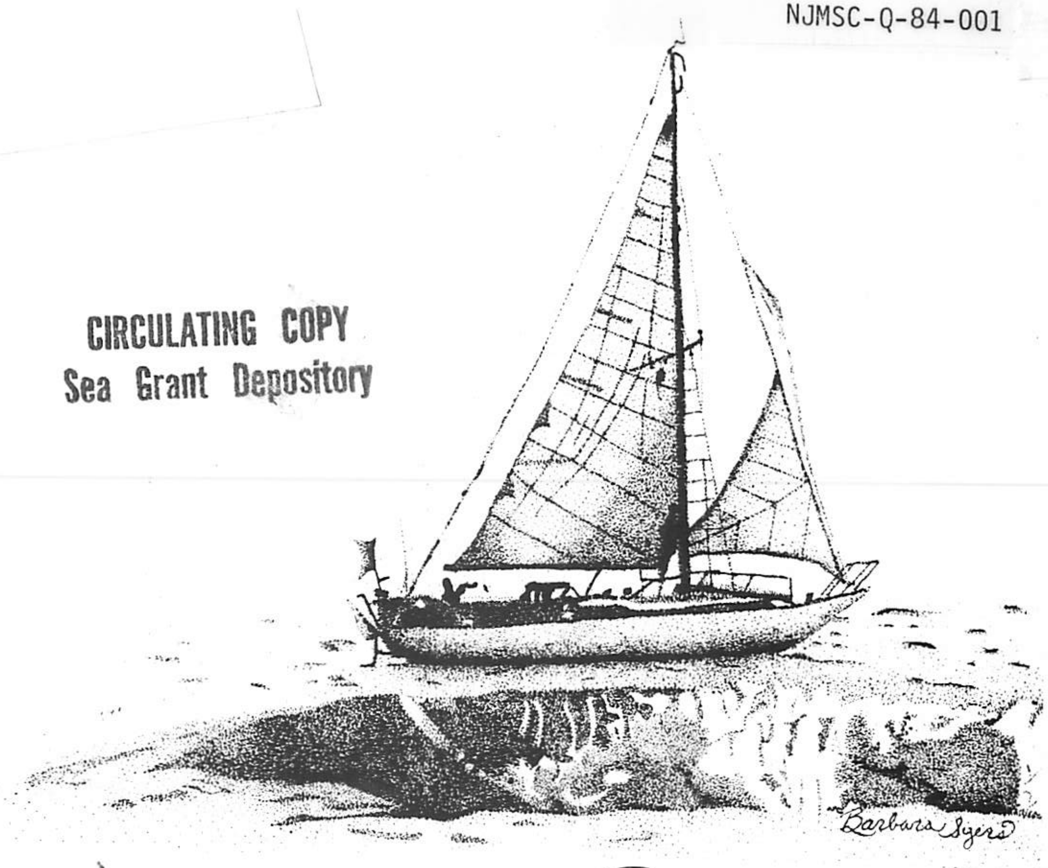
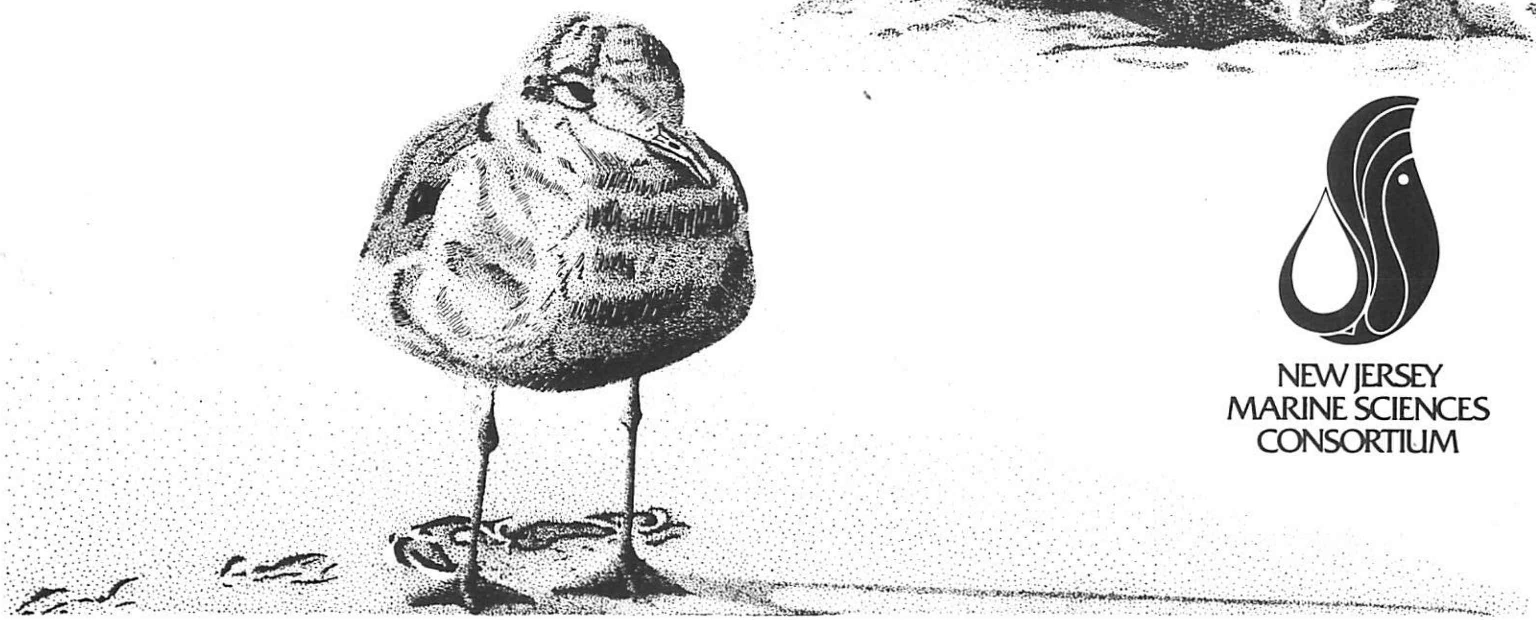
New Jersey Sea Grant Annual Report 1983-1984





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INTRODUCTION TO THE NEW JERSEY SEA GRANT PROGRAM

Report of Sea Grant Eight: 1983-1984

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The National Sea Grant College Program is conducted by the National Oceanic and Atmospheric Administration of the U.S. Department of Commerce. Through the education, research, and advisory activities of the state Sea Grant programs, Sea Grant is a partnership of government, university, and industry, successfully working toward sound economic development and wise use of the nation's marine resources.

In New Jersey, the Sea Grant Institutional Program is managed by the New Jersey Marine Sciences Consortium. As of this writing, the Consortium has grown to represent an alliance of some 28 institutions of higher education, as well as a number of business, industrial, and private organizations with interests in New Jersey's marine environmental affairs.

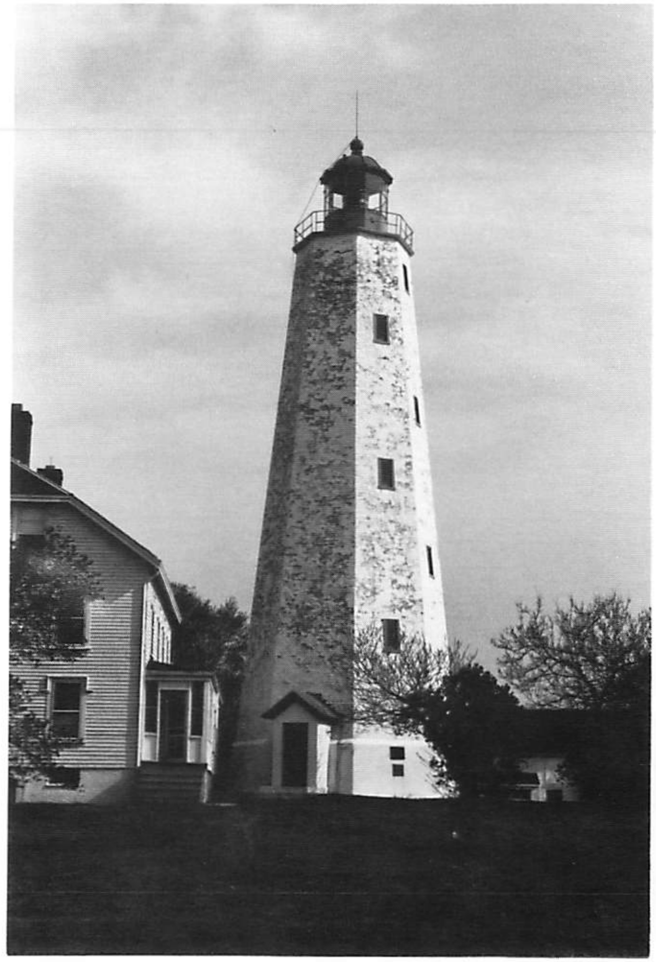
New Jersey Sea Grant's eighth year was, in many ways, complimented by the successful completion of several projects during the past seven years. During 1983-1984, we conducted projects in four program areas — Fisheries, Coastal Systems, Estuarine Studies, and Marine Education. All were responsive to well-defined objectives arrived at with the aid of our advisory committees and persons, and with direct participation by state and federal agencies.

One of the great strengths of the New Jersey Sea Grant program is its strong links with users of the information our researchers develop. There is little or no hiatus between determination of a research result and its transmission to the primary users. Not only do our Advisory Service people work closely with their communities, they provide positive feedback in project planning and help to ensure cooperation between researchers and users.

Elements of our major programs were planned and carried out in cooperation with elements of the New Jersey Department of Environmental Protection. This Department has a very broad mission which covers a large number of subjects of Sea Grant interest, and a very capable scientific and technical staff whose advice and cooperation have been a prime factor in forming an excellent university-agency Sea Grant partnership. We enjoy similar working relationships with the State Department of Agriculture and the State Department of Higher Education. At the federal level, the aid and cooperation of the National Marine Fisheries Service is outstanding, and we also enjoy a close and productive relationship with NOAA's Ocean Assessments Division and the U.S. Army's Corps of Engineers.

In summary, New Jersey Sea Grant is a program fully integrated with its communities, both private and governmental, to the extent our resources permit. While much remains to be done toward further integration with private communities outside of the fisheries sector, positive action in this regard will be complemented by continued growth. For year Eight, we are pleased to present the results of projects fully consistent with National Sea Grant Goals and with state, local, and regional problems and opportunities. It is my pleasure to transmit this account of the eighth year of Sea Grant in New Jersey.

Dr. Robert B. Abel
Director



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FISHERIES PROGRAM

The goal of the New Jersey Sea Grant Fisheries Program is shared with the New Jersey Department of Environmental Protection, and the National Marine Fisheries Service:

> Achievement of the full economic, social, and environmental potential of New Jersey commercial and recreational fisheries.

The importance of New Jersey fisheries to the state and nation was emphasized in March, 1982, in a report issued by the Bureau of Commercial Fisheries of the New Jersey Department of Environmental Protection. Survey data for the year 1980 showed nearly 10,000 persons employed in various parts of the fisheries business by over 400 companies with a total payroll of more than 100 million dollars.

About 60 finfish and shellfish species are fished commercially in New Jersey, and in 1979 the state ranked 9th in the nation in harvested tonnage and 12th in dollar value. The state's fisheries supply the great fish markets of Boston, New York, Philadelphia, and Baltimore.

In 1979 the port of Cape May-Wildwood ranked second after New Bedford on the Atlantic Coast in total exvessel value landing, but in 1980 and 1981 the trend was downward for several of the most important species. Catches of fluke, sea bass, weakfish, whiting, sea scallops, surf clams, and ocean quahogs declined. Only scup and mackeral showed increases. The decline in harvests appears to be more related to fish population fluctuations than to the distressed state of the economy.

Against this background, Sea Grant fisheries research emphasizes a new and promising use for underutilized resources, development of new resources, and continuing improvement in means of rapid assessment of mollusk populations at a very early stage of development. We also aggressively pursued research that will determine how the state's very serious marine pollution problems affect the health and reproduction of fish stocks, a factor of importance in trying to determine the causes of population declines in the last two years. We also continued the productive studies of socio-economic factors that affect and are affected by fisheries management decisions.

SOCIOECONOMIC EVALUATIONS OF INNOVATIONS IN COMMERCIAL FISHERIES — THE HARD CLAM RELAY PROGRAM OF NEW JERSEY: HISTORY, EVALUATION, AND RECOMMENDATIONS

B. McCay

INTRODUCTION

The "hard clam relay" or transplantation program is one of the innovations developed in New Jersey and other shellfish-producing states to cope with the problem of marine pollution and of decline in shellfish resources in unpolluted areas. In New Jersey, the supervised transplantation of hard clams from polluted to clean waters has become a critical component of the commercial shellfish industry: in 1980 the relay accounted for 20% of total hard clam landings in New Jersey. This report of Sea Grant research on the hard clam relay program is based on a paper co-authored by Bonnie McCay, Associate Professor in the Department of Human Ecology, Rutgers University, and William Jenks, professional bayman and clammer (Jenks and McCay 1984). Our emphasis is on the historical development of these programs, the role of baymen in their inception and change, and ways that the hard clam relay program could be improved.

POLLUTION PROBLEMS AND RELAYS: A THUMBNAIL SKETCH

New Jersey's hard clam relay program is a response to the problem of pollution and public-health hazards in the shellfish-bearing waters of the state. These problems are very old and widespread, and are almost inevitable consequences of the urbanization and industrialization of the Middle Atlantic coastal regions. In New Jersey and neighboring New York waters the problems were recognized as early as the 1880s (pollution affecting the health of shellfish) and 1907 (pollution affecting the health of shellfish consumers). The water-quality classification of the state's waters followed numerous surveys and shellfish-linked epidemics in the first decades of the 20th century. By 1914 the state had begun closing shellfish beds in "sewage polluted thorofares." Matawan Creek, which empties into Raritan Bay, was the first so "condemned." Numerous and larger "condemnations" followed soon afterwards, especially in the backbay waters behind Atlantic City, in south Jersey, and in the large bays, tidal rivers, and creeks of Monmouth and Middlesex Counties, north Jersey.

Clam relays are almost as old as the official condemnation of shellfish waters in New Jersey (Table 1). The first relays took place in the Navesink River, northern New Jersey, in 1920 and in Atlantic City and Wildwood in southern New Jersey in 1925 and 1926. Their major purpose was to deplete clam stocks in polluted waters to reduce the risk of shellfish-borne disease epidemics. They were short-lived, but were revived during the Depression years for a while because of strong social pressure to provide more opportunities for the unemployed of the state—a second important goal of relays. The closure of almost all of the waters of Monmouth County in 1961-62 led to experimentation in hard-clam "depuration" and, in response to pressure from baymen, a new hard clam relay program. This began in 1970, first at Lakes Bay in the Atlantic City area. It was later extended and eventually concentrated in the northern waters of the state. In the summer of 1983 a hard clam relay *and* a hard clam depuration operation (utilizing short-term controlled purification of clams) both came into effect in northern Monmouth County enabling the legal harvest of hard clams there for the first time since 1962 (see Jenks and McCay 1984 for more detail). Since 1983 these programs have provided income-generating opportunities for variable numbers of men, especially those of traditional fishing and shellfishing communities in the Raritan and Barnegat Bay regions.

GOALS: DEPLETION, LEGITIMATE PROFITS, AND RESOURCE MANAGEMENT

Until the 1980s the two official goals of shellfish relays were (1) to prevent the harvest of shellfish (for immediate sale) from condemned waters; and (2) to maximize profit opportunities for legitimate clammers. The two goals were met by what was called a "depletion relay," that is, opening the beds to supervised clamming at as fast a rate as possible in order to deplete tempting clam beds in polluted waters.

Today's hard clam relay involves (1) the supervised harvest of clams from waters deemed suitable by DEP Division of Water Resources; (2) the transplant of clams by baymen to leased lots in state-certified waters; (3) harvest of clams from the lots by the lessees 30 days or more after transplant (state-monitored). There are many advantages of the hard clam relay to society at large as well as to individual baymen, including the fact that in New Jersey it gives baymen access to a lease in the bay bottom and hence to some of the benefits of "private ownership."

SEVEN ADVANTAGES OF A HARD CLAM RELAY FROM A CLAMMER'S PERSPECTIVE

1. Makes a businessman out of a clamdigger,

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because he has an inventory of clams on his lease. He is more dependable and valuable to a dealer or a fish market.

2. He can continue clamming when the market is oversupplied (glut).
3. He has access to better clamming, in a situation, increasingly the case in New Jersey, in which clams are scarce in unpolluted waters. (Today, in the "wilds" of South Jersey, 400-500 clams are considered a "good day's take;" on the northern Monmouth County hard clam relay 2000-3000 are seen as a "good day".)
4. He is depleting the thick clamming in condemned waters, making pirating unprofitable.
5. He is utilizing a renewable resource that is otherwise wasted or marketed through piracy.
6. After a day of relaying he is just too darn tired to think about pirating that night!
7. It is endorsed by the Federal Government (FDA, EPA).

We also wish to add the point, extremely important given the costs of transplanting clams and enforcing regulations, that using individual leases in a relay program places many of the costs of the program on the clammers, who are motivated to accept those costs by the benefits they gain from having access to otherwise "condemned" clam beds and from the ways that using leases enhances their marketing positions.

In the 1980s an additional goal was added by the Department of Environmental Protection: to conserve the hard clam resource in areas approved for relay and depuration clamming. This new management goal has been very controversial (see Bauer 1983, "Politics on the Clam Bed"), as have other features of the state's method of regulating the hard clam relay and depuration clamming businesses, especially the number of days that clammers are allowed to participate in the relay per week. A problem not yet solved by the state agencies involved is how to avoid alleged regulatory discrimination against one group of clammers and in favor of another.

TABLE 1: KEY DATES IN THE HISTORY OF NEW JERSEY'S HARD CLAM RELAY PROGRAM:

1914	First "condemnation" of shellfish beds in N.J.
1920	First shellfish "relay" from polluted to clean waters, Navesink River, Monmouth County (followed by Atlantic City, 1925, Wildwood, 1926; revived in 1930s)
1961	Hepatitis epidemic; closure of many clamming areas in N.J.
1962-67	U.S. Public Health Service-sponsored research on hard clam depuration at Monmouth Beach (H. Haskin, Z. Steever)
early '60s	Organization of South Jersey baymen to pressure for hard clam relay
1970	Relay started, Lakes Bay
1973	Extended to all areas between Absecon Bay and Scull Bay in Atlantic County
(1974	Soft Clam Depuration Plant, Highlands)
1975	Hard Clam Relay Extended to Reed Bay, to Great Egg Harbor
1976	Pressure to Extend Relay to Northern Monmouth County; March 7th: Resource Survey of Shrewsbury River (four baymen); Plan for Northern Monmouth County Hard Clam Relay Proposed by Southern and Opposed by Northern Monmouth County Clammers.
1977	Manasquan, Shark River Relays Began; Tuckerton Creek Emergency Relay
(1977	Soft Clam Depuration Plants, Highlands)
1978	Meeting at Monmouth Beach Marine Police Station: representatives of DEP and many clammers from Belford and Highlands. It was decided that no relay would start until a depuration plant was built.
1980	Manasquan River, Shark River relays
1982	Shark River relay
1983	February 28th: Shark River Relay, 6 days a week June 1st: Navesink River Relay, 2 days a week July 1st: Hard Clam Depuration Plant, Highlands (Harvey) Followed by Shrewsbury River, Sandy Hook Bay Relays, 3 days a week after political pressure
1984	Navesink River, Shrewsbury River, Sandy Hook Bay, 3 days a week and then 5 days after political pressure.

BAYMAN AND/*VERSUS* THE STATE

New Jersey's program has evolved slowly, and sometimes painfully, the state usually displaying the style of decision-making known as "incrementalism" or "muddling through" (Lindblom 1959) rather than full-scale planning that looks at a wide variety of alternatives and carefully considers objectives and means of attaining them. The state has taken its incremental steps primarily because it was forced to by baymen who have played and continue to play a major role in the hard clam relay program.

The discrimination issue noted above is only one of many "design" problems in the hard clam relay program that the clammers themselves have played a role in redressing. The only official role that the baymen can take is through an industry advisory council, the Atlantic Coast Shellfish Council the powers of which were sharply cut back due to reorganizational changes in 1979-1980. The state's organizational model for shellfisheries and fisheries does not allow for the direct interaction between agency representatives and industry that would seem important to the workings of a program as complex as a clam relay in particular or bay shellfish resource management in general. However, the baymen have been very effective in working through politicians, personal relationships with state personnel, the media, the council, and from time to time the courts in order to gain state cooperation in implementing and changing the relay programs (see Jenks and McCay 1984). The system that exists today is the result of unofficial "co-management."

RECOMMENDATIONS

One outcome of this study is a series of recommendations for states or local governments considering the development of a hard clam relay program that includes the lease lot system used in New Jersey (Jenks and McCay 1984). These include recommendations, based on the New Jersey experience, about the selection of ground for proposed relay leases; the selection of landing sites for the relay harvest; and the design of relay lots and the relay itself to minimize cheating. Cheating hurts both the relay and, potentially, the health of the public and hence the health of the industry as a whole; a well-designed program will minimize the incentives and opportunities that tend to favor cheating in any "public goods" situation.

Those recommendations were based on the details of the New Jersey hard clam relay system and thus may not be relevant in specifics to others, particularly areas in which private leaseholds are not acceptable. The following general principles apply more widely:

1. *Educate the clammers in the public health aspects of the business.*

Unless there has been a recent shellfish-associated epidemic and full news coverage of it, clammers are unlikely to appreciate the dangers of eating clams from waters polluted with viruses and bacteria. Even then, they are likely to see only the effects of the epidemic on their market. State or local governments should take more care to educate the clammers, who are the critical epidemiological links.

2. *Design the harvesting and dumping areas for maximum ease of surveillance and law enforcement, balanced against the needs of the relay clammers for flexibility in relation to weather conditions, harvesting techniques, competition, independence, etc.*

This is not always easy. For example, in the New Jersey program in northern Monmouth County the state initially specified relatively small areas within which the relay clammers could work, to make law enforcement easier. This resulted in a high concentration of men, at times over 80 clammers, and clearly worked against the grain of most clammers, who prefer keeping information about the "spots" they find, whether "hot" or "cold," to themselves. In 1984 the state expanded the harvesting areas as requested by the clammers.

It also took awhile before the state responded to baymen's complaints that the areas selected were inappropriate given weather conditions, and that a better mechanism for making changes in the approved areas was needed. The starting and stopping times are another problem; to make enforcement easier, they are uniform, with seasonal adjustments according to changing day length. However, if it blows up out on the bay or in the rivers, men may wish to come in early, and then are forced to wait until 1:30 p.m. for the enforcement officer to arrive, check the bags, and seal the trucks.

Enforcement constraints may lead the state or other governmental unit to limit relay clammers to only a few days a week, as they did in New Jersey in 1983. When the northern Monmouth County relay began, in June 1983, the relay clammers were allowed to work there only 2 days a week. Through a great deal of political pressure, the relayers persuaded the state to up this to 3 days, and eventually, by 1984, to five days a week. While this kind of limitation may make sense from the enforcement standpoint, it may not from the clammers' perspectives. If the relay is a long distance from the usual clamming sites of many participants, they must move their clamming boats to the relay site, pay docking and moorage fees to marina owners, and undertake other expenses, which are magnified if they must divide their week up into relay clamming and other clamming, far away.

Another basis for the New Jersey relay clammers' objection to the 2 or 3 day limit was more complex, having to do with the fact that, in this particular relay, the shellfish grounds used were also worked by other clammers, those who harvested hard clams for the new hard clam depuration plant and those, to some extent the same, who harvested soft clams for the local soft clam depuration plants. The depuration clamming system is on an entirely different organizational basis, and enforcement methods are somewhat different, justifying as many as 7 days a week for the depuration clammers. The relay clammers perceived this as discrimination—and often pointed to the statement at the bottom of official state stationery that New Jersey "does not discriminate..." at the meetings where the issue was raised.

What really hurt was knowledge that on the days they were not allowed to relay the depuration men were out there working the same beds. In response to political action on the part of the relay clammers, the method of enforcement was changed somewhat to enable relay clammers to work 5 days a week. Clamming is an extremely competitive, as well as "independent" business, and this economic and social fact should be recognized in the design of management programs.

3. *Involve baymen in the design, implementation, evaluation, and modification of the program.*

The state's management style was to develop its own plans first, without official involvement of baymen (who did, however, use the telephone to state their cases), and then present the plans to the advisory shellfish council or implement them on the water. This style generated almost ritualistic hostility and allegations of favoritism and hidden political agendas on one side or another. If the state agencies had formally involved a few of the respected baymen in the program at an early stage, some of this might have been prevented.

In New Jersey's northern Monmouth County relay program the relationship between baymen and the state (DEP and its water resources, shellfisheries, and marine enforcement divisions; the Department of Health; the state police's marine law enforcement division) was mostly adversarial. The involvement of baymen was forced upon the state, rather than encouraged by it. This was costly for everyone involved, worked against rational planning, and reinforced the much older legacy of cat-and-mouse games on the bays and seas of the state. It also tended to pit groups of baymen against each other, making it difficult for them to recognize and work upon their common interests.

CONCLUSIONS

Because the resources at stake are public trust or common property, and because public health is also at stake, the state must be involved in a relay program. We suggest that the participants—the clammers—should also be officially and directly involved in the design and running of a relay program in the relationship now known in fisheries management circles as "co-management." A general principle of planning in general and "co-management" in particular is to structure the process for maximal participation by those who are most directly affected by the program and thus have both the motivation and the experience to contribute to its effectiveness. People whose livelihoods are most at stake and who know the resource, environment, and industry from experience and trial-and-error experimentation are not only valuable sources of knowledge and advice but invaluable allies of the various branches of government involved in any complex management program.

The framework for "co-management" exists. Our research observations (McCay) and experience (Jenks) have shown that the inception, continued existence and effectiveness of New Jersey's hard clam relay program have depended on relationships of trust and confidence as well as opposition and political pressure among representatives of both the commercial shellfish industry and the state.*

*New Jersey Agricultural Experiment Station, Publication No. R-16501-1-85, supported by State funds and by U.S. Department of Commerce, Sea Grant.

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*These papers are the result of interaction and sharing of data among hard clam relayers and the Principal Investigator; they are available through Dr. McCay, Department of Human Ecology, Cook College, Rutgers University, P.O. Box 231, New Brunswick, N.J. 08903.

IDENTIFICATION OF BIVALVE LARVAE: A MULTI-INSTITUTIONAL APPROACH

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R. Lutz

New Jersey Sea Grant VIII was the third year of a proposed 5-year project directed by Dr. Richard A. Lutz of Rutgers University. The primary objective of the effort is publication of a comprehensive manual/scientific monograph for the identification of bivalve larvae and early postlarvae (through *routine optical* microscopic examination of the larval hinge apparatus) in estuarine and marine waters of the North Atlantic. This objective is being accomplished through a multi-institutional, co-operative effort, involving 16 institutions (academic, federal, and private industrial) in both North America and Europe.

As emphasized in our Sea Grant VII annual report, the many difficulties associated with accurately identifying bivalve larvae within the plankton have long hampered applied and basic research efforts in estuarine and open coastal marine environments. For example, as a result of existing practical barriers, detailed studies concerning spatfall predictions for aquacultural and fisheries management purposes have been extremely limited. Year-to-year fluctuations in larval abundance and juvenile recruitment are often not possible to define due to an inability of researchers to discriminate individual larval and early postlarval specimens. Similarly, it has been virtually impossible in routine plankton identification studies to unambiguously assess the impact of various environmental perturbations (natural "disasters", chemical pollutants, thermal discharges, oil spills, dredge-spoil dumping, etc.) on the larvae of individual species of bivalves. While a few keys for larval bivalve identification do exist, their usefulness is limited and, at the present time, it is not possible to unambiguously identify the larvae of many bivalve species, particularly at the early (straight-hinge) developmental stages. This ongoing project offers an approach aimed at eliminating many of the existing obstacles to future research. The involvement in this project of a number of researchers at various institutions, who are presently culturing the larvae of numerous species of bivalves for other purposes, has proved to be an extremely cost-efficient means of achieving the goal of the proposed effort (i.e., publication of a practical identification manual).

Over the past year we have expanded our studies through a collaborative effort with Dr. Marcel Le Pennec of the Laboratoire de Zoologie, Universite de Bretagne Occidentale, Brest, France. Dr. Le Pennec presently has at his disposal preserved samples of the larvae and early postlarvae of over 20 species of bivalves and has agreed to provide us with sub-samples of these for photographic documentation of the various ontogenetic stages for inclusion in the final manual. We are presently in the process of assessing how adequate these specimens (which have been preserved for considerable lengths of time) will be for inclusion in the manual.

Over the past 3 years of our project we have obtained larval and, in many cases, postlarval specimens of the following 55 species of bivalves (the list includes those of Dr. Le Pennec, some of which may not be adequately enough preserved for inclusion in the final manual): *Mytilus edulis* (blue mussel); *Modiolus modiolus* (northern horse mussel); *Geukensia demissa* (Atlantic ribbed mussel); *Mytilus californianus: Ischadium* (= Brachiodontes) *recurvum* (hooked mussel); *Brachiodontes exustus; Perna perna, Mytilus galloprovincialis, Crassostrea virginica* (American oyster); *Crassostrea gigas* (Japanese oyster); *Ostrea edulis* (European oyster); *Argopecten irradians* (bay scallop); *Placopecten magellanicus* (deep-sea scallop); *Pecten maximus; Chlamys opercularis; Chlamys varia; Chlamys distorta; Mya arenaria* (soft shell clam); *Mya truncata; Hiatella arctica; Hiatella rugosa; Spisula solidissima* (surf clam); *Spisula subtruncata; Mulinia lateralis* (dwarf surf clam); *Macoma mitchelli; Macoma balthica; Tagelus plebeius* (stout razor clam); *Donax variabilis; Ensis directus* (razor clam); *Arctica islandica* (ocean quahog); *Noetia ponderosa* (ponderous arc); *Arca noae* (common arc); *Astarte castenea* (chestnut clam); *Periploma leanum; Lyonsia hyalina; Anomia ephippium; Anomia patelliformis; Anomia simplex* (common jingle shell); *Cyclocardia borealis; Cerastoderma edule; Cerastoderma glaccum; Corbicula manilensis; Pholas dactylus; Diplothyra smithii; Nucula proxima; Nucula annulata; Venerupis aura; Ruditapes decussata; Ruditapes philippinarum; Venus verrucosa; Venus faciata; Petricola pholadiformis* (false angle wing); *Gemma gemma* (gem clam); *Pitar morrhuanus;* and *Mercenaria mercenaria* (hard clam). Photographic sequences of the available larval and/or postlarval specimens of each of these species are being prepared for inclusion in the final monograph, together with other useful aids for the identification of individual organisms isolated from both benthic and plankton samples.

An invited paper entitled IDENTIFICATION OF LARVAL BIVALVES IN THE PLANKTON: IMPLICATIONS FOR PREDICTING SPATFALL was presented at a special international meeting hosted by the Irish Marine Farmers' Association in Tralee, Ireland entitled MANAGEMENT OF A SHELLFISH RESOURCE. Seven papers and six abstracts have been published in refereed journals summarizing our results obtained to date.

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DEVELOPMENT OF A FISHERY FOR THE UNDERUTILIZED AMERICAN CONGER EEL

K. Able and C. Grimes

Conger eels are an important component of local fisheries in many parts of the world. The American Conger Eel, *Conger oceanicus*, occurs along the east coast of the U.S. from Cape Cod to the Gulf of Mexico. In the Mid-Atlantic Bight the conger eel is taken consistently on longlines set for tilefish, *Lopholatilus chamaeleonticeps*. Typically, many more conger eels are caught than can be landed and most of the catch is discarded. We believe this presently underutilized species could provide an important source of income to longline fishermen. To this end, our objectives were to determine the location of primary fishery areas for conger eels and relevant aspects of their habitat and life history. In the course of our studies we found that conger eels occupy a variety of habitats, especially along the outer continental shelf. During submersible operations we observed conger eels, often in association with tilefish, at or in the vicinity of Lydonia, Veatch, Hudson, Baltimore and Norfolk submarine canyons (Fig. 1). Our most extensive observations occurred in the three northern sites. Here conger eels were found in pueblo habits and around boulders in the canyons and in the vertical burrows of tilefish on the flanks of the canyons.

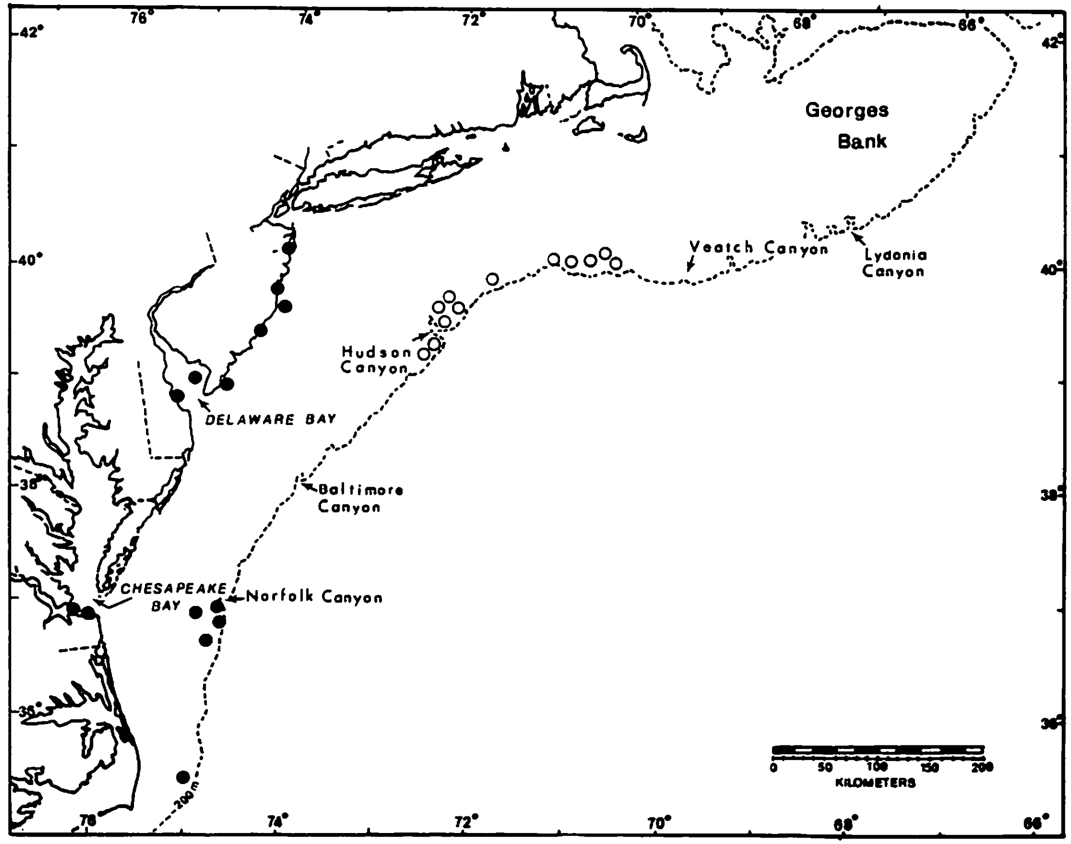


Figure 1. Distribution of American Conger Eel (Conger oceanicus) samples in the study area. Open circles = longline samples, closed circles = museum collections.

We examined over 1000 individuals from throughout the Mid-Atlantic Bight and southern New England (Fig. 1) to determine size structure and life history characteristics. During four seasonal longline cruises the catch per unit of effort from the tilefish longline fishery ranged from 0.5-4.0 kg/tub (one tub of longline gear is equal to 0.8 km of line with 250 hooks) with the largest catches occurring during the winter. The size structure of the longline catch of conger eels was fairly consistent during all seasons (Fig. 2) but larger fish, up to 12 kg, were also reported by the fishermen. Based on museum collections (Fig. 1), smaller eels were taken inshore, but were also collected offshore in the Norfolk Canyon area with a small meshed trawl. The apparent absence of conger eels over most of the continental shelf is due to lack of sampling effort.

Preliminary estimates of age composition were based on thin sections of the sagittal otoliths of conger eels caught on longlines. Otolith sections from 193 eels were examined and banding patterns could be counted in 161 (83%) of these. Validation of the annual deposition of these bands proved difficult. If our aging technique is valid, the conger eels in the fishery (Fig. 2) ranged from 2-13 years of age.

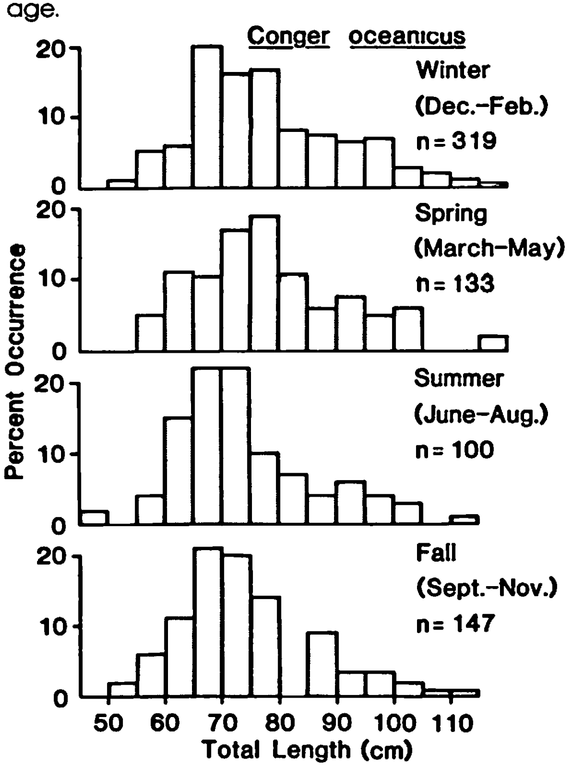


Figure 2. Seasonal variation in size structure of conger eels from the longline fishery for tilefish in the Mid-Atlantic Bight.

The reproductive characteristics of conger eels in the study area are distinctive. Visual and histological observations of over 200 gonads indicated that they are similar to that reported for other eels. Differentiation into recognizable testes and ovaries occurred between 35-40 cm in total length. As the ovary began to mature large amounts of lipids were deposited in the adipose cells in the ovary. By approximately 85 cm the diameter of oocytes began to increase in size and the average size of the ovary increased as well (Fig. 3). However, mature ovaries were never observed from specimens collected in the Mid-Atlantic Bight. This suggests that they may reproduce in the Sargasso Sea, as implied by an earlier researcher.

The sex ratio of all samples was skewed markedly toward females. Of 470 fish taken (480-1260 mm total length) from the fishery over 98% were females and the sex of the remaining individuals was not possible to determine. However, at least 15 males (228-494 mm TL) from museum collections were identified from the 22 fish whose sex could be determined. The size of these fish suggests that males are typically smaller than females. This may be the reason the males were not taken in the longline fishery, which uses relatively large hooks. As a result of these studies, we can predict that any future fishery would harvest primarily the larger, but still immature females.

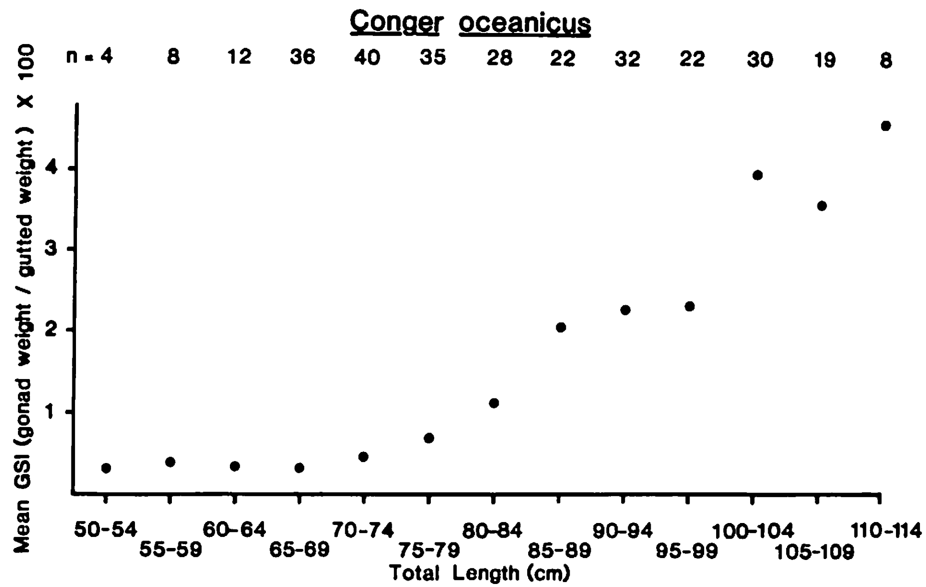


Figure 3. Changes in the gonosomatic index for conger eels relative to length.

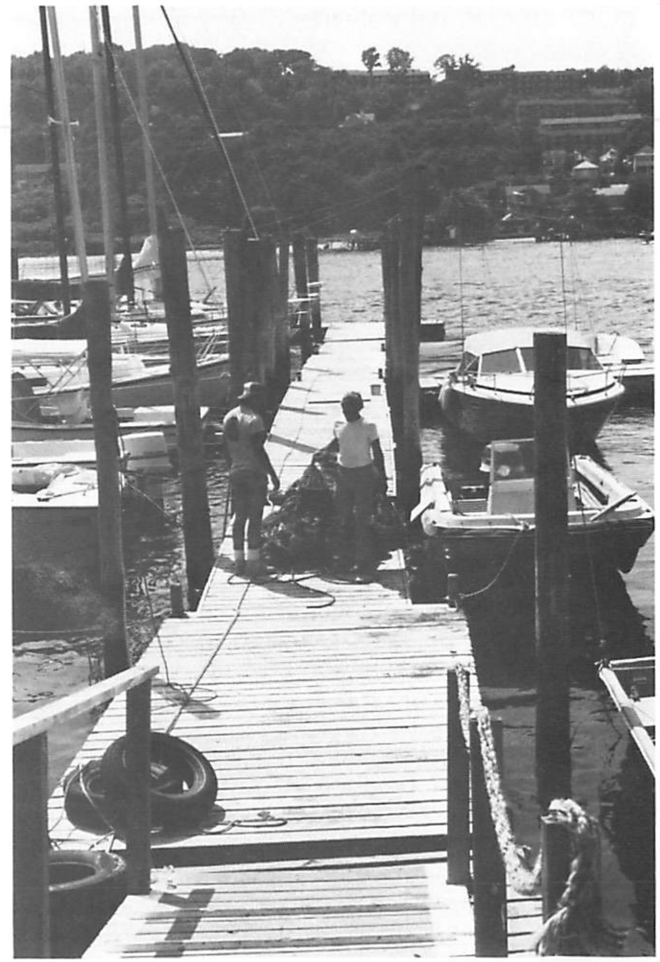
ESTUARINE PROGRAM

The estuaries of Northern New Jersey have a long history of importance as producers of finfish and shellfish, as well as providers of jobs and recreation to an ever increasing metropolitan population. During this century, these estuaries have also been the recipients of tremendous volumes of industrial and domestic wastes. These factors combine to cause the waters of this extensive system of rivers and bays to be severely stressed and considered among the most heavily polluted waters of the nation.

Research into pollution sources, processes, and impacts has remained a priority for New Jersey Sea Grant because of the importance of contamination problems in these northern estuaries.

In fact, in past years the Estuarine Program has been titled, "The Northern New Jersey Estuarine Program," because of our focus on the grossly polluted bays and estuaries of the region from Newark Bay to Raritan Bay and Sandy Hook. The problems remain as serious and complex as ever, but this year saw the completion of projects dealing with this area, thus offering an opportunity to reevaluate the research needs of the region before proposing new studies, and to pay overdue attention to others of New Jersey's many estuarine areas.

Future Sea Grant estuarine projects will continue to provide data useful for management of the state's estuarine resources in light of the many competing, and often conflicting uses they are subjected to.



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INCIDENCE AND DEVELOPMENT OF *GLUGEA STEPHANI* IN FIELD COLLECTED AND LABORATORY INFECTED WINTER FLOUNDER FROM THE NY-NJ AREA

A. Cali and P. Takvorian

In 1976 Dr. Ann Cali of Rutgers University began work on the microsporidan parasite, *Glugea stephani*, in *Parophrys vetulus* (English sole). Since 1978 she and Peter M. Takvorian, also of Rutgers, have been studying *G. stephani* in *Pseudopleuronectes americanus* (American winter flounder) off the New Jersey coast.

American winter flounder represent a major portion of the fishery in the northeastern Atlantic coastal area and account for over 32 million pounds of the flatfish landed commercially in 1982. In addition, they comprise a major portion of the sport fishery as indicated by a 1979 U.S. recreational survey, which reported over 22 million winter flounder were caught by sport fishermen in that year.

One of the diseases that flatfishes are susceptible to is microsporidosis. Microsporida are spore-forming intracellular obligate protozoan parasites, known to infect every major group of animals.

Species of the microsporidan genus *Glugea* parasitize fish and produce large "cysts" or xenomas that range in size from microscopic to greater than five mm in diameter. *Glugea* infections are highly pathogenic and cause numerous disorders that may lead to death or reduction of survival capabilities. Additionally, *Glugea* organisms have been responsible for massive fish kills in other host genera.

Glugea stephani parasitizes several genera of economically important flatfish throughout the world. In the United States, at least five flatfish species have been identified as hosts for *G. stephani*.

Although *P. americanus* is a major component of the commercial and sport fishery, little attention has been given to this disease (*G. stephani*), since 1901, when it was first described by Linton.

The first objective of our study was to ascertain if this parasite was found off the N.Y.-N.J. shore. The microsporidan is known to infect winter flounder from Massachusetts to Canada and recent investigations with *Parophrys vetulus* demonstrated the parasites' preference for warmer water, >15 C, (both for initiation and development of parasite infections). A combination of the above two facts led us to believe that *G. stephani* would be present in winter flounder from tne N.Y.-N.J. area. Studies of winter flounder collected in this area revealed the presence of *G. stephani* (Fig. 1). In 1981 we documented the presence of the disease in this area.

The second objective was to determine tne incidence of this disease in local flounder. To accomplish this, the presence of *G. stephani* has been monitored in winter flounder continuously since 1978. Our examinations of more than 7,500 winter flounder (age = 1+years) demonstrate that *G. stephani* is present in local flounder stocks on a year-round basis. Monthly infection prevalances as high as 28% have been observed in the New York-New Jersey area (Fig. 2). Our data include only infected fish that survived beyond the yearling stage and developed macroscopic cysts.

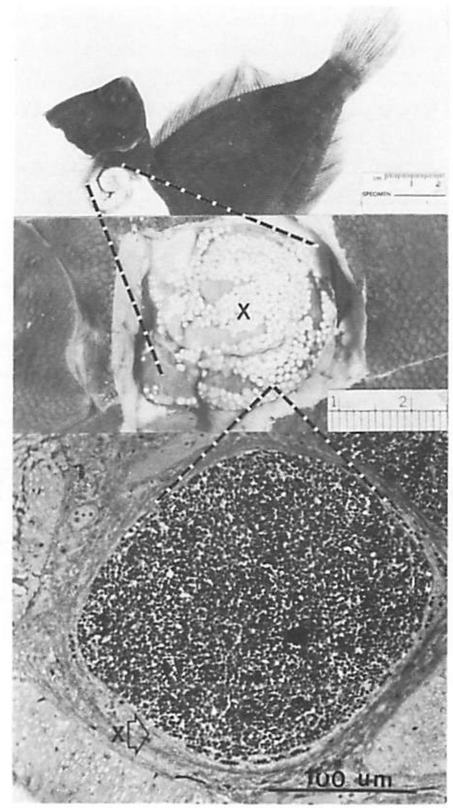

Figure 1
Winter Flounder infected with Glugea stephani

Top photograph - 21 cm fish with heavily infected intestine
Middle photograph — enlargement of intestinal area
Bottom photograph - histological tissue section, through one Glugea cyst.

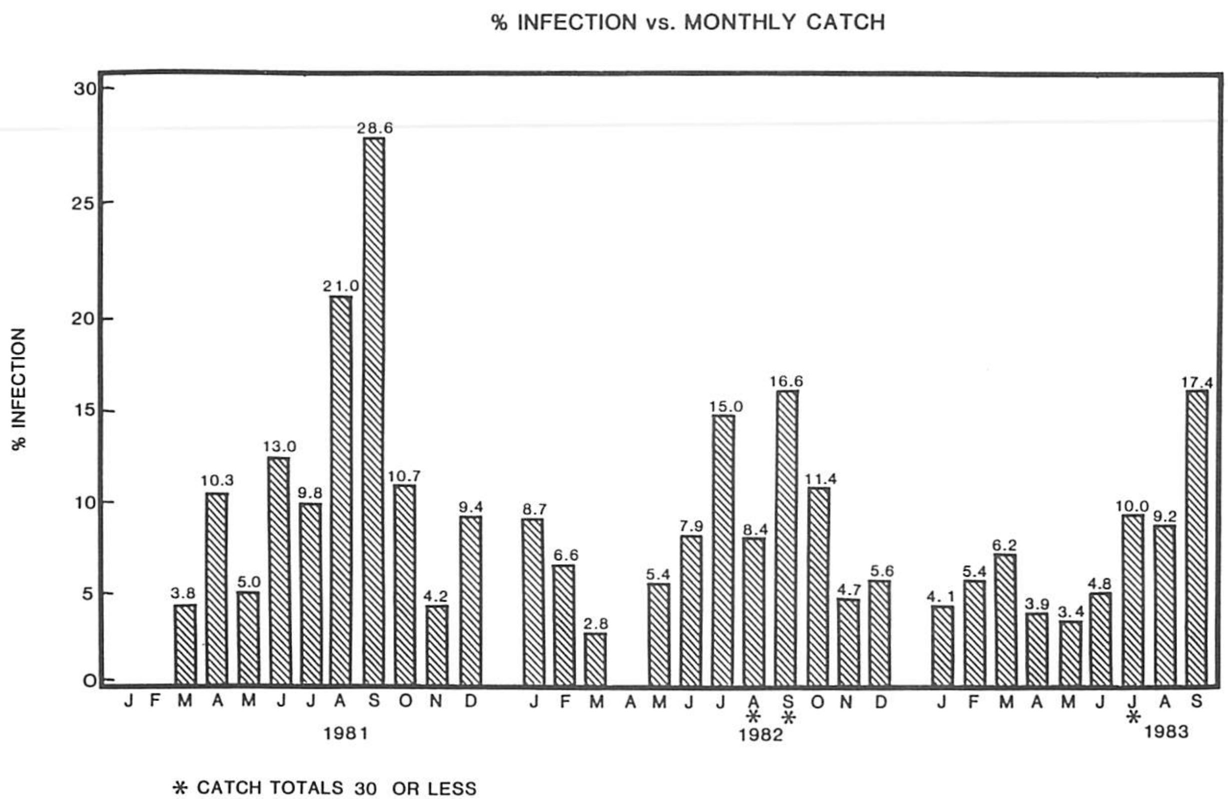

Figure 2

Monthly Infection Prevalance (%) of Glugea stephani in Winter Flounder from the N.Y.-N.J. Area 1981-1983.

In addition to noting the presence of the disease, it was observed that the parasite had a seasonal variation. This seasonal change appeared to correlate with water temperature fluctuations (Fig. 3).

The third objective was to define the pathology associated with the development of the parasite. Studies of *G. stephani* pathology indicate that it invades connective tissue cells of the digestive tract (Fig. 1). Infected cells may be found in any of the connective tissue areas from the mesentary to the laminar propria of the villar projections,

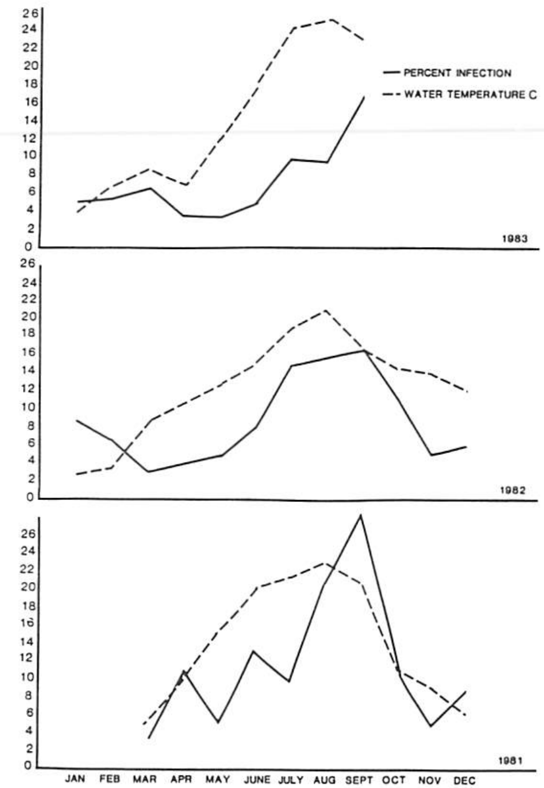

Figure 3

Relationship Between Percentage of Glugea stephani Infection and Water Temperature in the New York-New Jersey Area, 1981-1983.

producing massive host cell hypertrophy, xenomas, often exceeding five mm in diameter. With the histological observations obtained during this portion of the project we became increasingly aware that the pathology led to death of the fish.

The fourth objective was to see if we could experimentally infect winter flounder and demonstrate mortality. In an effort to ascertain the percentage of young of the year mortality attributable to the disease, we exposed feral young flounder captured in Sandy Hook Bay to the protozoan. In addition to proving that *G. stephani* can be experimentally cycled in winter flounder, our data indicate that the disease is fatal in approximately 60% of the *G. stephani* infected fish.

Our ultimate goal is to create an awareness of this disease, and its impact on the fishery. There is a pressing need, for management purposes, to expand our knowledge of diseases of such commercially important resources as the flatfish.

This research represents the cooperative involvements of Rutgers University, New Jersey Sea Grant, the National Marine Fishery Service, N.E. Laboratories, and the NEMP program.

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AN INTERDISCIPLINARY INVESTIGATION OF NITRIFICATION IN RARITAN BAY

NEW JERSEY MARINE SCIENCES CONSORTIUM

F. Simpson, H. Ducklow, B. Deck and F. Cantelmo

The overall objective of this research is understanding the role of autotrophic microbial nitrification processes in the oxygen and nitrogen cycles in the Lower Bay Complex. Raritan Bay, which is shallow, and has a high nutrient loading and sluggish circulation, is an optimal environment for nitrification. Further, autotrophic bacterial nitrification, the oxidation of ammonia to nitrite, can consume significant quantities of oxygen in the Bay. To test these hypotheses for Raritan Bay, three mutually independent research projects were conducted:

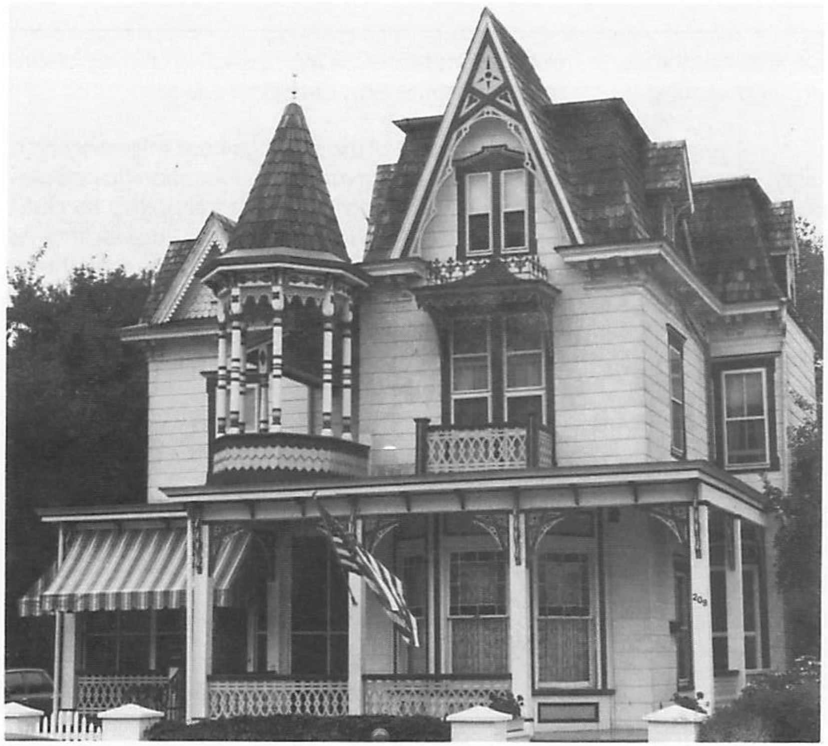
1. An evaluation of the production of nitrous oxide (N_2O) as a useful indirect indicator of oxygen consumption during bacterial nitrification — the nitrogenous biological oxygen demand (NBOD),
2. A determination of in situ nitrification rates in the Bay water column and sediments, and
3. An assessment of the role of the benthic meiofaunal communities in stimulating nitrifier populations.

Drs. Deck, Ducklow, Simpson and Cantelmo have attempted to fulfill these aims for the New Jersey Sea Grant Program over several years of research. During the second year of research they characterized the temporal and spatial distributions of nitrogenous nutrients and nitrification rates in Raritan Bay. They established that nitrification, evidenced by the accumulation of NO_2^- and N_2O in Bay waters, is highly seasonal, with a peak in late summer. Ultimately the project led to a better understanding of in situ nitrification — a poorly understood and little investigated process— and its role in the Lower Bay Complex.

Another result of this research was the development of methodology and sampling sites for further, more detailed research. It has also been demonstrated that several techniques used for the study of nitrification in other systems do not work in Raritan Bay. Further, it has been demonstrated that microbial nitrification is proceeding at a rapid rate throughout the Bay, as hypothesized.

The foremost of the findings from this research is that high rates of microbial nitrification do occur in Raritan Bay. This conclusion is supported by data on NH_4^+, NO_2^-, NO_3^-, and N_2O distribution as well as our measurements of nitrification rates themselves. This conclusion supports the hypothesis that Raritan Bay is an optimum environment for nitrification.

It has also been shown that nitrification is often more rapid in bottom waters than in top waters, and that benthic meiofaunal nematodes can stimulate nitrification. The shallow depths and largely muddy bottom of the Bay, with its rich meiofaunal population, and the high concentrations of ammonia imported from the Hudson and Arthur Kill probably explain the rapid rates we have measured.



COASTAL SYSTEMS PROGRAM

It is well documented that, as sea level has risen around the world during the Holocene transgression beginning about 12,000 B.P., sediments have been driven landward and upward in time and space. As a consequence of the landward migration of barrier island systems, the back barrier areas located between the barrier islands and the headlands are being narrowed. The environments are evolving from subtidal to intertidal and, in the future, to supra-tidal conditions.

According to recent detailed data in the back barrier environments of Atlantic and Cape May Counties, New Jersey, in the geomorphic segment known as the barrier island chain area, the rate of sedimentation has been found to be much greater than predicted from the extant sea level curves for the area.

The sediment sources, transport mechanisms, "natural" system dynamics, and the effects of such human activities as dredging and spoil disposal are not well defined or understood. What is needed is a combination of understanding of the processes and ability to predict changes under various assumptions. If profound changes occur in the back barrier areas, there will be equally profound impacts on the productive wetlands and their associated ecosystems, the intense human uses of the areas for tourism, boating, and commercial fishing, and increased building on the barrier islands.

In addition, the Intercoastal Waterway threads through all the back barrier areas of Southern New Jersey, providing a vital link with adjacent states for pleasure craft. Disruption of the waterway by filling already is having serious effects on its use.

Four projects, initiated during Sea Grant Eight, form an integrated attempt to answer the many questions raised above about rapid accumulation of fine-grained sediments in the coastal lagoon complex of Southern New Jersey.

SEDIMENT CHARACTERISTICS AND RECENT ACCUMULATION RATES: DETERMINATION OF VARIABLES REQUIRED FOR A NUMERICAL SIMULATION OF MODERN SEDIMENTATION IN THE SALT MARSH COMPLEX OF SOUTHERN NJ

B. Carson

The first year of this study was devoted to determining the characteristics, distribution, and accumulation rates of modern bottom sediments accumulating in Great Sound, a tidal lagoon located west of Avalon and Stone Harbor, New Jersey (Figure 1). The sound is shallow (average depth = 0.5 m at mean low water) and large areas (27% of total 6 km^2 area) are intertidal (Figure 2). Previous estimates (Kelley, 1975) indicated modern accumulation rates of 0.5-1.0 cm/yr, and suggested that under stable sea level conditions, Great Sound could be expected to fill in 50-100 years.

Bottom sediments in Great Sound (Figure 3) range from clayey silts (mean diameter, md $\lesssim$ 16 um) on the southwestern margin, to sands (md = 125 um) and silty sands (md ~115 um) along the Intracoastal Waterway which transects the Sound from south to north. These end-members represent accumulation from single-grain (sand) and agglomerated (organic-mineral aggregate and fecal pellet) populations, respectively. Mixtures of these populations result in bimodal or multimodal bottom sediments of intermediate grain size (md = 30-100 um) in the south central portions of the sound, in a small, unnamed embayment on the east side of the waterway, and along the margins of the sound. Biogenic structures are common in the finer, subtidal deposits, in the form of indistinct mottling, polychaete worm tubes, shells and shell layers (Figure 4). Occasional sand layers may reflect scouring or rapid deposition by tidal currents and/or wind waves. Intertidal sediments near the

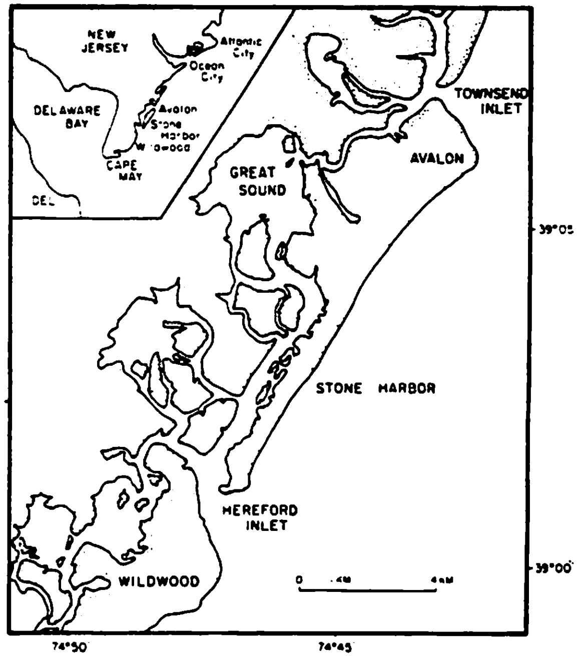


Figure 1. The location of Great Sound along the southern coast of New Jersey (from Thorbjarnarson et al.).

islands (created or augmented by dredge spoil disposal) consist of silty sands and sands which overlie finer, silty clay. The dredged material is clearly being redistributed over the characteristic lagoonal sediment, particularly in the northern portion of the sound where strong flood tidal currents from Ingram Thorofare transport sand (md = 125 um) from two island disposal sites into the northern third of the sound (Figure 3).

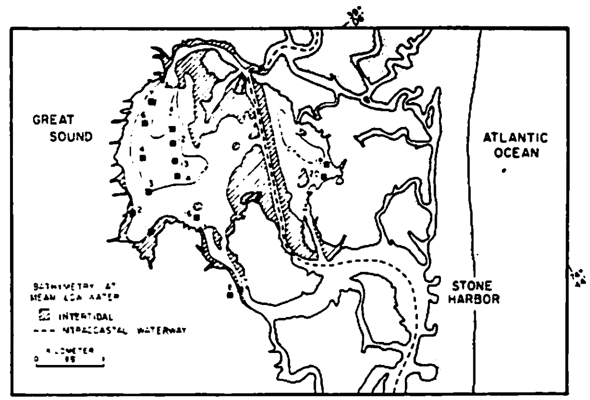


Figure 2. Bathymetry, core locations, and position of the Intracoastal Waterway in Great Sound. The islands and intertidal portions of the sound represent regions affected by dredge spoil disposal (from Thorbjarnarson et al.).

Radiochemical determinations of Pb-210 and Cs-137 in four of the cores collected (Figure 4) indicate that apparent accumulation rates in the subtidal portions of Great Sound range from 0.1-0.5 cm/yr. Intertidal accumulation may be lower. These rates represent maximum rates of modern (~50 years) accumulation, as biological mixing has effected active transport of the radionuclides to depth (Thorbjarnarson, et al., submitted). Sediment consolidation, which might be expected to reduce the measured accumulation rates, is not an important factor. Consolidation tests on three cores (Figure 3) indicate that compaction accounts for less than 10% shortening in the upper 20 cm. The accumulation rates are only slightly higher than the recorded rise in sea level (0.12 cm/yr; Gornitz, et al., 1982) over the past 100 years, suggesting that infilling of Great Sound is not imminent.

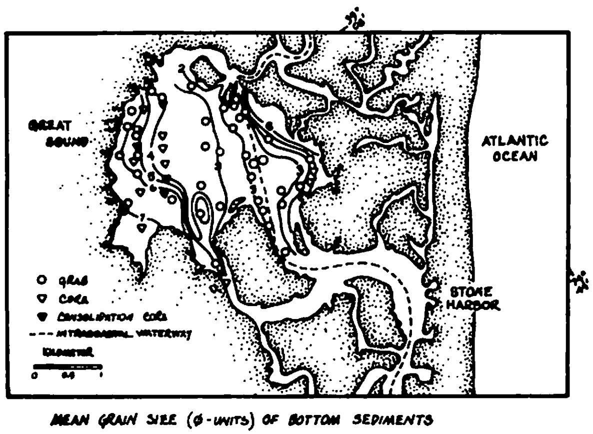


Figure 3. Sample locations and mean grain size of bottom sediments in Great Sound. Consolidation tests were conducted on three cores, as indicated.

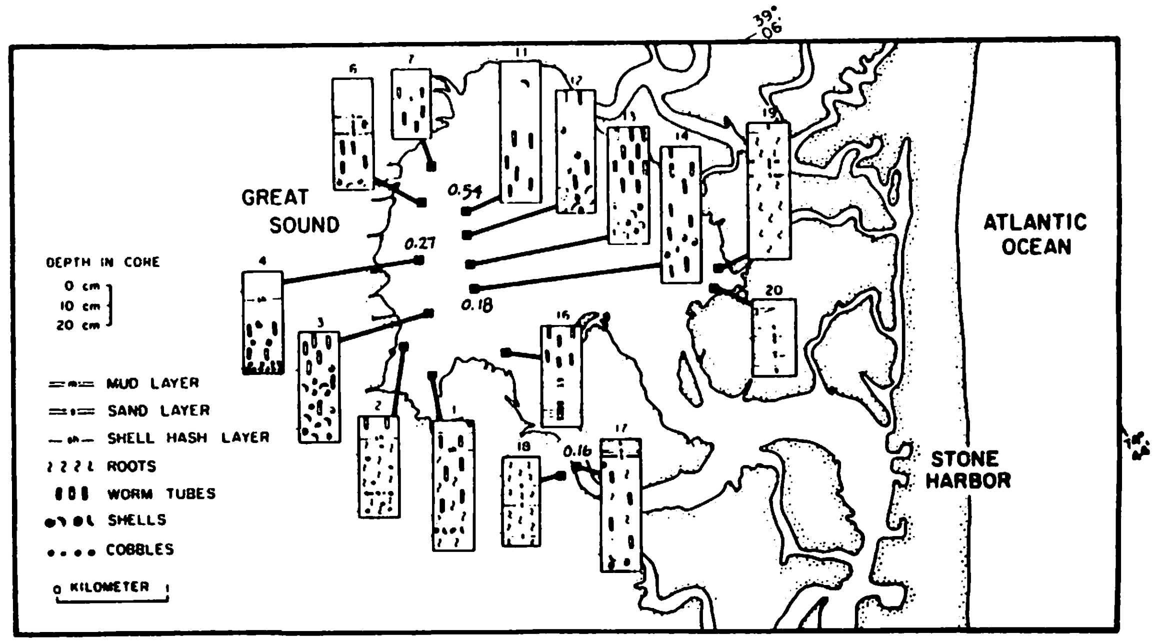


Figure 4. The distribution of sedimentary structures in Great Sound cores (after Thorbjarnarson et al.). Accumulation rates (cm/yr) based on radioisotope determinations are given for cores 4, 11, 14, and 17.

These findings constitute a portion of the ground-truth to which a numerical model of sedimentation in Great Sound must be calibrated. Present accumulation patterns, as determined by sediment traps, detailed characterization of the agglomerated and disaggregated sizes and settling velocities of particles in transport, and comparison of these particles with the bottom sediments, are the subjects of the second (1984-1985) year of this study.

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HYDRODYNAMIC MODEL OF AN INLET-SOUND SYSTEM IN SOUTHERN NJ

G. Lennon and R. Weisman

The first year of this study was devoted to applying the two-dimensional hydrodynamic numerical model, HYDTID, to the Great Sound region of New Jersey. The model had previously been used for Masonboro Inlet, North Carolina by the U.S. Corps of Engineers and for Hereford Inlet, New Jersey by these writers. New geographic boundaries were defined encompassing Great Sound, Ingram Thorofare to the north (connecting Great Sound to the ocean through Townsends Inlet), and Great Channel to the south (connecting Great Sound to the ocean through Hereford Inlet). Figure (1) shows the study area with the grid lines that indicate the discretized cells of the system.

The model required a tidal water level forcing function as a function of time at the appropriate boundary locations. Then, for the given discretized geometry and assumed values of the roughness parameter, the model calculates water depth in and flow through each cell including flow into the model through the boundaries.

In order to calibrate and verify the results of the model, a field effort was undertaken in the first year (1983) to obtain water level data at three locations and flow rates at two locations as indicated in Figure (1). Water level recording stations were installed at Ingram Thorofare Bridge, Stone Harbor Boulevard Bridge, and Reuben's Wharf in Great Sound. A survey team ran a vertical survey, which tied into several U.S.G.S. bench marks, in order to reduce all water level measurements to a common

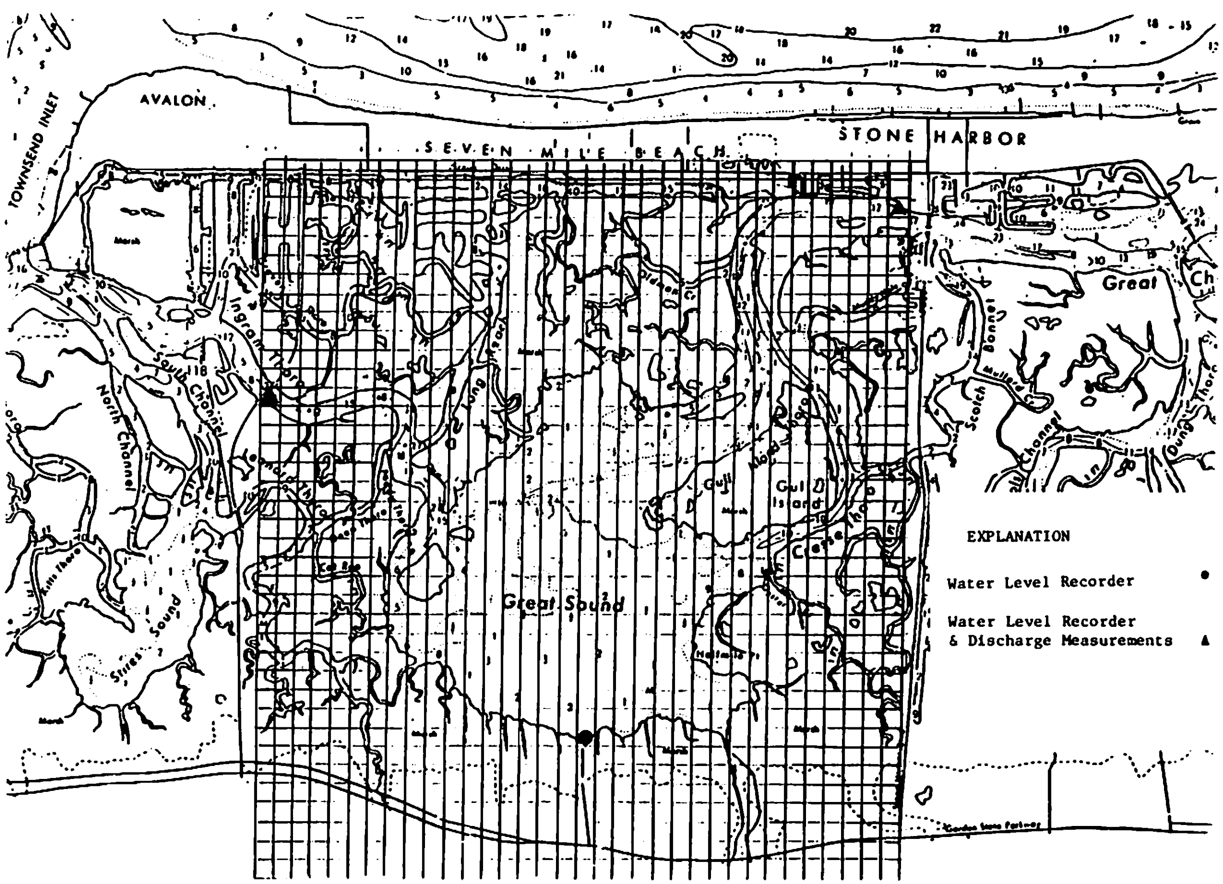

Figure 1. Model of Great Sound With a Cell Size of 500' by 500'

vertical datum (National Geodetic Vertical Datum or NGVD). With water level recorders in operation, flow data were obtained near the two bridge sites using a Gurley-Price saltwater current meter. Upon data reduction, the field work yielded simultaneous stage and flow hydrographs at the above mentioned locations for both neap and spring tides. These data were acquired while other investigators were simultaneously obtaining velocity, bathymetry, and sediment data (Carson, Ashley, Hall and Nadeau). Some of the data are shown in Figures (2), (3a), and (3b).

Figure (2) shows simultaneous water level data for a neap tide at the three water level stations. Figures (3a) and (3b) show flow rate hydrographs at the two discharge measurement locations.

At the end of the first year, the hydrodynamic model was calibrated for the 1983 neap tide data. Figure (4) depicts a current pattern throughout the system and Figure (2) shows measured and predicted water levels at Reuben's Wharf during neap tide.

From these results it can be seen that the model accurately simulates neap tide conditions in Great Sound. Further calibration for the more difficult spring tide, in which wetland areas are inundated, is the next task.

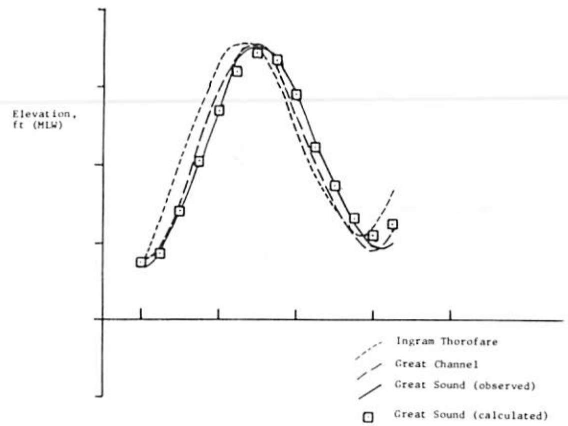

Figure 2. Model calibration using neap tide water level measurements

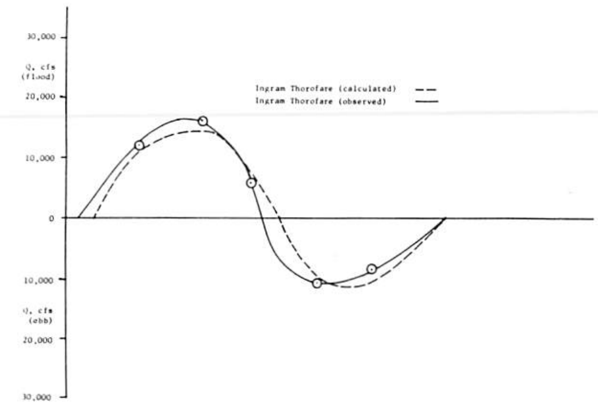

Figure 3b. Model Calibration Using Discharge History at Ingram Thorofare

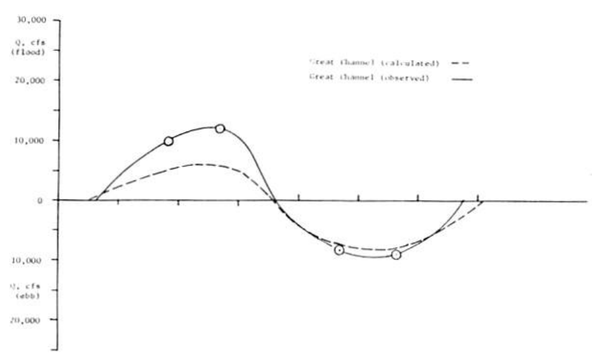

Figure 3a. Model Calibration Using Discharge History at Great Channel

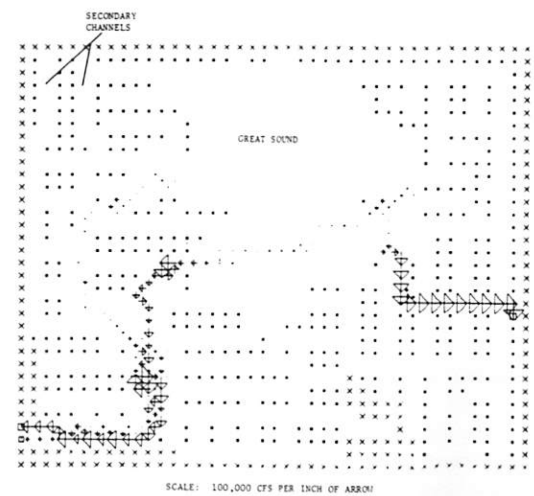

Figure 4. Flow Map of Great Sound

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FLOW CHARACTERISTICS AND SEDIMENT FLUX IN THE GREAT SOUND SECTION OF THE INNERCOASTAL WATERWAY: THE ROLE OF TIDAL CHANNELS IN SEDIMENT DISPERSAL IN A BACK BARRIER SALTMARSH

G. Ashley and M. Zeff

The southern coast of New Jersey consists of a series of developed barrier islands backed by salt-marshes. The wetlands here are important areas of recreation and navigation (the Intercoastal Waterway crosses the marshes), and they serve as breeding and nursing grounds for wildlife as well.

Little is understood about the natural processes active within the back-barrier salt-marsh environment, however, knowledge of flow characteristics and sediment flux is critical for proper management of this valuable natural resource. A 3-year research project designed by Dr. Gail M. Ashley (Rutgers University) and assisted by Marjorie L. Zeff (a PhD student at Rutgers), has been undertaken to assess the different roles played by the various tidal channel types that dissect the marshes of Stone Harbor, New Jersey and to characterize sediment dispersal patterns throughout the back-barrier environment.

Branching networks of tidal channels of a variety of dimensions traverse the marshes (fig. 1). The 2 largest, or primary, channels of the study area are Ingram Thorofare and Great Channel. They lead from Townsend Inlet in the north and Hereford Inlet in the south, respectively, to shallow Great Sound. Secondary and tertiary channels, smaller segments branching off the primary channels, penetrate the marsh interior (fig. 2). The erosion and transport of sediment through these channels, under the influence of tidal flow, lead to a complex sedimentary framework.

Figure 1. Aerial view of the back-barrier environment of Stone Harbor, N.J. illustrating the various sizes of meandering channels. Great Sound is in the background.

The first year of this 3-year project was aimed at systematically investigating water movement and sediment flux through the 2 primary channels. Field data were collected during the spring and summer of 1983. Velocity profiles, suspended and bedload sediment samples, transmissometer readings, and depth sounding records were taken in Ingram Thorofare and Great Channel over complete tidal cycles and under both spring and neap tidal conditions.

The synchronous collection of data types over a tidal cycle permitted the temporal correlation of variations in water flow strengths and the sediment load. This was accomplished in both ebb and flood directions. In addition, spatial variations within each channel were determined by the collection of data at the thalweg (deepest portion) and at 2 channel margin locations.

Ingram Thorofare leads to Great Sound from Townsend Inlet and Great Channel connects Great Sound and Hereford Inlet. Ingram Thorofare had higher flow velocities than Great Channel and maintained the presence of bedforms while Great Channel did not. The tidal prism of Hereford Inlet, however, is twice that of Townsend Inlet. This suggests that perhaps a large proportion of the flow passing through Townsend Inlet is projected directly into Great Sound while that of Hereford Inlet is diverted into the smaller subsidiary channels.

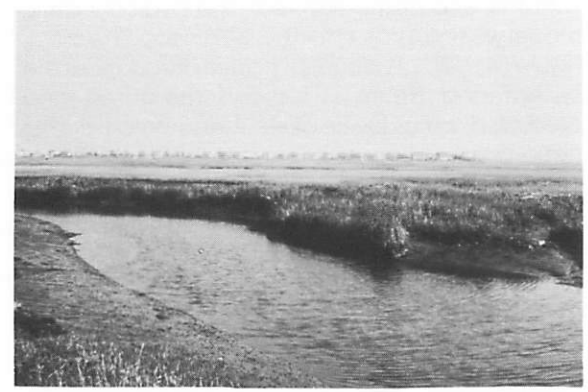

Figure 2. Smaller, subsidiary channel at low tide. Note the exposed mud flat at left.

Velocity measurements in the primary channels show both to be flood-dominant and to exhibit very little time-asymmetry (fig. 3). Peak velocities in both channels were recorded on the inside of meander bends and occurred during spring tides. Higher velocities were encountered in Ingram Thorofare with a maximum of 90 cm/sec. Both channels generally follow logarithmic trends in velocity profiles through the water column. The analysis of velocity profiles has yielded shear stress values which will be used to quantitatively relate current velocities to bedload transport.

The velocities reached in the primary channels are competent to support bedload transport, in ebb and flood flow directions, consisting of over 95% medium sand and 5% shell debris. Instantaneous bedload transport appears to correlate with flow velocities and maximum values were measured during the ebb. Flood-oriented bedforms, however, were found in Ingram Thorofare (fig. 4). The nature of the relation between flow velocities, bedload, and tidal stage will be clarified with further analyses, including an evaluation of bottom shear stresses. The data obtained thus far demonstrates that sand moved landward through tidal inlets is being carried via primary tidal channels through the marsh to Great Sound.

The total suspended sediment load is low (7-33 mg/L), uniform with depth, greatest at spring tide, and increases late in the ebb cycle (fig. 3). The increase in the concentration of the finer sediments carried in suspension during the ebb cycle is likely due to the contribution of sediment draining off the

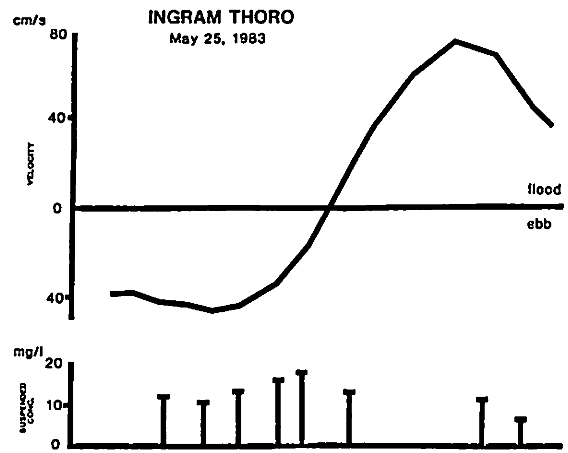

Figure 3. Time-velocity data and concurrent suspended sediment load in Ingram Thorofare thalweg during a spring tide.

marshes directly into the primary channels and entering via subsidiary channels. This is in addition to the supply of fines from the erosion of channel margins and resuspension of channel bottoms as ebb velocities increase, much of which may be supplied from the smaller channels.

The results of the first year of this study show the primary channels to be important conduits of sand transport in the salt-marshes of Stone Harbor, yet the dispersal pattern of the sand and finer sediment is not clear. It is apparent that the role of the smaller subsidiary branches of the system must be taken into account in order to accurately describe sediment movement. Therefore, the second year of this project will extend the data base and include similar hydraulic and sediment data collected from secondary and tertiary channels. The temporal and spatial relationships of water velocities and sediment load characteristics in these channels will be fully integrated with the data from the primary channels. A comprehensive characterization of sediment movement will be complete after the third year of work when summer/winter and storm/fair-weather dynamics are evaluated.

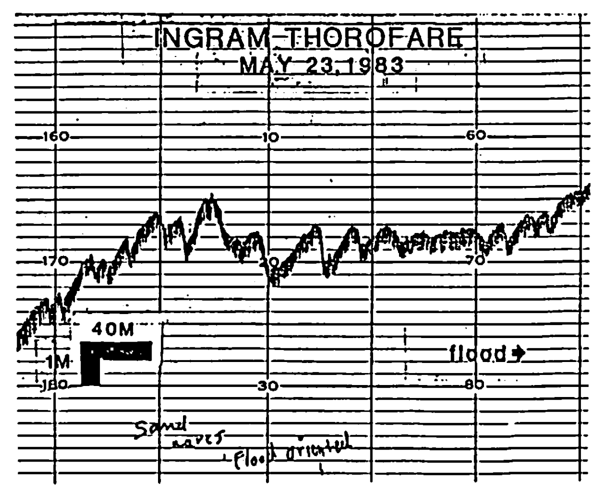

Figure 4. Depth sounding record of flood-oriented bedforms in Ingram Thorofare.

NEW JERSEY
MARINE SCIENCES
CONSORTIUM

TRACING POLLUTANTS USING TRACE METALS ASSOCIATED WITH SEDIMENTS IN THE LAGOONS OF SOUTHERN NEW JERSEY

M. Hall and J. Nadeau

Great Sound is located in southern New Jersey behind the barrier island between Hereford Inlet and Townsend Inlet (Figure 1.). Great Sound was selected for intensive study since the fresh water inlet is minimal or non-existant and some prior information and historical studies had been completed previously.

LOCATION MAP

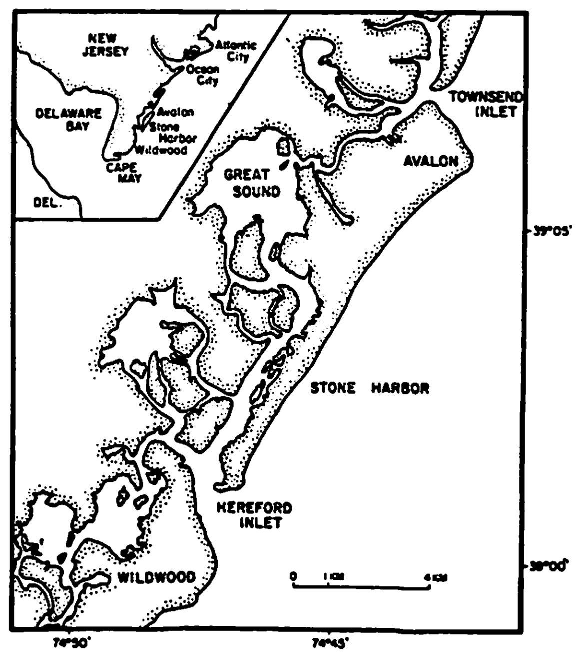

Figure 1.

During the initial year of this investigation the primary goals were to: 1.) define the source of the sediments in the coastal and lagoonal complex, 2.) determine the areal distribution of selected trace metals within Great Sound, and 3.) determine the vertical distribution from core sites within Great Sound.

Previous work had been completed, or was nearly completed, by the authors and several students in the nearshore environments of southern New Jersey. Trace metals had been used to establish the existence of a plume which, under certain conditions, moved sediments from Delaware Bay northward into the shallow marine environment in southern New Jersey.

Fifty-four bottom sediment samples were collected using a Ponar grab sampler from sites within the Great Sound complex (Figure 2.). Splits of each

BOTTOM SEDIMENT COLLECTION SITES

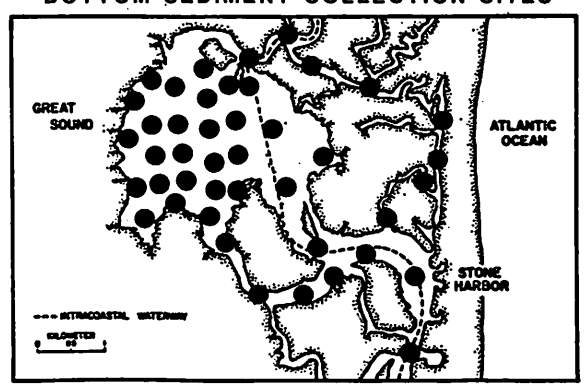

Figure 2.

sample were furnished to Dr. Bobb Cason of Lehigh University for grain size analysis. Bathymetry data was also collected to allow calibration of the computer model developed by Lennon and Weisman. Each of the samples collected was split for archive, metal digestion, and mercury digestion. Atomic absorption was used to analyze the samples for Ag, As, Cd, Cr, Cu, Fe, Ni, Pb, and Zn. Flameless atomic absorption was used to determine the concentrations of Hg present in the samples.

AREA OF METAL CONCENTRATION

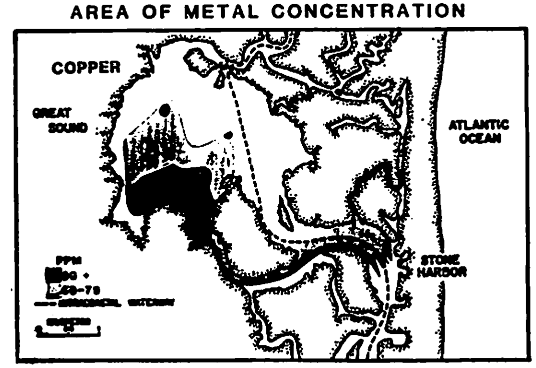

Figure 3.

Aerial distributions reveal that higher concentrations of all metals considered in this work were associated with the southern access route to Great Sound via Gull Island Thoroughfare. Copper (Figure 3.) and lead (Figure 4.) distributions, for example, are typical of the areal metal concentration in the fifty-four grab samples collected from the system. Concentrations (Table 1.) are compar-

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MARINE SCIENCES
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able to those in the shallow marine environment and suggest that some of the materials have been brought into the Great Sound system by tidal activity. This is further supported by the distribution of higher metal levels in the southern access area even though the major flow volume of water now enters from the north.

AREA OF METAL CONCENTRATION

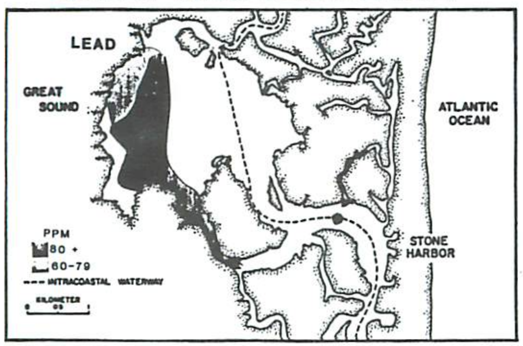


Figure 4.

ELEMENT	MEAN	RANGE
Ag	21.73	0.68 to 134.13
As	0.68	0.01 to 16.12
Cd	1.15	0.01 to 2.74
Co	9.85	0.00 to 28.26
Cu	71.66	3.96 to 328.39
Fe	1135.64	685.38 to 1490.74
Hg	2.86	0.03 to 15.87
Pb	49.55	1.79 to 227.24
Zn	121.33	62.31 to 197.81

TABLE 1.

Six cores were collected from sites in Great Sound (Figure 5.) in conjunction with Chuck Nittrauer of North Carolina State University. Splits were used from grain size study, for lead dating to support accumulation rate, and for metal concentrations determined in this phase of the investigation. Cores were separated into five centimeter increments and metal concentrations determined as previously

CORE SITES

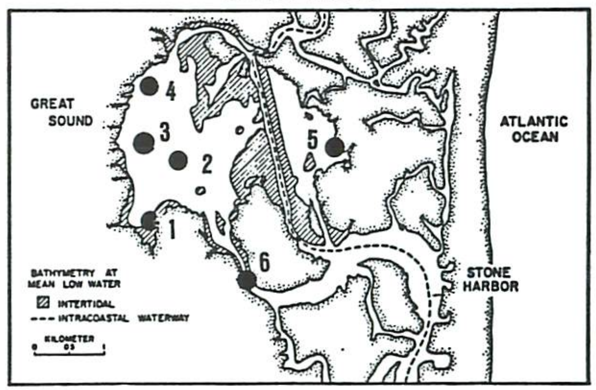


Figure 5.

described. Vertical distributions produced data that is difficult to interpret. Normally, it is expected that higher concentrations of metals would be associated with the shallower depths within the sediment column reflecting the increasing cultural input to the system. In this case, metal distributions do not conform to the expected pattern (Figure 6.) but, rather, occur in multiple peaks within each core as demonstrated by the copper and lead concentrations presented. The other metals follow

METAL CONCENTRATIONS WITH DEPTH

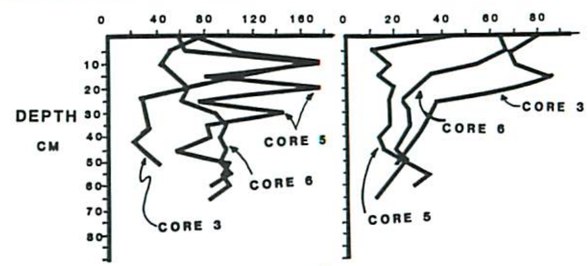


Figure 6.

CORE 1
METAL CONCENTRATION
PPM

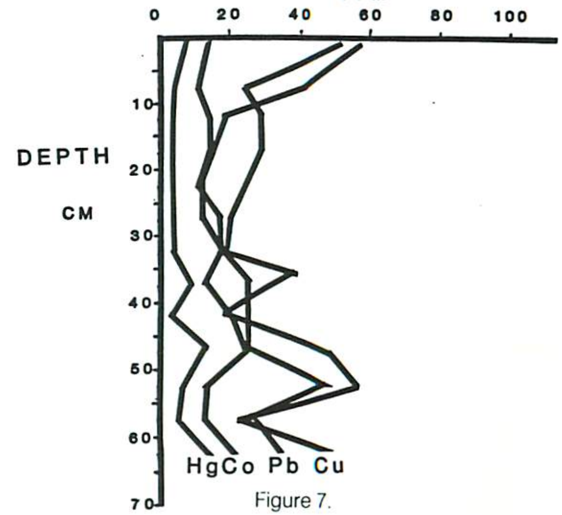


Figure 7.

this general pattern though the patterns are not consistent from core to core. Within a single core the vertical distribution pattern is more consistent (Figures 7 and 8.). Metals within core number one (Figure 7.) decrease in concentration with depth as is typical until 50-55 cm. of depth when another major peak is obvious. When the same metals in core number four (Figure 8.) are evaluated, the second peak occurrs at 20-25 cm. in depth and might be attributed to tube worm activity. At 50-55 cm. depth, in the same core, another peak may be observed. At this point in time, interpretation of this information in uncertain and continuing.

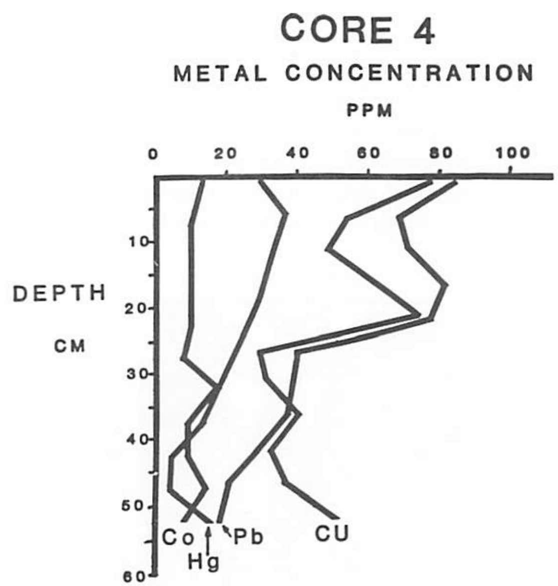
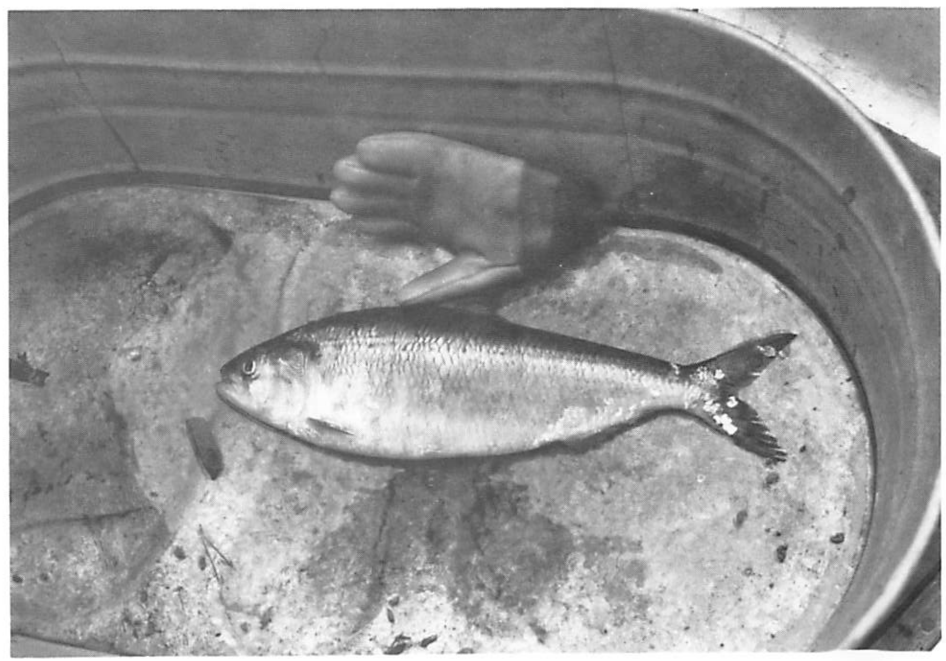


Figure 8.

In summary, the source of the sediments which now fill Great Sound is suggested to be a mixture of materials derived from suspended sediment moved out of Delaware Bay and northward along the shore where it is mixed with older clays and organic material before being deposited in Great Sound. The major access of sediment is through the southern reaches of Great Sound as indicated by areal metal distribution patterns. Vertical distribution patterns of metals from cores from within Great Sound are complex suggesting the necessity for further study before an understanding of the system is reached.



NEW JERSEY
MARINE SCIENCES
CONSORTIUM

MARINE EDUCATION PROGRAM

The sea encompasses more than 70% of the earth. The ancestors of the many millions of inhabitants of lakes and forests emerged from the sea eons ago. The waters and the shore are barriers that are often violently attacked but seldom bridged. The ocean and beach zones are one of conflict and an arena for the development of unique lifestyles by species from both the land and the sea.

The 1,792 mile shoreline of New Jersey is, without question, one of the state's major natural resources. It is obvious that there is a pressing need to ensure the future of the beaches, estuaries, the inland waters and the living ocean that are so much a part of the Garden State. To meet this need will require wise use of these marine resources, as well as their intelligent development.

An early, positive exposure to our coastal resources is essential as a first step in educating the people of New Jersey about the value, beauty, and critical importance of these parts of their environment. Marine topics canalso be used to motivate learning in all subject areas, since the sea and its creatures have a fascination for most students which is often sadly lacking in their other studies. For these reasons, we need programs for everyone, not just future marine scientists.

The marine educational needs of New Jersey are many. New Jersey Sea Grant's goal is to provide comprehensive marine education programs tailored to the needs of New Jersey. Our programs are designed to educate citizens through pre-college, college and public programs aimed at those not involved with marine related fields.

SPECIAL STUDENT RESEARCH TOPICS ON NEW JERSEY MARINE AFFAIRS

NEW JERSEY MARINE SCIENCES CONSORTIUM

D. Morell and J. Highland

Princeton University's Center for Energy and Environmental Studies continues to support several university departments independent senior thesis and other independent student research projects related to marine affairs in New Jersey. By so doing, highly qualified Princeton students are encouraged to examine issues of marine science in New Jersey; and the quality of their research is enhanced. As a result, our knowledge about New Jersey's marine environment, the pool of individuals knowledgeable on this subject, and the number of students interested in marine careers also increases.

Student research may cover a wide range of coastal topics relevant to New Jersey, and students from any of the university's departments may apply. In each case, students requesting research support under this program submit a brief proposal and supporting budget to Dr. David Morell, the Principal Investigator.

Results of this activity are in the form of student research reports, primarily senior theses, but also include some doctoral dissertations, junior independent papers, and graduate or undergraduate student coursework papers. Where appropriate, these papers are reproduced as formal Working Papers or Reports of the Center for Energy and Environmental Studies, thereby available for wide distribution to interested users in government, industry, academia, environmental groups, and the public at large. Through this mechanism, new information about marine affairs in New Jersey should reach a broader audience.

This effort has been funded by New Jersey Sea Grant as a marine education project for the past four years. The following are the independent student research projects completed in the 1983-84 academic year with some financial assistance from N.J. Sea Grant:

1. Joseph Ryan, '83 Geological Engineering
   "Nutrient Behavior in the Raritan River Estuary, New Jersey"
2. Bradley T. Wendler, '83 Department of Geological and Geophysical Sciences
   "A Survey of the Raritan River Bottom Sediments"
3. Vivien Li Master's Candidate, Woodrow Wilson School
   "Regional Planning in the Hackensack Meadowlands and Along the New Jersey Coast"
4. Ann S. Maest, Ph.D. 1983, Department of Geological and Geophysical Sciences
   "The Geochemistry of Metal Transport in Low and High Temperature Aqueous Systems"
5. Jeanne Panek, '84, B.A. Biology
   "A Study of Lichens as Indicators of Air Pollution in the New Jersey Pine Barrens"

NEW JERSEY
MARINE SCIENCES
CONSORTIUM

RESEARCH PAPERS IN MARINE LAW

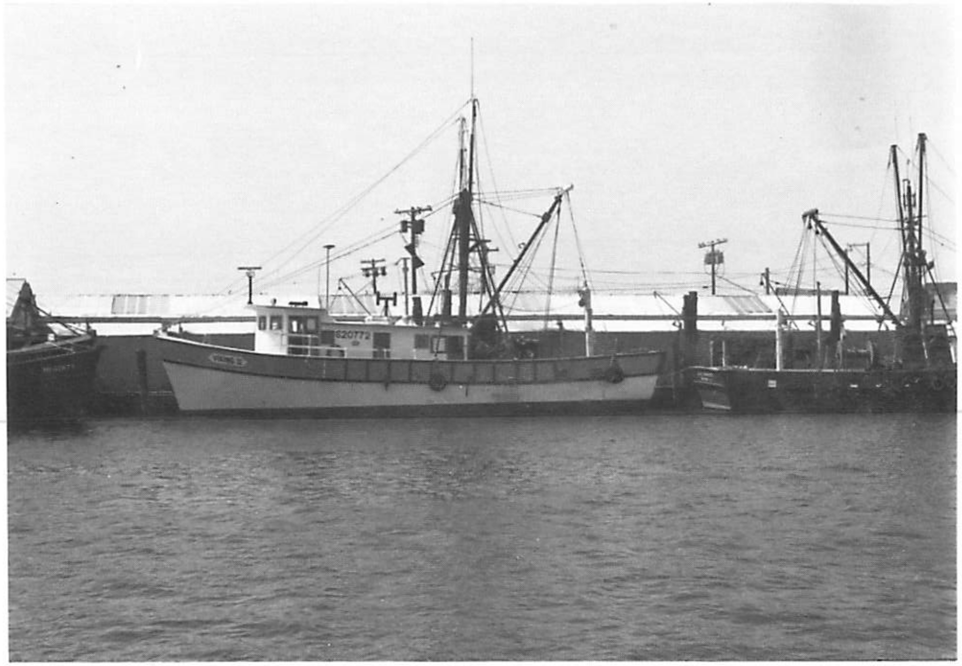
A. Wypyszinski

In order to stimulate legal research in marine affairs, hopefully with a focus on state or regional problems, the New Jersey Sea Grant Extension Service Director and Coastal Law Specialist, Alex Wypyszinski, implemented a law student writing competition through the Sea Grant Program. The short-term objective is to identify to both students and faculty the New Jersey Sea Grant Program, the New Jersey Marine Sciences Consortium, and the important need for this type of research. Long-term objectives which could be accomplished by this program are provision of the impetus for development of a law school course offering in ocean and coastal law, as well as development of a better educated legal community; more aware of the legal issues and problems related to the many facets of marine affairs.

Legal writing is an integral part of a law student's education. Usually, a major written work or at least some evidence of facility in legal writing is a requirement for graduation. While the choice of topics is normally not extensive there is some flexibility. Established graduate law programs at the University of Washington and the University of Miami law schools require a major writing effort on a marine affairs topic. Furthermore, similar legal writing competitions presently exist in other areas of the law; e.g., the Letourneau Award given for the outstanding paper on a legal-medicine topic.

Papers submitted in conformity with the promulgated rules for this project are reproduced and distributed to members of the Student Awards Committee. This committee is presently composed of four attorneys, each a graduate of the Marine Affairs program of the University of Washington School of Law and each employed in some aspect of the marine affairs specialty. The committee chooses winners by consensus.

In 1984, the New Jersey Sea Grant Law Award was received by Mr. Michael Orey, of Ann Arbor Michigan. Mr. Orey holds a J.D. from University of Michigan. His original paper submitted in the competition was "The Reagan Administration and the Law of the Seas Treaty".

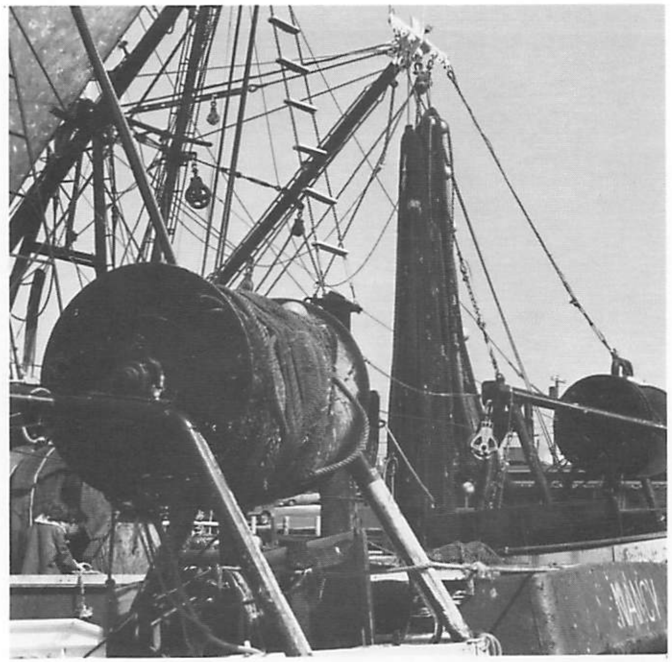


NEW JERSEY
MARINE SCIENCES
CONSORTIUM

ADVISORY SERVICES

More than one-sixth of New Jersey's land area is classified as "coastal." It is vitally important, therefore, to see to it that this fragile environment be protected, maintained, and conserved. The tremendous pressures placed on the marine related resources — the beaches, marshes, and estuaries — require careful and considered decisions concerning their multiple uses.

In 1976, a full decade following the inception of the federally-funded Sea Grant Program of the National Oceanic and Atmospheric Administration, U.S. Department of Commerce, New Jersey joined the national effort. Under the Sea Grant Program managed by the New Jersey Marine Sciences Consortium, the New Jersey Sea Grant Extension Service (SGES) operates as part of the Cooperative Extension Service at Cook College, Rutgers, The State University of New Jersey.



With a methodology similar to the highly successful, experienced and visible land-grant agricultural program, SGES is a natural component of the Cooperative Extension Service. The tripartite philosophy of both land-grant and sea-grant is based on the integration and articulation of teaching, research, and extension. This is the unique feature of the educational programs and projects of the Extension Services, and responsible for their proven effectiveness in the application of research to practical situations in a relatively short time frame.

The goal of SGES is quite simple and direct: To inform the citizens of New Jersey and other user groups of the value of coastal resources and the need to promote the intelligent management of these resources.

Acting on the principle that only can an informed public act in a responsible manner, SGES facilitates the flow of information to assist in the maintenance of the quality of the marine environment as it accepts and responds to intensive use.

NEW JERSEY SEA GRANT EXTENSION SERVICE

NEW JERSEY
MARINE SCIENCES
CONSORTIUM

A. Wypyszinski

This reporting period covers the fifth year of its engagement with the N.J. Marine Sciences Consortium and the N.J. Cooperative Extension Service at Cook College, Rutgers, the State University. It embraces, in addition, the first full year under the direction of its former coastal law specialist.

SGES has maintained a consistent, enthusiastic and experienced approach in its educational mission of transfering knowledge and information concerning the State's extensive marine resources.

This year saw the expansion of the staff to include a full-time recreation agent—and the planning for a marketing specialist. There is such a thing as "critical mass"; SGES continues to strive for that situation, providing it with the ability to respond to the varied needs of its constituents.

Our marine agents, stationed at Toms River and Cape May, continued to operate professionally with the commercial fishing interests. Much time was devoted to assisting researchers in the area of solid and waste water treatment from surf clam processing. Major focus was on the recovery of protein wastes for use as a standardized protein source for manufacture of aquaculture feeds. Interest also centered on the feasibility of using salt marshes for the removal of wastewater pollutants, rather than the current practice of discharging these waters into the estuaries—a practice that must terminate.

The director of SGES has been instrumental in stimulating interest in a marine legal project at Seton Hall Law School. He has been the driving force behind the Sea Grant Law Award, with funding anticipated for another year. Working with the Rutgers Small Business Development Center in Newark, he has held discussions concerning tax and financial information, development of fishing joint ventures and expansion of international markets of New Jersey seafood.

The Cape May agent was one of the observers on board the NMFS sponsored cruise of the Polish fishing vessel, Admiral Arciszewski. This vessel was allowed to fish for mackerel in U.S. waters in exchange for collection of data on mackerel stocks and habits. He was also heavily involved in crab shedding, to emphasize increase in peeler harvests and to explore new markets in our region for soft crabs. The first experimental squid fishing trip with the Mid-Atlantic Foundation's new Mid-Water Trawl Net, coupled with a new temperature probe, was used for squid/temperature relationships. The summer program of comparing samples of squid held in chiled seawater and squid packed in ice resulted in variable bacteria levels. However, chiled seawater held squid exhibited better organoleptic properties.

Fishermen in New Jersey, and as distant as Maine and North Carolina, have reported improved catches and fuel savings from subscribing to a satellite reporting service provided by SGES. The success of this three-year program resulted in its transfer to a private company, SGES having proved its value. This was a project of our Toms River agent, along with his interest in marketing. He developed a popular NEW JERSEY CLAM CHOWDER recipe, to help our clammers. THis was the subject of the third in our Marine Cuisine series to help consumers appreciate the value of seafood. This agent's horizons were expanded by his participation in the Paris International Food Show. He also worked with broken shell obtained from a Cape May clam processing plant to be used as cover over hatcher-raised hard clams to decrease predation and increase survival.

On the communications front, the entire staff made significant contributions. The Second Annual Seafood Festival was held at Cape May, with the marine agent totally involved. About 3,000 people attended and consumed about 500 pounds of fried squid, shark and clam strips. Printed material for broad distribution included a paper place mat illustrating the major species of fin and shell fish common to the New Jersey coast, with the theme, "The Shortest Distance Between Catchin' and Kitchen is New Jersey!"; a new series, entitled Sea Notes, prepared by our recreation agent, including a fishermen's calendar AQUA-LINES, a birding calender SAND PIPER, and a fishermen's temperature chart CATCH 'EM ...BY DEGREES.

The second fresh seafood marketing workshop for retailers was held, although the attendance was somewhat less than the previous year. Nevertheless, the high caliber of presentations fully compensated.

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CONSORTIUM

SGES maintained its excellent relationships with the Bi-State Seafood Quality and Promotion Group of the Port Authority of NY/NJ, the state departments of Agriculture and Environmental Protection and other public agencies. Its major publication, THE JERSEY SHORELINE, continues to interest its readers, as indicated by an increase in circulation.

As the year came to a close, it was clear that SGES had kept true to its mission, with a noticeable maturation, due primarily to the experience and commitment of its small, but dedicated, staff.

Who's On Board

At present, the Sea Grant Extension Service consists of the following individuals whose expertise is available to provide educational and informational assistance to marine researchers, marine resource users, teachers, consumers and citizens throughout the state.

Alex Wypyszinski, Director/Coastal Law Specialist
Cook College, 201-932-9636
P.O. Box 231, New Brunswick 08903

Chester Teller, Communications Coordinator
Cook College 201-932-9498
P.O. Box 231, New Brunswick 08903

Gef Flimlin, Marine Extension Agent
Ocean County Agricultural Center, 201-349-1152
Whitesville Rd., Toms River 08753

Kim Kosko, Communicator
Building 22
Sandy Hook Station 201-872-1300
Fort Hancock, New Jersey 07732

Stewart Tweed, Marine Extension Agent
Cape May Extension Center, 609-465-5115
Dennisville Rd., Cape May Court House 08210

John Tiedemann, Marine Extension Agent
Southern Ocean County
Resource Center 609-597-1500
Recovery Rd., Manahawkin 08050

PUBLICATIONS

NEW JERSEY MARINE SCIENCES CONSORTIUM

FISHERIES PROGRAM

Cali, A. and P.M. Takvorian (1983). Environmental variability as reflected in *Glugea stephani* incidence in winter flounder, (Pseudopleuronectes americanus). ICES symposium on Mar. Env. Qual., Sweden.

Grimes, C.B., S.C. Turner and K.W. Able. (1983). A technique for tagging deep water fish. Fish Bull. 81(3):663-666.

Hood, P.B., K.W. Able and C.B. Grimes. (1983). Reproductive biology of the Conger Eel, *Conger oceanicus*, in the Mid-Atlantic Bight. Annual Meeting of American Society of Ichthyologists and Herpetologists.

Katz, S.K., C.B. Grimes and K.W. Able. (1983). Delineation of tilefish, *Lopholatilus chamaeleonticeps*, stocks along the U.S. east coast and in the Gulf of Mexico. Fish. Bull. 81(1):41-50.

Lutz, R. and D. Jablonski. (1983). Larval ecology of Mamine benthic invertebrates: palebiological Implications. Biol. Rev. 58:21-89.

Lutz, R. (1984). Paleoecological implications of environmentally-controlled variation in molluscan shell microstructure. GeoBios. 8:93-97.

Lutz, R. and G.R. Clark II. (1984). Seasonal and geographic variation on the shell microstructure of a salt-marsh bivalve, *Geukensia demissa (Dillwyn)*. Journal of Marine Research. 42:943-956.

L.W. Fritz, R. Lutz, M.A. Foote, C.L. Van Dover and J.W. Ewart. (1984). Selective feeding and grazing rates of oyster *Crassostrea virginica* larvae on natural phytoplankton assemblages. Estuaries. 4B:513-518.

McCay, B. (1984). The pirates of piscary: ethnohistory of illegal fishing in New Jersey. Ethnohistory. 31(1):17-37.

McCay, B. and W. Jenks. (1984). New Jersey's hard clam relay program. Prepared for Hard Clam Management Alternative Working Group. SUNY, 14 pp.

Takvorian, P.M. and A. Cali. (1984). Seasonal prevalence of the microsporidan, *Glugea stephani* in winter flounder, *(Psuedopleuronectes americanus* from the N.Y.-N.J. lower bay complex. J. Fish Biol. 24:655-663.

NORTHERN ESTUARINE PROGRAM

Burger, J., M. Gochfeld and C. Leck. (1984). Waterbirds on Raritan Bay: A preliminary analysis of their distribution and heavy metal levels. Bull. N.J. Acad. Sci. 29(2):133-142.

Hires, R.I., L.Y. Oey, G.L. Mellor. (1984). Numerical model study of the tidal hydraulics of Raritan Bay. Bull. N.J. Acad. Sci. 29(2):59-68.

Multer, H.G., D.M. Stainken, J.M. McCormick, K.J. Berger. (1984). Sediments in the Raritan Bay-lower New York Bay complex. Bull. N.J. Acad. Sci. 29(2):79-96.

Stainken, D.M., J.M. McCormick, H.G. Multer. (1984). Seasonal survey of the macrobenthos of Raritan Bay. Bull. N.J. Acad. Sci. 29(2) 121-132.

COASTAL SYSTEMS PROGRAM

Gabriel, R.J., G.P. Lennon and R.N. Weisman. (1983). Hydraulics of the Hereford Inlet and back bay system. Fritz Engineering Lab Report No. 477.1.

MARINE EDUCATION PROGRAMS

Li, Vivien, Masters' Candidate, Woodrow Wilson School "Regional Planning in the Hackensack Meadowlands and Along the New Jersey Coast"

Meast, Ann S., Ph.D. 1983, Department of Geological and Geophysical Sciences "The Geochemistry of Metal Transport in Low and High Temperature Aqueous Systems"

Panek, Jeanne, '84, B.A. Biology "A Study of Lichens as Indicators of Air Pollution in the New Jersey Pine Barrens"

Ryan, Joseph, '83 Geological Engineering "Nutrient Behavior in the Raritan River Estuary, New Jersey"

Wendler, Bradley T., '83 Department of Geological and Geophysical Sciences "A Survey of the Raritan River Bottom Sediments"

SEA GRANT EXTENSION SERVICE

Flimlin, G. 1984. Is The Fishing Industry Floundering? MODC. pp. 8-9.

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Tiedemann, J. 1985. Sea Note Series No. 2, Sandpiper-A Birding Calendar for Coastal New Jersey. Sandy Hook, N.J.

Tiedemann, J. 1985. Sea Note Series No. 3. Catch 'em by Degrees-Fisherman's Temperature Chart for Coastal New Jersey. Sandy Hook, N.J.

Tiedemann, J. 1985. An Annotated Listing of Field References for Coastal N.J. 9 pgs. NJSG Pub No. NJSG-85-140.

NEW JERSEY
MARINE SCIENCES
CONSORTIUM

ACTIVITY BUDGET

ACTIVITY BUDGET SHEET (Summary Totals by Activity)

	NOAA Grant Funds	University Matching Funds
MARINE RESOURCES DEVELOPMENT	73,000	126,400
Living Resources	73,000	126,400
MARINE LAW AND SOCIO-ECONOMICS		
Socio-Political Studies	13,000	7,000
	13,000	7,000
MARINE ENVIRONMENTAL RESEARCH		
Research in Support of Coastal Management Decisions	117,000	93,000
Pollution Studies	0	69,900
Environmental Models	0	122,200
	117,000	285,100
MARINE EDUCATION AND TRAINING		
College Level	4,500	4,100
	4,500	4,100
ADVISORY SERVICES		
Extension Program	129,400	132,800
	129,400	132,800
PROGRAM MANAGEMENT AND DEVELOPMENT		
Program Administration	117,200	102,500
Program Development	0	20,000
	117,200	122,500
TOTAL	454,100	677,900

	DRBA	University/ Sea Grant Matching Funds
BISTATE DELAWARE ESTUARY PROJECT		
NEW JERSEY COMPONENT (NJMSC)	20,000	94,500
Aquaculture	10,900	192,500
Applied Oceanography		
TOTAL	30,900	287,000

NEW JERSEY MARINE SCIENCES CONSORTIUM

PROGRAM SUMMARY

MARINE RESOURCES DEVELOPMENT

Living Resources

R/F-7
Identification of Bivalve Larvae: A Multi-Institutional Approach.
Dr. R.A. Lutz, Rutgers University

R/F-8
Development of a Fishery for the Underutilized American Conger Eel
Dr. K.W. Able and Dr. C.B. Grimes, Rutgers University

R/F-11
Incidence and Development of *Glugea stephani* in Field Collected and Laboratory Infected *Psuedopleuronectes americanus* (winter flounder)
Dr. A. Cali and Dr. P. Takvorian, Rutgers University

MARINE LAW AND SOCIO-ECONOMICS

Socio-Political Studies

R/F-3
Socioeconomic Evaluations of Innovations in Fisheries
Dr. B.J. McCay, Rutgers University

MARINE ENVIRONMENTAL RESEARCH

Research in Support of Coastal Management Decisions

R/S-5
Sediment Characteristics and Recent Accumulation Rates: Determination of Variables Required for a Numerical Simulation of Modern Sedimentation in Salt Marsh Complex of Southern NJ
Dr. B. Carson and Dr. J. Parks, Lehigh University

R/S-6
Hydrodynamic Model of an Inlet-Sound System in Southern NJ
Dr. G.P. Lennon and Dr. R.N. Weisman, Lehigh University

R/S-7
Flow Characteristics and Sediment Flux in the Great Sound Section of the Intercoastal Waterway (Avalon-Stone Harbor)
Dr. G.M. Ashley, Rutgers University

R/S-8
Tracing Pollutants Using Trace Metals Associated with Sediments in the Lagoons of Southern NJ
Dr. M.J. Hall and Dr. J. Nadeau, Rider College

Pollution Studies

R/E-6
An Interdisciplinary Investigation of Nitrification in Raritan Bay
Dr. H. Simpson, Dr. B. Deck, Dr. H. Ducklow, Lamont-Doherty Geological Observatory
Dr. F. Cantelmo, St. John's University

MARINE EDUCATION AND TRAINING

College Level

E/T-2
Special Student Research Topics on NJ Marine Affairs
Dr. D. Morrell and Dr. J. Highland, Princeton University

E/T-3
Research Papers in Marine Law
A. Wypyszinski, Esq.

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Extension Programs

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BISTATE DELAWARE ESTUARY PROJECT

Aquaculture

R/F-14
Oyster Quality on Delaware Bay Planted Grounds and Its Relationship to Environmental Factors
Dr. H. Haskin and Dr. W. Canzonier, Rutgers University

Applied Oceanography

R/E-8
Physical Oceanographic Studies in Delaware Bay and River
Dr. G.L. Mellor, Princeton University
Dr. R.I. Hires, Stevens Institute of Technology

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Program Management

M/M-2
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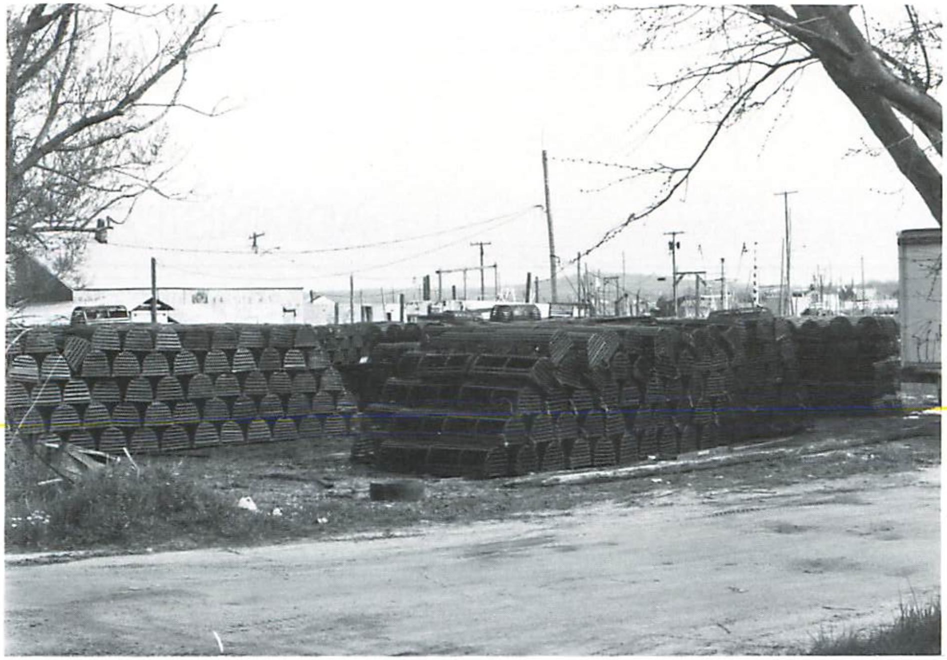

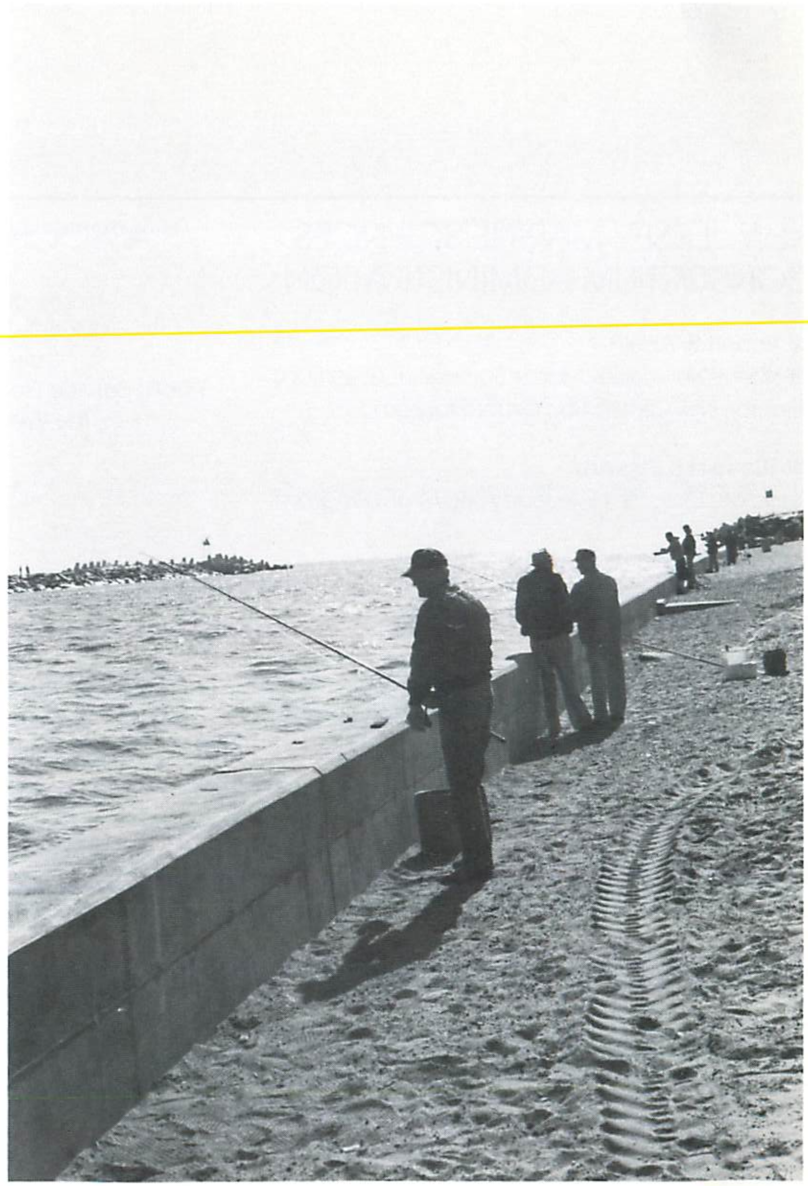

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