RETROSPECTIVE ASSESSMENT OF THE RETIRED DIRECTOR

By Victor E. Scottron

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THE
UNIVERSITY OF
CONNECTICUT

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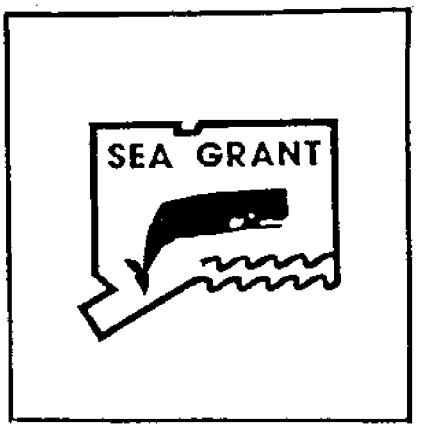

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Victor E. Scottron, former Director of Connecticut Sea Grant (1980-1985) was Associate Dean of the University of Connecticut School of Engineering from 1967 to 1969. He was also Director of the Institute of Water Resources.

RETROSPECTIVE ASSESSMENT OF RETIRED DIRECTOR

INTRODUCTION

In 1985, the Marine Campus at Avery Point continued its move forward with the selection of Dr. Donald F. Squires as director of Marine Sciences. Both the Connecticut Sea Grant Program and the National Undersea Research Center are parts of the expanded Marine Sciences Institute.

During the Spring of 1985, Dr. Richard Cooper was selected to head the 12-state program in cold-water undersea research as director of the National Undersea Research Program, University of Connecticut at Avery Point. Norman K. Bender became the program leader for the Marine Advisory Program, and served as acting director of the Connecticut Sea Grant Program until Dr. Edward C. Monahan arrived as director in early 1986. As is detailed later in this report, the Sea Grant Program continued to expand and diversify. This resulted in the designation of the Connecticut Sea Grant Program as a Sea Grant Institute.

The fiscal year 1984-1985 included a number of both project completions and new project initiatives. The hard- and soft-clam research projects which had started the program reached completion. The educational project for gifted high school students introduced minority students to marine sciences. The television program on marine weather problems produced a video film called "Eye on the Maritime Sky" as its final report. New to Connecticut were two fellowships: a Sea Grant Fellowship in marine safety, which was supported by the Coast Guard, and a first Congressional Fellowship supported by the National Sea Grant Program.

Several other research projects were started, making careful use of a combination of federal and state funding. These included studies on hormonal growth regulators for blue crabs and lobsters, the development of biomass in certain brown seaweeds, and the evaluation of tourism impact on coastal towns. A single project on dredge spoil behavior and capping procedures continued for an additional year.

The benefits of some of this research were immediate: Both clam projects are providing guidelines and techniques to improve the development of a small but growing native resource. The dredge spoil work has shown that it is possible to predict mound settlement and stability behavior and to isolate contaminants from the benthic population by capping. The compounds which regulate crustacean reproduction and development have been isolated, and their influence on the life cycle of blue crabs and lobsters is being examined. The research on brown seaweeds has succeeded in identifying fast-growing strains, and also strains

which will survive effectively in the higher temperatures existing south of Connecticut.

The Marine Advisory Program worked closely with Extension Service home economists during this period to improve its knowledge of seafood selection, handling and preparation. This was passed on to consumers via workshops and articles in newspapers. Over 3,000 recreational fishermen were shown how to maintain bluefish at marketable quality. New fishing gear technologies involving the hydraulic rake for soft-clamming and net design, handling and repair are producing annual economic benefits of more than $50,000. And nationally, more than 300 Marine Advisory Program agents are benefiting the industry by using MAP's Advisory Handbook on Fishing Management.

A RETROSPECTIVE

My own time as Director of the Sea Grant Program in Connecticut--from 1980 to 1985--covered an eventful era at both the national and state levels. It seems appropriate to document the events of this period for the benefit of those who might care to look back at some later date.

Except for a Sea Grant research proposal in the early 1970's which lasted only two years, Connecticut Sea Grant began in 1974 with a small advisory service. By 1980, this had grown to a four-person operation with $90,000 in annual federal monies. At this time, a legislative study on the uses of Avery Point made strong recommendations about marine sciences and Sea Grant. Finding Number 7, Recommendation Numbers 1, part of 2, and 3B are pertinent to Sea Grant:

"7. Connecticut has not been very successful in securing federal funds under the National Sea Grant College Program. This is due in large measure to the lack of firm funding commitment by the State to Sea Grant activities.

"1. Due to the extent and importance of the State's marine environment, the State's commitment to the marine sciences should be increased and made more explicit. (Final Report: A Study of the Feasibility of Establishing a Maritime Academy and Expanding Marine Sciences Activities in Connecticut. Board of Higher Education, Hartford, CT, November, 1980).

"2. Interaction and coordination among appropriate public and independent institutions of higher education and state and federal agencies should be improved.

"3B. The State should increase the level of financial support for the Marine Sciences, while other sources of funding, particularly federal, continue to be pursued. Additional State

support can come from the reallocation of existing resources at The University of Connecticut and the State Colleges and/or supplemental appropriations.

"The University of Connecticut should expeditiously pursue the development and submission of a 'Coherent Project' proposal for funding under the National Sea Grant Program in cooperation with other eligible parties."

This report was adopted by the Legislature and the Governor's Office. As a consequence, a Sea Grant Office was established in late 1980, with a three-quarter time Director and a full-time Assistant to the Director.

The election of President Reagan produced many budgetary uncertainties. In spite of a glowing report on Sea Grant in the Heritage Foundation Study, the Office of Management and Budget and the Congress reduced the federal budget. It was thus July, 1982 before a small Coherent Program got under way.

The present situation in Marine Sciences and Sea Grant is a result of careful study. Much careful soul-searching from 1983 on led to:

A. A short-range internal plan for growth at Avery Point;

B. An unhappy external review by Ralph Fields Associate; and

C. Many reviews of the structure and content of our Sea Grant Program.

Several major efforts and changes came out of the rather heavy interaction between the University of Connecticut and the NOAA establishment. These are:

1) The creation of the Northeast Undersea Research Center (National Undersea Research Program/University of Connecticut at Avery Point), commencing in 1983.

2) The commitment of the State and the University of Connecticut to upgrading of the Marine Sciences Institute at Avery Point.

3) The commitment to establish several upper level key positions within the Marine Sciences Institute, including Sea Grant and Undersea Research.

The improvements in the Sea Grant Program, in addition to the above commitments, led in the Spring of 1985 to designation of Connecticut Sea Grant as an Institutional Program. Sea Grant is now moving upward from the plateau of Institutional Status toward Sea Grant College level, with the fulfillment of the com-

mitments made to NOAA in 1984. The Marine Sciences Institute and other related disciplines are increasing in growth and status.

A further commitment to interdisciplinary research and broadening of the institutional base should soon create proper conditions for full Sea Grant College Status. The full scope of the current effort is illustrated in Table 1.

Educational projects and publications cut across the areas listed. The Project Oceanology study (E/T-1) guided gifted high school students in coastal oceanography and marine biology. The local Sea Grant fellowship (E/F-1) was concerned with the engineering aspects of volatile fuels in small boats. The Congressional Internship (E/F-2) involved the Oceanographic Sub-Committee of the House with its many maritime concerns.

No description of this five-year effort would be complete without acknowledgments for the assistance of a great many individuals. Senator Lowell Weicker, as the long-time champion of maritime programs, convinced the late Governor Ella Grasso that Connecticut needed Sea Grant. She in turn charged the University with the task of moving forward under its new President, John DiBiaggio. The latter, with two of his vice-presidents, Kenneth Wilson and A. T. DiBenedetto, closely monitored the development of the program at Avery Point. In more recent times, Dr. DiBenedetto (Vice President for Academic Affairs) and Dr. Fred Burke (Vice President for Graduate Education and Research) provided support and guidance from the University administration.

Meanwhile, a separate movement for support of Sea Grant was under way in the Connecticut General Assembly. Senators Richard Schneller and George Gunther sponsored studies of marine activities and appropriation bills for the Advisory Service. One of these, cited earlier, led to full support by the Legislature and Governor William O'Neill. More recent Sea Grant legislative action also has been led by Representatives Terry Bertinuson, Dorothy Goodwin, and Janet Polinsky, with support by Senators O'Leary and Skowronski, Representatives Cibes, Helfgott and Neumann.

At the national level, Senator Lowell Weicker continues to promote and defend Sea Grant and other marine programs. Senator Chris Dodd and Representatives Sam Gejdensen and Barbara Kennelly have co-sponsored reauthorization and continuation of a strong Sea Grant Act. Many other members of the Connecticut delegation were also helpful.

In order to provide effective guidance in the development of programs, a State Advisory Committee and a Program Review Committee were established at an early date. Both of these committees contributed a great deal of time and effort in moving the Connecticut Sea Grant Program to its present level.

Since the Marine Advisory Program constituted the strong base from which Sea Grant was developed at Avery Point, the Cooperative Extension Service played a major role. Particular thanks are due to Anne Rideout, Associate Director of the CES, for her efforts with the Legislature and within the University. A succession of Advisory Service leaders -- George Geer (1974-1982), Lance Stewart (1982-1984), and Norman Bender (1984-) -- have made major contributions in running effective programs and in building Sea Grant. Norman Bender carried a very heavy assignment for a year as both MAP Leader and Acting Sea Grant Director.

A great many other people at Avery Point provided valuable assistance and services which included, as a sampling: evaluation of research projects, construction of offices, provision of meeting spaces and food services. Two persons must be singled out for their cooperation: Sung Feng, past Director of the Marine Sciences Institute, for his help in developing and evaluating the research program, and James Baird, Director of the Avery Point Campus, who effectively managed the facilities and other essential operations. Last, but not least, Eleanor Minik, as Assistant to the Director, did a superb job of creating an office, masterminding an unfriendly computer system, editing reports and proposals, developing budgets and doing any other related tasks that came her way.

In all of this, the National Office of Sea Grant has been most helpful and very patient. We would like to acknowledge particularly the assistance of Ned Ostenso, Robert Shepherd, Hugh McClellan, and our Technical Monitors, Art Alexiou and Gene Fritz, for giving us the guidance necessary to reach Institutional Status.

TABLE 1

COHERENT AREAS WITHIN THE CONNECTICUT PROGRAM, 1985

	Research Areas	Extension Areas	Remarks
1. Shellfish; Aquaculture; Gear Conflicts; Fishing Gear Technology	Hard Clams Soft Clams Oysters Crustacea Seaweeds	Major Interest of Tim Visel, Lance Stewart and Peter Auster	Regional connections
2. Finfish International Fish products Fish processing Increased yield	New fish products; use of underutilized species	Major interest of Jim Wallace and Donald Kinsman (Animal Industries)	Regional connections
3. Recreational/Tourism; Charter Boats; Coastal Planning; Coastal Land Use	Coastal Town Management; Charter Boat Studies	Specialist - Marilyn Altobello and Norman Bender	Strongly regional and national
4. Economic and Fiscal Policy; U.S. Internal Revenue Service; State Tax Service; Fishing Financial Management	Oyster studies; Commercial fishing fleet	Specialist - Marilyn Altobello and Norman Bender	National in scope
5. Port and Harbor Development; Dredging and dredge spoils; Coastal Sediments; Estuarine Studies	Dredge spoil stability; Marine Sciences Biotechnology; NURP	Lance Stewart continues to write in this area as part of NURP, and Jim Wallace for Extension Services	Regional
6. Oceanographic and Atmospheric; Remote Sensing; Extreme Weather Problems; Pollutants; Trace Metal Studies	Naval Underwater Systems; Physical and chemical oceanography	Proposed by Western Conn. State Univ. and William Kennard (Natural Resources)	National and regional

RESEARCH SUMMARIES

PROJECT R/A-2:

Growth Regulators Affecting Crustacean Resources

Hans Laufer

The focus of this program was the identification of endocrine factors that regulate crustacean development and reproduction. This work included the initiation of studies on commercially important crustaceans (the lobster and blue crab) and the continuation of work on other species, including the spider crab.

This last species is a useful crustacean model for reproduction, since it undergoes several rounds of reproductive activity during one summer. Results from studies on this crustacean can then be confirmed in other species of greater commercial importance, which generally have a more restricted breeding cycle. During the first year of this project's support from Sea Grant, progress was made in the following areas:

1) Maintenance and Rearing Conditions

During the summer of 1984 at the Marine Biological Laboratory (MBL) at Woods Hole, several aspects of the rearing of crustaceans--especially blue crabs and lobsters--were investigated. Necessary collecting permits were obtained, and arrangements were made for the collection of animals by divers at MBL and commercial lobstermen. Arrangements were confirmed with Michael Syslo, the Director of the State of Massachusetts Lobster Hatchery on Martha's Vineyard, for the acquisition of larval stages. The hatchery proved to be very cooperative in supplying ovigerous females for shedding larvae during the summer. Finally, other investigators in residence at Woods Hole--both at WHOI, Woods Hole Oceanographic Institute, and MBL--were contacted to exchange ideas, experiences, facilities, and specimens.

First through fourth stage (juvenile) lobster larvae were maintained in mass culture in kreisels (that were borrowed from investigators at the MBL). It was necessary to cool the circulating seawater for this and other holding facilities during July, since mortality increased in seawater at ambient temperatures. The optimal temperature for the studies was 19° C, which was warm enough for rapid metamorphosis, but cool enough for larval survival. Surgical and treatment regimes for experiments to be carried to completion in future spawning seasons were explored.

2) The Effects of Mandibular Organs and Insect Growth Regulators on Crustacean Reproduction

The mandibular organ (MO) of the spider crab, Libinia, has been shown to contain a regulatory agent for reproduction. When MOs from large Libinia males are implanted into juvenile females, which are not normally reproductively active, the ovaries are stimulated to grow and mature. Such observations suggest a physiological role for this tissue. Since MOs produce JH-like compounds (see below), these observations also suggest an endocrine function for such organs in the regulation of reproduction. The importance of repeating and extending this experimental result to other crustaceans, including Homarus and Callinectes, is obvious. A difficulty in such experiments involves the mortality that occurs after implantation. To this end, the effect of implanting fragments or whole MOs on the survival of Libinia, Homarus and Callinectes was examined. Implants of MOs or control tissue (hepatopancreas) were made, and survival was generally good, greater than 70% in most cases, for the duration of 20 days or more in this experiment.

Hemolymph samples of Libinia were analyzed by immunological techniques for the presence of vitellogenins (see below). Evidence was found for the presence of vitellogenins in about 50% of the juvenile animals in the absence of ovarian maturation. This observation suggests that the synthesis of yolk proteins and the development of ovarian tissue may not be tightly coupled in this species. The presence of MO implants had no discernible effect on either the presence of serum vitellogenin or the visual appearance and size of the ovary at autopsy after transplantation for 20 days. Since results have been reported after 60 days, it will probably be necessary to maintain animals for longer times in future experiments.

The effect of Precocene II on reproduction in female Libinia also was investigated. Precocene II belongs to a subset of insect growth regulators that are known to inhibit the production of JH by the corpora allata. To determine if this compound might have a physiological effect on crustacean reproduction, ovigerous adult female Libinia were treated on alternate days with Precocene II at several concentrations. The injection of 50 ul of 10^{-1} and 10^{-2} solutions of this compound proved toxic. However, the injection of 10^{-4} solutions did not affect mortality, and decreased oviposition markedly in comparison to control-treated animals. However, this compound had no effect on serum vitellogenins, suggesting that the action of this drug was distal to those mechanisms involved in the regulation of yolk protein synthesis. These results suggest that oviposition in this crustacean may be regulated by a tissue with a metabolic sensitivity similar to the corpus allatum of insects, further supporting speculation regarding homology of crustacean and insect reproductive systems.

3) Immunological Tools for Studies of Vitellogenin Synthesis

Several antisera specific for vitellogenins in Uca, Carcinus and Libinia had been developed prior to the award of this grant. During the present award period, these antisera were tested for reactivity with vitellins (the major egg proteins) from Homarus and Callinectes. Several of these antisera were species specific and did not react with lobster or blue crab antigens, but some, especially those to Carcinus vitellin, did recognize antigenic sites held in common with these other crustacean vitellins.

Work is now progressing to determine if these antisera also react with Homarus and Callinectes vitellogenins (precursors for vitellin found in the hemolymph). If they do, these antisera can be used to determine quantitatively (by radioimmunoassay or rocket immunoelectrophoresis) the amount of vitellogenin present in the hemolymph of these crustaceans during the reproductive cycle and after various treatments. Recently, antisera against lobster vitellin has also been obtained (through the generosity of Dr. Ernie Chang, Bodega Bay Marine Laboratory) that can be used if the antisera prove unsuitable for the quantification of vitellogenin.

At present, antisera to Libinia vitellogenin are being used to determine qualitatively, by Ouchterlony diffusion or immunoelectrophoresis, if vitellogenins are present in the hemolymph of experimentally treated animals. As indicated above, immunoreactive material related to vitellogenin is present in the hemolymph of some juvenile animals. Since ovarian development does not occur in juvenile females, this observation raises questions about the relationship of vitellogenin synthesis and reproductive status of this species.

4) The Analysis of Hemolymph for the Presence of JH-like Compounds

During the past year (1986), efforts have continued to identify and quantify the presence of JH-like materials in the hemolymph of Crustacea. In collaboration with Drs. Schooley and Baker (Zoecon Corp., Palo Alto, CA), gas chromatography/mass spectroscopy (GC/MS) has been used with selected ion monitoring (SIM) to detect JH-like compounds in Libinia hemolymph. Using this approach, three related compounds have been detected: JHIII, JHIII acid and methyl farnesoate (MF), at approximately 0.1% of the concentration of MF. (MF is the major compound present with JHIII present in only trace amounts, at approximately 0.1% the concentration of MF).

The presence of such large amounts of MF compared to JHIII suggested the possibility that JHIII was a non-specific oxidation product of MF. To test this possibility, chromatographically pure MF was run through the analysis procedure and monitored for the presence of JHIII. Trace amounts of JHIII at about 0.1% the

concentration of MF were found. Since this is the same relative amount of JHIII to MF found in the hemolymph samples, it is thought likely that MF is probably the sole JH-like compound circulating in this crustacean. It is of interest that the level of MF is three-fold greater in males than in females, and is raised another two- to three-fold in male animals without eyestalks. The eyestalks are important neuroendocrine centers that may regulate MF levels by inhibiting its secretion.

5) The Site of Synthesis of JH-like Compounds

The mandibular organ is a glandular tissue that lies at the base of the mandibles in crustaceans. In crabs and the lobster, it is closely applied to the base of the tendon of the posterior abductor muscles of the mandibles. No clear function had been heretofore determined for this tissue, partly because of confusion between this tissue and the Y-organ.

The materials synthesized and secreted by the MO have been examined for the presence of JH-like compounds. Tissues were incubated in vitro with radiolabeled methionine. This approach has been used successfully in the past in studies of JH biosynthesis in the insect corpus allatum, where the methyl group from methionine is used exclusively for the production of the methyl ester of JH. MOs from Libinia were incubated in Pantin's crustacean saline, supplemented with either [methyl-^{3}H] methionine or [methyl-^{14}C] methionine. At the end of the incubation, the culture medium was extracted with pentane, and the extract analyzed by HPLC. Analysis of materials secreted by MOs of Libinia by normal-phase HPLC showed a major peak of material co-migrating with MF and several smaller peaks, one of which co-eluted with JHIII. Analysis of incubation media from other tissues (hepatopancreas, muscle, epidermis, eyestalk) did not disclose the presence of radioactive products that co-migrated with either of these compounds on normal-phase HPLC.

Radioactive material that co-eluted with MF and JHIII was collected and analyzed further by reverse phase (C18) HPLC. Both materials co-eluted with the appropriate standard (not shown) strongly suggesting that these compounds were MF and JHIII. The identity of both compounds has recently been confirmed by collaboration with Drs. Schooley and Baker. JH was identified by GC/MS with SIM, and MF was identified by its complete fragmentation pattern.

As with the hemolymph samples described above, MOs secrete MF in great excess to JHIII, suggesting again that the presence of JHIII is due to the chemical rather than biochemical oxidation of MF. This suspicion was borne out by chiral analysis of biosynthetic [^{3}H]JHIII, which showed that this product was racemic, indicating that it was probably not the product of an enzymatic reaction, which are stereospecific in their introduction of functional groups such as epoxides. Thus, the JHIII detected in MO

incubation media probably is an artifact due to the oxidation of MF. Differences in the estimated rate of MF synthesis when [^{3}H] methionine and [^{14}C] methionine are used suggest that the high specific activity [^{3}H] methionine is being diluted substantially by endogenous (unlabeled) methionine in the tissue, causing an underestimate of the synthetic rate.

MF is clearly a major synthetic product of the MO in Libinia, a conclusion that confirms our identification of this compound in the hemolymph of this species. MF is also synthesized and secreted by the MOs of other crustaceans. As can be seen, MOs from other Brachyurans appear to synthesize appreciable amounts of MF. In contrast, synthesis of MF is quite low in the crayfish. Low synthetic activities by the MOs of lobsters have also been detected, but the secreted compounds have not yet been identified. One complicating factor in the analysis of MO function in these latter two species may be the reproductive stage of these animals. The corpora allata of adult insects only produce JH at times of reproductive activity, being quiescent at other periods, and a similar situation probably exists in crustaceans. Libinia is reproductively active during the entire summer and may therefore always have an active MO. In contrast, lobsters and crayfish have one or part of one reproductive cycles per year. The inability to detect substantial production of MF or other JH-like compounds by lobster MOs may merely reflect the use of animals at a point in the reproductive cycle where the MOs have very low activity.

PROJECT R/A-3

Strain Selection in Laminaria longicruris (Phaeophyta, Laminariales) for Development of Maximum Biomass

Charles Yarish

Laminaria is a genus of brown seaweed (Phaeophyceae), considered to be one of the most important benthic genera in the subtidal euphotic zone. The genus is a major biomass producer in the shallow marine waters of the temperate zone. It is a valuable source of phycocolloids, algal storage products that are chemically extracted and used in diverse food and chemical industries. Annual production of Laminaria in China approached 275,000 dry tons (one million wet tons) in the harvest year 1978-1979, with an approximate value of $300 million.

More than 80% of the seaweed harvested in the United States, though, is the giant kelp, Macrocystis pyrifera, a major source of alginic acid worth more than $22 million per year in 1979. The only large-scale seaweed culture practiced in the U.S. involves seeding and transplanting Macrocystis to revitalize overharvested kelp beds in southern California.

Recent efforts in British Columbia to establish an edible kelp cultivation technology for Laminaria, however, have been reported. The first experimental kelp farm on the east coast of North America was established by Brinkhuis and co-workers in Long Island Sound in 1980.

The Sea Grant Aquaculture Plan of 1983-1987 calls for the continuation of experiments with seedstock production to determine the most desirable genetic strains for seaweed aquaculture both for productivity and for tissue chemistry and composition. This report also states that even though the kelp crop from California is now successfully managed, supplies still do not meet industrial demand.

The purpose of the project reported here is to select possible warm-water tolerant strains of Laminaria, since the genus is normally confined to cold temperate waters. The species selected was Laminaria longicruris, the largest growing kelp in this region, thus providing the best potential for greater biomass production. This project at the University of Connecticut is being conducted in close cooperation with the State University of New York At Stony Brook (New York Sea Grant) and is thus regional in character.

This project was originally accepted, but deferred in 1984 due to lack of funding. However, a small amount of money was located to get the project started. Over the years, good progress has been made in spite of this limitation.

Materials and Methods

A field study site at Black Ledge, New London, CT in eastern Long Island Sound was selected in November, 1984, after investigating several possible suitable locations in the region.

A rope transect structure was deployed in the kelp bed using SCUBA. One hundred and fifty plants growing adjacent to the underwater transects were tagged with numbered plastic forestry tape. An alternative tagging procedure had to be employed in January, 1985, when it was found the tape could not withstand environmental conditions. The new tagging method consisted of plastic flower pot identification stakes attached to the kelp stipes with plastic-coated wire. Holes were punched in the blades of the tagged plants, 10 cm above the blade/stipe juncture.

The field site was visited each month and irradiance, water temperature, pH, and salinity were determined at each site visit. Twenty plants were randomly selected on each dive and stipe length, blade length and blade width (widest) were measured underwater. Holes were punched (see above) in all plants. The distance between the newly punched hole at 10 cm and the hole punched in the previous month was measured. This measurement gives the elongation of the plant for the interval between sampling periods.

Fertile Laminaria longicruris sporophytes were returned to the laboratory every month. Sections of sorus (reproductive) tissue were washed with sterile seawater and partially air-dried at 10°C for three hours. Spore release was induced by placing these tissue sections in sterile seawater. The resultant meiospore suspension was pipetted onto glass coverslips, at a density of approximately 1,000 spores per coverslip, in petri dishes containing PES. Gametophytes were allowed to develop under red light which prevents the formation of gametes. Male and female gametophytes were separated and stored independently under red light.

Every second month, newly released spores from one plant and a mixture of spores from two plants were subjected to 25 different combinations of temperature and irradiance. This was achieved by placing spore-containing petri dishes on gradient plates.

Germination percentages, on the basis of germ tube production, were determined 48 hours after inoculation. Growth of the gametophytes was determined on day 9 of the experiment by measuring the diameter of the primary cell of the female gametophytes.

In cases where gametophytes produced vegetative filaments (e.g., males and gametophytes growing under non-optimal conditions), growth was determined by counting the number of cells in each gametophyte. Lengths were difficult to determine in these

cases, due to profuse branching of the filaments. Percent occurrence of female unicell and filamentous gametophytes was determined for each growth condition. Experiments were terminated on day 23. Lengths and percent occurrence of fertile and non-fertile gametophytes, and lengths of young sporophytes were determined. All measurements for each coverslip were conducted on 100 plants in four groups of 25.

Sections of Chinese seed string used for cultivating Laminaria in the Orient were also inoculated with the meiospore suspension. These were transported to the greenhouse facilities at the State University of New York at Stony Brook when sporophytes on the strings had attained lengths of 5-10 cm.

Results and Discussion

Laboratory Studies

Results from the cross gradients of temperature and light on Laminaria gametophytes indicate a seasonal shift in optimal growth conditions.

Germination data show that the lowest occurred in March plants and 1-3% germination was encountered at 25°C in plants obtained in January, March and May. Germination at 25° increased to a maximum of 68% in spores derived from July plants. Although the latter experiment had not been completed before the preparation of this progress report, constant monitoring of the gametophytes has shown that they did not survive a period greater than 10 days.

It is reported that the upper lethal limit of gametophytes of L. saccharina is 22-23°C with optimal growth occurring between 10°C and 15°C. It is also reported that the formation of gametangia only occurred below 18°C. In the experiments reported here, gametangia were observed at 20°C. No gametangia were observed before nine days at any temperature in the January, March and May experiments.

By day 23, sporophytes were formed at temperatures from 5-15°C in the January and March experiments, and also at 20°C in the May experiment. Gametangia had been formed by day 9 in the July experiment at temperatures from 5-15°C. A broad optimum for growth was shown between 10°C and 20°c. Best growth can be seen to occur at 15°C and 20°C at irradiance of 25 to 70 uE m^{-2} s^{-1}. A seasonal shift in optimal growth temperatures has been noted for Laminaria saccharina in New York.

Seed string cultures of L. longicruris being grown beside L. saccharina in the greenhouse at Flax Pond, Long Island, appear to be growing faster than the latter, although complete data sets are not yet available. Carbon and nitrogen analyses of field material from Black Ledge (also being conducted at SUNY) were not

available at the time of the preparation of this report.

Field Studies

Stipe and blade lengths and blade widths generally increased throughout the experimental period from December 1984 through July 1985. A decrease in blade length noted in January may not be a true reflection of this parameter because only three tagged plants could be found for measurement. Maximum stipe and blade lengths and blade widths occurred during May and early June. Blade lengths and widths decreased from the middle of June. Similar patterns have been reported for L. saccharina grown at Crane Neck, Long Island.

Meristematic growth rates (cm d^{-1}) increased from December (0.9) through May (3.73), and declined sharply in June (1.7). A rapid decline in growth rate in relation to increasing water temperature in late June and early July has also been reported for this region. Optimum temperature for growth in L. saccharina is 10-15°C. L. saccharina had a mean elongation rate of 1.7 cm d^{-1} in Great Britain, 1.1 and 1.5 cm d^{-1} at different depths in 1981, and 1.0 cm d^{-1} in 1982, 1.1 cm d^{-1} in Long Island Sound, and 2.0 cm d^{-1} in Rhode Island during the spring season of maximum growth. In contrast, populations of L. longicruris in Nova Scotia exhibited maximum growth in winter.

In June, 1985, the biomass (fresh weight/m^2 of rocky area) was determined from a random sampling of three quadrats. The mean biomass was 27.76 kg $m/^2$. Values have been reported of 4-16 kg/m^2 (fresh weight), from diverse coastlines in the temperature region. Maximum biomass was 18 kg/m^2 for the kelp Ecklonia radiata from southwestern Australia.

Modifications in field sampling techniques are planned for the autumn of 1985. The new procedures will allow for the determination of biomass and productivity values as well as the parameters being measured at present. The methods follow those described by Mann and Kirkman (1981) and Kirkman (1984).

Laboratory experiments and experiments in cooperation with SUNY at Stony Brook will be continued.

Life History, Modelling and Resource Utilization of the Soft-Shell Clam, Mya Arenaria

Diane J. Brousseau, Jenny Baglivo and George Lang
Fairfield University, Fairfield, Connecticut

The objectives of this study were to generate information on locations of natural populations of Mya arenaria in Connecticut, conduct field studies to determine life history parameters (age-specific fecundity and survivorship) for the soft-shell clam, and--with the use of computer models--design and evaluate adaptive harvesting strategies that can be used for the management of the resource.

Based on data generated to date, it appears that one or two spawnings per year are possible in Connecticut populations of M. arenaria. All three populations studied (two from Westport and one from Stonington) spawned during the month of June in 1984; however, the Stonington population also showed evidence of a secondary spawning occurring during the month of September. Data collection is continuing and information on spawning frequency/duration during 1985 was compared with that obtained in 1984.

Through the efforts of one of our students, Ms. Anne Kochendorfer, we began to explore a new technique to determine age-specific fecundity from fecundity-size data. Age-specific fecundity is needed in the modelling phase of the project, while fecundity-size data is more easily determined from field efforts. The technique involved fitting a step function to the fecundity-size data, allowing the computer to determine both the approximate age classes and the estimate of mean fecundity per class. Figures 1, 2, and 3 give examples of the results of the equation-fitting process for each of the three study sites: Westport 1 (WP1), Westport 2 (WP2), and Stonington (STN). Further research is needed.

Age-size relationships for clams from the three study sites (WP1, WP2, and STN) were determined using internal growth lines in the shells (Fig. 4). Preliminary statistical analyses of age/size data indicate that growth rates differ at the three sites. In all three cases, the vonBertalanffy curve represents a convenient summary of the growth patterns as we now see them (Fig. 5, 6, 7). In addition to shell length, we also considered the use of other size variables, such as shell width and shell weight, as predictors of age.

In the modelling phase of the project, we were interested in designing adaptive harvesting strategies which could be useful in the management of the soft-shell clam resource. The model contains age-specific life history parameters, some of which are more easily estimated from field data than others. Recently, we have determined which parameters in the model are most important

in the design of the harvesting strategies. The implication of these calculations is that certain life history parameters need not be known with the same precision as others. Since survivorship parameters have been shown to be critical, effort focused on the estimation of these important rates during the final year of the study.

Mark and recapture experiments were begin in May at two additional sites, one at Old Mill Beach in Westport and the other at Barn Island, Stonington. Recovery rates from the four experimental plots planted last summer ranged from 40% - 50% (both live and dead recoveries included). Statistical analysis of the 1984-85 survivorship data from adult clams was underway.

Efforts to determine survivorship rates for juvenile clams continue. Repeated sampling of the study areas established in 1985 will provide information on the survival of the 1984-year class. Natural recruitment of M. arenaria at these field sites in 1985 was, as in the previous year, extremely variable. The largest spatfalls occurred in Westport and Cove Beach, Stamford. Light recruitment ($<100/m^2$) occurred at the Milford Point, West Haven, New Haven, and Waterford sites.

Figure 1

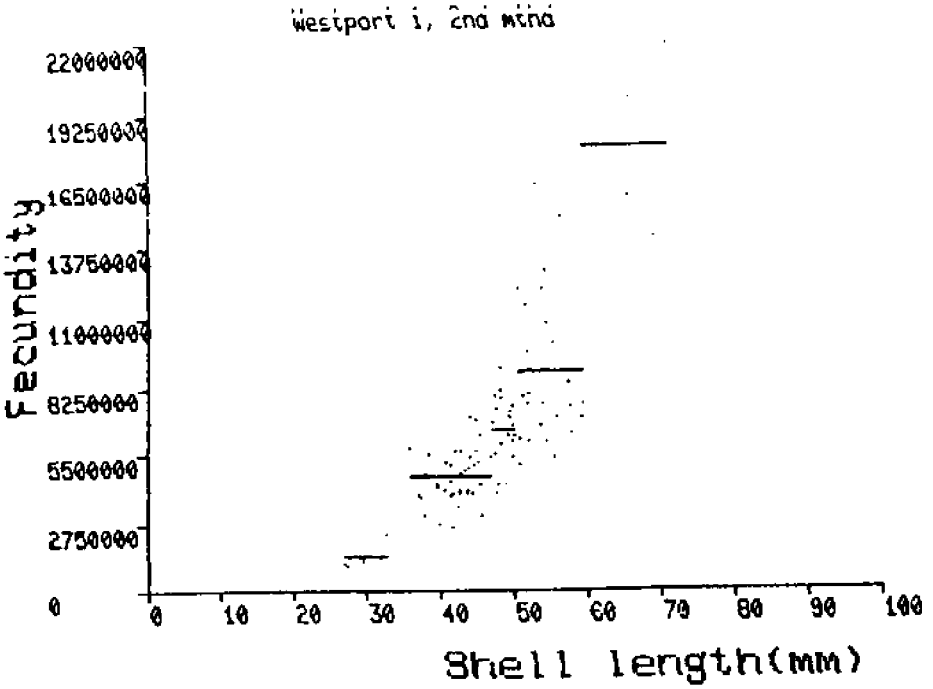


Fig. 1 Data for Westport 1 with fitted step function.

a_1= 1428000 c_1= 36.15 mm

a_2= 4583684 c_2= 47.25

a_3= 6508947 c_3= 50.85

a_4= 8946786 c_4= 59.4

a_5= 17867500

R^2=0.74

Figure 2

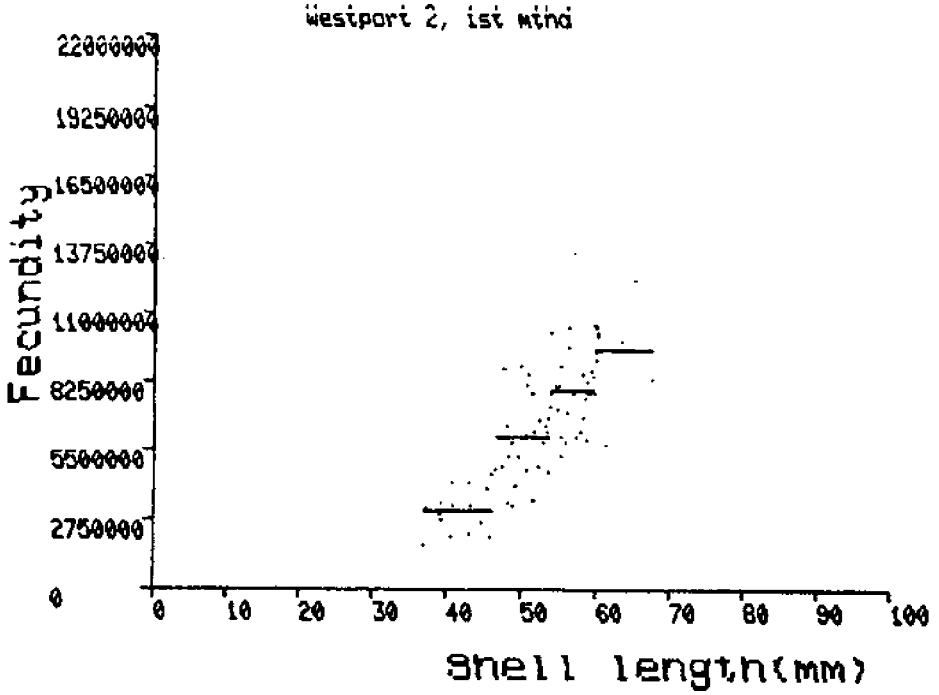


Fig. 2 Data for Westport 2 with fitted step function.

a_1= 3114727 c_1= 46.7 mm

a_2= 6020095 c_2= 54.1

a_3= 7910682 c_3= 59.7

a_4= 9540604

R^2=0.64

Figure 3

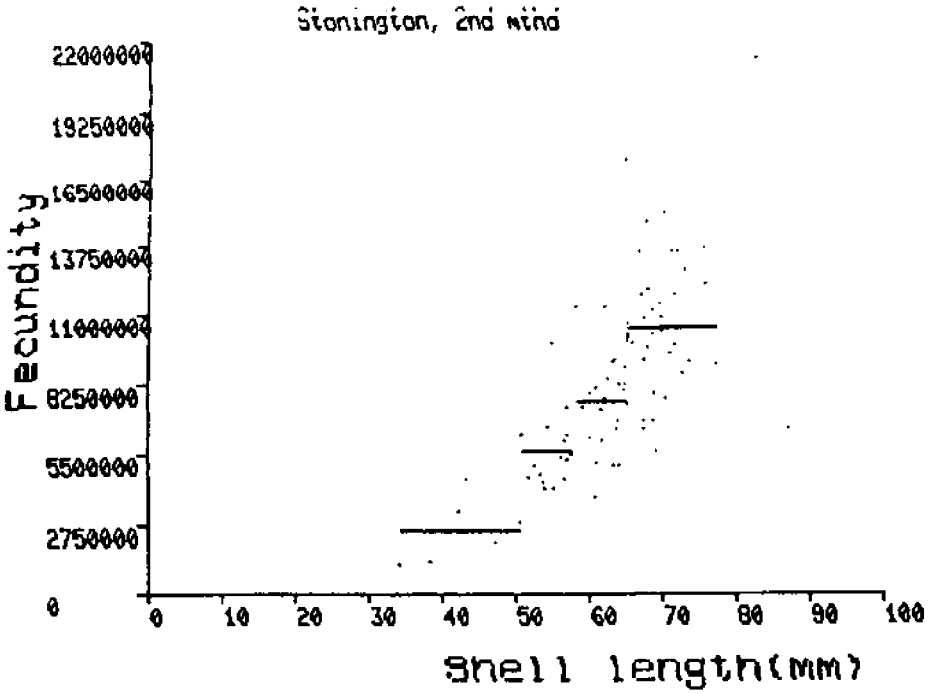


Fig. 3 Data for Stonington with fitted step function.

a_1 = 2540000 c_1 = 51.0 mm

a_2 = 5639375 c_2 = 58.3

a_3 = 7634231 c_3 = 65.35

a_4 = 17320000 c_4 = 65.45

a_5 = 10400570

R^2 = 0.64

Figure 4

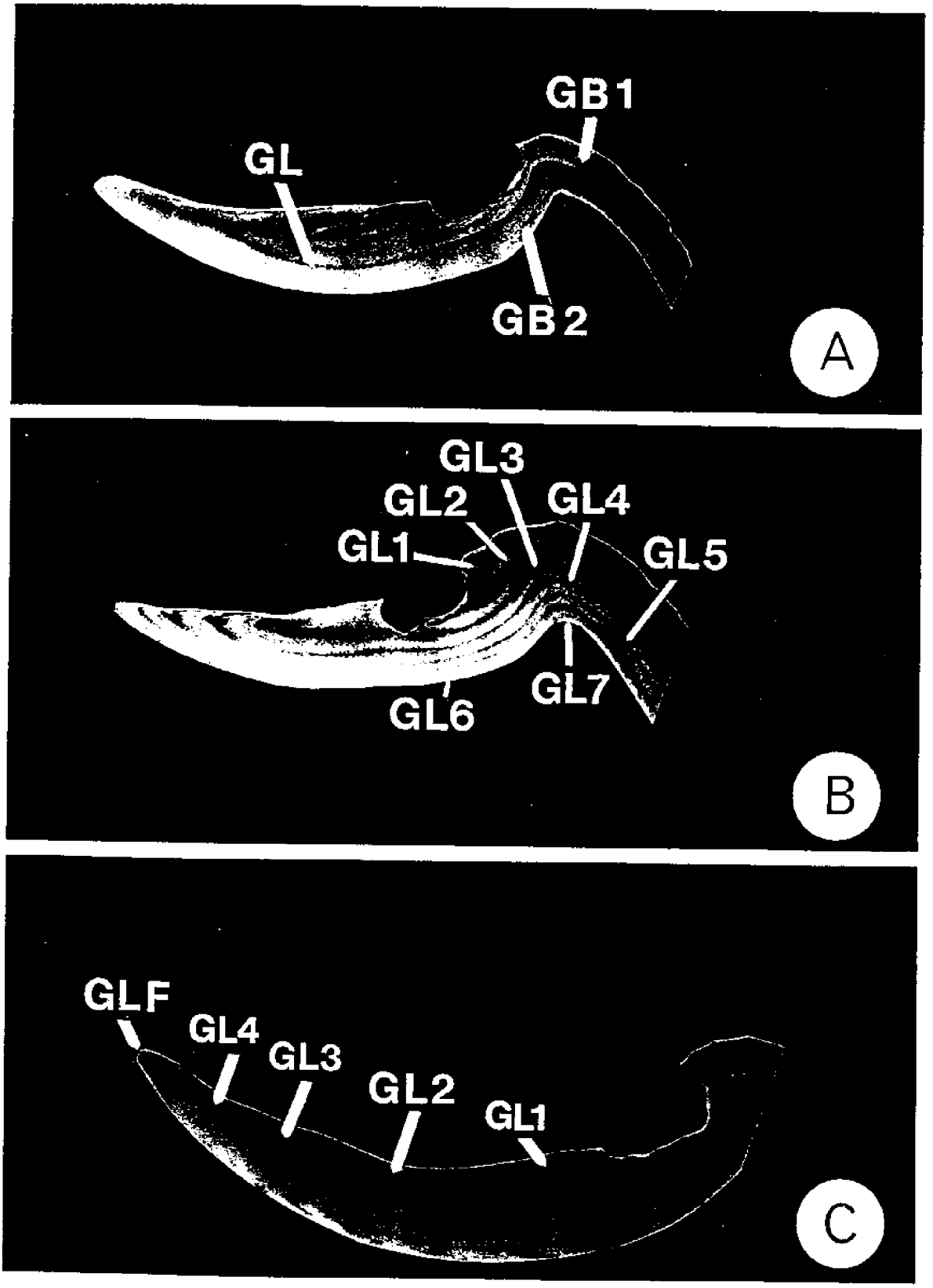


Fig. 4. Growth lines appear between white growth bands in M. arenaria.

Figure 5 Westport, Conn., Site 1
Display of Shell Length vs. Age

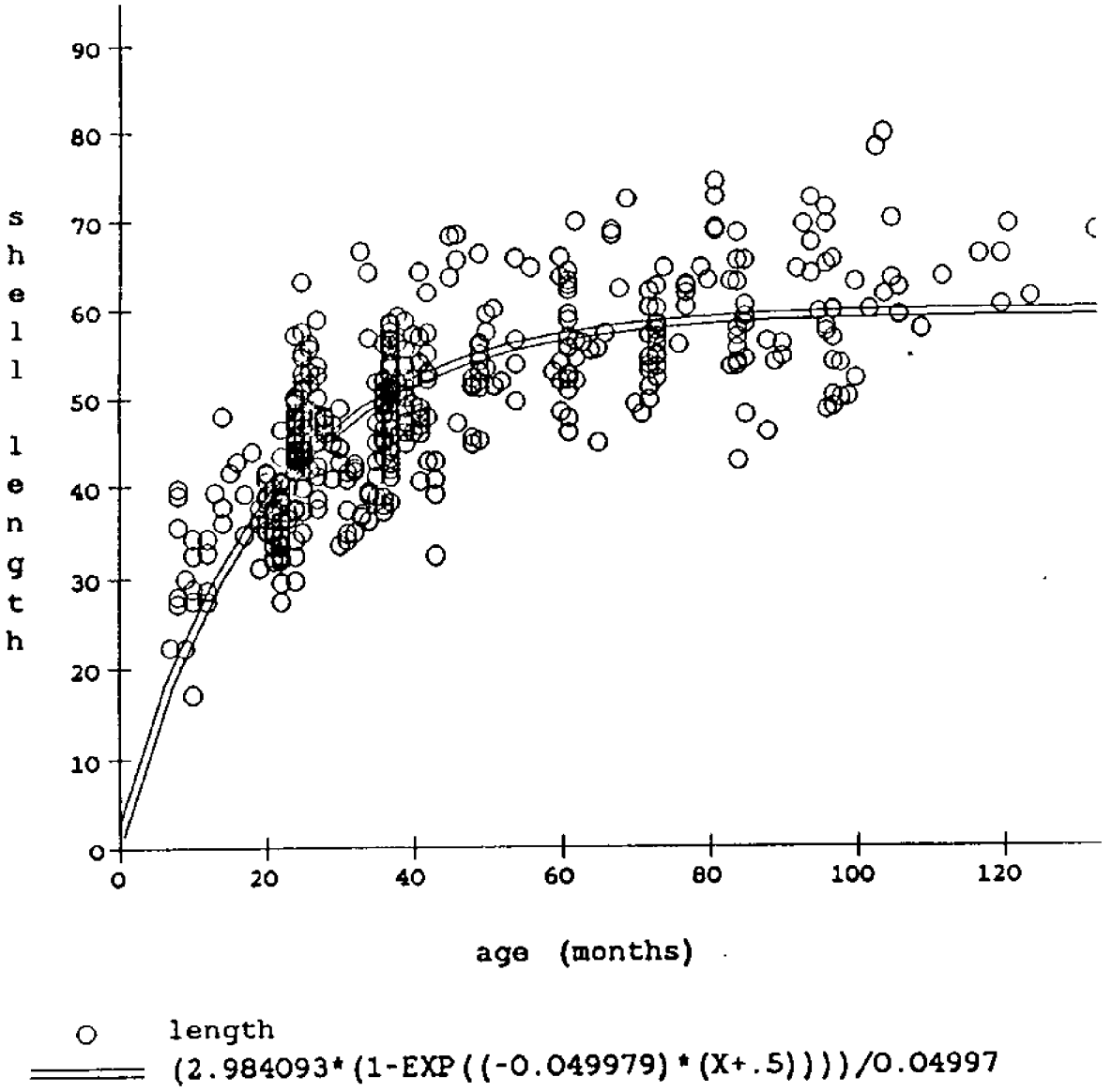


Fig. 5. Von Bertalanffy growth curve fitted to age-size data from Westport 1.

Figure 6 Westport, Conn., Site 2
Display of Shell Length vs. Age

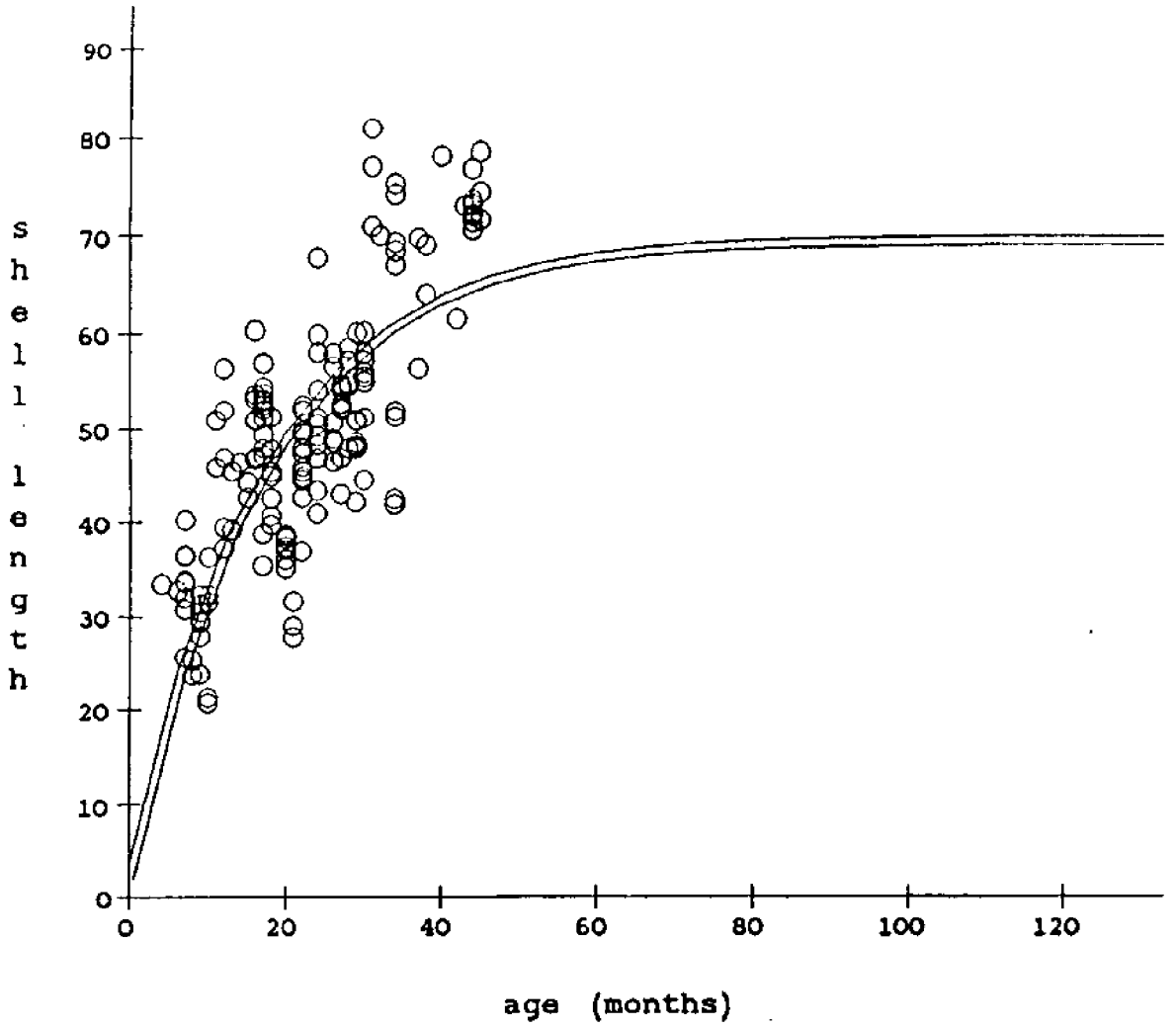


Fig. 6. VonBertalanffy growth curve fitted to age-size data from Westport 2.

Figure 7 Stonington, Conn., Site
Display of Shell Length vs. Age

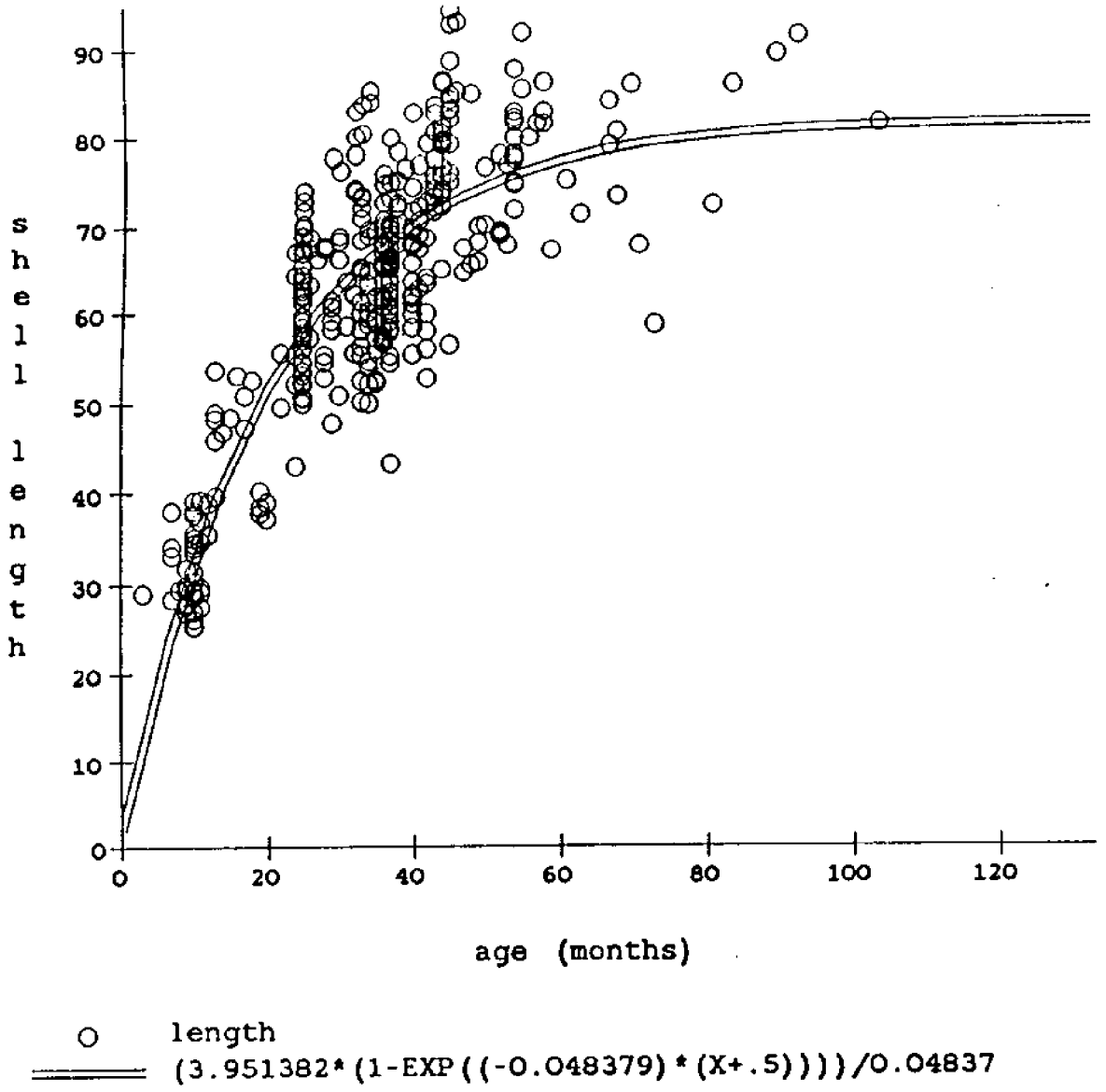


Fig. 7. Von Bertalanffy growth curve fitted to age-size data from Stonington.

PROJECT R/LR-1

Life History and Resource Management of the Hard Clam, Mercenaria mercenaria

Robert Whitlatch and Wendy Wiltse
The University of Connecticut

The earlier focus of the research by Robert Whitlatch and Wendy Wiltse was to examine experimentally the population dynamics of M. mercenaria and to apply the resulting data to the development of effective resource management practices. Their research included studies of natural populations, larval settlement and recruitment, experimental evaluations of the growth and survivorship of juvenile and adult clams, and comparative studies of grow-out techniques.

In 1985, it was possible to apply a mathematical technique to the analysis of life history patterns which show strong similarities among hard clams, soft clams and oysters.

Development of a Model

Presently, there exist a variety of shellfish resource management practices ranging from harvesting strategies which limit the minimum size and quantity of adults that may be taken, to reseeding programs which supplement local populations with artificially planted juveniles. Other policies include predator control, enhancing the suitability of potential larval settlement areas, and planting adult shellfish for spawning purposes.

Conceptually, these resource management alternatives are dramatically different, since each concentrates on a different portion of the organism's life history. To date, however, no quantitative attempt has been made to assess the relative benefits of the various programs. While their relative success can be assessed after implementation, realistically it may be years before this is possible. An alternative approach is to evaluate the various management policies using theoretical mathematical models.

It is obvious that the success of any management program is dependent upon the biology of the exploited species. In 1980, P.B. Adams illustrated a theoretical relationship between the harvestability and life history strategies of various fish species. He found that those species with more r-selected traits (e.g., fast growth, early maturity, production of large numbers of offspring) could withstand more intense harvesting than more K-selected (e.g., slow growth, delayed maturity) species. Only after understanding how a natural population of a species projects itself through time is it possible to predict its response to human intervention.

To simplify the problem of comprehending how a population projects itself through time, it is often convenient to use demographic data as the parameters in mathematical models that depict the growth (or decline) of a population. One advantage of this type of analysis is that it computes a population growth rate which may then be used as a criterion to assess the relative fitness of different suites of demographic parameters. After establishing baseline demographic data (e.g., a life table), it is then possible to represent management policies demographically by identifying their impacts on the baseline life table. The population growth rate resulting from the altered life table can then be used as a relative measure of the long-term impacts of various management alternatives on the target species.

A model commonly used for this purpose is the Leslie matrix, which has been used extensively for analyzing life history tactics, such as optimum harvesting problems. Since this is an age- or stage-classified model, it is possible to investigate processes which impact the population at specific, isolated portions of the life history. For instance, it is possible to classify a population of insects by life stages and simulated differential stage-specific mortality rates, and the Leslie matrix has been used to determine the effect of increased juvenile mortality on trout population yield.

Bivalve management policies can be translated into changes in the demography of local populations. For example, planting spawner stocks may increase the fecundity of the population, reseeding programs may increase the survivorship of the juveniles, and harvest strategies affect the survivorship of adults and the fecundity of the population. In the present study, the Leslie matrix has been used to analyze the life history tactics of three species of commercially important bivalves: Mya arenaria (soft-shell clam), Mercenaria mercenaria (hard-shell clam), and Crassostrea virginica (American oyster). The relative benefits of commonly used resource management policies are then assessed in light of their differential impacts on various stages of the species' life cycles.

Methods

A. The use of the Leslie Matrix for Resource Management Problems

The Leslie matrix is a linear, discrete, time invariant model, based on an age-structured population, that may be used to describe the direction and magnitude of population growth, as well as the stable age distribution and reproductive value of each age class.

While the Leslie matrix has been frequently used for the analysis of life history strategies and optimum harvest problems, the approach has been criticized because it neglects density effects. Indeed, density dependence is intimately linked to the

harvesting problem, since if population growth is limited by intraspecific interactions, then harvesting can change the demography of the harvested species. Sustained harvesting is most easily tolerated by those species that experience increased productivity after individuals have been removed. Simulated exploitation studies in the laboratory have documented enhanced productivity following removal of individuals.

However, Malinowski and Whitlatch found that adult growth, fecundity, survivorship and recruitment were not significantly affected by population density in M. mercenaria. Many others have been unable to document density-mediated growth effects. In addition, several studies have concluded that predation (particularly on juvenile age-classes) ultimately determines the distribution and abundance of M. mercenaria and M. arenaria. Therefore, the omission of density dependence from the model may not necessarily sacrifice realism and many objections to the use of the model are not relevant.

Since the assumptions of the model are violated, how can its use be justified? Solutions to the optimal yield problem require a precise prediction of the actual number and/or biomass of organisms in a population through time. Since these bivalve populations violate the assumptions of the model, it is clear that the model cannot be used to accurately predict the size of these populations through time. However, it is possible to use this model to address a more general problem; namely, what are the relative contributions of different stages of the life history to population growth rates?

Our purpose is to use the Leslie matrix in its simplest form in order to translate induced demographic changes into a meaningful population parameter, such as population growth rate which can then be used as a measure to assess the relative importance of each age-class. Although the Leslie matrix lacks realism, it can be applied toward general problems yielding quantitative predictions concerning the dynamics of population growth rate at the age class-level of resolution.

Conclusions

The life history tactics of each of the bivalves examined are characterized by high fecundity, iteroparity, large-size and high juvenile mortality (relative to adults). Because of these similarities, as well as the resolution of the data bases, the analyses of the different species yielded approximately similar results and the species will be discussed collectively.

Current shellfish management policies have taken many forms, and while the ultimate goal of each is to increase the yield of the fishery, there have been no attempts to quantitatively determine the relative effectiveness of each policy. The establishment of minimum harvest sizes serves at least two purposes.

First, by allowing the harvest of only large individuals, the potential yield (biomass) of a single cohort in the population is increased (provided adult survivorship is high). A second purpose, and one more relevant to the present analyses, is that larger individuals realize increased fecundity and the reproductive contribution of a cohort to future generations will be increased as the minimum harvestable size increases.

There are two separate but related results of this study that apply to the establishment of a meaningful minimum harvestable size: reproductive values and sensitivity analyses. Because the reproductive values of most organisms peak early in life and then decline throughout adulthood, it is reasoned that harvesting should be restricted to those older age classes with low reproductive values. Interestingly, the three bivalves examined deviate from this general pattern. The reproductive values peak early in life, and since fecundity is size-related, remain high throughout adulthood (Fig. 1). Coupled with stable age distribution, reproductive values are used to compute the survivorship sensitivity which applies directly to the determination of optimal harvest sizes.

The identification of a major change in the slope of the survivorship sensitivity function (Fig. 2) would suggest a logical minimum harvest size. However, the results indicate that there are only slight differences to changes in survivorship among the adult (>2 years old) age-classes. Therefore, removing a certain proportion of an old-age class is essentially equivalent to removing the same proportion of three or four year olds. Provided the organisms are allowed to reach reproductive maturity (and spawn), any age class may be harvested with approximately equivalent effects on population growth rate.

Since predation is generally the cause of extremely high rates of juvenile mortality, both re-seeding beds and predator control are synonymous with increasing juvenile survival. Figure 2 indicates that population growth rate is most affected by alterations in juvenile survivorship. In fact, there are at least two orders of magnitude difference between adult and juvenile survivorship. Reductions in juvenile mortality will have 100 times the impact on the future number of individuals in the population than a proportional reduction in adult mortality, suggesting that protecting the juvenile stages of the life history rather than establishing size-specific harvest strategies would be a more sound management policy for the three species examined.

To assess the relative benefits of these two alternatives, three different harvest strategies were simulated on M. arenaria and compared with reductions in juvenile survivorship. Each harvest strategy removed 97% of the adult population and differed with respect to the intensity of age-specific removal. Despite drastic differences between harvest strategies, there was little difference with respect to effects on population growth rate (Fig. 3), and, when compared to simulated reductions in juvenile

survivorship (Fig. 4), indicate that removing 97% of the adults is equivalent to decreasing juvenile survivorship from 0.07 to 0.03%. Since larval and early post-settlement mortality rates are extremely high, very large increases in fecundity are necessary to duplicate the consequence of only slight increases in juvenile survivorship.

Collectively, these results suggest that far greater return may be gained from management efforts aimed at increasing juvenile survivorship than from other alternatives. Since juvenile bivalves (e.g., 1-10 mm shell length) may experience intense predator-mediated density dependent mortality (Boulding and Hay, 1984; Malinowski and Whitlatch, 1985b), it is probable that increased recruitment (resulting from spawner plantings or increased average adult size) will be followed by increased rates of predation and no benefit will be realized. By similar reasoning, the return on seed plantings is not likely to be greater than the harvest of the individuals planted (there will be little if any contribution to future generations). It appears, therefore, that only persistent predator control can be expected to significantly increase the maximum sustainable harvest of these species.

FIGURE LEGENDS

Fig. 1. Age-specific reproductive values. The shaded area encompasses all values of all three species of bivalves.

Fig. 2. The relative sensitivity of the population growth rate. The shaded area encompasses all values of all three species of bivalves.

Fig. 3. Simulated harvesting strategies of M. arenaria. Each strategy removed 97% of the adults in the population, but concentrated on different adult age classes (Strategy I: equal intensity of harvesting on all adult age classes; Strategy II; concentrated harvesting on younger adult age classes; Strategy III: concentrated harvesting on older adult age classes). The shaded areas represent the age-specific decreases in survivorship resulting from the simulated harvesting.

Fig. 4. The effect of simulated reductions in juvenile survivorship on the population growth rate of M. arenaria. A larval survivorship value of 0.01 was arbitrarily chosen for these simulations (Fig. 3).

Figure 1

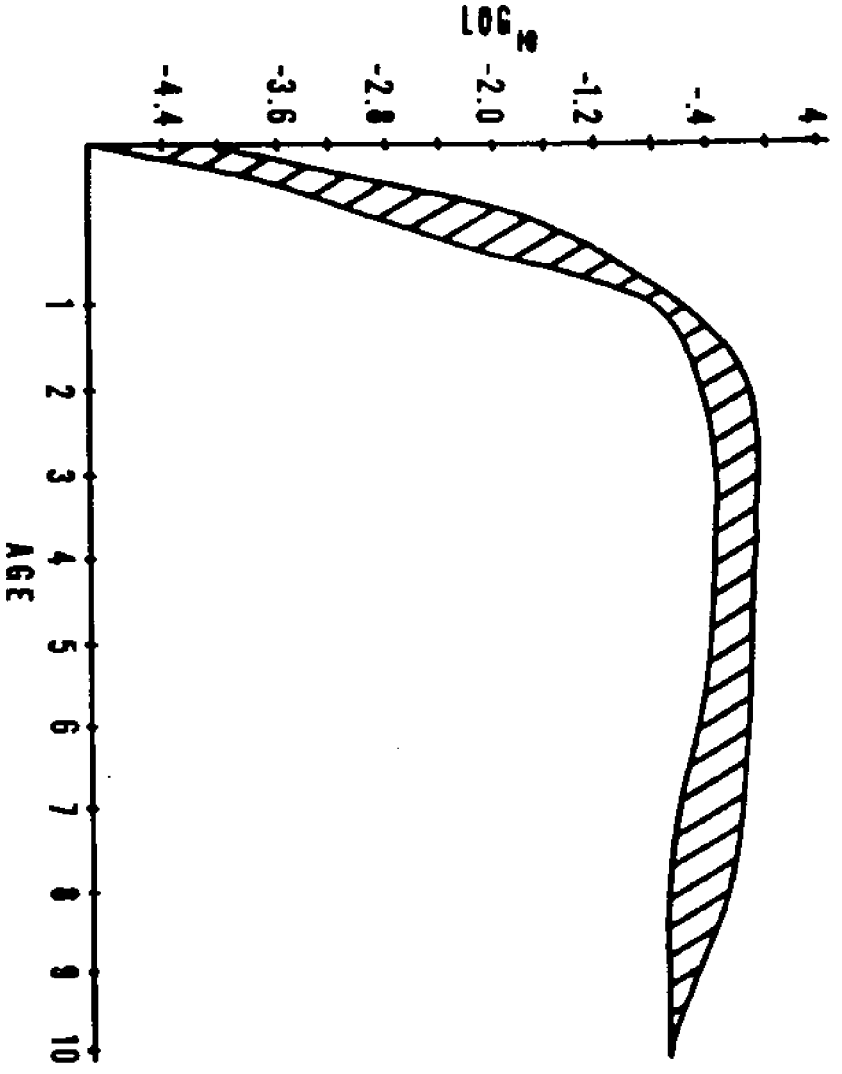


Figure 2

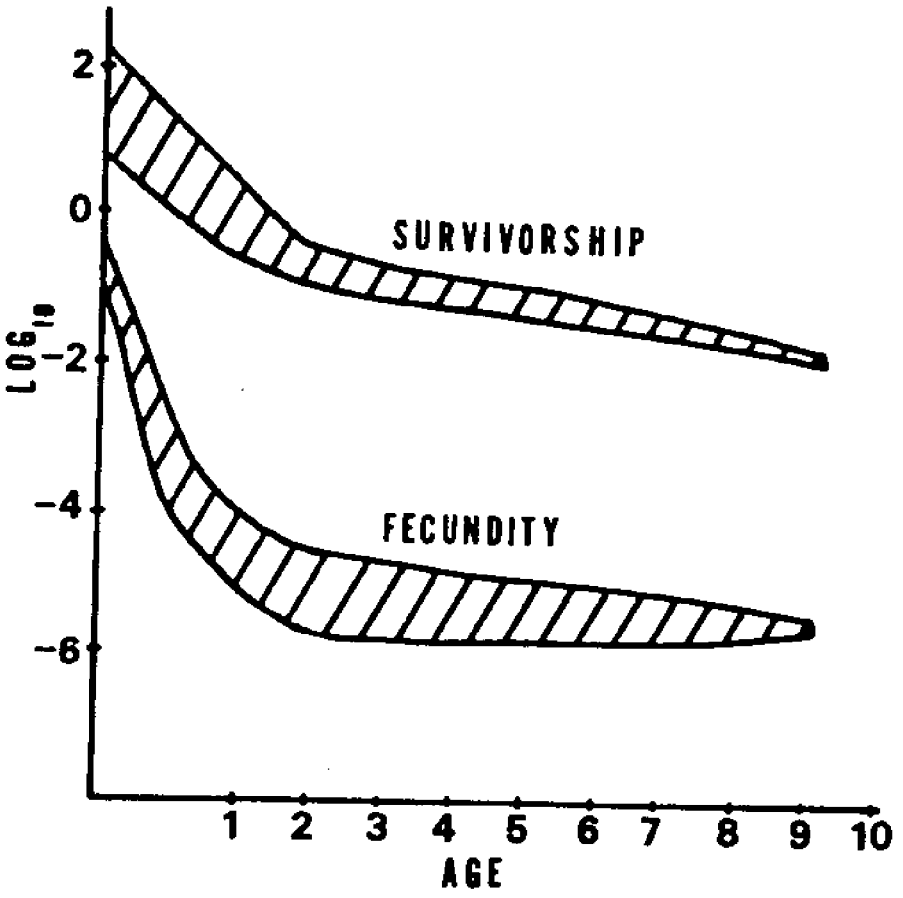


Figure 3

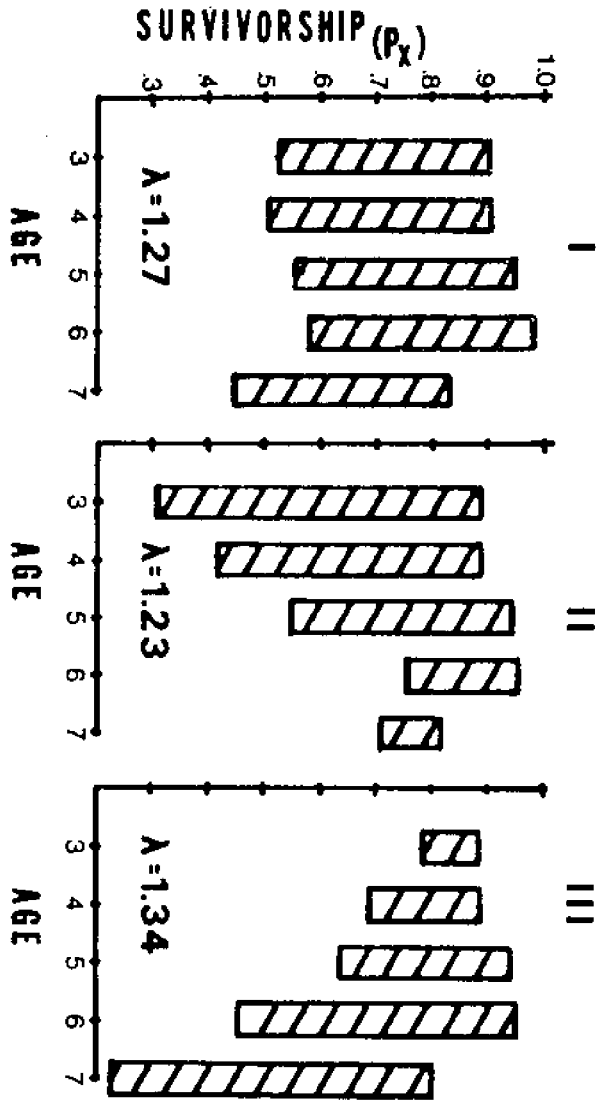
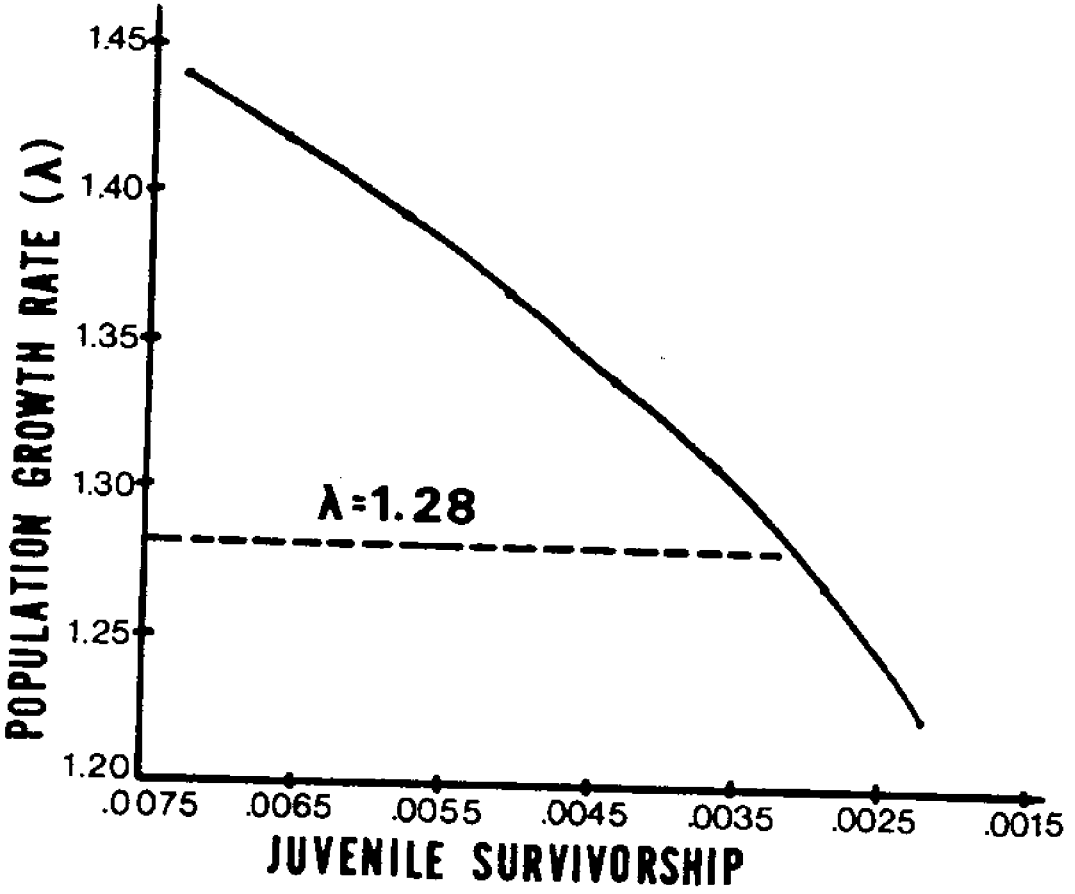


Figure 4


1.45
1.40
1.35
1.30
1.25
1.20
POPULATION GROWTH RATE (λ)
λ=1.28
.0075
.0065
.0055
.0045
.0035
.0025
.0015
JUVENILE SURVIVORSHIP

PROJECT R/ME-1

Geotechnical Aspects of Dredge Spoil Mass Behavior and Capping Procedures for Managing Coastal Disposal Operations

Kenneth R. Demars and Richard P. Long
The University of Connecticut

Research during the second year of this study focused on deformation and capping requirements of disposal mounds in Long Island Sound. The efforts included additional sampling of dredged material from disposal mounds, geotechnical testing in the laboratory and on ship, prediction of mound settlement for comparison with field measurements, and an analysis of cap thickness for containment of chemical effluents.

Sediment samples were acquired from several mounds and the seabed with both a gravity corer and a box corer. The twelve gravity cores which varied in length from 0.5 to 2.0 m were split longitudinally and subjected to shipboard measurements of water content (void ratios) and undisturbed and remolded shear strength.

A typical sediment strength and density profile for the natural seabed is shown in Figure 1, where the seabed is shown to be normally consolidated. This sediment has zero strength at the sediment-water interface and would be displaced like a dense fluid during the development of a mound. Similar strength profiles were obtained for the mounds, but scattering of strength results is observed because of the stratified and heterogeneous nature of capped mounds. Additional consolidation and triaxial strength tests were performed to complement the previous year's efforts.

The box corer was used to fill two 55-gallon drums with contaminated sediment from the uncapped FVP mound. This sediment was used in both a large-scale and small-scale slurry consolidometer to simulate consolidation settlement of mounds. Measured settlements were compared with predicted values, using both Terzaghi and finite strain theories as shown in Figure 2. Both Terzaghi and finite strain theories agree well with measured settlements. However, the results also show the importance of accurately defining the initial void ratio of a soft sediment for purposes of predicting settlements.

Using laboratory consolidation parameters, the Terzaghi and finite strain models were used to predict settlements of three central Long Island Sound disposal mounds. These predictions were compared to measured settlements obtained from replicate bathymetric surveys during a period of several years. Figure 3 shows a typical comparison of measurement and theory for the sand-capped Stamford-New Haven North Mound. This 3.3m high mound

was observed to settle about 1.4m over a period of about three years. While the comparison of measurement and theory are good, field predictions are difficult because of heterogeneous nature of material deposit, poorly defined drainage conditions and potential creep deformations in the mound.

Figure 1

University of Connecticut
Geotechnical Engineering Laboratory

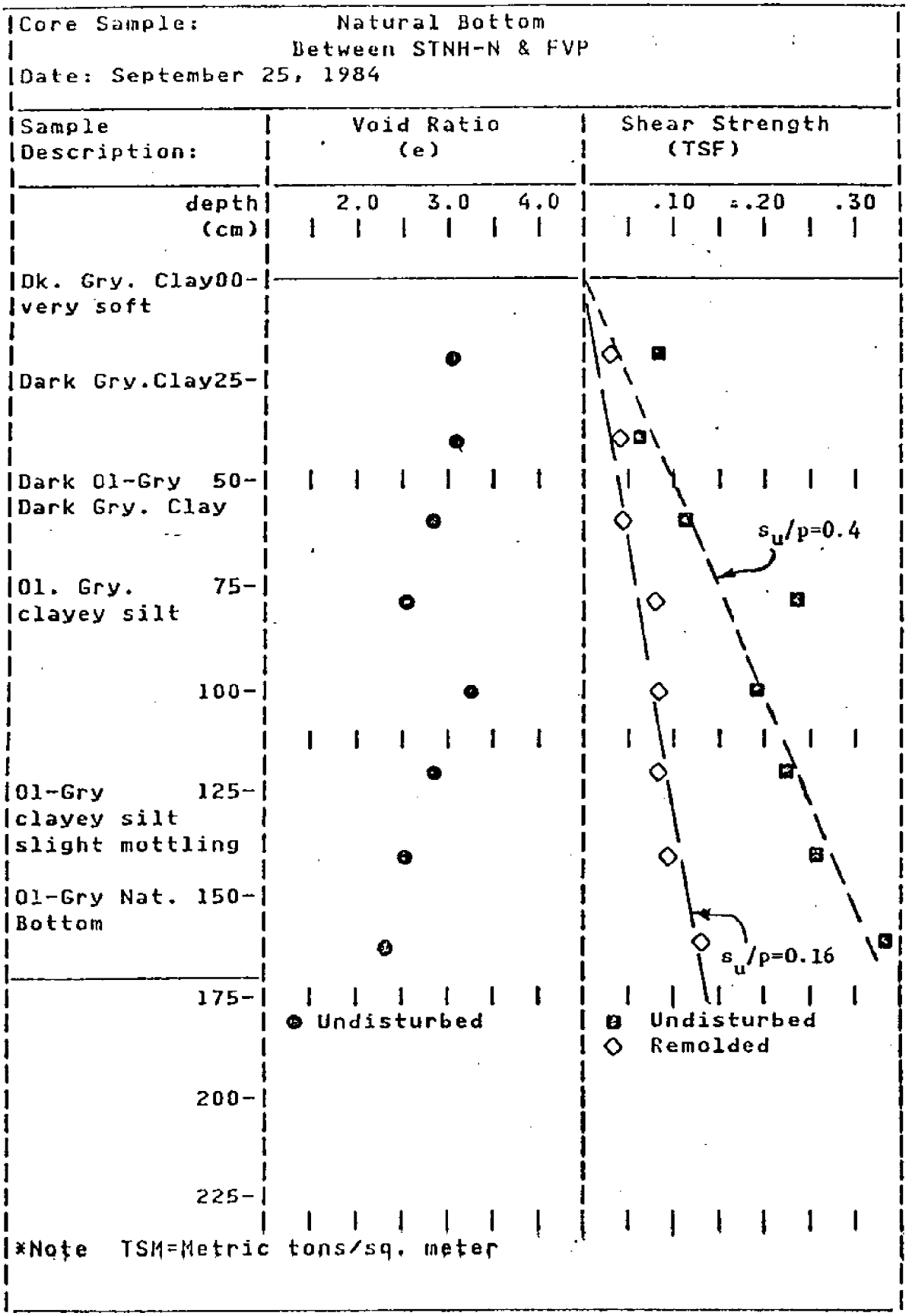


Figure 2

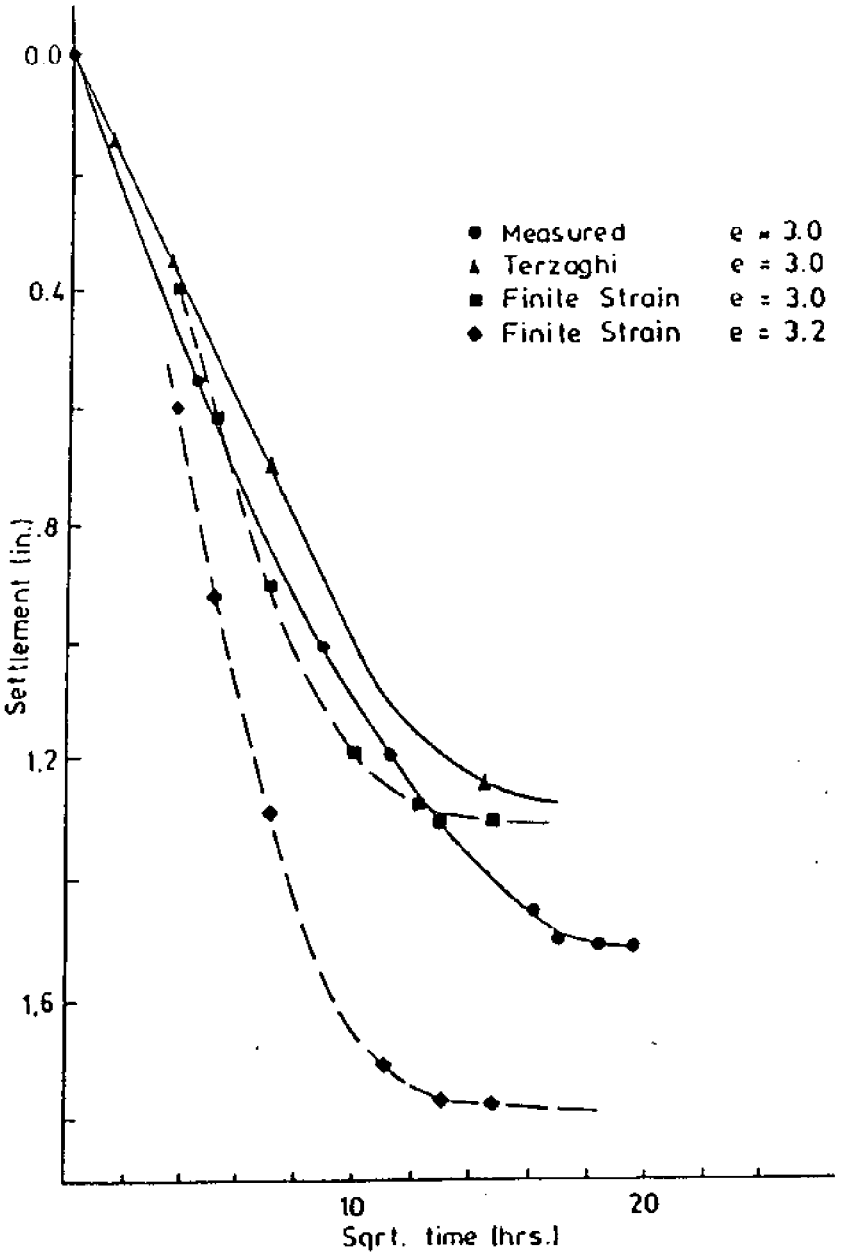


Figure 2 : Large scale model settlement compared to Terzaghi and finite strain predictions

Figure 3

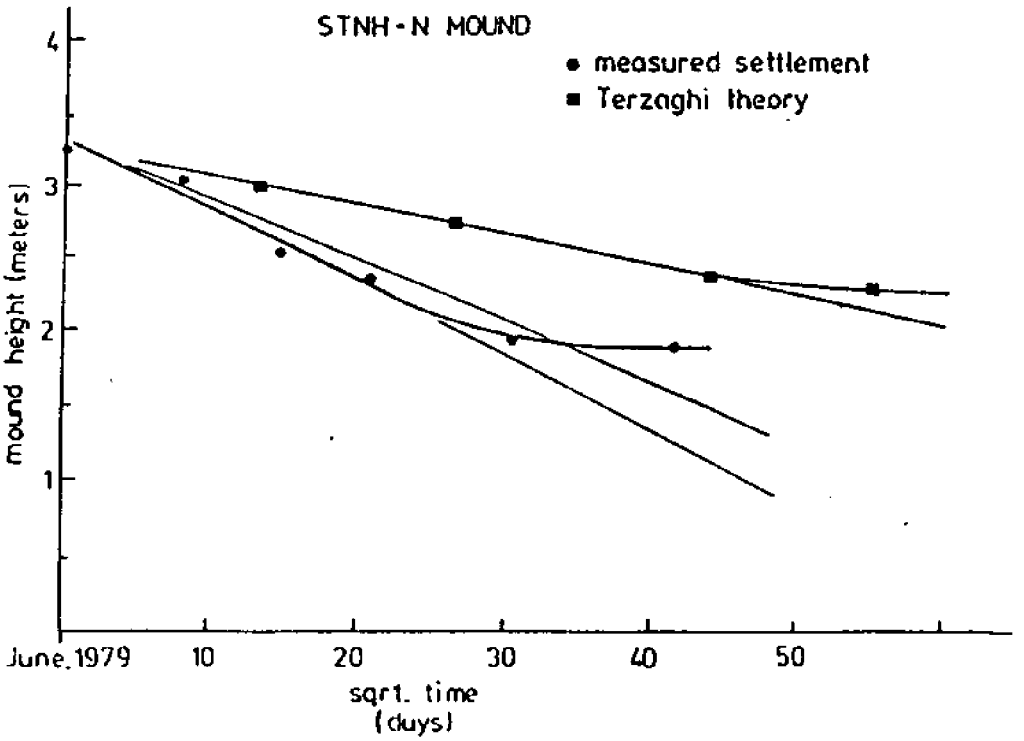


Figure 3 : Predicted and measured time rate of settlement for the STNH-N disposal mound

PROJECT R/SL-4

A Framework for Evaluating the Impacts of Coastal Tourism Product Mixes at the Local Level

Marilyn Altobello, University of Connecticut
Tommy L. Brown, Cornell University
Madeleine Hall-Arber, Massachusetts Institute of Technology
Mark Okrant, Plymouth State College (New Hampshire)
Timothy Tyrrell, University of Rhode Island

Under the sponsorship of the Northeast Sea Grant Directors, a symposium was called in 1983 to have researchers identify good regional projects common to many states. Three possible projects were considered seriously by the research teams, and of these, the proposal described here seemed to have the best potential.

It was agreed that the five states of Connecticut, Massachusetts, New Hampshire, New York and Rhode Island would provide the support necessary to start in the summer of 1984.

Rationale

For several decades, the shoreline in the Northeast has been in strong demand for residential, commercial, and tourist-related purposes. An increased demand for the use of the shoreline for these and other purposes in the past two decades -- combined with the reality of a fixed supply -- has resulted in a growing number of conflicts between potential individual users, developers, and regulators. Consequently, municipalities and regional planning officials are faced with the difficult task of allocating limited coastal areas among these and other competing uses.

The demand for marine recreation and coastal tourism, including second homes, is expected to continue to increase substantially in the Northeast, as well as nationally. Recreational expenditures of over $15 billion per year are concentrated in the coastal recreation market, and over half of the national population lives within 50 miles of the coast (Siehl, 1977). Leisure activities customarily have high income elasticities of demand, and as the middle and upper income population increases, demand for marine recreation and tourist-related activity is expected to grow in the region.

It is unlikely that supply or availability of coastal land for tourism-related purposes will keep pace with demand, because of the limited amount of shoreline that can be developed for these purposes. The result probably will be excess demand for coastal land and a subsequent rise in prices, or the establishment of some other rationing policy. Given this situation, it is imperative that any proposed reallocation of coastal lands be

carefully evaluated to ensure that the advantages and disadvantages associated with proposed new uses are thoroughly documented and considered.

Although tourism has become increasingly important and generally recognized as one of the major coastal industries in the Northeast, most planning decisions and recommendations related to tourism are made at the local level. This is because local communities in the Northeast have historically had primary jurisdiction in deciding use options within municipal boundaries. State and federally funded coastal management programs have assisted localities in protecting beaches, dunes, and other critical habitats, and in enhancing public access. Decisions about development of recreation and tourism services, primarily by the private sector, are expected to remain largely under the purview of local government.

Despite the prevalence of decision-making at the local level, community leaders and municipal planners have insufficient procedures for documenting the relative advantages and disadvantages of encouraging one versus another of the numerous activities which comprise coastal tourism. Legislators and other local officials who daily face problems of determining plans for future tourism development need a framework from which they can array and evaluate the impacts of alternative tourism product mixes. Little in the way of research applicable to the Northeast is currently available.

Because tourism has become a significant industry and source of employment, numerous socio-economic and environmental impacts of tourism-related activity on a coastal region have become apparent. Among the benefits properly developed tourism can provide are: a) increased employment; b) increased income; c) resulting increases in the standard of living of the local population; d) development of recreational facilities for tourists which may be used by local residents; e) greater cultural awareness on the part of local residents; f) improvements in infrastructure (utilities, transportation facilities, etc.), and g) reduced property taxes.

A number of tourism-related costs also have been observed. Among these are: a) deterioration of the natural environment (i.e., damage to plant and animal life and beach and dune erosion); b) increased pollution in the form of diminished air and water quality, litter, and noise; c) congestion of highways and other transportation facilities; d) increased population density; e) increased land and housing prices as well as prices of other goods and services resulting from increased tourist demand; f) fluctuations in employment due to seasonality of tourist demand; g) increased use of local water, sewage, and other utilities; h) increased incidence of crime.

A fairly substantial literature base exists on the need for tourism planning and on planning considerations and strategies.

Numerous case studies have estimated both positive and negative benefits associated with particular types of tourism. Other bodies of literature have examined considerations in the formation of data bases and planning models ranging from simple information systems to decision-making models that incorporate multiple criteria. This project sought to apply this literature to the problem of choosing at the local level among various mixes of tourism development, and to develop a modified benefit-cost framework having application at the local level.

Work on the project began by following the recommendation made by one of the reviewers of the original project proposal. The reviewer suggested that an advisory committee should be developed with the assistance of a marine advisory agent. Members of this committee consist of state and local officials, planning and community development staff, cooperative extension agents and coastal area management staff.

As called for in the proposal, three coastal communities in each state were chosen as case study areas, based on interactions with the advisory committee and other knowledgeable people. For example, the case study areas chosen for Connecticut are the Towns of Norwalk, Madison and Stonington. These study areas have been classified and compared according to demographic characteristics, relative economic importance of tourism, level of tourism development, relative availability of several types of tourism (product mix), and types of access used by tourists. Background and/or preliminary tasks undertaken have included site visits and meetings with advisory committee members, regional meetings of the project staff, and frequent telephone conversations between the various investigators.

The ultimate goal of this project was to develop a methodology for estimating relative benefits and costs to communities from projected increases or alterations in tourism product mixes, and from this to construct a decision-making framework that community leaders can use to estimate the relative impacts of developments in tourist attractions.

Several research procedures were used to develop methodologies for estimating the relative benefits and costs to communities from projected increases or alterations in their tourism product mixes. First, relevant secondary data sources and interviews with key informants, chosen with the assistance of the advisory committee, were used to provide estimates for social, economic, and environmental costs and benefits. The interviews were also able to ascertain both an historical perspective and future directions for tourism development. Second, content analysis was used to identify the social, environmental and economic impacts of tourism-related activity.

Because of the regional nature of this study, the local in-state team provided essential data for its three study towns for the other four researchers in their areas of specialization.

For the Connecticut case studies, three local newspapers were selected as the communications base: New London Day (Mystic), The Hour (Norwalk), and The Shoreline Times (Madison), to gather primary data for the content analysis. Due to the repetitive nature of the information, two weekday issues were selected for the analysis. For the years 1975, 1980, and 1983/84, each Tuesday and Friday issue was assessed. For the interim years, only the months of February and July were assessed, again each Tuesday and Friday issue. This information was computerized and will be pooled with the information collected by the other universities to project the impact of future tourism development in communities similar to those under investigation.

In addition to developing local data for all of the areas under investigation, the Connecticut team had the responsibility to provide a fiscal impact analysis for all of the coastal towns under consideration.

Six types of fiscal impact analysis were reviewed. The technique selected is used to determine the impacts of non-residential facility development in terms of economic costs and benefits. This approach is particularly well-suited to tourism development because it can be used to evaluate the impact of "one of a kind" phenomenon such as a sports complex or convention center, which would place unique demands on specific public goods and services.

PROJECT E/F-2

National Sea Grant Congressional Fellowship

Donna A. Johnson
The University of Connecticut

In the fall of 1984, the National Sea Grant Fellowship program selected Donna A. Johnson, a doctoral candidate in estuarine ecology at The University of Connecticut, to be a Congressional Fellow or Intern during the year February 1, 1985 to January 31, 1986. Her unusual background in both marine and environmental matters made her an ideal choice for the first person selected to represent Connecticut Sea Grant in this fellowship program.

Ms. Johnson was assigned to the Oceanography Subcommittee, chaired by Congresswoman Barbara Mikulski, of the Merchant Marine and Fisheries Committee in the House of Representatives. The Subcommittee's jurisdiction includes: marine science generally; oceanographic research, including vehicles, platforms and structures; ocean engineering, including materials, technology and systems; ocean environmental protection, including any ocean resources development and conservation; coastal zone management; marine and estuarine sanctuaries; National Oceanic and Atmospheric Administration; U.N. Conference on the Law of the Sea; and Sea Grant programs and marine extension services.

Activities

Reauthorizations

* National Oceanic and Atmospheric Administration's 1986 Budget
* Marine Research, Sanctuaries and Protection Act - Titles I (Ocean Dumping) and II (Ocean Dumping Research)
* National Ocean Pollution Planning Act
* Coastal Zone Management Act

Hearings

* Marine Biotechnology
* Ocean Service Centers

Introduced Legislation

* National Estuaries Bill

The first month, Ms. Johnson spent working on NOAA's budget, writing the Committee's Views and Estimates, and preparing testimony before the Appropriations Committee. Following that, she helped with the remaining reauthorizations.

The Committee was working on developing a national estuaries program. Legislation was written and introduced for this purpose.

Finally, Congresswoman Mikulski has begun a series of hearings on "The Oceans and the Future." Marine Biotechnology was the first in the series. It also was the first hearing that she was responsible for organizing.

Educational Value

The experience of working for Congress for a year is invaluable for a scientist. Learning how to communicate with policy makers and how to present science in a format they can use and understand is an important part of the training. At the same time, the scientist learns how the legislative process really works.

PROJECT A/E-1

Connecticut Sea Grant Marine Advisory Program Cooperative Extension Service

Gene Whaples, Lance Stewart, Norman Bender
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Connecticut's coastline, comprised of 583 miles of embayment and tidal shoreline, forms the northern border of Long Island Sound. Starting in the mountains to the north, numerous rivers form the land drainage systems that eventually flow to the Sound.

The rivers discharge into the Sound, creating fertile estuaries and marshes that provide highly productive nurseries for flounder, striped bass, oysters, scallops, blue crabs, lobsters, shad, salmon and waterfowl.

Long Island Sound has been called an "urban sea," due to the high population concentrations found along parts of its shoreline. Among the human activities that affect the Sound are industrial, housing, transportation, waste disposal, fishing and recreational uses of water and coastal land.

Traveling from the western Connecticut shoreline (Fairfield and New Haven Counties) with its high concentrations of industry and population to the less densely populated eastern counties (Middlesex and New London) illustrates the spectrum of coastal resource uses and situations that provide the starting points for marine advisory programs in Connecticut.

The Sea Grant Marine Advisory Program (MAP) was established at the University of Connecticut in 1974. It functions as both a marine program unit of the Cooperative Extension Service (College of Agriculture and Natural Resources) and the outreach arm of the Connecticut Sea Grant Program.

MAP educational programs help relay information from the scientific community to marine resource users and also demonstrate ways to apply new technological advances and methodologies to marine problems. MAP staff members also assist in identifying appropriate marine topics to be addressed by Connecticut Sea Grant researchers and review proposals during the proposal development process.

The new MAP Advisory Committee began to assist program planning and evaluation efforts on a formal ongoing basis. Its members represent the views and interests of key MAP audiences, including commercial fishermen, aquaculturists, marine trades managers, harbor masters, municipal planners, seafood processors and charter and party boat captains. MAP staff have always

utilized one-on-one techniques in assessing potential program topics and methods. The new Advisory Committee presented an opportunity to strengthen MAP's ties with diverse audiences in a manner conducive to improving support for the Marine Advisory Program in Connecticut.

During its ten-year history, the Connecticut Marine Advisory Program has addressed significant topics, including: marine commerce/energy impacts, fisheries issues (industry development and resource management), coastal resource planning, port and harbor management, aquaculture and marine resource economics. Educational programs covering these topics have resulted in cooperative efforts with marine industries, public agencies and educational institutions.

The Marine Advisory Program, in concert with the total Connecticut Sea Grant Program, provides educational programs that increase the ability of the State's citizens, marine industries and other educational institutions.

The fishing industry benefits from programs covering: shellfish production and management, fishing gear technology, seafood marketing, fisheries development and financial management. Connecticut's consumers are learning how to maximize their use of locally caught seafood, resulting in improved nutritional and long-term health benefits. Coastal communities are planning waterfront development projects, using information obtained from MAP.

Overall, the MAP assists the public in:

* making wise decisions regarding the use and development of living and non-living coastal resources;

* managing marine resources and products to achieve optimum uses;

* monitoring and protecting seafood products from marine pollution and quality deterioration;

* improving their understanding of products derived from the sea, marine resource industry's contributions to society and the fragile nature of the ocean and coastal environment;

* improving the marine and coastal environment, resulting in greater productivity of marine resources.

The specialties of the MAP staff are directed primarily into: fisheries development, fisheries gear technology, aquaculture, shellfish management, seafood marketing, applied economic research in fisheries and marine resources, marine business and financial management, and coastal resource trends.

Fisheries Development

Connecticut's fishing industry landed over 7.7 million pounds of seafood valued at $13.5 million (at dockside) during 1984. There were more than 1,000 commercial license holders within the State, with about 300 full-time fishermen earning their living from marine waters. MAP organized the Annual Marine Fisheries Forum, which involved over 200 harvesters, processors, resource managers and University specialists. Participants learned about findings of the Connecticut Department of Environmental Protection-UConn lobster conflict study, underwater research regarding fishing gear behavior, business development opportunities and assistance, and fisheries management issues.

Fishing Gear Technology

MAP was instrumental in setting up a pilot project which introduced the hydraulic clam rake into Connecticut. It will result in more efficient harvesting of subtidal soft clams. To date, six municipalities have approved the use of hydraulic harvesting equipment on their town shellfish grounds. They are Madison, East Lyme, Groton, Waterford, Guilford and Clinton.

Shellfish Management

Four coastal towns used MAP assistance to organize shellfish management plans which were approved by the Connecticut Aquaculture Division. Six other towns are preparing management plans with guidance from UConn marine agents.

One immediate impact of management plans is the opening of shellfish beds for commercial and recreational harvesting activities. For example, the Town of Guilford approached the Sea Grant Marine Advisory Program requesting assistance in formulating a shellfish management plan.

Educational activities included slide presentations before the local Shellfish Commission, outlining steps needed in developing the plan, as well as field training sessions involving resource inventory techniques. Guilford developed a State-approved plan and proceeded to open up two previously closed rivers to shellfishermen. Over 5,000 bushels of oysters worth $60,000 were harvested in these areas.

Seafood Utilization

Seafood firms are improving their knowledge of handling, processing and marketing techniques resulting in fresher products and improved nutritional benefits to consumers. Training programs are being set up for seafood firm employees, Extension home economists, and consumers.

Recreational fishermen are using a fact sheet to maintain the quality of bluefish caught in Connecticut's waters. Three thousand copies were distributed to fishermen on 55 charter and party boats operating from State harbors, as well as local boat rental stations.

A series of articles on seafood selection and preparation reached hundreds of thousands of consumers through the "Food Section" of The Hartford Courant.

Marine Financial Management

Commercial fishermen are using MAP information to manage their financial affairs, resulting in greater financial stability and increased incomes. One large shellfish firm increased its net income by using tax management tools to build new fishing vessels and modernize existing ones. The owner is increasing net income by up to $160,000 per year, while adding to his firm's harvesting capacity with more fuel-efficient vessels. More than 1,000 commercial fishermen updated their knowledge of tax management techniques through newsletter articles, workshops and individual advising. Over 340 marine agents throughout the United States are utilizing a UConn publication, "Financial Management Handbook," when advising commercial fishermen.

Coastal Development

Municipal agency planners use MAP information and training programs when making decisions concerning proposed waterfront development projects. Five municipalities have resolved problems associated with overcrowded small boating harbors through State-approved harbor management plans. MAP organized a Coastal Trends Conference on their subject, which taught 130 participants how to use alternative approaches to resolve multiple-use conflicts common to the State's coastline. Work is continuing in this area with emphasis upon ensuring mixed-use development of urban waterfronts.

PROJECT A/O-2

Eye on the Maritime Sky: A Marine Meteorology Video

Mel Goldstein
Weather Center, Western Connecticut State University
Danbury, Connecticut

with

Channel 20, WTXX, Television

Because of the large number of ships and boats on Long Island Sound, of the order of 250,000, and the sudden disastrous nature of many weather events which include fog, squalls, hurricanes and an occasional tornado, the WCSU Weather Center has developed a special competence in such prediction. The heavy concentration of pleasure boats on the Connecticut shoreline makes assistance to these boaters of very high priority to the State.

As a consequence, this project was supported by a special State fund for Sea Grant projects, and by matching funding from the Western Connecticut State University.

Each year, numerous accidents occur on the water because of sudden weather changes. If these changes were known in advance by the boaters, then the number of incidents could be dramatically reduced. There is a wealth of material available on marine meteorology in numerous books; however, this information is not necessarily widely circulated among boaters, especially the pleasure boater.

Because of the need to present material on marine weather and because some of the printed material is not being used optimally, a video tape presentation on marine weather was prepared and will be widely distributed on commercial and public television. The film also will be made available to numerous groups, such as power squadron groups and marine associations. It is hoped that the film will provide some useful information and at the same time inspire boaters to go further in pursuing more detailed meteorological understanding.

The film, entitled, "Eye on the Maritime Sky," was prepared on an elementary level. Consequently, the main target audience is the pleasure boater who has limited knowledge about marine weather. However, commercial operators should also find some useful information contained within the film.

Included in the film is an extensive discussion with Dr. Neil Frank, Director of the National Hurricane Center. Much of the filming was performed in the Florida Keys during January

1985, and additional footage was taken on Long Island Sound. Because of time and financial constraints, the film can only touch upon some basic topics. Additional films are contemplated for providing further understanding of marine meteorology.

There are four main segments within the film. The first focuses on cloud and thunderstorm formation. The second describes the formation of fog, and the third deals with wave height forecasting. The final segment concentrates on hurricanes and their potential threat.

The film opens with a discussion on how ocean squalls and thunderstorms develop and goes on to describe how boaters might suspect when these storms will form. The film shows that thunderstorms and squalls develop whenever moist, unstable air builds up in the atmosphere.

A basic process of such destabilization is described through an explanation of differential advection. Differential advection is a process by which low levels of the atmosphere become increasingly warm and moist, while high levels become colder. The proper amount of differential advection often leads to big squalls. Graphics are used to show the process, and footage of clouds and squalls vividly show the result of such occurrences. Viewers are shown how to identify the clouds which lead to thunderstorms. Of course, NOAA Weather Radio is described as a useful and important tool for gathering weather information.

In addition, the film points out how an AM radio can be useful in detecting thunderstorms by giving off static from the lightning discharges. The static can be detected by tuning into an AM radio, and with experience, a boater can measure the thunderstorm threat by noting the frequency and level of the static. It may not be a radar, but the method is known to yield useful information.

In addition to examining clouds which form well above the sea surface, the film describes the formation of clouds directly on the surface, a phenomenon called fog. In order to explain the formation of fog, it was necessary to describe the basic concept of relative humidity as well as the concept of dew point. Viewers are shown how to use a simple sling psychrometer with its wet and dry bulb attached to a rotating chain. The sling psychrometer used in the film is a simple instrument which most boaters can purchase at any marine supply store. The film shows how the wet and dry bulb temperatures are measured, and how both the relative humidity and dew point can be determined from the differences between the two readings. Viewers are shown how to use charts which yield the humidity and dew point from the wet and dry bulb readings. The film points out that when the dew point is higher than the sea surface temperature, fog will likely form. Consequently, if a boater monitors the dew point and surface temperature, the chances for fog formation can be readily assessed. It is hoped that the description and demonstration can

be put into practice and eliminate the potential for a boater being caught by surprise. Graphics of temperature and dew point were used in this segment, along with fog scenes which were taken on Long Island Sound.

In addition to being unpleasantly surprised by a thunderstorm or a fog bank, a boater can easily be caught unprepared for tall waves, which can capsize a vessel or at the least make for an uncomfortable and unpleasant experience. Consequently, a segment on wave height forecasting was included. There is much confusion concerning wave height forecasts which are issued to the general boating community.

Most of the time, the predicted wave heights are the average wave heights which describe an average between the tall swells as well as the small ripples. The predicted wave heights may not be very useful because by averaging all waves, a forecaster is giving too much weight to the smallest waves which actually cause few, if any, problems to boaters. A more meaningful representation is the significant wave height, which is the average of the tallest one-third waves occurring on the sea for a given wind and fetch. These tallest waves represent the waves which will cause boaters problems, and as a result, the film concentrated on how these wave heights can be predicted by the boater. The concept of significant wave height was first introduced, and then the concepts of wind duration and fetch were described. Boaters are actually shown how to determine the significant wave height from the wind speed under optimum or fully developed conditions. Tables can be utilized for such a calculation; however, a simple formula was demonstrated through the use of different graphics. With this simple formula, a boater can readily calculate the significant wave height before leaving the dock.

Another hazard facing boaters is the threat of large-scale storms, such as hurricanes. Because many government officials are concerned that boaters and shore residents are unaware of the hurricane potential, it was decided to include a segment from the National Hurricane Center in Miami. This segment was filmed in Miami, and the Center's Director, Dr. Neil Frank, described extensively the problems associated with hurricanes. The interview itself stretched well over an hour; however, because of time constraints within the film, only highlights of the discussion could be included. Dr. Frank stressed the technological advances which have occurred for detecting hurricanes, but he also stressed that these technological advances will not necessarily lead to improved forecasts. In fact, he pointed out clearly that boaters and shore residents will be over-warned in the future. The need for such over-warning was due to the inability to precisely predict the landfall and track of such storms. It was pointed out that even with the over-warning, a major hurricane moving along the east coast could be catastrophic because of the extensive development which has occurred over the past 30 years, which have been relatively quiet with respect to hurricane occurrence.

Hurricanes are a common occurrence along the east coast, and in the near future, these will likely occur at a greater frequency than what has occurred over the past three decades. Viewers of the film will receive a strong impression of the hazards related to hurricane and a good feeling of the technological advances in meteorology.

The four topics of squalls, fog, waves and hurricanes are only a few of the many topics which can be included on marine meteorology. In addition, each one of these can be expanded upon to some extent. Consequently, this film is only meant to be an introduction, which hopefully will lead to further investigations on the part of the viewers. The main purpose of the film was to generate a fundamental understanding. This fundamental understanding can then generate further interest and eventually lead to a more informed boating community.

PROJECT A/CP-1

Communications and Publications

Patricia F. Staley

The communications effort in Connecticut included an annual report, newsletter, advisory bulletins and fact sheets, brochures and press releases, and meeting announcements, displays and other support materials. The communications staff also is involved in preparation and editing of the Sea Grant Project Proposal and preparations for the annual Site Visit.

Efforts have begun to attract more attention from the mass media, and some results from that effort are beginning to be seen. It is an effort being undertaken with some caution, however, since there is danger of being overwhelmed by requests for assistance that could be generated by wide-spread exposure of the program.

Through August of 1984, Connecticut Sea Grant distributed 16 publications plus a quarterly newsletter. Publications were mailed in response to well over 1,000 mail requests for specific items. In addition, booklets, brochures, tax and financial information were distributed by MAP specialists during conferences, at exhibits and fairs and workshops. There were also bulk mailings to targeted audiences.

During the 1983-84 project year, Connecticut published its first annual report, Sea Grant in Connecticut. The principal investigator wrote and edited the text and coordinated design work and printing, which was done by the University Press.

In July, 1984, Connecticut published the Advisory Handbook on Fishing Financial Management. The principal investigator served as editor for that publication, which was written by a committee of economists from throughout the Sea Grant network and related organizations, and chaired by Norman K. Bender, economist for Connecticut's Sea Grant Marine Advisory Program. The Handbook has been distributed to advisory service fisheries agents in every MAP program to provide them with basic background about the business end of fishing.

At the regional level, the principal investigator was co-chairman of a media seminar at Fish Expo '84, at which Sea Grant researchers from New England made presentations on their work. The seminar included a demonstration on preparation of surimi by Connecticut's seafood specialist, James Wallace, and Dr. Chong Lee of the University of Rhode Island. A press packet with materials about Sea Grant Programs in New England and nationwide was distributed. The communicator served as liaison with the

national office to coordinate the National NOAA exhibit with the seminar.

The communications staff also cooperated on these NOAA-agency projects:

- Assisted with advance publicity and served as on-site public information officer for a symposium on undersea research, sponsored by NOAA's National Undersea Research Program at Avery Point, and assisted with preparation of displays for exhibits at the symposium.

- Teamed with the MAP aquaculture specialist, Tim Visel, to assist a museum with an exhibit on oystering in Connecticut. Mrs. Staley provided the historical background that a folklorist used as he interviewed oystermen, retired and active, who were the focus of the exhibit at the Connecticut River Foundation Museum in Essex. Mr. Visel provided technical assistance and advice. In addition, MAP provided the museum with 500 copies of Mr. Visel's fact sheets, "Life History of the Oyster," and "History of the Natural Growth Oyster Industry in Connecticut," for distribution to museum visitors.

- Developed a marine studies class for pre-school children and conducted a beachwalk with assistance from Mr. Visel, as a marine education pilot project. Response from the school involved suggests that it would be appropriate to develop a booklet for distribution to nursery schools and day care centers in the 25 shoreline towns, and other inland towns.

- Provided educational materials and programs such as displays and exhibits, primarily for MAP.

- Reviewed project proposals, internal and external, as requested.

- Assisted in proposal preparation and preparation for the Site Visit.

- Provided support for program management, by editing and/or writing documents such as reports to the University administration, legislature, Congressional delegations and providing the means for documentation of Sea Grant activities.