Research Program of the
National Marine Fisheries Service
at the

James J. Howard Marine Sciences Laboratory

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EXECUTIVE SUMMARY

The James J. Howard Marine Sciences Laboratory is a new research facility that is shared by the National Marine Fisheries Service and the State of New Jersey. The facility consists of two buildings: a new structure (32,000 sq ft) and, when renovated, a 35,000 sq ft structure within the Fort Hancock Historic District of the Gateway National Recreation Area. The new two-story building is devoted to experimental and analytical laboratories and their support systems; the functions of the renovated building are primarily for office space and program support.

The primary mission of the laboratory is to CONDUCT RESEARCH LEADING TO AN UNDERSTANDING OF THE ECOLOGY OF COASTAL AND ESTUARINE ORGANISMS AND THE EFFECTS OF HUMAN ACTIVITIES ON NEARSHORE MARINE POPULATIONS.

To achieve this mission, research at the laboratory should be organized into three program areas: fishery ecology, environmental chemistry, and habitat processes. The FISHERY ECOLOGY program area should focus on the resiliency of coastal and estuarine systems to fishing activities. The objective of the ENVIRONMENTAL CHEMISTRY program area should be to investigate the biological effects of contaminants in coastal and estuarine systems, and the HABITAT PROCESSES program area should concentrate on determining the role of coastal and estuarine habitats in sustaining marine populations.

The facilities of the Howard Laboratory are well suited to address the most immediate and pressing needs for information leading to understanding the ecology of coastal and estuarine systems and the effects of human activities on them. Appointment of additional NMFS scientific staff, collaborative research with scientists and students from other institutions, and extension of the seawater system to provide higher salinities for experiments should ensure that the laboratory will attain a strong national and international reputation in experimental ecology.

BACKGROUND

The Sandy Hook Marine Laboratory began operations in 1961 through Congressional funding provided to the U.S. Fish and Wildlife Service by Senator Clifford Case and others. Dr. Lionel A. Walford, the first Director of the Laboratory, using the old post hospital at Fort Hancock, Sandy Hook, New Jersey, established a facility where marine recreational gamefish research would be undertaken. The laboratory started with about a dozen people, including a few principal scientists in addition to Dr. Walford and a small support staff. The first research vessel was the *R/V Dolphin*, a converted seagoing tug.

The laboratory grew quickly, adding approximately 50 scientists, technicians, and support persons. Early research was concerned with the biology of principal gamefish species, such as bluefish and striped bass, the behavior of coastal species (including tautog, bluefish, Atlantic mackerel, and summer flounder), the early life history stages of principal coastal species, and environmental issues. Considerable emphasis was given to scuba observations by a volunteer divers program, which eventually led to the establishment of the American Littoral Society, housed in the laboratory.

In 1967, the laboratory began a program concerned with marine artificial reefs; biologists studied the efficacy of old car bodies, tires, and construction rubble as materials that might form artificial reefs to improve recruitment to fishery stocks. Scientists examined the behavior of fish in relation to the reefs, principal invertebrate food species that settled upon the reefs, and possible effects of the reefs themselves on the fishes and their habitats. By 1969, several programs had been funded to study the major issues associated with ocean dumping.

In 1971, the then Sandy Hook Marine Laboratory of the U.S. Fish and Wildlife Service was incorporated into the new National Oceanic and Atmospheric Administration (NOAA) within the U.S. Department of Commerce. The laboratory operated under the Middle Atlantic Coastal Fisheries Center from 1971 to 1977, when the Middle Atlantic Coastal Fisheries Center was absorbed into the Northeast Fisheries Science Center (NEFSC). The laboratory continued to emphasize programs concerned with environmental matters, early life history stages of fish, fish behavior, and the biology of coastal species.

Studies related to ocean dumping eventually developed into research on sludges accumulating on the seafloor, effects of contaminants found in sludges, the development of hypoxia and associated conditions at sites characterized by heavy loading of organic materials from sludge, and the avoidance of sludge depositional areas by key fishes and invertebrates, such as crabs and lobsters. Studies of contaminants effects were broadened to include innovative research on behavioral responses of polychaetes and crustaceans to petroleum hydrocarbons and other environmental stressors. Particular emphasis was given to benthic ecology, sediment chemistry, microbial communities, and the various diseases that were noted in fish and shellfish found near the dumpsites. The environmental thrust of the laboratory grew and other programs began to make major contributions to region-wide research, such as the MARMAP Program and, eventually, the Northeast Monitoring Program.

The main laboratory building burned in September 1985; the building and its contained laboratories and libraries were almost a complete loss. The displaced staff was accommodated in other buildings at Fort Hancock. Temporary space was provided for a library, offices, and very limited laboratory use. The research program concentrated on topics that could be addressed with the available facilities: describing the trophic exchange among benthos, plankton, and nekton with reference to hydrography; characterizing changes in marine ichthyoplankton assemblages; tracking changes in the community structure of coastal fishes; and estimating total finfish biomass in areas of the Northeast Continental Shelf. A major field program was conducted during that time to evaluate the biological effects of closure of the 12-mile sewage sludge dumpsite in the New York Bight.

In 1986-1987, extensive planning was undertaken after New Jersey was selected as a location to construct a new marine sciences facility. The agreement included construction of a new building at Sandy Hook to house extensive seawater labs, a 32,000 gallon experimental aquarium, analytical laboratories, and renovation of the historic building housing the NEFSC staff. The new building, built by the State of New Jersey and leased to the federal government, is completed, and renovations of the historic building are now underway. The complex, to be shared by NEFSC, state agencies, and national and international scientists and students, will be dedicated as the *James J. Howard Marine Sciences Laboratory*.

DESCRIPTION OF THE FACILITIES

The Howard Laboratory complex consists of two buildings: a new structure (32,000 sq ft) and a renovated structure (35,000 sq ft) within the Fort Hancock Historic District of the Gateway National Recreation Area.

NEW BUILDING

The majority of space in the new two-story building is devoted to experimental and analytical laboratories and their support systems.

Wet Labs

Under the current agreement between the National Marine Fisheries Service (NMFS) and the State of New Jersey, three of the five large wet labs (30 ft x 40 ft) are assigned to NEFSC and the other two to the State of New Jersey. Open floor space in each lab is maximized with three equally spaced floor drains running the length of the room. Wall and floor cabinets are limited to the inner wall. An 8 ft wide door opening to the outside, facilitates transfer of animals and equipment.

Utilities run the length of each wet lab along each wall and include: 2 in. lines for heated, chilled, and ambient seawater and low pressure, high volume air; 1 in. lines for vacuum and fresh water; 120 volt and 208 volt outlets; and closed-circuit television (CCTV) camera outlets that feed to a centralized video room. The plumbing is fitted with valves equally spaced at three locations, which may be used directly or fitted for additional plumbing, depending on use. Additional ceiling drops are placed at five locations for seawater and air lines, four locations for CCTV, and eight locations for electricity (retractable reels) to provide access to the central floor area. Deionized water, fume exhaust, propane gas, and access to the local area network (LAN) computer are located in the cabinet area.

Lighting in each wet lab is provided by six banks of lights running the width of the room. Each bank consists of six 4 ft fluorescent and four incandescent fixtures. Control of the lights is via a computerized system with software designed to provide complete flexibility in manipulating photoperiod, light intensity, and changes in light intensity.

In addition to the five large wet labs, there are six smaller labs (15 ft x 20 ft): four assigned to NEFSC and two to the State of New Jersey. Their design and utilities are essentially the same as for the large wet labs.

Filtered seawater (24-25 practical salinity units, PSU) for the wet labs is drawn continuously from well screens in Sandy Hook Bay at a rate of 350 gallons per minute (gpm). Prior to distribution to the experimental areas, the water is divided into 250 gpm of ambient seawater and 50 gpm each of heated and chilled seawater. The titanium heat exchangers for the two temperature-controlled lines have the capacity for a temperature differential of 21°C (*e.g.*, heating 4°C ambient to 25°C).

Research Aquarium System

The focal point of this system is an elliptical, 32,000 gal *Fiberglas* aquarium with internal dimensions of 35 ft x 15 ft x 10 ft housed in a 32 ft x 48f ft room. The layout of the room is based on monitoring activities within the aquarium. On the lower level, electrical and CCTV outlets are located on the wall opposite each of the eight viewing windows. There is also a small cabinet with a sink and LAN connector. The upper level and access to the top of the aquarium is created by Fiberglas grating. Four remote-controlled cameras are centered over the aquarium. The aquarium is supported by a series of biological filters and computer-controlled lighting and temperature systems. Built-in sensors monitor temperature, salinity, dissolved oxygen, and pH. The aquarium can be operated as either an open, closed, or semi-enclosed system in either up- or down-flow modes, with a maximum flow rate of 180 gpm.

Aquarium Control Room

The aquarium control room contains the computers for configuring, controlling, and monitoring the lighting and various aspects of the seawater system in the experimental areas. In addition to built-in sensors (*e.g.*, water flow and temperature), the system can monitor any other type of sensor (via a 4 to 20 ma transmitter) within the experimental areas. Facilities for routine water chemistry are also provided.

Video Room

This centralized room permits remote monitoring and recording of video inputs from the wet labs and the research aquarium, and the analysis and editing of video tapes.

Laboratory Suites

The trace metal suite, consisting of five laboratories and an office, provides the appropriate environment for all activities related to preparing and analyzing sediment, water, and tissue samples for trace metals. Particle-free air for the heavy metal suite is achieved by maintaining positive pressure and HEPA filtration. The organic chemistry suite consists of three laboratories and an office. It provides the appropriate environment for all activities related to preparing and analyzing sediment, water, and tissue samples for organic contaminants. Particle-free and organic vapor-free air is achieved by maintaining positive pressure and HEPA and charcoal filtration. The microbiology suite consists of two laboratories, a culture room, and an office to support activities related to the culture and study of phytoplankton. Two laboratories are designed for the preparation of isotopes (^{14}C) and counting of radio-labeled samples, with four additional laboratories for sediment and water chemistry analyses. One laboratory is designed for the study of various aspects of the early life history of aquatic organisms, including taxonomy, development, and growth.

There is an additional section with seven undesignated laboratories. One of these is explosion-proof and is suitable for working with compounds such as acetone and ether. Another lab will house the LAN computer and could also be used for other systems. The remaining labs could be designated for a variety of activities, including remote sensing work and sediment grain size analysis.

Support Areas

Support areas in the new building include three temperature-control rooms; a shop for fabricating experimental and field equipment; emergency power generators; and a field prep room for preparation, maintenance, and cleaning of field equipment and processing or dissecting large or "dirty" samples. This room also houses a walk-in freezer. Additionally, there are nine offices and four lab offices. A lab office contains a cabinet with sink, countertop space, and fume exhaust.

RENOVATED BUILDING

The renovated building will be used primarily for office space, conferences, a marine sciences library, and program support services. The NEFSC has 23 offices, 10 lab offices, and 2 "executive" office suites with adjacent small conference rooms. Three additional laboratories for sorting or dissecting types of activities are also located within this building. Support areas include a dive locker; darkroom; storage rooms for equipment and biological samples; library; a staff common room; a kitchen; and a multimedia conference room that can be divided into smaller conference rooms.

LABORATORY INSTRUMENTATION

The recent purchase of substantial scientific instrumentation, equipment, and computer systems will modernize and extend the capabilities of the existing research programs and enhance support of them at the Howard Laboratory. The purchased items are listed in Appendix 1.

NMFS MISSION AT THE HOWARD LABORATORY

Reconciling multiple uses of the marine environment will undoubtedly remain the central issue in coastal zone management into the next century. Directed research on evaluating anthropogenic effects on fish and shellfish populations is crucial in guiding management decisions affecting coastal areas. As a major research facility of NMFS, whose goals are to promote conservation and management of the nation's living marine resources, the primary mission of the James J. Howard Marine Sciences Laboratory is to:

CONDUCT RESEARCH LEADING TO AN UNDERSTANDING OF THE ECOLOGY OF COASTAL AND ESTUARINE ORGANISMS AND THE EFFECTS OF HUMAN ACTIVITIES ON NEARSHORE MARINE POPULATIONS

The estuarine and nearshore environment is subject to severe stresses including pollution, habitat degradation, and the direct and indirect effects of harvesting activities. The Howard Laboratory offers unique facilities for research on these and related problems. The laboratory is located near a spectrum of relatively pristine to heavily impacted sites, permitting long-term comparative field studies and providing source populations for laboratory experiments.

Cooperative research programs involving NMFS, other federal agencies, state agencies, and academic scientists is highly encouraged. These programs should include long-term ecosystem research in protected areas, reserves, and other long-term sites such as the NOAA-sponsored New York Bight National Undersea Research Center LEO (Long Term Ecosystem Observatories) sites. Student involvement through the Cooperative Marine Education and Research programs at Rutgers University and other institutions is also strongly endorsed. Results of research conducted at the laboratory should be used by the Mid-Atlantic and New England Fishery Management Councils, the Atlantic States Marine Fisheries Commission, the states of New Jersey and New York and others states in the mid-Atlantic and southern New England regions, the Port Authority of New York and New Jersey, the U.S. Environmental Protection Agency, the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, and other agencies, including other offices within NOAA. It is expected that collaboration with other investigators will be both at the national and international levels.

RESEARCH PROGRAM AREAS

The fundamental purpose of fisheries management is to sustain production of stocks. Production of a stock is maintained through its capability to regenerate at least as many individuals as are lost from fishing and other added sources of mortality. Complexity of fisheries management is caused by the fact that events affecting stock abundance rarely act sequentially or in complete isolation. Measuring the influence of a single event or set of events (such as fishing or pollution) on the regenerative capability of a stock cannot be done without also measuring the influence of other events that also may be occurring. A manager cannot work toward a predictive understanding of a fishery system without fully appreciating the influences of human activities and natural processes on variability in stock abundance.

Interactions between human activities and natural processes are particularly acute in the coastal and estuarine waters of the New York and New Jersey coasts. Historically a region of intense shoreline development for housing and industry, residents of this area face conflicts between technological growth, resource utilization, and resource conservation. Centrally located within this area, the Howard Laboratory is in a unique position to study first-hand how natural processes and human activities affect coastal fishery systems. With an overall emphasis on experimental ecology, three research program areas are suggested for the Howard Laboratory. One area, FISHERY ECOLOGY, involves understanding the relationship between fishing activities and the ecology of coastal and estuarine systems. The Howard Laboratory is especially well suited for studying the effects of fishery-related mortality on the dynamics and recruitment processes of nearshore marine communities, and the effects of wasteful and destructive fishing practices on coastal and estuarine organisms and their habitats.

The Howard Laboratory is equipped to address one of the significant environmental issues facing the region: chemical contamination of coastal and marine waters, sediments, and organisms. Because of this capability, ENVIRONMENTAL CHEMISTRY should be a major research program area for the laboratory.

A third research program area recommended for the Howard Laboratory is HABITAT PROCESSES, which would address the increasing degradation and loss of nearshore and estuarine habitats to pollution, development, and other human activities. This program area should be closely integrated with the FISHERY ECOLOGY program area to provide information of life habits and habitat requirements of nearshore marine populations, which can then be used as a baseline to measure the effects of fishing and other human activities, including those identified in the ENVIRONMENTAL CHEMISTRY program area (see Appendix II).

FISHERY ECOLOGY

The FISHERY ECOLOGY program at the Howard Laboratory should focus on the resiliency of coastal and estuarine systems to fishing activities. Resiliency determines the extent to which fishing activities can be undertaken without undue harm to a natural system; it depends on the reproductive potential and recruitment dynamics of the populations being exploited, and the interactions of species within the communities being exploited. Fishing activities affect the resilience of a nearshore system through direct removal of organisms by harvesting, alteration of population and community structure by size- and species-selective exploitation practices, mortality of individuals captured and then released, and destruction of habitats by fishing operations.

The coastal region of New York and New Jersey probably represents the highest concentration of fishing activities along the northeast U.S. coast. Surveys conducted by NMFS indicate that approximately two million people participate annually in recreational fishing in coastal waters of this region. The commercial fisheries in nearshore waters concentrate efforts on migratory stocks passing through the region such as striped bass, shad, river herring, weakfish, Atlantic mackerel, black sea bass, bluefish, summer flounder, American eel, and Atlantic sturgeon; and on resident stocks such as surfclams, ocean quahogs, scallops, oysters, lobster, tautog, white perch, and winter flounder. Fishing gear used in the region include trawls, dredges, gill nets, haul seines, trap nets, longlines, pots, and handlines.

Multispecies Interactions

The biodiversity and trophic linkages among species within an ecosystem play a critical role in determining the dynamics of the individual species and the system as a whole. Understanding the role of predator-prey interactions is particularly important in determining how selective harvesting of some components of a system might directly or indirectly affect others. The Howard Laboratory is ideally located and equipped to examine the role of key predators within the mid-Atlantic Bight region. In particular, species such as bluefish, summer flounder, dogfish, skates, and striped bass are known to be dominant predators with at least seasonal importance in the middle Atlantic region. Documenting the roles of these predators and their potential impacts on other species in the system requires information on diet composition, prey selectivity, and feeding rates. The tank facilities at the Howard Laboratory are ideal for examining key aspects of the behavior and ecology of these species in an experimental setting. Controlled and replicated experiments on predation involving temperature, light, prey-choice, prey type, and gastric evacuation rate for euryhaline predator species can be readily carried out with the state-of-the-art wet-lab capabilities. With respect to the behavioral aspects of predator-prey dynamics, issues such as the effects of prey density on predation rates and aspects of prey selectivity are particularly important. It is well recognized that experiments of this type are particularly difficult to undertake in small tanks or enclosures. The large tank facilities at the Howard Lab offer an unparalleled opportunity to study these processes.

Recruitment Processes

Recruitment of many marine populations is extremely variable. An understanding of the factors affecting recruitment of marine fish and invertebrate populations is critical for effective management. Studies of recruitment in coastal and estuarine species offer a number of advantages in terms of tractability relative to oceanic species. The recruitment process should be examined using selected species as model systems. The location and facilities of the Howard Lab are well suited for an integrated approach of field research and controlled laboratory experiments. These experiments may be augmented by the modeling studies and real time physical measurements through the remote sensing facilities conducted by physical oceanographers at Rutgers University. Through models of interactions among biological and physical processes new approaches to fisheries management can be developed.

Species of commercial and recreational importance in the region might be identified as target populations for study. Questions such as whether growth of larvae and juveniles is density-dependent and whether predation on juveniles is size dependent should be addressed. Density-dependent growth coupled with size dependent predation could be an important compensatory mechanism and therefore play a central role in recruitment dynamics. The large tanks at the Howard Laboratory afford an opportunity to conduct important experiments on this topic.

Studies of behavior and life histories of valuable food species will also support the NOAA-wide effort to foster aquaculture through environmentally sound, efficient programs.

Fishery-Related Mortality

Fisheries practices affect the dynamics of nearshore marine communities by influencing factors such as mortality rate, growth rate, age structure, reproductive potential, and stock composition. Understanding the seasonal and diurnal movement patterns of stocks, including their origins, that may affect their vulnerability to fisheries is also necessary. Removal of one sector of a nearshore marine community by selective fishing pressure could increase the abundance of less desirable or invading species. The Howard Laboratory could be used to measure reproductive rates, identify stock origins using molecular techniques, describe movement patterns, and determine latent effects of fishery-induced mortality.

Destructive and Wasteful Fishing Practices

Elimination of destructive and wasteful fishing practices is an objective of fisheries management. The Howard Laboratory is equipped to investigate how much habitat disturbance may be caused by fishing operations, and how quickly the habitat can recover. The lab could also be used to examine size- and species-selectivity of fishing gear, and to develop new gear and methods that would reduce bycatch and discard mortality. The current growth in popularity of catch-and-release fishing practices to promote conservation of stocks has raised serious questions within the scientific community concerning the survival of the released fish (see Appendix II).

ENVIRONMENTAL CHEMISTRY

The objective of the ENVIRONMENTAL CHEMISTRY program should be to understand the pathways, biological effects, and fates of contaminants in coastal and estuarine systems. Contamination from industrial and municipal effluents, dumping, and land runoff affects the sustainability and utilization of fishery resources. The high concentration of human activities in coastal and estuarine areas makes these systems especially vulnerable to the effects of environmental contamination.

Because of the international importance and high visibility of environmental contamination, the location of the Howard Laboratory at Sandy Hook provides an ideal setting for studying problems associated with an urban coastal ecosystem. Sandy Hook is located at the entrance to one of the most intensely studied and widely described bodies of water in the world. The water body contains one of the largest shipping complexes, major coastal fisheries, and all of the problems of coastal contamination found in a major urban setting. Despite the urban setting, the coastal ecosystems in the area maintain a rich diversity of life and are remarkedly resilient. The laboratory is in a unique position to recommend management practices required to sustain fisheries. Contaminants in water, sediments, and organism tissues, as well as their effects on living resources, have been a major focus of research in this region by state and federal agencies for more than two decades, and the results of the research have provided benchmarks for similar studies elsewhere.

Analytical Chemistry

Biological effects of environmental contamination cannot be understood without first understanding the means by which contaminants accumulate and persist in coastal and estuarine systems in their original or altered forms. The laboratory should have an active research program that develops new techniques and maintains high standards of quality control and assurance. Besides providing measures for the accumulation and dispersal of contaminants in the nearshore environment, the laboratory should provide chemistry support to programs throughout NEFSC.

Three types of contaminants known to affect living resources should be the focus of analytical chemistry research at the Howard Laboratory: nutrients, metals, and synthetic organics. Eutrophication of coastal waters due to nutrient contamination from sewage effluent, land runoff, acidic precipitation, and ocean dumping has led to a variety of problems including hypoxic episodes and harmful algal blooms. Low oxygen conditions throughout the New York Bight and Long Island Sound complex have resulted in major animal kills and will continue to require research and monitoring efforts. Harmful algal blooms are of increasing concern in coastal waters, causing mass mortalities of finfish and shellfish and contaminating seafood with potent biotoxins. In many cases the increased incidence of these blooms is clearly associated with the eutrophication of coastal environments. Investigation of this association and the impact of blooms on fisheries requires the development and improvement of analytical methods for measuring levels of nutrients and biotoxins and the capability to culture a wide variety of phytoplankton species.

The presence of so-called trace or heavy metals has been a source of concern in the New York Bight for decades. Industrial effluent, sewage discharge, atmospheric fallout, and ocean dumping continue to be primary sources of such metal pollutants as copper, cadmium, lead, mercury, arsenic, silver, nickel, iron, and chromium. In addition to routine measures of metal levels in tissue, water, and sediments, research should be conducted to determine the character of the metal complex occurring, since metals commonly exist in or are transformed into forms other than the pure metal.

Environmental quality is often compromised by contamination from organic compounds such as petroleum hydrocarbons, pesticides (including metabolites of DDT), and a host of toxic synthetic compounds including polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs). Serious consideration should be given to establishing a dedicated dioxin laboratory including the acquisition of instrumentation for analysis of this potentially serious contaminant. Contamination of the New York Bight, Newark Bay, and their associated rivers by organic chemicals is of immediate and continuing concern to local, state, and federal agencies. The Howard Laboratory will continue to be called upon for analytical expertise in this area.

Biological Effects of Contaminants

The NEFSC has had an internationally recognized research program on biological effects of contaminants since the late 1960s. A broad mix of fishery biologists, physiologists, biochemists, pathologists, immunologists, geneticists, behavior biologists, and microbiologists, together with a support team of analytical chemists, has made many significant contributions to this field of marine science, and has participated extensively in national and international activities associated with marine pollution.

The wet-lab facilities of the Howard Laboratory should enable studies of the exposure of animals to many contaminants that have not been studied before because of waste treatment limitations. The laboratory is especially well suited for studies of sublethal effects, such as changes in behavior and vital rates (growth and reproductive) in response to contaminant exposure. The laboratory is also suited for simulation of near-shore dumping, and for studies involving alteration and restoration of contaminated habitats. Fate and effects studies could be conducted with a variety of organisms and contaminants, including biotoxins.

A major strength of NEFSC research is a long history of productive multidisciplinary studies on biological effects involving many of the NEFSC laboratories. This cooperative research effort among laboratories should continue. For example, animals exposed to contaminants in aquaria or mesocosms at the Howard Laboratory may be distributed to other laboratories for further examination or research. The numerous scientific disciplines available in NEFSC, together with the behavior, pathology, and algal microbiology teams located at the Howard Laboratory, should provide a wide range of expertise that can be brought to bear on understanding the complex and often subtle effects of contaminants on the sustainability of living resources. The research program at the laboratory should be prepared to take advantage of scientific opportunities provided by the accidental introduction of contaminants into coastal waters.

HABITAT PROCESSES

HABITAT PROCESSES research at the Howard Laboratory should concentrate on determining the role of coastal and estuarine habitats in sustaining biodiversity of resident species and developmental stages of transitory species. It is expected that habitat projects requiring the acquisition and interpretation of hydrographic data will be developed on collaboration with scientists at the Institute of Marine and Coastal Sciences at Rutgers University.

The traditional approach to studying the function and use of habitats has been to model the physical and chemical parts of the system, relate these parts to primary and secondary productivity, and then relate the productivity to status and trends in fishery populations. Attempts to extend the models to assessing recruitment success and to link changes in productivity to fishery-level effects will be more successful if habitat productivity components are measured more accurately. An ecosystem approach that includes definition of the niches of important coastal and estuarine species is a necessary step towards predicting the potential effects of habitat degradation and loss on fisheries and undertaking habitat mitigation projects.

Habitat Requirements

Understanding how nearshore marine organisms of different ages utilize different habitats would complement research topics outlined for the FISHERY ECOLOGY program area. Although processes affecting recruitment to a fishery are complex and not well understood, recent research has focused on those factors that contribute to survival, particularly during the late larval and juvenile life stages. Since survival of early life stages is influenced by growth rates, which in turn vary as a function of habitat type and quality, the amount of optimal habitat can significantly influence year class strength.

For any life stage, factors affecting habitat dependency can be identified through closely coordinated field observations and laboratory experiments. Ideally, descriptive observations made in the field could be the basis for laboratory experiments under controlled environmental conditions. The laboratory results could then be tested in the natural system.

Habitat Degradation and Loss

Studies on habitat degradation and loss can be expected to continue receiving high priority in federal, state, and private sector programs. Three topics that are now receiving special attention are sediment contaminants, eutrophication, and coastline construction projects. Contaminated sediments and related issues, including resuspension, transport, and eventual disposal, form a major environmental concern in the mid-Atlantic region. Resolution of these problems has worldwide implications for highly industrialized coastal areas.

The problem of eutrophication necessitates studies of the impacts of algal blooms on fishery resources. The relationship of the blooms to nutrient enrichment and resultant seasonal hypoxia may lead to loss of suitable habitats. In addition, the mid-Atlantic region has experienced an increase in toxic and noxious algal blooms in recent years. Research on the effects of nutrients and contaminants on coastal and estuarine plankton communities, together with the established program of basic study on the biology and ecology of harmful algal blooms, could form the basis of a program for the study of a problem of growing concern in the New England and middle Atlantic states.

Coastline contamination projects such as pier development, bulkheading, and construction are continually proposed in the coastal and estuarine areas of the mid-Atlantic. Effects of these activities are cause for concern, not only from the perspective of habitat modification and loss, but also because distributions of species may be shifted.

The ENVIRONMENTAL CHEMISTRY and HABITAT PROCESSES program areas should be well integrated at the Howard Laboratory. Loss of acceptable habitat for nearshore marine species is affected by human activities and natural events such as coastal storms. Quantitative studies of species diversity and habitat diversity may prove useful in measuring habitat loss and the success of restoration projects. Through NOAA's National Systematics Laboratory and its relation to the Smithsonian Institution, the Howard Laboratory is in an excellent position to participate in the developing national biodiversity program. The synergistic interactions of natural processes and human activities complicate realistic evaluation of habitat function and the extent to which habitat loss affects productivity.

Habitat Mitigation

The Howard Laboratory is located within a region of continuing shoreline development. Regulatory agencies are currently seeking methods to mitigate the loss of coastal habitat due to construction (and, in some instances, removal) of piers, bulkheads, and marinas. A field program combined with laboratory experimentation could lead to improved construction and removal methods, designs, and materials that would minimize adverse impact on nearshore marine populations. Mitigation studies should seek to integrate scientific information derived from studies identified under the topics of *habitat requirements* and *habitat degradation* and loss, to provide agencies with means to reduce impacts of shoreline development and restoration projects on coastal systems. Potential exists for collaboration with the regulatory agencies in designing and locating mitigation structures, and rejuvenating disturbed habitats.

RELATED RESEARCH PROGRAMS

References are made in this document to research programs of other agencies and institutions that would benefit from collaboration with scientists at the Howard Laboratory. Building upon the intellectual and technological base in the region, while avoiding unnecessary redundancy, should enable NEFSC to foster an efficient and far-ranging research program at the Howard Laboratory.

The major federal program in the region that sponsors research related to the proposed mission of the Howard Laboratory is the National Estuary Program, co-sponsored by the U.S. Environmental Protection Agency (USEPA) and NOAA. Two estuaries within the region are the focus of research funding under this program. The New York-New Jersey Harbor Estuary Program is intended to address pathogen and toxic contamination, nutrient enrichment, and habitat alteration in the Hudson-Raritan Estuary. The Delaware Estuary Program has six areas of priority attention: habitat conservation, point source compliance, non-point source pollution, public access, sustainable development, and estuarine education. The program is in the process of developing management plans for habitats, toxics, and land use, as well as an environmental biomonitoring plan. The Coastal Ocean Program of NOAA especially the "South Atlantic Bight Recruitment Experiment" (SABRE) is relevant to the proposed FISHERY ECOLOGY and HABITAT PROCESSES research at the Howard Laboratory. SABRE is directed at studies of recruitment in coastal and estuarine regions.

Another federal agency that is presently providing funding on related research topics is the U.S. Army Corps of Engineers. Removal and disposal of contaminated sediments (including possible biological effects), site surveys for meeting permit application requirements, and other issues related to habitats for coastal fishery resources have been funded by the Corps and can be expected to form the basis of future research support. The Howard Laboratory has the resources to study the effects and ecological consequences of a variety of Corps-initiated activities.

Various state programs in New Jersey are addressing coastal and estuarine systems, principally focussing on water quality monitoring. The programs cover all major bodies of saline waters within three nautical miles of the coastline. Cooperators with state and county agencies in the monitoring programs include the Delaware River Basin Commission, the USEPA, the National Park Service, and the U.S. Department of Agriculture.

The principal academic arrangement with NEFSC for collaborative research at the Howard Laboratory is through a Cooperative Marine Education and Research Program with the Institute of Marine and Coastal Sciences (IMCS) at Rutgers University. Established in 1989, IMCS conducts basic and applied research needed to understand and sustain the state's coastal estuaries and wetlands, foster development of the state's marine industries, and train graduate and undergraduate students in marine sciences. The institute works closely with scientific and resource management agencies at all levels of government and with many academic centers. Working through IMCS, scientists from throughout Rutgers investigate pollution and waste management, fish and shellfish diseases, recruitment, population genetics, physical oceanography, and the impact of coastal development and waterfront rehabilitation on shoreline areas. Rutgers Long-term Ecosystem Observatories (LEO), one of which is situated at an inner shelf site off New Jersey (15 m depth), provides opportunities for in situ experimental studies with real time imaging and sensing capabilities. Another LEO is planned for a Hudson Valley site.

Another major academic program in New Jersey concerned with coastal and estuarine research is the New Jersey Marine Sciences Consortium. The consortium is a nonprofit, independent corporation consisting of 30 colleges and private organizations interested in marine affairs in New Jersey, Pennsylvania, and New York. The purpose of the consortium is to provide opportunities for collaboration in all areas of marine research among its member institutions. In 1989 it was designated by NOAA as the National Sea Grant College for New Jersey. The Consortium is currently involved in fisheries and aquaculture research, marine technology research and development, coastal zone management, ecosystem research, socio-economic and legal studies, and educational and advisory services. Its offices are located adjacent to the Howard Laboratory at Sandy Hook.

The Hudson River Foundation is also expected to conduct collaborative research and educational projects with scientists at the Howard Laboratory. Established in 1981, the purpose of the Foundation is to sponsor scientific and educational programs contributing to an understanding of public policy issues related to the ecology of the riverine system, including neighboring coastal waters that may influence the system.

FUTURE NEEDS

To take full advantage of the facilities and successfully undertake the research mission recommended for the Howard Laboratory, the scientific expertise of NEFSC staff should be increased by appointments in the following disciplines with appropriate technical support staff: microbiology, developmental biology, biochemistry/molecular biology, physiology, organic chemistry, behavioral ecology, experimental quantitative ecology and pathology. The relationship of these new and current staff to the research projects is given in Appendices IV and V. Also important is the initiation of cooperative research projects with students and visiting scientists. The involvement of students in research cannot be overemphasized since they provide fresh points of view and links to area colleges and universities.

Seawater for the laboratory is currently obtained from subsurface wells located in Sandy Hook Bay. The salinity of this incoming water averages 24-25 PSU. The low salinity seawater currently available limits research that could be carried out at the laboratory. Drawing full salinity, unfiltered water from the ocean would broaden experimental opportunities to include offshore marine organisms, and enable scientists at the lab to conduct studies that integrate all phases of the life cycle of nearshore species that move between waters of low and high salinity (*e.g.*, summer flounder, bluefish, and weakfish). The higher salinity water would also enable experimentation on survival, growth, and reproduction of euryhaline species, such as the surfclam, using a wider and more representative range of salinity patterns and permit the maintenance of organisms that filter feed.

Pier facilities at Sandy Hook are inadequate for berthing laboratory vessels and transient research vessels of various sizes that are conducting research in the New York Bight. Enlargement of the existing pier or development of new docking facilities would greatly improve the staging and logistics of cruises as Sandy Hook is a good base for a coastal vessel to study efficiently the adjacent continental shelf ecosystem and the major fisheries located there.

Included in the NOAA Small Craft Replacement Plan is the replacement of *R/V Gloria Michelle* in 2001. The new vessel is expected to be in the 70 ft range and will provide a better platform for making oceanographic observations, conducting environmental surveys and collecting organisms.

The participation of students and visiting scientists in the research program is currently limited due to a lack of suitable housing in the Sandy Hook area. Renovations of one or more of the former officer's quarters would provide living accommodations for those engaged in research of limited duration.

CONCLUDING REMARKS

The facilities of the Howard Laboratory are well suited to address the research goals of understanding the ecology of coastal organisms and the effects of human activities on estuarine systems. The ability to attain these goals depends on the quality of the resident scientific staff, its leadership, interactions with scientists and students from other institutions, continuity of support, and availability of higher salinity seawater in the laboratory. A major asset of this laboratory is its design flexibility, allowing programs to adjust as objectives are achieved and new research directions emerge in response to additional needs for information. It is our belief that the Howard Laboratory can become a prestigious research facility with a strong international reputation.

APPENDIX I

Scientific Instrumentation and Equipment Ordered for the James J. Howard Marine Sciences Laboratory

Aquarium and Wet Laboratories

video systems
Fiberglas tanks
control system

Computers - LAN

Sun station
computers (386/486)
printers

Chemistry

automated high-pressure liquid chromatograph
CHNS analyzer
electrophoresis system
ion chromatography system
gas chromatograph
inductively coupled plasma mass spectrometer
mettler balances
freeze dryer
deionized water system
solvent condenser
glassware washer
freezer/refrigerator
diurnal incubator
fluorometer
centrifuge, refrigerated
freezer, ultra-low temperature
salinometer
hydrogen generator
oxygen generator

Ichthyoplankton

microscopes, stereoscopic
microscopes, stereozoom
microscope, compound
refrigerator/freezer
image analysis system
exhaust hood
Seacat *Profiler*

Experimental Ecology

balance, analytical
microscopes, stereoscopic
microscopes, dissecting
microscope, research
photomicrography system
fluorometer
refrigerator/freezer
camera, 35 mm
microprojector
freezer, chest
sealogger
rocking chair dredge

Microbiology

flow cytometer
UV-VIS scanning spectrophotometer
culture room light bank
luminescence spectrometer
microscope, transmission electron
autoclave
flow cabinet
particle counter
microscope, inverted
microcentrifuge
sonicator
ph meter
balance, analytical
balance, electronic
light meter
shaker
microtome

Other

FAX machines
cameras, 35 mm
calculators
Boston Whaler with motors
weather station

Appendix II

Examples of Single Disciplinary and Multidisciplinary Research Projects That Could be Conducted at the James J. Howard Marine Sciences Laboratory

Project	Fishery Ecology	Environmental Chemistry	Habitat Processes
Fishery Ecology			
Fecundity and maturity relationships to size and age of fish and shellfish	X		
Latent mortality of discarded catch	X		
Identification of species in gut content analyses using molecular techniques	X	X	
Stock identification using molecular techniques	X	X	
Gut evacuation rates of fish and shellfish	X	X	
Bioenergetics	X	X	
Disease susceptibility of environmentally stressed fish and shellfish	X	X	
Otolith marking techniques for larval fishes	X		X
Recruitment processes of estuarine dependent fish and shellfish	X		X
Phytoplankton ecology	X		X
Testing of biodegradable net material	X		X
Feeding preferences (larvae, juveniles, and adults)	X	X	X
Techniques for tagging shellfish	X	X	X
Responses of larval fish and shellfish to environmental gradients	X	X	X
Environmental Chemistry			
Rapid assay techniques for identification of disease and bacteria in shellfish		X	
Degradation and speciation of contaminants		X	
Depuration of contaminant body burdens		X	
Effects of contaminant exposure on reproduction of fish and shellfish	X	X	
Contaminant uptake and transfer through the food chains	X	X	

Appendix II
Continued

Project	Fishery Ecology	Environmental Chemistry	Habitat Processes
Environmental Chemistry (continued)			
Pathological impacts of contaminants	X	X	
Development and improvement of analytical methods for measuring biotoxins		X	X
Development of predictive models for harmful algal bloom (HAB) occurrences and effects		X	X
Relationship of HABs to hypoxia and anoxia events		X	X
Pathological results of low oxygen levels		X	X
Fate of biotoxins in the marine food web and impact on fisheries resources	X	X	X
Biogeochemical sediment processes affecting benthic communities	X	X	X
Effects of contaminants on swimming performance and predator avoidance	X	X	X
Habitat Processes			
Development of methods for mitigating the impacts of harmful algal blooms			X
Effects of docks, pilings, and decking on fish and shellfish distributions			X
Experimental habitat modifications			X
Effects of changes in physical habitat on reproductive behavior of fish and shellfish	X		X
Behavioral responses of organisms to environmental degradation		X	X
Nutrient control of phytoplankton growth		X	X
Effects of nutrient loading and contaminants on incidence of HABs		X	X
Ecology, physiology, and toxicology of HABs		X	X
Sediment toxicity and remediation processes		X	X
Factors controlling production of eel grass	X	X	X
Effects of bottom disturbance and siltation caused by dredging on recruitment	X	X	X
Impact of suspended sediments on larval recruitment	X	X	X

APPENDIX III

Examples of Research Topics That Integrate the Three Program Areas Proposed for the James J. Howard Marine Sciences Laboratory

Major research efforts at the Howard Laboratory should be designed to integrate a variety of disciplines to address species-specific and/or process-oriented studies. Given the three principal program areas, FISHERY ECOLOGY, ENVIRONMENTAL CHEMISTRY and HABITAT PROCESSES, the unique experimental capabilities of the facility, and potential for university collaboration, this approach provides maximum flexibility in committing personnel and resources.

Example 1

Researchers could investigate factors controlling recruitment in the surfclam *Spisula solidissima.* Surfclams live in sand beds off the mid-Atlantic coast from the beach zone to depths of about 60 m (200 ft). Surfclams are an important resource of the mid-Atlantic region, especially New Jersey. Oceanic surfclam populations are now composed almost entirely of adults born in the late 1970s. These stocks will be depleted in 5 to 10 years unless a major recruitment event takes place. The major recruitment that took place in the late 1970s occurred just after hypoxic water conditions, related to an enormous algal bloom, caused widespread mortality of benthic invertebrate species.

Aspects of surfclam recruitment are relevant to each of the three program areas and to researchers at academic institutions. The ENVIRONMENTAL CHEMISTRY and FISHERIES ECOLOGY program areas could examine whether contaminants found in sediments and in the water column around the New York/New Jersey area reduce vital rates (*i.e.*, survival, growth and reproduction) of larval, juvenile and adult surfclams. The HABITAT PROCESSES and FISHERIES ECOLOGY program areas could be involved with the question of whether dredging reduces the area of substrate suitable for larval settlement, and evaluate the extent of mortality and harmful sublethal effects induced by dredging and discarding. The ENVIRONMENTAL CHEMISTRY and HABITAT PROCESSES program areas could study factors that induce hypoxia of the bottom water, and the FISHERIES ECOLOGY program area could determine whether rates of recruitment to these areas increase following recovery of the habitat. The FISHERIES ECOLOGY program area could also determine which substrata are optimal for larval settlement, and those factors that potentially reduce juvenile growth and survival (*e.g.*, quality of food available; intraspecific competition with adults for food and space; ingestion of larvae by filter-feeding adults; and predation by crabs, snails, and starfish on juvenile surfclams). Surfclam stocks on Georges Bank have been closed to harvesting since 1990 due to paralytic shellfish toxins. The ENVIRONMENTAL CHEMISTRY and HABITAT PROCESSES program areas could study the causes, accumulation and fate of biotoxins in surfclam tissues, and the overall impact of harmful algal blooms on surfclams.

The present seawater system uses salinities of 25 PSU or less, which is appropriate for experiments on surfclams from bays but not for oceanic surfclams, which live in higher salinities. It has been shown that low salinity seawater is harmful to gametes and embryos of offshore clams. See discussion of seawater systems in the Future Needs section on page 11.

Example 2

Summer and winter flounder are two important commercial and recreational species in the Northeast. For several decades they have been the focus of a variety of studies by federal and state agencies, universities, and public utility companies. Summer flounder stocks are currently low in abundance due to overexploitation and poor recruitment. As a result, a restrictive catch quota is now in place. To make more accurate predictions about their population dynamics, better data are needed on the reproductive process in this species, particularly the relationship between stage of ovary development and the quality and number of eggs produced.

Winter flounder are also heavily exploited. For example, a dramatic decline of the winter flounder stock in Narragansett Bay led to closure of that fishery. Because different populations spawn in different estuaries in winter, there is the potential for genetic divergence among populations along the coastline. The current understanding of stock differentiation could be greatly improved, and this information could affect population assessments and management of winter flounder. For both species, better data are needed on their life histories, habitat requirements, and responses to contaminants. It should be noted that many of the same types of studies outlined below could be conducted with any number of commercially important estuarine-dependent species.

(a) Reproduction

Factors influencing spawning can be identified through laboratory and field studies. In the laboratory, where seasonal changes in light and temperature can be simulated, adults can be held throughout the year in large aquaria while feeding and reproductive activities are monitored on a 24 hr cycle. This could provide data on how environmental factors influence reproduction. Although winter flounder are adapted to survive severe cold during winter through production of "antifreeze", subsequent effects on their ability to reproduce are not well understood. Experiments could be conducted to determine the influence of temperature and photoperiod as cues to migratory behavior and spawning. Such studies could be combined with research on contaminants to evaluate the degree to which contaminants along with other environmental factors reduce spawning.

Results of laboratory studies can be compared with data on field animals collected from estuaries where spawning occurs. Spawning sites and associated bottom types, salinities, and degree of habitat refuge from predators can be identified. Because flounder spawn in both clean and contaminated habitats, studies could determine effects of contaminants on spawning success and survival of early life stages. This would involve scientists from the FISHERIES ECOLOGY, HABITAT PROCESSES and ENVIRONMENTAL CHEMISTRY programs areas.

(b) Settlement and early life history studies

Growth during early life stages is dependent on habitat quality and the amount of suitable habitat available. Habitat utilization by fish of different ages can be studied with field and laboratory components by researchers in all three program areas. Habitat characteristics can influence prey choice, feeding rate, growth rate, and, ultimately, fecundity. Field studies can be conducted to establish patterns of fish distributions and abundance throughout the first year of life and relate this to habitat type. A mark/recapture study using ultrasonic telemetry could be conducted to determine seasonal movements by young fish. Such studies, in combination with population genetic studies, could improve our definition of stocks. Habitat-specific food habits of young fish could be measured to understand factors controlling growth, as well as the trophic pathways through which contaminants pass. Studies in the laboratory could expand on previous work on how low levels of dissolved oxygen modify distributions of young fish. There may be important interactions between vegetation, which may provide a refuge from predation, and gradients in levels of dissolved oxygen.

Experiments conducted by the ENVIRONMENTAL CHEMISTRY program could also examine whether contaminants alter habitat use, and go on to determine, with the FISHERIES ECOLOGY and HABITAT PROCESSES program areas, to what extent this reduces the fitness of young fish. Possible links between winter flounder pathology and ingestion of contaminated prey could also be explored. Experiments could examine whether young fish avoid feeding on contaminated prey. The relationship between contaminant levels in the environment, in flounder tissues, and pathological conditions could also be examined. Young flounder are common in the heavily degraded areas of Newark Bay. Fish from these areas could be collected to see whether they are negatively affected by the contaminants.

APPENDIX IV

Scientific Expertise Needed to Address Research Projects That Could be Conducted at the James J. Howard Marine Sciences Laboratory

Project	Micro-Biologist	Develop. Biologist	Biochemist/ Molecular Biologist	Physiologist	Organic Chemist	Behavioral Ecologist	Pathologist	Experimental Quant. Ecologist
Fishery Ecology								
Fecundity and maturity relationships to size and age of fish and shellfish		X	X					X
Latent mortality of discarded catch				X		X	X	X
Identification of species in gut content analyses using molecular techniques	X		X					
Stock identification using molecular techniques	X		X					X
Gut evacuation rates of fish and shellfish				X				X
Bioenergetics				X				X
Disease susceptibility of environmentally stressed fish and shellfish							X	
Otolith marking techniques for larval fishes		X	X					X
Recruitment processes of estuarine dependent fish and shellfish				X				
Phytoplankton ecology	X		X	X				X
Testing of biodegradable net material					X			
Feeding preferences (larvae, juveniles, and adults)		X		X		X		X
Techniques for tagging shellfish								X
Responses of larval fish and shellfish to environmental gradients	X	X		X		X	X	X

APPENDIX IV
Continued

Project	Micro-Biologist	Develop. Biologist	Biochemist/ Molecular Biologist	Physiologist	Organic Chemist	Behavioral Ecologist	Pathologist	Experimental Quant. Ecol.
Environmental Chemistry								
Rapid assay techniques for identification of disease and bacteria in shellfish	X		X	X	X		X	
Degradation and speciation of contaminants			X		X			
Depuration of contaminant body burdens	X		X	X	X			X
Effects of contaminant exposure on reproduction of fish and shellfish	X	X		X	X	X		X
Contaminant uptake and transfer through the food chains	X		X	X	X			X
Pathological impacts of contaminants	X	X	X	X	X	X	X	X
Development and improvement of analytical methods for measuring biotoxins	X		X		X			
Development of predictive models for harmful algal bloom (HAB) occurrences and effects	X							X
Relationship of HABs to hypoxia and anoxia events	X		X	X	X			
Pathological results of low oxygen levels	X	X	X	X		X	X	X
Fate of biotoxins in the marine food web and impact on fisheries resources	X	X	X	X	X	X	X	X
Biogeochemical sediment processes affecting benthic communities	X		X	X		X		X
Effects of contaminants on swimming performance and predator avoidance	X	X	X	X	X	X		X

APPENDIX IV
Continued

Project	Micro-Biologist	Develop. Biologist	Biochemist/ Molecular Biologist	Physiologist	Organic Chemist	Behavioral Ecologist	Pathologist	Experimental Quant. Ecologist
Habitat Processes								
Development of methods for mitigating the impacts of harmful algal blooms	X			X				X
Effects of docks, pilings, and decking on fish and shellfish distributions		X				X		X
Experimental habitat modifications						X		X
Effects of changes in physical habitat on reproductive behavior of fish and shellfish	X	X		X		X		
Behavioral responses of organisms to environmental degradation		X		X		X		
Nutrient control of phytoplankton growth	X			X	X			
Effects of nutrient loading and contaminants on incidence of HABs	X			X	X			X
Ecology, physiology, and toxicology of HABs	X		X	X	X			X
Sediment toxicity and remediation processes			X	X				
Factors controlling production of eel grass	X			X				X
Effects of bottom disturbance and siltation caused by dredging on recruitment		X	X		X	X	X	X
Impact of suspended sediments on larval recruitment	X	X		X	X	X		X

APPENDIX V

Current Professional Staff at the James J. Howard Marine Sciences Laboratory

Environmental Assessment Branch

Anne Studholme - Behavioral Ecology
Sukoo Chang, Ph.D. - Biometry

Environmental Chemistry Investigation
- Andrew Draxler, Ph.D. - Chemical Ecology
- Ashok Deshpande, Ph.D. - Organic Chemistry
- Vincent Zdanowicz, Ph.D. - Inorganic Chemistry
- Patrice Fournier - Computer Science

Environmental Analysis Investigation
- Stuart Wilk - Fishery Biology
- Frank Steimle - Fishery Biology
- Anthony Pacheco - Fishery Biology
- Robert Pikanowski - Biometry
- Donald McMillan - Computer Science
- Linda Stehlik - Fishery Biology
- Suellen Fromm - Computer Science
- Christine Zetlin - Ecology

Experimental Ecology Investigation
- Robert Reid - Ecology
- John Mahoney - Microbiology
- Clyde MacKenzie - Fishery Biology
- Allen Bejda - Fishery Biology
- Beth Phelan - Fishery Biology
- Steven Fromm - Computer Science
- David Packer - Ecology

Ecosystems Dynamics Branch

Ichthyoplankton Dynamics Investigation
- Wallace Smith - Fishery Biology
- Wallace Morse - Fishery Biology
- Michael Fahay - Fishery Biology
- Peter Berrien - Fishery Biology
- John Sibunka - Fishery Biology
- Myron Silverman - Fishery Biology