. (Chapter 2.) (P)

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Cohen, E.; Grosslein, M.; Sissenwine, M.; Steimle, F. A comparison of energy flow on Georges Bank and in the North Sea. Int. Counc. Explor. Sea, Comm. Mem. 1980/L:64;1980. 13 p.

Pearce, J. B. Status of estuaries and coastal waters between Cape Hatteras and Maine; a review. Int. Counc. Explor. Sea, Comm. Mem. 1980/E:56; 1980. 16 p.

AQUACULTURE DIVISION

Aquacultural Genetics Investigation

Mass Selection

Growth data from the 1978 year-class American oysters at 20 mo of age have been analyzed. These oysters comprise the F₁ generation (first generation from selected parents) of the mass selection experiment for juvenile growth rate. There are seven crosses in the fast-growth line. Growth data from these crosses have been compared with those from their contemporary control crosses. In five out of the seven comparisons, the fast-growth line oysters were significantly larger ($P < .01$) than the control crosses for shell width, shell length, and total shell area.

Lou Bacchiocchi has completed his work tour with the Aquacultural Genetics Investigation and is returning to Fairfield University to continue his studies in biology.

Experimental Inbreeding and Hybridization

Spawnability of local adult American oysters and their culture success dropped markedly this month. Most recent set of metamorphosed larvae have come from F₁ and backcross geographic hybrid cultures. Generally, though, this season's new oyster set from lab brood stock are growing and surviving better than did young oysters last year. The mortality rate among some of the older animals appears to have declined overall from earlier in the summer. These groups consist primarily of consanguineous populations. Nearly all animals of sufficient size have been labeled individually.

Significant fouling, especially with barnacles, was observed on oysters in the field grow-out experiment in the lantern net and the suspension-dock tray.

Progeny of an interspecific hybrid cross between the American oyster (Crassostrea virginica) from Texas and the Pacific oyster (C. gigas) performed in a manner similar to hybrids between local Connecticut C. virginica and C. gigas. This cross was part of an attempt to determine whether there might be better growth and survival of this interspecific hybrid when a different geographical population of C. virginica is used.

Final drafting was done on the report of the Genetics Study Group of the ICES Mariculture Committee. This report covers both genetics in artificial hatchery culture, and genetics in management of the traditional fisheries.

Cytology and Cytogenetics

Peripheral blood of 7 of 91 (about 8%) field-sampled Atlantic cod thus far studied showed moderate to high levels of chromosome abnormalities in \pm 5-30% of the red blood cells as assessed by the micronucleus test applied to circulating erythrocytes. Normal background levels for cod are about 0.3%. Blood from another 50 cod is yet to be analyzed. An explanation for this phenomenon could be elevated body burdens of contaminants capable of acting as chromosome mutagens. These burdens of pollutants may or may not have still been present in the fish at the time their blood was sampled. In the latter case, maturing or stem line cells were permanently

affected prior to metabolism and/or loss of the chromosome-active substance. Preparations of blood sampled from Fundulus 5 wk after their experimental exposure to X-irradiation are now being scored in the same test. Since irradiation is well-known for its chromosome-breaking effects, this experiment can be used to assess the reliability and sensitivity of the micronucleus test as applied to fish in lab experiments or in field surveys.

A formal report has been prepared for publication on the cytology and cytogenetics of fourbeard rockling and yellowtail flounder eggs sampled last year at the M/V Ocean 250 gasoline spill in Block Island Sound.

Aspects of Nutritional Requirements of Mollusks Investigation

Experiments were conducted for the past 8 wk on young American oysters (2 cm) to determine which of four species of algae can provide the best relative growth. An original design for a flow-through culture chamber was used in these experiments and weekly size determinations were made of the oysters. Although seawater was filtered through a series of variable-sized orlon filters, the oysters which received no supplementary algae as food showed a slow rate of growth for the first 5 wk, but appear to have reached a stationary size in the past 3 wk. The implication here is that at the start of the experiments the oysters contained a sufficient level of stored nutrients to enable this slow growth to occur. Also, it is possible that a sufficient amount of nutritive material in the seawater can pass the filtration barrier to explain the observed growth. Among the algae tested was Chlorella autotrophica. There has been a long-standing dispute as to whether this species can be utilized as a food source by oysters. Results in these experiments have shown that the growth of oysters receiving this alga is less than oysters receiving no added algal food, hence suggesting that some toxic factor is present in C. autotrophica.

The largest growth increase in oysters was observed when feeding Tetraselmis maculata; a smaller growth increase was obtained on Thalassiosira nana and Dunaliella euchlora. Considerably less growth was observed with Phaeodactylum tricornutum as the food source.

Despite some serious problems in maintaining the temperature in the culture room at 20°C during the recent extremely warm summer weather, a good harvest was produced by the mass culture laboratory. The total larval food harvested was 1398 liters (PCV=.013), and the juvenile food harvested was 1113 liters (PCV=.013). The cultures (PCV=.003) were distributed to the various investigations as follows: Spawning and Rearing of Mollusks, 3293 liters; Aquacultural Genetics, 4270 liters; Physiological Effects of Pollutant Stress, 3372 liters.

Stock cultures were subcultured on schedule. Suggestions were offered and questions answered on algal culture systems for Dr. Iracema Nascimento of Brazil.

Spawning and Rearing of Mollusks Investigation

Surf clams being maintained in protective enclosures in Long Island Sound have shown only slight growth during August. This slow field growth corresponds to a dramatic drop in growth of clams held in our pumped raceway system. The reasons for the midsummer drop in growth rate are not clear, but have been observed in previous years. Since water temperatures are at their maximum at about 24°C and the oxygen-carrying capacity of seawater is low, it is possible that the animals are physiologically stressed. Phytoplankton levels have remained moderate through this period, but showed a pronounced drop at the end of August. Stocking density in the raceway system appears to have had an effect on growth. Clams held at densities of 100/m²

and 125/m² showed significantly more growth than those planted at higher densities. From past experience it is expected that phytoplankton levels will increase and growth will resume during the fall months.

Using SCUBA divers, we have deployed six vinyl-coated bottomless cages with bottom areas of about 0.5 m, and stocked them with hatchery-reared bay scallops. These cages are being tested against Japanese-style lantern nets for growth and mortality differences. The three densities used in this experiment are 100, 500, and 1000/m².

We also deployed two groups of four lantern nets that span a depth from 13 m to the surface in Long Island Sound. This experiment is designed to determine if there is a growth difference with depth for scallops over this depth range.

A replicate experiment testing survival and growth of juvenile scallops grown in our raceway system versus those grown in pearl nets is now in progress.

Preliminary data from our density experiment with scallops in 9-mm-meshed lantern nets were collected. The scallops were then pooled and placed in 12-mm-meshed lantern nets at new densities, and then redeployed. A replicate of the initial 9-mm-meshed lantern net experiment was subsequently deployed.

Meetings, Talks, Visitors, and Publicity

Visitors to the Milford Laboratory included Earl Roberts of Sterling, Connecticut; Dr. Richard Lutz of Rutgers University; Alan Taylor of the University of Glasgow (Scotland); Chris Buckland of Manchester, England; Bernard Vezina of New Brunswick, Canada; Dr. Iracema Nascimento of Brazil; and Wendy Wiltse from the Woods Hole Oceanographic Institution.

Publications

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Reports

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PATHOBIOLOGY DIVISION

Comparative Invertebrate Pathology Investigation

Sea scallops collected for Ocean Pulse studies from the sea scallop assessment survey in June have been examined. Scallops examined for histopathology were selected

on the basis of external signs of stress. No parasites or infectious agents have been detected thus far that can be associated with the observed signs of stress. It should be noted that these animals represent a very small percentage of the total population that was surveyed.

Examination of corbiculid clams from Kentucky which experienced heavy mortalities in July revealed a very unusual syndrome characterized grossly by roughened shell and poor condition. Microscopically, the digestive glands were necrotic and the gonad had pearls, fibroplasia, inflammatory infiltrates, and proliferation of teratomatous lesions containing nerve, glandular, epithelial, and connective tissue elements. Etiology was not evident and tissues have been fixed for electron microscope studies.

Considerable progress was made on the preparation of a manuscript, coauthored with Dr. Iracema Nascimento of the Federal University of Bahia (Brazil), concerning oyster mortality studies conducted in Todos os Santos Bay, Brazil. Dr. Nascimento was a visitor to the Oxford Laboratory for the past several weeks, but now has returned to Brazil.

Papers on viral gametocyte hypertrophy in oysters, and phylogenetic relationships between viruses, marine invertebrates, and neoplasia, are being prepared. An abstract of the latter has been completed for presentation at an international symposium on neoplasia in Japan in November.

Ms. Jackie Swing Slater identified all euphausiids collected on the DWD 106 cruise in May. They now are being examined for focal gill melanization, apostome and suctorian ciliate infestations, and gross abnormalities and parasites. These data will be added to those gathered thus far on euphausiids collected from DWD 106 and MARMAP cruises. Planktonic crustaceans collected on the July Ocean Pulse cruise were received at the Oxford Laboratory and prepared for examination.

Ms. Dorigatti has spent most of the month sorting and identifying amphipods collected during the July Ocean Pulse cruise. Amphipods were collected at 13 of the stations (by grab and by epibenthic sled), and more than 20 species were collected overall. Species chosen as models for the histological survey (*Ampelisca agassizi*, etc.) were taken from a fair number of stations but, except for *A. agassizi*, were abundant in only a few of the samples.

The Histological Services Unit processed fish and shellfish tissues from Ocean Pulse, resource assessment, and ocean dumping cruises, and from Chesapeake Bay. Over 65 blocks were prepared and over 180 sections cut, stained, and mounted for histopathologic examination. A considerable number of hours were spent in the preparation of a histology procedures manual and in developing a tissue transfer technique for electron microscopy.

Fish Pathology Investigation

Mr. Thomas Daniels completed the microscopic examination of gonad, gill, and liver tissues excised from fish collected in the Gulf and Atlantic petroleum hydrocarbon survey. Altogether, tissues from 14 species of fish from 17 different stations along the cruise transect were examined for histopathology (90 fish). No lesions were noted in gonad tissues. Gill lesions consisted of congestion and hemorrhage (20; 22.2%), hypertrophy and hyperplasia (13; 14.4%), and cyst formation (16; 17.7%). Gill parasites included monogenetic trematodes (10; 11.1%) and ciliates (7; 7.7%). Some gill ectoparasites (12; 13.3%) could not be identified. Liver lesions consisted of focal and diffuse necrosis (26; 28.8%), inflammation (7; 7.7%), and cyst formation (12; 13.3%). Liver parasites typically were nematodes. None of the lesions

or parasites observed are life-threatening for fish and none have any relation to petrochemical pollution. All lesions and parasites observed have been noted in marine fish which are in apparent good health.

X-ray analysis of sand lances (Ammodytes sp.) collected from summer bottom trawl surveys has begun; X-rays of fish from spring bottom trawl surveys have been completed. When the summer samples have been completed, the total number of Ammodytes sp. examined will equal or exceed 2000 individuals. A general pattern appears to be developing in which fish from inshore stations display a greater number of skeletal anomalies than those from offshore stations.

A paper describing results of field and lab studies of IPN virus disease in Atlantic menhaden and American shad has been submitted to the ICES Special Meeting on Diseases of Commercially Important Fish and Shellfish.

Specimens of a Eustrongylides sp. nematode from Chesapeake Bay American eels are being sent to Dr. N. O. Christensen at the Royal Veterinary and Agricultural University in Copenhagen, Denmark, and a list of known parasites from American eels is being compiled. These activities are part of a cooperative study to confirm the identity of nematodes found in American eels exported to Northern Europe.

A manuscript on "Ultrastructural Studies on the Developing Cranial Cartilage in Several Species of Larval Fish" was completed and submitted to the ICES Biological Oceanography Committee. As has been frequently reported, skeletal anomalies involving the head and jaws have been observed in larval and juvenile fish from polluted and nonpolluted environments. The developing cartilage in larval fishes often serves as a template for bone formation; however, little is known about the cellular composition of these tissues. Owing to our interest in the development of structures involved in feeding, an activity which would depend on normal development of the skull, we have begun to study the cells (chondrocytes) responsible for the formation of cartilage. Modifications in the structure or function of these cells may occur in animals exposed to contaminants.

Chondrocytes observed in procartilage found under the developing forebrain of striped bass, winter flounder, and summer flounder larvae had two distinctly different appearances. Some cells appeared to be actively elaborating and secreting an amorphous glycoprotein-like material (presumably chondromucoprotein) which resembled the slightly more condensed substance found in the matrix that surrounded them. Others appeared to be degenerate or effete in that their cytoplasm was disrupted with large vesicles, their nuclei were condensed and heterochromatic, and in some instances their cell membranes were no longer intact. Interstitial growth of the cartilage appeared to be minimal for neither cell division nor isogenic groups of chondrocytes were readily observed. The cartilage was delimited by a well developed perichondrium with growth presumably occurring by apposition.

Microbial Ecology and Parasitology Investigation

Mr. Jay Lewis collected bottom sediments from the Philadelphia-Camden ocean dumpsites during an August cruise on the US Coast Guard vessel Evergreen. Stations were selected on the basis of historical coliform bacteria data provided by CPT Newt Adams and CDR Jack Gaines of the US Food and Drug Administration (FDA), Davisville, Rhode Island. Sediments were sampled from the following areas: five control stations, six sewage dumpsite stations, one old acid waste dumpsite, and seven stations south-to-southwest of the sewage dumpsite. Sediments from each station were streaked on six replicate bacterized agar plates and examined for the presence of Acanthamoeba. Results are as follows:

No. (and type) of station	No. of positive dishes	Comment (a)
E-12 (sewage)	1/6	3/5 sewage stations positive
E-18 (")	2/6	
423 (")	1/6	
203 (SW of sewage)	1/6	4/7 S-to-SW stations positive
206 (" " ")	3/6	
437 (" " ")	1/6	
443 (" " ")	1/6	
406 (acid waste)	1/6	1/1 acid stations positive

(a) 6/6 control stations were negative.

Results from the Evergreen cruise agreed with our previous studies in the Philadelphia-Camden dumpsite area 40 mi from shore. Data collected during the past 3 yr are being analyzed by LCDR Berman to determine whether there is a statistical correlation between bacterial MPN's and the number of stations positive for Acanthamoeba. Preliminary results using maximum-degree regression analyses showed that there is a higher degree of correlation between the presence of amoebae and fecal streptococci than there is between the presence of amoebae and fecal coliforms.

Three hundred eleven rock crabs were collected for visual evidence of gill blackening or carapace erosion. An additional 35 crabs were collected for histological study and for chemical analyses by Richard Greig at the Milford Laboratory. All of the specimens were collected by Mark Galasso during a July cruise on the Kelez. Collections were made from 14 different stations situated near the New York Bight dumpsite or in offshore waters. The identification of each station as "clean" or "polluted" will be made when the final cruise report is available for circulation. Black gills were noted in only 2 of the 346 crabs and discolored or slightly black gills were noted in 42 of them. Perforations or blackening of the appendages or carapace were noted in 31 specimens. The reasons for the very low numbers of crabs with black gills are not clear but may be explainable when station location data are available. Also, standard procedures for our sampling strategy were not met since large numbers of specimens collected for other investigators were not available for shipboard examination. A second collection was made during the last week in August and all specimens will be opened for observations of gill condition. It is of interest that our August collection from the Philadelphia dumpsite yielded 11% of the crabs with black gills.

One hundred seventy-three rock crabs were examined from the Philadelphia dumpsite during the August cruise on the Evergreen. The collection coincided with the molting cycle of both males and females, and 51 of the 1973 (21 males, 30 females) were in either the premolt stage (peeler) or the postmolt stage (soft- or papershell carapace). Although only 70% of the total were in the intermolt condition, 14 specimens had black gills (14/122; 11%); 8 were females and 6 were males. The August collection yielded more crabs with black gills than did any of our previous collections. Previous collections yielded crabs in which approximately 70% had clean gills while the present collection yielded only 53%. Crabs categorized as discolored totaled 82 and 16 (20%) of them had less than 50% of their gill surface blackened. Furthermore, it was noted that 28 (16%) specimens had rotted or missing appendages, and 25 (15%) had perforations or black discoloration of the carapace or the appendages. The August collection provided rock crabs that were in the poorest condition that has

been noted to date. Results of the cruise indicate that the collection probably coincided with either the beginning or the midpoint of the annual molting period, and most of the animals were adults. Only one female and six males measured less than 5 mm in carapace width. Males measured up to 12 cm in width and females up to 10 cm. The numbers and types of observations on rock crabs made during the August collection represent one of the most complete and thorough blocks of data that we have obtained from the Philadelphia dumpsite. Marria O'Malley of the EPA and Jay Lewis of NMFS are gratefully acknowledged for their dedication and skill in characterizing the crab condition during the Evergreen cruise.

Diseases of Larval Mollusks Investigation

In our hatchery disease control project, the effects of ultraviolet (UV) irradiation have been determined on two additional pathogenic bacterial isolates. One isolate, obtained from a Maine shellfish hatchery, is resistant to UV irradiation. Although it is too early to be definitive, the other isolate, from the Milford Laboratory's water system, appears to be susceptible to permanent UV irradiation damage. It would be interesting to compare the G+C content of the DNA of the two resistant strains found thus far with the G+C content of the susceptible strains tested. The resistant microbes have either a higher G+C content or a superior repair system. If the former, then they probably have been incorrectly identified as vibrios.

One additional suspect bacterial pathogen was received from Monterey Abalone Farms in Monterey, California. Fifty-three biochemical tests were completed, along with two American oyster challenge tests. Of the five suspect pathogens tested, none caused significant mortality to the oyster larvae.

Another monthly sampling cruise to Long Island Sound shellfish beds provided 36 bacterial isolates for oyster-larval pathogenic evaluations. These isolates, along with others, were tested in four separate challenges with oyster larvae. Data on the 600+ other isolates from monthly cruises which started in March 1979 are being correlated for presentation at the meeting of the New York-Connecticut Chapter of the American Society of Microbiologists.

A great deal of time was spent designing a new laboratory water table and obtaining price quotes for its construction. Dr. Brown will move into this new laboratory as soon as all recently purchased equipment is delivered and installed. Increased water table space will double oyster-larval challenge capacity.

To perform in-vitro experiments with oyster hemocytes, the problem of cell attachment to container surfaces must be solved. Published work indicates that mammalian phagocytic cells are attracted to hydrophobic but not hydrophilic surfaces. Limited experimental work suggested that mechanisms in oyster hemocytes may be similar. Agar, the gelling agent used in bacteriological media, and its more purified form, agarose, used in gel electrophoresis, is polysaccharide in nature and therefore hydrophilic. Surfaces coated with three types of agar or two types of agarose were examined for their usefulness in repelling the attachment of oyster hemocytes. One type of agarose was found to resist attachment of all but 3% of the oyster cells. All other types attracted relatively high percentages of cell attachment. These experiments are being repeated using cells from other oysters and additional types of agarose.

Meetings, Talks, Visitors, and Publicity

Dr. Rosenfield attended the Superflux meeting at the Tidewater Inn in Easton, Maryland, on 19 and 20 August. Drs. Rosenfield, Sawyer, Murchelano, and Ms. MacLean

attended the NEMP meeting at the Tidewater Inn on 20 and 21 August, where they participated in a Pathobiology Division program review covering the Division's interactions with Ocean Pulse, Ocean dumping, resource assessment, MARMAP, and other NOAA and interagency (EPA, FDA) programs. On 22 August, Dr. Rosenfield presented a report on his trip to the Peoples Republic of China to the NMFS Office of Science and Environment and guests in Rockville, Maryland. He also attended a meeting of the Advisory Board to the American Littoral Society at Sandy Hook, New Jersey, on 28 August.

Dr. Brown conducted a seminar on 30 July at the Milford Laboratory to share with interested staff members information obtained during her attendance at the Federally Employed Women's 11th National Training Program.

In Cleveland, Ohio, on 1 August, Dr. Blogoslawski was elected Chairman of the Pan American Committee of the International Ozone Association.

The Oxford Laboratory hosted the annual crab feast of the American Littoral Society on 3 August.

Two seminars were presented to the Oxford Laboratory staff during the month. The first was presented on 12 August by Ms. Arva Jackson, Director of the NOAA Office of Civil Rights, on "Alternative Career Planning." The second was presented on 15 August by Dr. Iracema Nascimento, visiting investigator from the Federal University of Bahia, on "Oyster Culture in Brazil."

Ms. Stephanie Hundley of Lincoln University began a 4-mo work/study assignment with the Diseases of Larval Mollusks Investigation at the Milford Laboratory.

On 15 August, we bid fond farewell to Christa D'Auria, a temporary summer employee who is returning to Gallaudet College in Washington, DC, to complete her final year of undergraduate study, and to Maria Martin, a cooperative work/study student, who completed a 3-mo program in library science and is returning to the University of Maryland Eastern Shore to continue her degree program.

Visitors to the Oxford Laboratory during the month included: Ms. Maria Baranowska and Ms. Malgoszata Adamus of the Plankton Sorting and Identification Center in Szczecin, Poland; Ms. Doris Finan of the Sandy Hook Laboratory; Ms. Ann Davidson of Gallaudet College in Washington, DC; Dr. Edward Meyer of NOAA in Rockville, Maryland; Mr. Donald Gilpatric of Annandale, Virginia; and Mr. Cyrus Shares of Villanova University.

Publications

Farley, C. A. Phylogenic relationships between viruses, marine invertebrates and neoplasia. Proc. 11th Int. Symp. Princess Takamatsu Cancer Res. Fund. (Abstract.) (S)

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Reports

Bodammer, J. E. Ultrastructural studies on the developing cranial cartilage in several species of larval fish. Int. Counc. Explor. Sea, Comm. Mem. 1980/L:36;1980. 9 p.

Robohm, R. A.; Brown, C.; Cox, M. E.; Blogoslowski, W. J. An attempt to use two miniaturized, multiple test systems to identify bacteria from lesions of marine fish and shellfish. Int. Counc. Explor. Sea, Contrib. No. 31; 1980. 16 p.

NATIONAL SYSTEMATICS LABORATORY

Penaeoid Shrimp Investigation (July and August)

During most of July, Dr. Canet worked at the Estação de Biologia Marinha (EBM) in Arrail do Cabo, Brazil, at the invitation of the Instituto de Pesquisa da Marinha, Rio de Janeiro. During her visit she examined samples of the commercial catch, identified the shrimp collection at the EBM, examined postlarval stages of Penaeus, and collected shrimps and assembled material for return to Washington, DC, for subsequent lab study. In August Dr. Canet completed reports on her Brazilian trip and continued work on rock shrimp of the genus Sicyonia.

Crustacea Investigation

Preparation continued of a handbook of the decapod crustaceans of the temperate western North Atlantic.

Benthic Fishes Investigation

Work was done on the gadiform section of the United Nations Educational, Scientific, and Cultural Organization project-- "Checklist of the Fishes of the Eastern Tropical Atlantic." The first draft of a manuscript was completed on a new species of bythitid from the Caribbean. Preliminary work was done on a new reef bythitid from Western Australia and a review of the cusk eel genus Sirembo in the Indo-Pacific.

Pelagic Fishes Investigation

Research continued on the systematics of the Spanish mackerel genus Scomberomorus. Two papers on New Guinea fishes were under preparation -- one the description of a new species of halfbeak, the other an analysis of mangrove swamp fishes.

Academic Activities

Dr. Bruce Collette was appointed Adjunct Professor at Northeastern University, where he taught an ichthyology course.

Talks

Dr. Isabel Canet presented two lectures on shrimps, one at the EBM, the other at the Fundação de Estados do Mar in Rio de Janeiro. Dr. Austin Williams presented a public lecture at the Smithsonian on "The Life History of Crabs in East Coast Estuaries."

Visitors

Visitors included Professor Kunio Amaoka of the University of Hokkaido, who spent 2 wk working on flatfish systematics and the taxonomy of cottids and other northern fishes. Other visitors were Dr. John Wourms of Clemson University for discussions on viviparous fishes, Dr. C. R. Robins of the University of Miami for discussions on Sirembo, and Eric Anderson from the Virginia Institute of Marine Science.

Publications

Perez Farfante, I.; Boothe, B. B. A new species of rock shrimp of the genus Sicyonia (Crustacea: Decapoda: Penaeoidea) from the American Pacific. J. Crustac. Biol. (S)

ATLANTIC ENVIRONMENTAL GROUP

Ocean Monitoring and Climatology Task

Talbot Murray attended a meeting of the American Meteorological Society in Milwaukee, Wisconsin, on "Climatic Impacts and Societal Response" from 25 to 28 August. He presented a paper on the "Impact of Climate on Early Life Stages of Atlantic Mackerel." This paper is a joint contribution he has been working on with Sharon LeDuc of the NOAA Environmental Data and Information Service in Columbia, Missouri, and Mert Ingham of AEG. It is scheduled for publication in a symposium issue of the Journal of Applied Meteorology. The results of this study of extreme years in recruitment indicate that the wind field in the Middle Atlantic Bight leading to long offshore transport is associated with poor year classes; while alongshore and short transport is associated with strong year classes.

The cooperative Ship of Opportunity Program obtained five XBT transects and two continuous plankton recorder (CPR) transects in July: two XBT and one CPR transect in the Gulf of Maine, one XBT transect off Southern New England, one XBT and one CPR transect across the shelf and slope off New York, and one XBT transect across the Gulf of Maine.

The following announcement of eddy conditions in the Georges Bank - Middle Atlantic Bight area was sent to the Commander of the Atlantic Area for the US Coast Guard for publication in the August issue of Atlantic Notice to Fishermen:

GULF STREAM EDDY LOCATIONS

AEG/August 15, 1980

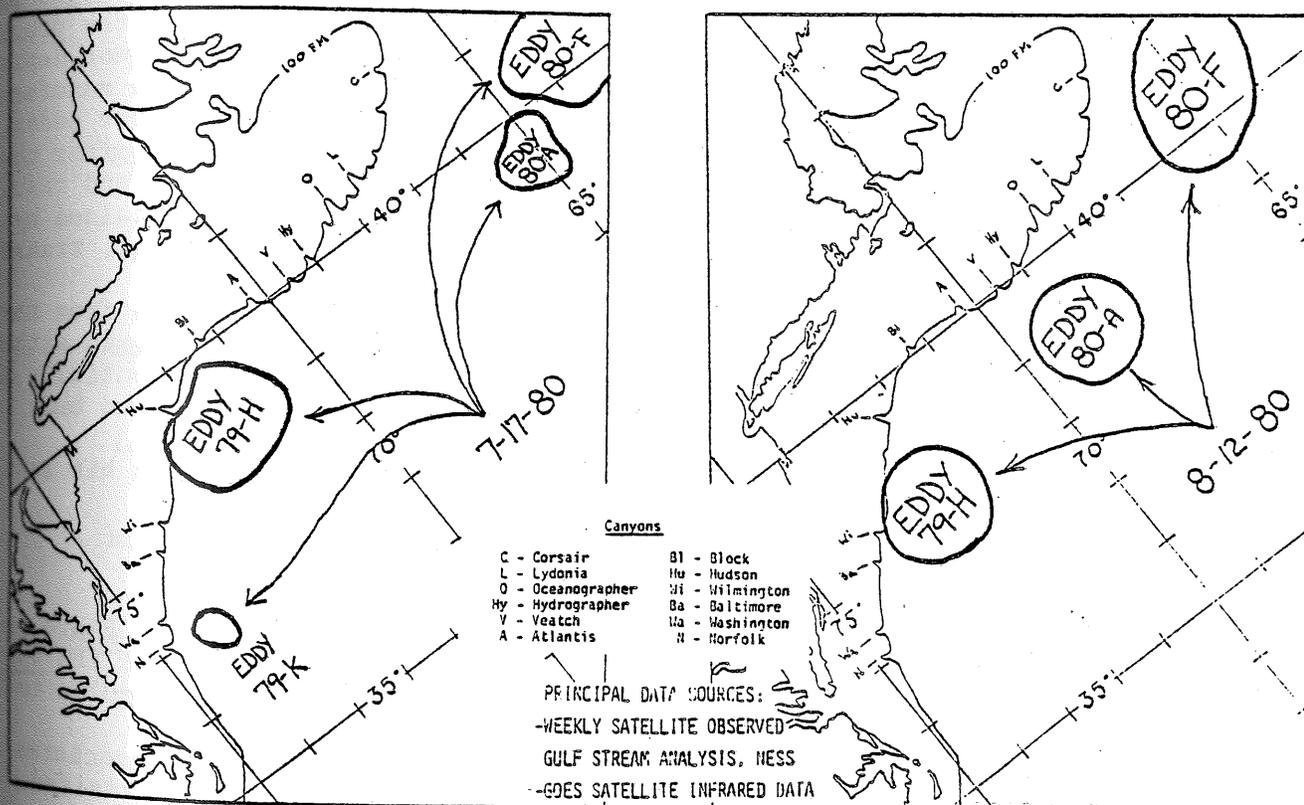
The Atlantic Environmental Group of the National Marine Fisheries Service reports that three warm core Gulf Stream eddies were present off the northeast coast of the United States in mid-August.

Eddy 79-K was resorbed by the Gulf Stream, east of Norfolk Canyon, during the fourth week of July. Eddy 79-H traveled 98 km (53 nm) to the southwest and is now centered at 38.2°N, 72.5°W, east of Wilmington Canyon. Eddy 80-A is located south of Hydrographer Canyon, after moving about 132 km (125 nm) to a center position at 38.9°N, 68.5°W. Eddy 80-F was temporarily overrun

with Gulf Stream water during July, and reemerged as a large eddy, southeast of Georges Bank in early August. The eddy advanced about 30 km (55 nm) to a position centered at 40.5°N, 64.9°W.

During the next 30 days Eddy 79-H may travel south to a position east of Washington Canyon, Eddy 80-A may move west to offshore of Block Canyon, and Eddy 80-F may move south and west to a center location south of Lydonia Canyon.

Fishermen are requested to report unusual conditions or catches occurring in the vicinity of these eddies to the Director, Atlantic Environmental Group, National Marine Fisheries Service, RR 7, South Ferry Road, Narragansett, Rhode Island 02882, by mail. Updates on eddy positions and general information on Gulf Stream eddies may be obtained by calling the Atlantic Environmental Group (401-789-9326).



Good quality half-hourly GOES images and high-resolution picture transmissions from TIROS-N and NOAA-6 polar-orbiting satellites are being received real-time at AEG from the Washington Satellite Field Services Station. Ocean thermal features are clearly visible in imagery enhanced for that purpose. In order to make more effective use of the service, suitable ocean enhancement curves are sought to cover regularly desired ocean sectors. Geographical overlay grids are being made to fit polar orbiter data which can be received by the UNIFAX II also.

Five years of bottom temperature data from the Southern New England transect and three years of New York transect data have been digitized and MARMAP Information System table segments written for inputting the data into the computer. Methods for calculating basic statistics from the data set are developed and presently being programmed. Subsequent data collections from along those transects will be added to the data base so that long-term statistics and yearly bottom temperature anomalies can be calculated in both depth and time.

Ocean Dumping Studies Task

Two Ocean Research Equipment Model 820 ocean drifting buoys were delivered to the NOAA Marine Ecosystem Analysis Program's warehouse at Floyd Bennett Field (Brooklyn, New York) on 5 August. Jim Bisagni and John Hartley traveled to Floyd Bennett Field to stage the 9-26 August cruise to DWD 106 and the inner New York Bight aboard the Kelez. Both buoys were activated on 7 August at dockside. Due to the presence of an anticyclonic Gulf Stream ring located at DWD 106, the buoys were not deployed. As noted by Service ARGOS, the buoy had not been set up properly by the manufacturer, i.e., problems were occurring with repetition rate, identification number codes, and sensor outputs. It was decided to deploy the buoys on a future cruise after these problems were solved. When the Kelez returned the buoys were examined and reset after much consultation with the manufacturer. Satisfactory results were obtained by 30 August which indicated that both buoys were now operating properly, i.e., transmitting while still aboard the Kelez.

Computer plots of radio-direction-finding (RDF) buoy trajectories from the March and May 1979 RDF experiments have been completed. All buoys were deployed within DWD 106 proper. Wind data analyses from the three experiments are essentially completed. Work can now proceed on the relationship between wind stress and buoy movements.

John Hartley returned from duty at sea on 26 August and completed his last day of work with the group on 29 August.

Meetings, Talks, Visitors, and Publicity

Jim Bisagni and John Hartley left Narragansett, Rhode Island, for Floyd Bennett Field on Long Island on 7 August. Jim assisted in staging the cruise of the Kelez and returned to the laboratory on 9 August. John participated in the cruise to DWD 106 and returned on 28 August.

On 13 August, Steve Cook and Grayson Wood met with Microvector Associates in Mamaroneck, New York, to discuss digitizers and components. They also visited Governors Island and Brooklyn, New York, to resupply Ship of Opportunity Program vessels. They returned on 14 August.

Mert Ingham and Jim Bisagni traveled to Oxford, Maryland, on 19 August to attend a Northeast Monitoring Program Management Team meeting and returned on 21 August.

Talbot Murray went to Milwaukee, Wisconsin, from 25 August to 28 August to attend the conference on "Climatic Impacts and Societal Response," at which he presented a paper titled "Impact of Climatic Factors on Early Life Stages of Atlantic Mackerel" authored by Talbot, Sharon LeDuc, and Mert Ingham.

Publications

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- Armstrong, R. S. Transport and dispersion of potential contaminants at the Buccaneer Oil Field. EXPOCHEM '80; Houston, Tex.; 1980 October. (A)
- Celone, P. J.; Chamberlin, J. L. Anticyclonic (warm core) eddies off the northeastern United States during 1978. Ann. Biol. 35. (P)
- Cook, S. K.; Hughes, M. M. Water column thermal structure across the shelf and slope southeast of Sandy Hook, NJ USA in 1978. Ann. Biol. 35. (P)
- Crist, R. W.; Chamberlin, J. L. Bottom temperatures on the continental shelf and slope south of New England during 1978. Ann. Biol. 35. (P)
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- Hilland, J. E.; Armstrong, R. S. Variation in the shelf water front position in 1978 from Georges Bank to Cape Romain. Ann. Biol. 35. (P)
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- Hughes, M. M.; Cook, S. K. Water column thermal structure across the shelf and slope southeast of Sandy Hook, New Jersey in 1979. Ann. Biol. 36. (S)
- Ingham, M. C.; McLain, D. R. Sea surface temperatures in the northwestern Atlantic in 1978. Ann. Biol. 35. (P)
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