

**International Council for the
Exploration of the Sea**

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Report of Activities



THÜNEN

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BIOLOGICAL OCEANOGRAPHY COMMITTEE

by

M. Reeve

1992

BELGIUM

(C. Heip)

North Sea Activities

Research Projects

E.C. STEP Project: Modelling *Phaeocystis* blooms, their causes and consequences

Belgian Impulse Programme: "Marine Sciences": Dynamics of coastal eutrophicated systems

General Objectives

Short-term and long-term assessment of the eutrophication level of the continental coastal waters of the North Sea through the combined analysis of new field survey data at reference stations and existing data.

Development of an integrated approach of the eutrophication problem of the continental coastal waters of the North Sea through numerical experimentation based on process-oriented studies.

1992 Activities

Annual survey of *Phaeocystis* blooms in Belgian coastal waters at reference station N 52°26 05 , E 02°49 08. The following physico-chemical and biological variables were measured: temperature, salinity, suspended matter, inorganic nutrients (nitrate-nitrite, ammonium, silicate, phosphate), chlorophyll *a*, diatom and *Phaeocystis* cell and colony enumeration. Data are stored on Lotus file.

The MIRO ecological model of *Phaeocystis* blooms development in the continental coastal zone of the Channel and the North Sea has been established and validated within the scope of the first phase of the EC project "Dynamics of *Phaeocystis* Blooms in Nutrient Coastal Zones". The structure of the model, the mathematical formulation and simulation results are discussed in the final synthesis report submitted to the Commission and edited by C. Lancelot and G. Billen. A manuscript is in preparation.

Scientific Research of the Ecology and Systematics Laboratory (Free University of Brussels)

The general aim of the research in our laboratory is the understanding of the functioning of marine ecosystems. Our research topics are situated in estuarine/coastal and pelagic areas as well as in the North Sea and the Indian Ocean. We distinguish four research topics:

1. Particulate material in estuarine and coastal areas and its transfer to zooplankton.

Characterisation of the different components of the particulate material (detritus of different origins, marine, brackish, and freshwater phytoplankton) and their availability for the dominant grazers by means of population dynamic studies and experimental grazing work. These studies take place within the framework of an EC programme on different European estuaries, and within the framework of a mangrove project along the coast of Kenya.

2. Structure of pelagic oceanic ecosystems.

Modelling of different ecosystems with particular emphasis on the relation between phyto- and zooplankton. This study takes place in particular in the Indian Ocean (JGOFS, Indian Ocean), and in the North Sea.

3. Transfer of pollutants through food chains.

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Characterisation of different lipid classes and their association with PCBs in phytoplankton, crustaceans, molluscs and fish by means of experimental intoxication, accumulation and elimination kinetics via food and water. The link between the measured concentrations *in situ*, particularly the Belgian coastal zone, and the experimental accumulation in the laboratory, aims to explain the mechanisms involved in the transfer of pollutants through the food chains.

4. Auto-ecology of oysters

Study of food uptake of different species such as *Crassostrea cucullata*, living on mangrove roots in the intertidal zone of Kenya, *Ostrea edulis* and *Crassostrea gigas* both living in the sub-littoral and the intertidal zones of the eastern Scheldt respectively. Their feeding strategies are studied as a function of time of submersion and food composition.

University of Gent, Zoology Institute, Marine Biology Section

Ecology of Demersal Fish and Hyperbenthic Animals

An assessment of the spatial structure of the communities of fish and epibenthic invertebrates of the Dutch Delta and the adjacent shallow coastal area (the Voordelta) was made. The richest communities in density and biomass terms are found in the ebb-tidal delta of the former Grevelingen estuary. This area acts as a sink for mud and larval stages of different groups, and has become an important nursery area for sole and dab. The Westerschelde estuary is greatly impoverished in comparison to similar areas. Anoxia in the brackish part poses a problem to anadromous fish. Heavy metals and organic pollutants presumably limit the occurrence of starfish and eelpout. The Oosterschelde remains an area of high diversity, both for fish and epibenthic invertebrates.

Continued research on hyperbenthic mysids confirms their keystone function in the estuarine system, not only in the Westerschelde, but also in the Gironde and the Eems. Production estimates are now in progress.

Ecology of Meiobenthos

The inventory of the meiobenthos of five European tidal estuaries (Schelde, Eem, Somme, Gironde, Tagus) (MAST-JEEP 92) has been completed.

The study of energy fluxes between microbial communities and meiobenthos is continued. Quantitative results were obtained from tidal areas and deep-sea areas in the Atlantic Ocean (MAST-007-C(EDB)).

The structural characteristics of the meiobenthos of the Antarctic Weddell Sea is being investigated (EPOS) and cooperation with the Belgian Antarctica project (ANTAR III) has been started. The title of our contribution for the next three years is: Role of the Meiobenthos in the Antarctic Ecosystem.

The Belgian Impuls Programme on Marine Research will finance for the next four years our research project "Structure and function of the benthos in estuarine and coastal ecosystems in relation to the present and future anthropogenic impact".

The study of the systematics and morphology of meiobenthic organisms is still being continued.

These topics are investigated by means of financial support offered by the Belgian National Science Foundation, the Belgian Ministry for Science Policy, The Belgian Ministry of Public Health, EEC (MAST), the University of Gent (Belgium), the Centre for Estuarine and Coastal Ecology (Yerseke) and Rijkswaterstaat (Netherlands).

ICELAND

(T. Thordardóttir, O.S. Asthorsson)

As in previous years the monitoring of primary production (P_{max}) and chl-*a* was conducted in a hydrobiological survey of Icelandic waters during May-June. At selected stations within different water masses, data on PvsI relationships were obtained. The depth distribution of AN's in turbulent as well as stratified waters was studied. A special emphasis was placed upon observations in the frontal zone of Polar and Atlantic water northwest of Iceland.

During a 0-group survey in August-September in the waters around Iceland, primary production (P_{max}) and Chl *a* were measured at standard hydrographic stations.

Continuous recordings of fluorescence were made in several surveys of Icelandic waters during April-July.

Hourly recordings of the surface irradiation (PAR) were continued in Grimsey and Vestmannaeyar. Surface samples of Chl *a* and environmental data were taken from a ferry near Grimsey at weekly intervals during April-october.

A study of seasonal changes in phytoplankton biomass and PvsI relationship in Eyafjordur were carried out along with hydrographic and zooplankton investigations of the fjord. Surveys were made at approximately monthly intervals from April/May on.

Long-term studies on the densities and composition of zooplankton in the Icelandic shelf area during spring were continued.

Ecological investigations were continued southwest of Iceland on the spawning grounds of the most important commercial fish species. The study is aimed to understand the spring development of zooplankton and the spawning of fish in relation to the onset of spring growth of phytoplankton and oceanographic features.

Analysis of zooplankton material from the Isafjord deep, northwest Iceland, was continued. The aim of the study is to quantify seasonal variations in distribution and abundance of the major species of the zooplankton in relation to the physical environment.

As in previous years, the Sir Alister Hardy Foundation for Ocean Science was assisted in the running of the Continuous Plankton Recorders between Scotland and Iceland, and between Iceland and Canada. Further, scientists from the Plymouth Marine Laboratory were assisted in operating Undulating Oceanographic Recorders between Iceland and Portugal.

LATVIA

(G. Kornilov)

Mesozooplankton. In 1992 the volume and area of investigations was reduced. Only five samples were taken in the Baltic Proper, Sub-division 28, in February. In the Gulf of Riga zooplankton surveys were carried out in May and August and a total of 65 samples were collected. The fishing gear was Jeddy net of 37/50 with a mesh of 0.16 mm in the filtering cone. The species age and composition, abundance and biomasses, their distribution over the areas and layers were studied in relation to concrete oceanographical situations in the Gulf of Riga. The food available for larvae, young and adult fish in spring and summer was estimated.

Nectobenthos and macrobenthos fauna investigations were not carried out in 1992.#

Ichthyoplankton

Ichthyoplankton

Twenty-two samples were taken in Sub-divisions 25, 26 and 28 of the Baltic Sea in march, April, July and August. The fishing gear was the IKS-80 net for the eggs and small larvae sampling. In August, 18 samples were taken in the Latvian economic zone in Sub-divisions 26 and 28 with the 10 foot model of the Isaacs-Kidd trawl for larger larvae and fingerlings. The research work performed to investigate the character of spawning, egg survival and distribution of eggs and larvae (mainly in relation to sprat).

SPAIN

(E. López-Jamar)

Pelagic System

In the north-west area of Spain several studies on the pelagic system are being carried out. A fixed station located in Ria del Vigo is being sampled since 1987; CTD casts, fluorescence, inorganic nutrients and chlorophyll are analyzed. Several times a year samples are collected for microplankton counts and identification (Instituto de Investigaciones Marinas, Vigo). On the other hand, there are several research projects in progress on the ecology, taxonomy and toxicology of potentially harmful algal blooms. Three species are being investigated: *Alexandrium lusitanicum*, *Gymnodinium catenatum* and *Prorocentrum lima* (Instituto Español de Oceanografía, C.O. de Vigo). The relationship between hydrological conditions of the continental shelf and the occurrence of harmful blooms is being studied (Instituto Español de Oceanografía, C.O. de Vigo). Inter-annual variability in the occurrence of harmful algal blooms in this region is being investigated (Instituto Español de Oceanografía, C.O. de Vigo, in collaboration with Conselleria de Pesca, Xunta de Galicia).

The pelagic system of the continental shelf of La Coruña is being investigated on a long-term basis. Phytoplankton species composition, primary production, chlorophyll and zooplankton (micro- and mesozooplankton) are being studied (Instituto Español de Oceanografía, C.O. La Coruña). Recently, two new transects, off Santander and Oviedo, have been incorporated to this project. The study of phytoplankton on Ria del Huelva (SW Spain), a highly polluted estuary, has continued during 1992 (Instituto de Investigaciones Marinas, Vigo).

The whole N and NW of the Iberian Peninsula has been studied during the main spawning season of sardine (March to July). Phyto- zoo- and ichthyoplankton distributions are being related to hydrographic features of the area. Primary production, chlorophyll *a* concentrations and micro (< 53 μm) and mesozooplankton biomass are higher off Galicia, where upwelling conditions prevail. However, sardine larvae abundances are higher in the Bay of Biscay, and potentially prey for sardine larvae, are more abundant off Santander. Ecology of Sardine larvae (horizontal and vertical distribution, diet, growth, etc.) was also studied (Instituto Español de Oceanografía). Pelagic studies (phyto-, zoo- and ichthyoplankton) are being carried out in several transects of the Basque coast (N. Spain) (Servicio de Investigación Oceanográfica de Gobierno Vasco, San Sebastian).

Benthic System

Laboratory experiments on the biology of *Gelidium sesquipedale* are being performed in Santander (N. Spain) (Instituto Español de Oceanografía, C.O. de Santander), aiming at the determination of the controlling factors for re-attachment of this algae. The study of fossil diatoms and their role as paleoecological indicators has been continued (Instituto Español de Oceanografía, C.O. La Coruña). Studies on the reproductive biology of spider crab *Maia squinado*, began in the Galician area (Instituto Español de Oceanografía, C.O. La Coruña).

Long-term benthic studies on the subtidal infauna of Ria de La Coruña (NW Spain) continued during 1992. The effect on benthos of the enclosure of an area in La Coruña harbour is also being investigated. (Instituto Español de Oceanografía, C.O. La Coruña). Studies are being carried out on the intertidal infaunal communities of Rio Piedras (Huelva, SW of Spain) (Departamento de Biología Animal, Universidad de Alcalá de Henares, Madrid). Benthic samples were collected in 6 transects off the Basque coast both in the intertidal (rocky habitat) and subtidal (rocky and soft bottom) in a taxonomy study of this area (Servicio de Investigación Oceanográfica de Gobierno Vasco, San Sebastian).

RUSSIA

(Dr V. Krylov)

1.1 Hydrochemistry

In 1992 hydrochemical observations were carried out in the Barents Sea and the Norwegian Sea and in the Northeast Atlantic area. In the Barents Sea seasonal saturation with oxygen and phosphates was close to the long-term mean value on the side of negative values.

In the Norwegian Sea, the rate and intensity of the over-saturation of coastal waters with oxygen caused an earlier development of phytoplankton in the spring. Oxygen content in the 0-200 m and 200-500 m layers was less in 1992 than in previous years, which was a result of the higher temperature of the Norwegian Current waters.

In the Northeast Atlantic area, to the west from the British Isles, hydrochemical observations showed the intensity of spring phytoplankton blooms, which was comparable with last year's value and much lower than in 1990.

The peculiarity of the hydrochemical regime in this year was the extremely high concentration of biogenic elements in the surface layer. Phosphate concentrations exceeded the long-term mean level by 0.1-0.4 $\mu\text{mole/l}$, whereas nitrates exceeded by 1-4 $\mu\text{mole/l}$.

1.2 Plankton

Plankton investigations were conducted in the Norwegian Sea and the Barents Sea in 1992 in order to show the peculiarities of plankton development, determination of formation periods, and location of feeding zones and assessment of feeding conditions for fish.

Traditional observations over seasonal status of plankton were carried out during six cruises. A total of 1,671 plankton samples were collected, and the results were mapped and presented in tables. An idea of correspondence between abundant groups, biological status of predominant species, and of total plankton biomass size has been obtained.

The work carried out revealed that the higher water temperature in the winter-spring has resulted in earlier reproduction of plankton organisms and increased their abundance and biomass in the Barents Sea in 1992. The spawning of mass plankters (*Calanus* and euphausiids) took place two weeks earlier than in the long-term mean.

Young *Calanus* and euphausiids appeared in April-May, developed completely and formed maximum biomass (reaching 1,000 mg/m^3) at the end of June beginning of July along the path of fish larvae drift.

In 1992 formation of maximum biomass of feeding plankton took place 2-3 weeks earlier than the long-term mean. The largest biomass of copepods in the 0-50 m layer of the eastern part of the Norwegian Sea (500-

1,000 mg/m³) was registered in the first half of June, whereas in the north-western sea (500 mg/m³) in the middle of July, and in the north-eastern sea (500-800 mg/m³) in the first half of August.

High biomass of feeding plankton (reaching 800 mg/m³) predominated in the north-eastern Barents Sea in 1992, an occurrence which has not previously been observed. Plankton biomass has not usually exceed 200 mg/m³ in these areas.

In general, euphausiid distribution and density were characterised by opposite tendencies in the western area where they were poor and the north-western area where production was high (reaching 2,500 specimens per 1,000 m²).

Peculiarities of development and distribution of plankton in the Norwegian Sea are: earlier development than in 1991 in the offshore areas and correspondence of stages of development to the previous year indices in the southern and eastern seas.

Because of different terms and rates of development, plankton concentrated in the form of spots. Productive areas with a biomass from 500 to 2,000 mg/m³ distributed to the north and north-east in June. Predomination of older *Calanus* within the major part of the sea in June has influenced the mean value of biomass of plankton. In 1992, it was 1.6 times higher than in 1991 (713 and 426 mg/m³, correspondingly).

In 1993, plankton investigations in the Barents Sea and the Norwegian Sea will be continued according to the programme adopted earlier.

USA

Kenneth Sherman

Fisheries Ecosystem Investigations

National Marine Fisheries Service (NMFS), Northeast Fisheries Science Center (NEFSC) Laboratory, Narragansett, R.I.:

In response to new legislation passed by the U.S. Congress mandating biannual reports on the health of coastal ecosystems, the Ecosystems Dynamics Branch has continued to develop a prototype monitoring program for measuring variability in the changing-states (health) of coastal ecosystems. This study is being developed in collaboration with the Environmental Protection Agency and in consultation with the National Research Council. During the past 12 months, several monitoring cruises were completed within the Northeast Shelf Ecosystem from the Gulf of Maine to the Mid-Atlantic Bight using continuous plankton recorders fitted with sensors for temperature, salinity, and chlorophyll. Other key components measured during the past year include information on water quality, benthic quality, plankton community response to environmental change, and fish community response to environmental and fishery-induced changes. Among the ecosystem indices under development to quantify changing states of coastal ecosystems are stability, resilience, diversity, productivity, and yield.

Development of nucleic acid hybridization probes for estimation of growth and nutritional condition of Atlantic cod larvae was begun. DNA probes were produced from Atlantic cod (*Gadus morhua*) for small subunit ribosomal RNA and two abundant mRNAs encoded by actin and myosin heavy chain (MHC) genes. The polymerase chain reaction (PCR) method was used with consensus primers. A 1.8 kb nuclear 18S rRNA gene was amplified from cod genomic DNA. The cloned rRNA probe recognized the expected 18S rRNA band on Northern blots of cod and haddock RNA. About 700 nucleotides of the rRNA were sequenced and one region appeared to show sufficient variability, compared to other known fish 18S rRNA sequences, to allow the design of a species-specific probe. A 1-kb product from the actin gene and a 0.6 product from the MHC gene were amplified from cod muscle RNA and subcloned. Their identities were confirmed by partial sequencing. Northern blots of RNA extracted from cod muscle were reactive with both probes and indicated sizes of about 7.5 kb and 1.7 kb for the MHC and actin transcripts, respectively. Preliminary experiments were conducted to assess the utility of each probe as an indicator of changes in nutritional condition of Atlantic cod. Groups of laboratory-reared larvae were starved or fed for periods up to 2 weeks. Individual larvae were extracted, and total RNA and DNA content determined fluorometrically. Levels of rRNA and mRNA were determined using chemiluminescence after hybridization with labeled probes on a slot blot.

Cod and haddock larvae collected on Georges Bank were analyzed for RNA, DNA, and protein content as part of a study to determine the effects of stratification on growth and survival of this species.

NMFS, NEFSC Laboratory, Woods Hole, Mass.:

Researchers from the Northeast Fisheries Science Center, the Woods Hole Oceanographic Institution, and the Bigelow Laboratory for Ocean Sciences began collaborative studies on stratification variability on Georges Bank and its effect on larval fish survival. The study is part of the NOAA Climate and Global Change, Marine Ecosystem Response Program. A pilot study was conducted in May 1992 using two vessels, R/V ALBATROSS IV and R/V ENDEAVOR to test and intercalibrate a variety of sampling systems (net, acoustical, and optical) to determine the distribution and abundance of cod and haddock larvae and zooplankton on the southern flank of Georges Bank as seasonal stratification develops. Collections of larvae also were made to compare biochemical indices of larval growth and condition in relation to prey abundance at different sites: well-mixed versus stratified waters. Another important objective of the cruise was to test and evaluate different sampling strategies for the future field operations. Plans were made for another pilot study in May 1993.

NMFS, NEFSC Laboratory, Highlands, N.J.:

With the completion of the January 1993 larval herring survey, NEFSC personnel at Sandy Hook closed out the fifth consecutive year of monthly cruises in the Georges Bank area to: (1) document the recovery of Atlantic herring; (2) provide an index of population trends and an alternate source of information to tune biomass estimates; and (3) investigate density-dependent population regulation between herring and sand lance. This 5-year program represents the continuation of an uninterrupted ichthyoplankton time series during the autumn and early winter period that spans two decades. The principal spawning grounds of herring within the 72,000-km² study during the autumn of 1991 remained on Nantucket Shoals, a pattern that began in 1985. The study produced no evidence through the 1991 spawning season that the historically important spawning beds on Northeast Peak have been reactivated. However, preliminary observations of plankton samples taken early in the 1992 spawning season suggest that spawning beds on Northeast Peak were reoccupied for the first time since 1978. A more definitive appraisal of the eastward expansion of spawning onto Northeast Peak must await the processing of samples.

Larval abundance estimates of herring peaked in 1989 and remained at high levels in 1990 and 1991. Age analyses based on otoliths taken from fish between 12.5 and 35.3 mm revealed growth rates from 2.6 to 4.9 mm day⁻¹ in winter. Instantaneous mortality (Z) ranged from a low of 0.091 in 1988 to a high of 0.166 in 1989. Larval production indices indicate that spawning biomass peaked in 1990 at a level nearly seven times

greater than that in 1988. A decline in the 1991 index was attributed to a decrease in production on Georges Bank.

The abundance of sand lance larvae declined sharply during the winter of 1992 and remained low in January 1993. These latest trends in the relative abundance of herring and sand lance larvae indicate that we are witnessing a reversal of the situation observed in the late 1970s, when the sand lance population exploded after the collapse of the herring fishery.

NMFS, Southeast Fisheries Science Center (SEFSC), Beaufort Laboratory, Beaufort, N.C.:

In 1992, the Beaufort Laboratory continued work on oceanographic features and processes that influence the recruitment of fishes in the southeastern Atlantic Bight of the United States. A synthesis of existing biological and physical background data for this region was undertaken in preparation for a programmatic approach to the recruitment of "estuarine dependent" species. In this regard, existing data on intra-annual variation in hatch-date frequency distributions of Atlantic menhaden larvae caught as they enter coastal inlets were related to physical oceanographic events that occurred over the continental shelf.

At sea, cross-shelf sampling of eggs and larvae of "estuarine dependent" species, including Atlantic menhaden, for hatch-date distribution and condition continued, along with sampling for potential larval predators. In addition, moored current meters were deployed to allow measurements of the flow fields that can account for the shoreward advective transport of these larvae. The vertical distribution of larval fishes across frontal boundaries, including the Gulf Stream front, was also examined in an effort to elucidate exchange of larval fishes.

Seasonal sampling of the sargassum community is being conducted to survey the early life history of fishes and sea turtles associated with the pelagic sargassum habitat on the North Carolina continental shelf and in the adjacent western Atlantic. The purpose is to determine if the species composition, their relative abundance, and size vary with distance from shore or seasonally.

NMFS, SEFSC, Miami Laboratory, Miami, Fla.:

The Southeast Fisheries Science Center is conducting research on the early life history of fish and invertebrates to determine recruitment mechanisms and population sizes of spawning adult stocks. Research is principally focused on the early life stages of bluefin tuna in the Gulf of Mexico around the Loop Current which is the site of bluefin tuna spawning. As this is principally a tropical fauna, there are a large number of taxa and few specimens of each taxa which requires a great deal of time just to identify the samples. A community analysis will be the focus for studies on this material. Other

work in the Gulf includes studies on the early life history of tunas and mackerels along the Mississippi River plume. The major sampling effort in the Gulf is the SEAMAP Program which completed its 11th year in 1992. Reports are published for each year and a report on 1984 and 1985 results will be published in January 1993 (1986 results appeared in 1990). Sorting is nearly completed for samples collected in 1991 and much of the large backlog of sampling has been completed. All of the sorting is done by the U.S.-Polish Plankton Sorting and Identification Center, Szczecin, Poland.

A major study of recruitment mechanisms of early life stages is being conducted cooperatively by the Southeast Fisheries Center and the University of Miami's Cooperative Institute for Marine and Atmospheric Studies. It is part of a multidisciplinary project termed SEFCAR (Southeast Florida and Caribbean Recruitment) involving oceanographic studies and biological sampling along the Florida Reef tract around areas of current gyres and eddies which may be used as retention areas by early life stages of fish and invertebrates. Analysis has begun of the data collected from two years of field sampling across the Straits of Florida along the Florida Keys using CTD's, MOCNESS-1, current drifters, and fixed current meters. Preliminary results were presented in the 1992 Symposium on Florida Keys Regional Ecosystem held in November in Miami. These included papers on diversity of fish larvae, vertical and horizontal distribution of larvae, physical processes which may act as forcing functions, distribution of lobster phyllosomes and their relation to currents, and genetic composition of the spiny lobster using mitochondrial DNA. SEFCAR field work will resume in 1993 with emphasis on using light traps and a shore-based radar system which gives real-time current fields. In addition, sorting and analysis continues on material collected in field studies in previous years.

NMFS, Alaska Fisheries Science Center (AFSC), Seattle Laboratory, Seattle, Wash.:

Fisheries-Oceanography Coordinated Investigations (FOCI), a NOAA cooperative research program between the Recruitment Processes Task of the Alaska Fisheries Science Center and the Pacific Marine Environmental Laboratory is designed to investigate the causes of recruitment variations in commercially important fish and shellfish. The program's focus is recruitment to the well-defined spawning population of walleye pollock (*Theragra chalcogramma*) in Shelikof Strait, and is part of the Coastal Fisheries Ecosystem program, walleye pollock stock structure and recruitment in the Eastern Bering Sea. Areas of research include field studies of eggs and larvae in relation to zooplankton and the physical environment, biochemical methods for determining stock structure and assessing larval starvation and predation, and investigating pollock behavior. FOCI conducted four cruises aboard the NOAA ship MILLER FREEMAN during the spring of 1992, three in the Shelikof Strait region of the Gulf of Alaska to study the effects of the environment on the eggs and larvae of walleye pollock and one in the Bering Sea to investigate the physical environment and collect pollock eggs and larvae.

Laboratory studies on reared pollock larvae were conducted to (1) calibrate biochemical indices; (2) estimate feeding, digestion, and gastric evacuation rates; (3) calibrate histopathological condition indices; and (4) measure behavioral responses to a number of environmental stimuli. Eggs were spawned from fish trawled in the Shelikof Strait and Bogoslof Island area of the Bering Sea, maintained in refrigerators aboard ship, and then transported in thermos jugs to the culture center in Seattle and to the Hatfield Marine Center of Oregon State University, where the behavioral studies were conducted.