

BISCAYNE BAY
BENTHIC SAMPLING PROGRAM

A PROPOSAL

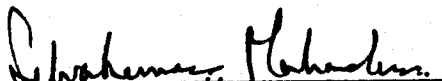
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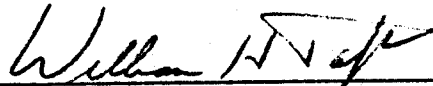
RFP Dated April 30, 1981
Biscayne Bay Restoration
and Enhancement Program

Submitted to:

Dade County Environmental
Resources Management
909 SE 1st Avenue
Miami, Florida 33131

Submitted by:


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ABSTRACT

Mote Marine Laboratory (MML) is pleased to submit this proposal for baseline benthic studies in Biscayne Bay. Dr. S. Mahadevan, a benthic ecologist with eleven years experience, will lead the MML's scientific team.

In Phase 1, MML proposes to sample sixty sites (representative of all habitats in Biscayne Bay) during a wet and a dry season. At the sixty sites, benthic macrofauna will be sampled with a diver-operated box-core (dimensions: 12.5 cm x 12.5 cm, area and 20 cm penetration). Two samples will be collected at each site, with one serving as a reserve (with the option for analysis if total organism numbers are low in the first sample). To ensure sampling adequacy, three replicates for sediment analysis and five quadrats (0.25 m x 0.25 m area) for macroalgae are proposed to be collected at each site. Seagrasses would be characterized with photographs, qualitative samples and the box-core samples. Selected abiotic parameters would also be measured. Species lists, various biotic-abiotic correlations, and a report summarizing the results of Phase 1 will be submitted. Also, recommendations of specific locations for Phase 2 sampling would be made in this report.

In Phase 2, MML proposes to sample about twelve stations every quarter for two years. Replication level for the macrofauna would increase to six samples (one sample will serve as a reserve). All other components would be sampled at the same replication level as Phase 1. Taxonomic adequacy, stringent quality controls and rigorous data analyses would ensure that the scientific data base is accurate and robust. The final report would summarize all data, provide statistical analyses of community interactions with other biotic and abiotic parameters, and generally describe seasonality and productivity of the Biscayne Bay benthos. Through the use of faunal similarity analyses, differences between seasons and between sites would be clearly delineated. The report would address the necessity of future studies and provide

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I. INTRODUCTION

Mote Marine Laboratory (MML) is pleased to submit this proposal and statement of qualifications in response to your RFP dated April 30, 1981 for benthic studies in Biscayne Bay. We have assembled an extremely competent team of scientists to adequately address the objectives of this program. MML has conducted benthic studies for twenty-five years. This experience, coupled with the excellent facilities available at MML, we feel, would provide a technically sound and cost-effective benthic baseline for Biscayne Bay.

a) Background

The benthic study would be conducted as part of the overall "Biscayne Bay Management Plan" adopted by the Dade County Commission in 1980. Overall objectives and specific projects of the Plan are described in the RFP.

b) Objectives

The overall goal of the benthic program is to establish a scientific data base of the benthic communities in Biscayne Bay. Specific objectives of the program are divided into two phases:

- Phase 1
 - (i) Seasonally describe benthic faunal abundance, diversity and distribution throughout Biscayne Bay.
 - (ii) Correlate faunal parameters to habitats (biotic: macrophytes, algae, etc.; abiotic: sediment type, circulation, urbanization, etc.)
 - (iii) Select representative sites for intensive data collection in Phase 2.

- McNulty et al. (1962); Sediment-macrofauna relationships.
- McNulty (1970); A follow-up study on sediments and macrofauna after sewage pollution abatement.
- Meyers et al. (1965); Studies of turtle grass infestations.
- Moore (1972); Carbonate production by macrobenthos.
- Nugent (1970); Macrofauna studies in relation to a thermal effluent.
- Orpurt and Boral (1964); Studies on Thalassia biology.
- Penhale and Sprogis (1976); Productivity of epiphytes associated with seagrass systems.
- Roessler (1971); Effects of thermal effluents on seagrasses and algae.
- Roessler and Beardsley (1974); An overall description of habitat alteration and its effects on flora and fauna.
- Roessler et al. (1974); Effects of thermal effluents on macroflora, algae, benthic fauna and fishes.
- Roessler (1977); Effects of thermal effluents on seagrasses and macrobenthos.
- Rosenberg (1975); Quantitative comparisons of benthic fauna between 1957 and 1974.
- Snedaker and Brook (1976); A review of ecological and trophic relationships between benthos and higher consumers.
- Sprogis (1975); Benthic diatoms in relation to thermal discharges.
- Thomas et al. (1961); Effects of hurricane Donna on Thalassia beds.
- Thorhaug and Bach (1973); Algal productivity in relation to thermal effluents.
- Thorhaug (1974); Seagrass and macroalgae biology.
- Thorhaug (1976); Seagrass functions, ecology and succession.
- Thorhaug and Roessler (1977); Seagrass distribution.
- Thorhaug (1980); Vegetation descriptions in Watson Island
- Univ. of Miami (1958); Checklist of fishes, benthos and algae.

II. STUDY PLAN

a) Phase 1: Sixty sampling sites will be chosen based on the following criteria:

- uniform distribution throughout the Bay
- diversity of habitats well represented
(e.g., seagrass meadows, mud, sand and silty sand bottoms, algal areas, etc.)
- ability to utilize historical data.
- coincident with water quality and fisheries monitoring stations, where practical.

At each site, two box-core samples* will be collected for analysis of fauna, and five random quadrats (0.25 m x 0.25 m) would be sampled for macroflora analysis. Three to five photographs of the bottom would also be taken (detailed methodology is presented in section c) below). In addition, four sediment cores* for granulometric analysis will be collected at each station. Qualitative data on abiotic conditions (depth, sources of freshwater inflow and/or pollutants, bottom characteristics and circulation) would also be collected at each station. Sampling will be conducted twice during the year (wet season and dry season).

b) Phase 2: Between 10 and 12 sites of Phase 1 stations would be selected for continued intensive sampling. All parameters sampled during Phase 1 would be collected during this phase. However, sampling will be on a quarterly basis; continue for two years; and five quantitative faunal replicates would be collected at each station.

c) Methods

(i) Sampling Devices

Samples for faunal analysis will be collected with stainless steel plug corers (dimensions: 12.5 cm x 12.5 cm x 23 cm, .016 m

*One sample will serve as reserve; if organism numbers are low in the first sample, extra faunal sample will be analyzed.

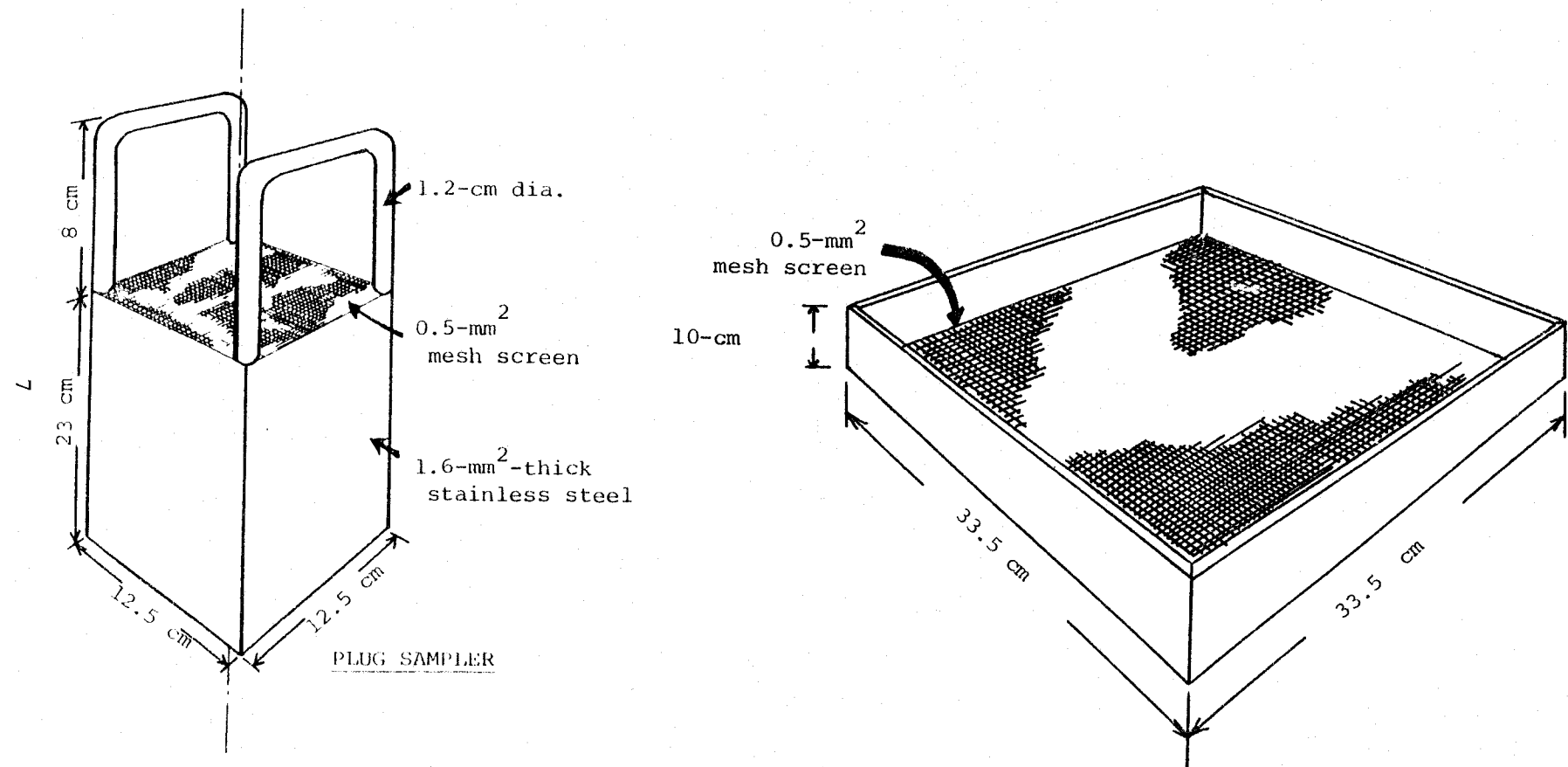


Figure 1. Sieve and Plug Sampler used for Quantitative Benthic Studies.

binocular microscope. The heavy fraction, containing primarily molluscs and larger animals, will be sorted with the unaided eye in a white background enamel pan. *Taxonomic identifications will be performed under various powers of the binocular microscope or an AO compound microscope. Biomass of individual taxon at each station will be measured as wet weight (grams).

Laboratory analyses of the sediment samples (grain size, organic and carbonate content) are shown in the form of a flow-diagram in Figure 2.

Seagrass and macroalgae species found in the box-cores will be identified to the species level* and biomass measured as dry weight. Similarly, drift and macroalgae from quadrat sampling would be identified and biomass measured.

(v) Taxonomic Procedures

Taxonomic identifications of species will be accomplished with the use of descriptive literature appropriate to the study area. In addition, taxonomic experts will be utilized to either identify or confirm the identifications of several species. The following scientists will assist in taxonomic identifications: Dr. R. Tucker Abbott (Mollusca), Dr. E.D. Estevez (Isopoda), Dr. E. Bousfield (Amphipoda), Dr. R. Heard (Crustacea), Dr. W. Price (Cumacea), Dr. J.L. Simon (Polychaeta), and Dr. R.C. Phillips (Algae and Seagrasses).

(vi) Data Analysis Procedures - Fauna/Flora

Numerical indices will be chosen on their ability to provide meaningful summaries of data. One criterion used in the selection of indices will be their widespread use in scientific literature, which should facilitate comparison of data from this study with other quantitative information available in literature. The following suite of indices are proposed for the summarization of data:

*All identifications will be to the species level, except for sponges, nematodes and ostracods. Also, a permanent taxonomic reference collection of representative individuals of each species would be prepared. Because of their importance as water quality indicators, we propose that polychaetes be identified to the species level, and not to the family level only, as suggested in the RFP.

Faunal Density

Faunal density will be reported as numbers of individuals per square meter. Values will be computed by dividing the total number of individuals found at a station by the total area sampled.

Biomass

Biomass will be reported as number of grams (wet weight for fauna; dry weight for flora) per square meter. Values will be computed by dividing the weight by the total area sampled.

Species Diversity

Menzies, George and Rowe (1973) define diversity as a concept in community ecology which refers to the heterogeneity (or lack of it) in a community or assemblage of organisms. Thus, diversity is dependent upon the number of species present (species richness, S) and the distribution of individuals among species (equitability or evenness). Another definition of diversity is simply the number of species found in a unit area (Whittaker, 1972). Indices to measure diversity, species richness and equitability are so numerous that confusion is rampant (Reviews in Hairston, 1964; Sanders, 1968; Hurlbert, 1971; Whittaker, 1972; Fager, 1972; Peet, 1974; Pielou, 1975; Smith et al., 1979; etc.). The proliferation of indices has prompted Hurlbert (1971) and Peet (1974) to recommend discarding diversity as a measure in ecological studies. However, placed in the proper perspective, diversity indices have been shown to be useful in "bio-environmental" studies (Boesch, 1972; Borowitzka, 1972; Swartz, 1972; Pearson, 1975; Swartz, 1976). In this study we will restrict our data analysis to the two commonly used diversity indices: the Shannon-Weaver index and the Gini's (Simpson's) index.

i. The Shannon-Weaver Index of Diversity (Shannon and Weaver, 1963).

The index is based on 'information' techniques, where diversity is equated to the amount of uncertainty which exists regarding the species identity of an individual selected at random from a community.

Faunal Similarity

A number of coefficients for measuring faunal similarities are available (Bray and Curtis, 1957; Sanders, 1960; Horn, 1966; Whittaker, 1967; Lie and Kelly, 1970; Grassle and Smith, 1976). However, most of the available coefficients consider only the number and rank of common species and not the distribution of individuals. The Morisita's index (Morisita, 1959), which takes into consideration both the number of species in common and the number of individuals shared, will be utilized for this study. Many authors in the past have used this index with a greater degree of success than overlap coefficients (Ono, 1961; Barnard, 1970; Mauchline, 1972; Bloom et al., 1972; Gage and Geekie, 1973; Menzies, 1973; Paul, 1973; Gage, 1975; Farrell, 1974; Marum, 1975; Mahadevan, 1979). The computational formula for the Morisita's index is:

$$C\lambda = 2 \sum_{i=1}^S n_{1i} n_{2i} / (\lambda_1 + \lambda_2) N_1 N_2$$

where $\lambda_1 = \sum_{i=1}^S \frac{n_{1i} (n_{1i} - 1)}{N_1 (N_1 - 1)}$

and $\lambda_2 = \sum_{i=1}^S \frac{n_{2i} (n_{2i} - 1)}{N_2 (N_2 - 1)}$

where N_1 and N_2 are the total number of individuals in sample one and two, respectively. n_{1i} and n_{2i} are the number of individuals in the i th species of sample one and two, respectively. The value of $C\lambda$ is about one when the two samples are identical and zero when no common species are present. The index is relatively free from sample size effects.

Data Analysis Procedures - Sediment

Analysis of the sediment samples includes determination of percentage volatile matter and grain size distribution. Statistics on the grain size distribution will be performed using the following formulae; where $\phi (\phi) = -\log_2 x$; x = particle size in millimeters:

(i) Mean grain size (Mz) - overall size measure (Folk, 1974).

$$Mz = \frac{\phi 16 + \phi 50 + \phi 84}{3}$$

- (iv) Graphic kurtosis (Kg) - ratio between the sorting in the "tails" of the granulometric curve and the sorting of the new central portion of the curve (Folk, 1974).

$$Kg = \frac{\phi_{95} - \phi_5}{2.44 (\phi_{75} - \phi_{25})}$$

<u>Kg Values</u>	<u>Degree of Kurtosis</u>
<0.67	Very platykurtic
0.67 - 0.90	Platykurtic
0.90 - 1.11	Mesokurtic
1.11 - 1.50	Leptokurtic
1.50 - 3.00	Very leptokurtic
>3.00	Extremely leptokurtic

Data Management

Computer data management of information collected in the proposed study will be conducted by an 8-bit H-8 Heath mini-computer (64 K memory, 3 disk system). All numerical indices listed above will be computed and species lists compiled by the computer system. Software for the system was prepared by Dr. William N. Tavalga (Senior Staff Scientist, Mote Marine Laboratory).

Quality Assurance

Stringent quality assurance (QA) procedures will be employed to ensure the validity and accuracy of collected data. Procedures that will be part of a project-specific, written QA manual will be strictly followed. Some highlights of the QA program for the proposed study will be:

- Documentation, in the form of internal and external sample labels, checked and copied bench sheets, and verified computer printouts.
- Data traceability will be maintained from sample collection to report presentation through consistent sample labelling and data-tracking.

III. PROJECT MANAGEMENT/PERSONNEL

The proposed project management structure is shown in Figure 3.

Dr. Selvakumaran Mahadevan would serve as the Principal Investigator for the study. He is a Senior Staff Scientist at MML and the Director of its Environmental Assessment Division (EAD). He has over eleven years experience in benthic faunal studies from a diversity of habitats. He has authored numerous technical reports and papers in the field. His responsibilities on the project would include project management, liaison between MML and DERM, participation in the Biscayne Bay Restoration Working Team, supervision and participation in all facets of the study and reports preparation. He is familiar with the Biscayne Bay system and its historical benthic literature. He would be assisted by Mr. James K. Culter, a Senior Staff Biologist in the EAD. Mr. Culter has over seven years experience in benthic ecological studies.

Dr. William H. Taft would supervise sediment analysis for composition and grain size. He is the President of MML. He has over twenty years experience in marine geology and sedimentology. He has conducted research in Florida Bays and is intimately familiar with the geological conditions of Biscayne Bay. Dr. Taft would be assisted by Mr. Robert Yarbrough, a Staff Geologist in the EAD. Mr. Yarbrough has over three years experience in grain size analysis and carbonates and organic content analysis.

Mr. Roy R. Lewis would supervise seagrass and macroalgae analysis. He is an Adjunct Senior Scientist at MML. He has over thirteen years experience in macrophytes ecology and has published numerous technical reports and papers on the subject. Recently, he concluded a study of seagrasses in Watson Island, Biscayne Bay. Since 1979 he has served as a member of the Scientific/Technical Committee, Biscayne Bay

Planning Project. Mr. Lewis would be assisted by Dr. Ron C. Phillips, an expert in seagrass ecology.

Mr. Ronald J. Falkey and Mr. John F. Michel would serve as consultants for abiotic parameters. Their intimate knowledge of the Biscayne Bay system, its circulation patterns, physical bottom characteristics and freshwater flow patterns would be invaluable in selecting stations and qualitatively describing abiotic parameters.

Resumes of the above senior personnel are provided in the Appendix.

An in-house Quality Assurance (QA) Committee consisting of senior MML scientists will oversee quality control, audit all project operations on a regular basis and report to the President. Corrective measures, if necessary, would be implemented by the Principal Investigator. The QA committee is independent of the project hierarchy and its sole function is to ensure that necessary and appropriate quality control procedures are implemented for the project.

V. MML FACILITIES/CAPABILITIES

A description of facilities, equipment and capabilities of MML are provided in the general qualifications statement (seperately bound and submitted with this proposal). MML is a private, non-profit organization specializing in environmental and biomedical research. Specific equipment and facilities available for the efficient execution of the proposed project are:

a) Facilities

(i) Space. Of the 18,000 square feet total laboratory space available, two 200 square feet laboratories will be set aside for this project. The set aside space will provide for added control of project related activities.

(ii) Administrative Facilities and Abilities. MML is staffed with adequate administrative personnel to ensure proper accounting and financial management of the proposed project. As evidenced by the Laboratory's research record (please see Standard Form 254 of the Qualifications Statement) and current projects, MML is familiar with federal accounting, procurement, quality assurance and reporting procedures. Typing, photocopying, and duplicating facilities are also available.

(iii) Library. MML maintains a library of 2,750 volumes, 180 serials and 15,000 reprints. A librarian supervises all circulating, research, and archival materials, transmits inter-library loan requests, and manages all information procurement. Computerized literature searches are conducted with the Laboratory's T.I. Silent 700 Portable Data Terminal, which accesses the Lockheed Dialog Information System. The library is equipped with a 3-M Model 500 Microfiche Reader and Printer.

with an instrument accuracy of $\pm 2\%$ of the reading. Conductivity is measured with a temperature compensated four-electrode AC cell with nickel electrodes and an instrument accuracy of $\pm 1.5\%$ using a standard KCl solution for calibration. Temperature is measured with a thermistor probe with an internal calibration standard and an instrument accuracy of ± 0.2 degrees C for temperature between -5 degrees C and $+25$ degrees C and ± 0.4 degrees C for temperature from 25 degrees C to 40 degrees C.

Dissolved Oxygen

Two YSI Dissolved Oxygen Meters (Model 57) are available at MML (accuracy $\pm 1\%$; automatic temperature compensation from -5° to 45° C) for this project.

S-C-T

Two Salinity-Conductivity-Temperature Meters (YSI Model 33) are available at MML (accuracy: conductivity $\pm 2.5\%$ to $\pm 3\%$; salinity $\pm 0.9\%$ to ± 1.1 o/oo; temperature $\pm 0.1^{\circ}$ to $\pm 0.6^{\circ}$ C). MML also owns an American Optical Temperature-Compensated Refractometer and a Beckman Model RC16B2 Conductivity Bridge and Model VH10-2100 cell.

c. Hydrography and Meteorology

MML owns or has contract access to 3 General Oceanic 2000 Flowmeters; 4 General Oceanic Continuous Recording Current Meters; 2 Hydroproducts hand-held Current Meters; Stevens type F Water Level Recorders; Smith Industries Si-Tex Recording Bathymeter; and thermometers (traceable to NBS).

d. Biological Sampling

MML owns a full complement of ship and diver operated grabs and coring devices; epibenthic sleds and other samplers, traps, pots, and weirs.

(ii) Laboratory Equipment

a. Reference Collections

MML curates reference collections of macroalgae (ca. 450 species); macroinvertebrates (ca. 1200 species) and fishes (ca. 275 species) for

VI. PAST EXPERIENCE

MML and its staff have extensive experience in conducting benthic studies. A brief description of representative benthic projects managed by MML in the last five years is presented below. Detailed information on these projects is presented in Standard Form 254 of the Qualifications Statement.

1. Marine and Sampling Program, Pinellas County. This recently completed, multidisciplinary study was conducted as part of a 2001 Program Assessment to evaluate the first Gulf of Mexico sewer outfall proposed for the Florida west coast. Meteorological, chemical, physical, and biological data were collected from a 200 square mile area and evaluated. Dye studies were also conducted. Other study elements included circulation, in situ chemistry, nutrients, sediments, microbiology, phytoplankton and chlorophylls, zooplankton, and benthos. A total of 336 benthic faunal samples and 84 sediment samples were collected and analyzed. All field collections, laboratory analyses, data reduction, and analyses were conducted by MML. A comprehensive report was submitted to the U.S. Environmental Protection Agency.

2. Whitaker Bayou, Sarasota County. In support of a preliminary interagency assessment of the effects of secondarily treated wastewater on the fauna and flora of Sarasota Bay, MML collected and analyzed data on chlorophyll 'a', phytoplankton, benthic fauna and sediments at stations in and near Whitaker Bayou. These studies were coordinated with studies by local and state agencies. A report was submitted to the County of Sarasota.

3. Review and Evaluation of a 316 Demonstration. This study involved the review of an EPA 316 Demonstration for the Anclote Power Plant. Contact with other regulatory agencies and a short-term field study in a Thalassia-Halodule grassbed were conducted. A report was submitted to the U.S. Environmental Protection Agency. The study provided important information for a permitting decision by EPA, Region 4.

permit reviews in the coastal counties of central and southwest Florida.* The work is performed for the National Marine Fisheries Service and involves constant consultation and collaboration with local, state and federal agencies. Benthic fauna and sediments are periodically collected and analyzed. Through this project MML has developed intimate familiarity of regional habitats and their resources. Over 500 reports have been submitted to the National Marine Fisheries Service in the past three years.

8. Sarasota Bay Studies. Sarasota Bay has been the subject of MML studies, including a preliminary phase which has been published. Included in the first report are habitat descriptions, studies of sea-grasses, fishes, crabs, shrimps, heavy metals, sediments, and plankton. Phase two studies are synoptic, bay-wide collections of major ecosystem components, designed to provide a comprehensive baseline of taxonomic resources, and estimates of condition.

9. Gardiner Biogeochemistry. This ongoing year long study of a phosphoric acid plant on Hillsborough Bay is a sequel to a study conducted in 1974, wherein the effects of radioactive, thermal and fluoride enriched, acidic effluents were determined. Following mitigation by the industry, MML is evaluating patterns of biotic recolonization and changing geological and chemical conditions. A total of 1200 benthic faunal samples and 120 sediment samples have been collected and analyzed thus far. A novel aspect of this study is the emphasis being placed on groundwater contributions of pollutants to surface waters.

10. Panama City Benthic Fauna. This study for the Army Corps of Engineers addressed the recolonization of benthic fauna following a beach renourishment project. The study involved collection and analyses of benthic fauna and sediments, hydrographic, and topographic surveys. A total of 490 benthic faunal samples and 196 sediment samples were collected and analyzed. A report was submitted to the Coastal Engineer-

*Studies in 1978 and 1979 included Dade and Broward Counties.

VII. COSTS

Project costs are detailed in Table 1. Total cost for the project for three years is \$175,275. Of this, MML is willing to cost-share approximately 15%, or \$25,275. Hence, cost to DERM would be \$150,000. Costs by phases are:

PHASE 1: DERM = \$50,000; MML = \$8,049
 Total Cost = \$58,049

PHASE 2: DERM = \$100,000; MML = \$17,226
 Total Cost = \$117,226

VIII. LITERATURE CITED

- Applied Biology, Inc. 1977. Ecological monitoring of selected parameters at the Turkey Point Plant. Florida Power and Light Co. Report.
- Bader, R.G., M.A. Roessler and A. Thorhaug. 1970. Thermal pollution of a tropical marine estuary, pp. 425-428, In: FAO Technical Conference on Marine Pollution and its Effects on Living Resources and Fishing. Rome, 1970. p. 624.
- Barnard, J.L. 1970. Benthic ecology of Bahia de San Quentin, Baja California. *Smithson. Contr. Zool.*, 44:60 p.
- Bloom, S.A., J.L. Simon and V.D. Hunter. 1972. Animal - sediment relations and community analysis of a Florida estuary. *Marine Biology* 13(1):43-56.
- Boesch, D.F. 1972. Species diversity of marine macrobenthos in the Virginia area. *Chesapeake Sci.*, 13(3):206-216.
- Borowitzka, M.A. 1972. Intertidal algal species diversity and the effect of pollution. *Aust. Journ. Mar. Freshwater Res.* 23(2): 73-84.
- Bray, J.R. and J.T. Curtis. 1975. An ordination of the upland forest communities of southern Wisconsin. *Ecol. Monogr.* 27:32-349.
- Brook, I.M. 1978. Comparative macrofaunal abundance in turtle grass (*Thalassia testudinum*) communities in south Florida characterized by high blade density. *Bull. Mar. Sci.*, 28(1):213-217.
- Carber, R.E. (Editor). 1971. *Procedures in Sedimentary Petrology*. Wiley-Interscience, New York.
- Fager, E.W. 1972. Diversity: A sampling study. *The Amer. Naturalist*, 106:293-310.
- Farrell, D. 1974. Benthic ecology of Timbalier Bay, Louisiana and adjacent offshore areas in relation to oil production. Ph.D. dissertation, Florida State University, Tallahassee, Fla. 151 pp.
- Folk, R.L. 1974. *Petrology of Sedimentary Rocks*. Hemphill Publishing Company, Austin, Texas. 182 pages.
- Gage, J. and A.D. Geekie. 1973. Community structure of the benthos in Scottish Sea-Lochs. III. Further studies on patchiness. *Mar. Biol.* 20:89-100.

- Mahadevan, S. 1979. A review and evaluation of the 316 Demonstration (Volume II, Benthos) by Florida Power Corporation on the Anclote Generating Unit No. 1. Environ. Prot. Agency, Region 4 Surveillance and Analysis Division. Tech. Rep. Cont. No. 8-01-5016.
- Margalef, R. 1958. Information theory in ecology. Gen. Sys. 13:36-71.
- Marum, J.P. 1975. Spatial and temporal variation of zooplankton in relation to offshore oil drilling and estuarine faunal exchange. 245 pp. Ph.D. dissertation, Florida State University, Tallahassee, Florida.
- Mason, W.T. and P.O. Yevich. 1967. The use of phloxine B and rose bengal stains to facilitate sorting benthic samples. Trans. Amer. Microsc. Soc. 86:221-223.
- Mauchline, J. 1972. Assessing similarity between samples of plankton. J.M.B.A. (India), 14:26-41.
- McNulty, J.K. 1961. Ecological effects of sewage pollution in Biscayne Bay, Florida: sediments and the distribution of benthic and fouling macro-organisms. Bull. Mar. Sci. Gulf Caribb. 11(3): 394-447.
- McNulty, J.K., R.C. Work and H.B. Moore. 1962. Some relationships between the infauna of the level bottom and the sediment in South Florida. Bull. Mar. Sci. Gulf Caribb., 12:322-332.
- McNulty, J.K. 1970. Effects of abatement of domestic sewage pollution on the benthos, volumes of zooplankton and the fouling organisms of Biscayne Bay, Florida. Stud. Trop. Oceanogr. Miami, 9:107 pp. 19 figs.
- Menzies, R.J. 1973. DWD Area A - Environmental Assessment. U.S. Navy Report. NRL #7553. 116 pages.
- Menzies, R.J., R.Y. George and G.T. Rowe. 1973. Abyssal Environment and Ecology of the World Oceans. John Wiley and Sons, New York. 488 pp.
- Meyers, S.P., P.A. Orpurt, J. Simms and L.L. Boral. 1965. Thalassiomycetes VII. Observations on fungal infestation of turtle grass, Thalassia testudinum Konig. Bull. Mar. Sci., 15 (3):548-564.
- Moore, H.B. 1972. An estimate of carbonate production by macrobenthos in some tropical soft-bottom communities. Mar. Biol., 17:145-148.
- Morisita, M. 1959. Measuring of interspecific association and similarity between communities. Mem. Fac. Sci. Kyushu Univ. Ser. E. (Biol.), 3(1):65-80.

- Sanders, H.L. 1960. Benthic studies in Buzzard's Bay. III. The structure of the soft bottom community. *Limnol. Oceanogr.* 5:138-153.
- Sanders, H.L. 1968. Marine benthic diversity: A comparative study. *The American Naturalist* 102:243-282.
- Simpson, E.H. 1949. Measurement of diversity. *Nature* 163:688.
- Smith, W., J.F. Grassle and D. Kravitz. 1979. Measures of diversity with unbiased estimates. *Ecological Diversity in Theory and Practice*, 6:177-191.
- Snedaker, S.C. and I.M. Brook. 1976. Ecology and the food web of Biscayne Bay, In: *Biscayne Bay: Past/Present/Future*. Papers prepared for Biscayne Bay Symposium 1. Univ. Miami SeaGrant. Spec. Rep. No. 5, pp. 227-233.
- Sprogis, J.M. 1975. Changes in benthic diatom assemblages within the thermal effluent at Turkey Point, South Biscayne Bay, Florida. Univ. Miami, M.S. Thesis.
- Swartz, R.C. 1972. Biological criteria of environmental change in Chesapeake Bay. *Chesapeake Sci.* 13(S):17-41.
- Swartz, R.C. 1978. Techniques for sampling and analyzing the marine macrobenthos. U.S. Environmental Protection Agency, Corvallis Environmental Research Laboratory, Corvallis, Oregon. EPA-600/3-78-030. 26 pages.
- Thomas, L.P., D.R. Moore, R.C. Work. 1961. Effects of Hurricane Donna on the turtle grass beds of Biscayne Bay, Florida. *Bull. Mar. Sci. Gulf and Caribb.*, 11(2):191-197.
- Thorhaug, A.L. and S.D. Bach. 1973. Productivity of a red and green macroalgae in a South Florida estuary before and after the opening of a thermal effluent canal. *J. Phycol.*, 9(Suppl.):10.
- Thorhaug, A. 1974. An ecological study of south Biscayne Bay and Card Sound, the *Thalassia* microcosm. U.S. At. Energy Comm. Annu. Rep. AN-40-1-4493, 182 p.
- Thorhaug, A. 1976. The vascular plants of Biscayne Bay, In: *Biscayne Bay: Past/Present/Future*, papers prepared for Biscayne Bay Symposium 1. Univ. Miami SeaGrant, Spec. Rep. No. 5, pp. 95-112.
- Thorhaug, A. 1980. Watson Island vegetation associations. Table 18.1 in *Watson Island Development of Regional Impact - Draft*. The City of Miami.

APPENDIX

Resumes of Senior Personnel

Dr. Selvakumaran Mahadevan

Dr. William H. Taft

Mr. Roy R. Lewis, III

Dr. Ronald C. Phillips

Mr. James K. Culter

Mr. Robert E. Yarbrough

Mr. John F. Michel

Mr. Ronald J. Falkey

DR. SELVAKUMARAN MAHADEVAN

Fields of Competence:

Environmental Assessment/Prediction,
Benthic Ecology, Biological Oceanography,
Deep-Sea Biology, Aquatic Baro-Biology,
Biometrical and Statistical Data
Analysis.

Experience Summary:

Dr. Mahadevan joined Mote Marine Laboratory (MML) in October, 1978. With the Laboratory, he has specialized in the field of marine biology with particular emphasis on environmental assessment/prediction investigations. Currently, he is (1) conducting a study of beach fill effects on benthic fauna (a study funded by the U.S. Army Corps of Engineers), (2) a review of benthic literature (including an assessment of general trends) of Florida's coastal and estuarine habitats (a study funded by SEAGRANT-NOAA), (3) field surveys of the southwest Gulf Coast for the National Marine Fisheries Service, (4) a field study of the benthos, plankton and hydrography of the continental shelf off Pinellas County (Florida) in relation to an Environmental Impact Statement (a study funded by EPA, Region 4), and (5) study of the soft-bottom benthos of the Southwest Florida Shelf Ecosystem in relation to offshore oil drilling operations (a study funded by U.S.B.L.M.).

Prior to joining MML, Dr. Mahadevan was employed by Conservation Consultants, Incorporated (CCI) where he conducted various environmental impact assessment projects. Before joining CCI, Dr. Mahadevan served as a consultant to the Arabian Oil Company (Dahran, Saudi Arabia) to assess the effects of oil refinery effluents on marine organisms (benthos, fishes and coral reef fauna). His other major past research projects include evaluation of ecological effects from increases in water quality along U.S. Coastlines, assessment of environmental impact on benthos from deep-ocean dumping of obsolete munitions, and computer processing of historical biological data from the Mid-Atlantic Bight area.

Honors, Societies, Etc.:
(Continued)

National Merit Scholarship in Marine
Biology (University Grants Commission,
India), 1969-1971.
Sigma Xi Research Society
Honorary Deep-Sea Biological Society
Marine Biological Association (India)
Marine Biological Association (U. K.)
International Association of
Mieobenthologists
North American Benthological Society
Estuarine and Brackish-Water Sciences
Association
Gulf Estuarine Research Society
American Society of Zoologists

Research Projects:

1981

A study of the benthic and phytoplankton
populations of Whitaker Bayou and adja-
cent Sarasota Bay (Florida) in relation
to secondarily treated wastewater dis-
charges (a study funded by the County of
Sarasota).

1980-Present

A Study of the Soft-Bottom Benthos
(including fishes, macroalgae,
sediments and infauna) of Southwest
Florida Shelf Ecosystem (a study
funded by the Bureau of Land
Management).

1980-Present

A Marine Sampling and Measurement
Program off Pinellas County (Florida) -
including benthos, plankton and
hydrography (a study funded by EPA,
Region 4).

1980

A Prototype Fine Mesh Impingement
Screen Evaluation - biological
studies of larval organisms (a study
funded by Tampa Electric Company).

1980

An Aquatic Ecological Study of Big
Bend, Tampa Bay - includes studies
of benthos, meroplankton, oyster
spats, manatee sightings, fish age
and fecundity and adult fishes and
invertebrates (study funded by Stone &
Webster Engineering Corporation).

Research Projects: 1976-1978 Studies on Benthic Methodology
(Continued) Evaluation (comparison of sampling
gears and evaluation of area relation-
ship, vertical faunal stratification
and sieve-size relationship).

1976-1977 A Study on Population Size Differ-
ences of Bivalve Species Between
Thermal and Non-Thermal Areas at
Big Bend, Tampa Bay, Florida.

1976 A Study on the Effects of an Acci-
dental Silt Spill and Subsequent
Dredging on Benthic Fauna in the
Waterfront Canals of Apollo Beach,
Florida.

1975 Computer Data Management (Biological)
of Phytoplankton and Zooplankton
Information from Hutchinson Island
(Florida) Area.

1975 Evaluation (and computer data
analysis) of Environmental Impact
on Marine Organisms due to refinery
effluents at Ras Tanura, Saudi
Arabia.

1975 Review of Power Plant Siting Environ-
mental Impact Studies for the A. B.
Hopkins and Caryville Power Plants,
Florida.

1975 A Literature-Research Study and
Assessment of consequences of
incremental increases in water
quality along the eastern coastline
of the United States.

1974 Biological Data Management (computer)
of Historical Information on the
Ecology of the New York Bight Area.

1973-1974 Study on the Effects of Chemical
Munitions (nerve gas and mustard gas)
on Deep-Sea Benthic Fauna at U. S. Navy
DWD Area A (off New Jersey).

Publications/Reports/Presentations: (Continued)

1980. A Biological and Water Quality Evaluation of a Proposed Organism Return Canal at Big Bend, Tampa Bay, Florida. 81 pages
1980. Ecological Effects of Power Plants in Hillsborough Bay. National Urban Runoff Program Technical Conference Proceedings.
1980. A Study on the Effects of Power Plant Thermal Discharges on Benthic Infaunal Communities at Big Bend, Tampa Bay (Florida). Paper presented at the Florida Academy of Sciences 44th Annual Meeting. March 23-25.
1980. A Study of Sieve (Screen Mesh Opening) Size Effects on Benthic Fauna. Paper presented at the Florida Academy of Sciences 44th Annual Meeting. March 23-25.
1980. A Study of the Biological Characteristics of Saltwater Settling Pond Discharge at the Big Bend Power Plant, Tampa Electric Company, Tampa, Florida. A Final Report submitted to Tampa Electric Company. 22 pages.
1980. Studies of the West Indian Manatee (Trichechus manatus) in Tampa Bay (Florida). A Final Report submitted to Tampa Electric Company. 65 pages.
1980. 1979 Aquatic Ecological Program, Big Bend Power Station, Tampa, Florida. A Final Report submitted to Tampa Electric Company. 142 pages.
1979. A Study of the Biological Characteristics of Saltwater Settling Pond Discharge at the Gannon Power Plant, Tampa Electric Company, Tampa, Florida. A Final Report submitted to Tampa Electric Company. 44 pp.
1979. Aquatic Ecological Studies - Big Bend, Tampa Bay. Status Reports 1 and 2. Submitted to Stone and Webster Engineering Corporation.
1979. A Review and Data Re-evaluation of the 316 Demonstration at Anclote Sound - 47 pages. A Report submitted to Environmental Protection Agency, Region 4.
1979. A Study of Sieve Size Effects on Benthic Infauna. 18 pages. A Report submitted to Environmental Protection Agency, Region 4.
1978. An Ecological Survey of a Waterfront Canal in Palma Sola Bay, Manatee County, Florida. A Report submitted to J. Pratt. 35 pp.
1978. A Continued Study of Benthic Infauna at Big Bend, Tampa Bay. A special report submitted to Tampa Electric Company by Conservation Consultants, Inc. 91 pp.

Publications/Reports/Presentations: (Continued)

1977. Macrobenthic Ecology Procedures. Conservation Consultants, Inc.
1977. Benthic Studies. Chapter IV. In: Tampa Electric Company 27th Quarterly Report on the Big Bend Thermal and Ecological Surveys. Contains 24th Quarterly Report by Conservation Consultants, Inc. R.D. Garrity, ed. pp. 138-182.
1976. A Study on the Effects of Silt-Spill and Subsequent Dredging on the Benthic Infauna at Apollo Beach. A Report to the Environmental Planning Division, Tampa Electric Company. 58 pp.
1976. Benthic Studies in the Beacon Key Area. Chapter IV (Section B) In: Tampa Electric Company 26th Quarterly Report on the Big Bend Thermal and Ecological Surveys. Contains 23rd Quarterly Report by Conservation Consultants, Inc. R.D. Garrity, ed. pp. 23-85.
1976. Benthic Studies. Chapter IV (Section A). In: Tampa Electric Company 26th Quarterly Report on the Big Bend Thermal and Ecological Surveys. Contains 23rd Quarterly Report by Conservation Consultants, Inc. R.D. Garrity, ed. pp. 65-259.
1976. Benthic Studies. Chapter IV. In: Tampa Electric Company 25th Quarterly Report on the Big Bend Thermal and Ecological Surveys. Contains 22nd Quarterly Report by Conservation Consultants, Inc. R.D. Garrity, ed. pp. 183-276.
1976. Some Methodologies and Problems Associated with Assessment and Impact of Power Plant Cooling Water Systems on Estuaries. Env. Impact News, 2: 7-10. (with R.D. Garrity).
1975. Data Analysis of Zooplankton and Phytoplankton Information from the Hutchinson Island Area. Final Report to the Marine Research Laboratory, Department of Natural Resources, St. Petersburg, Florida. 160 pp.
1974. The Effects of Hydrostatic Pressure on Living Aquatic Organisms VII. Size and Pressure Effects. Int. Revue Ges. Hydrobiol., 59(2): 213-218.
1974. The Effects of Hydrostatic Pressure on Living Aquatic Organisms VI. Organic Complexity and Hydrostatic Pressure Sensitivity. Int. Revue Ges. Hydrobiol., 59(2): 207-212. (with R.J. Menzies).
1974. The Effects of Hydrostatic Pressure on Living Aquatic Organisms V. Eurybiotic Environmental Capacity as a Factor in High Pressure Tolerance. Int. Revue Ges. Hydrobiol., 59(2): 199-205 (with R.J. Menzies).

DR. WILLIAM H. TAFT

Fields of Competence:

Marine Geology, Carbonate Geochemistry
and Mineralogy

Experience Summary:

In July, 1978, Dr. Taft accepted the appointment of President of Mote Marine Laboratory (MML). As President, Dr. Taft has supervised a preliminary investigation of the sediments of Sarasota Bay. Previously, he performed a similar project for the U.S. Bureau of Commercial Fishery - sediments in Tampa Bay, and has analyzed size-sediment parameters in Florida Bay, the Bahamas and the Gulf of California.

Prior to joining MML, Dr. Taft was Professor, Director of Graduate Studies, and Director of Research at the University of South Florida, Tampa, Florida.

Present Position:

President
Mote Marine Laboratory
1600 City Island Park
Sarasota, FL 33577

Education:

- 1962 - Doctor of Philosophy (Geology)
Stanford University
Stanford, California
- 1958 - M.S. (Geology)
University of South Dakota
Vermillion, South Dakota
- 1957 - B.S. (Geology)
Stanford University
Stanford, California

Past Employment:

- 1975-1978 Professor, University of South Florida
Tampa, Florida
- 1975-1978 Director of Graduate Studies
University of South Florida
Tampa, Florida
- 1971-1978 Director of Research
University of South Florida
Tampa, Florida

Research Projects:
(Continued)

- 1963 A Study of the Influence of Cations on Diagenesis of Carbonate Sediments.
- 1962 A Study of the Unconsolidated Carbonate Sediments of Florida Bay, Florida.
- 1962 A Study of the Influence of Magnesium on the Recrystallization of Metastable Carbonates, Aragonite, Vaterite and High-Magnesium Calcite.
- 1962 A Study of Dolomite from the South Florida Shelf.
- 1961 A Study of the Mineralogy of Carbonate Sediments Along the Western Margin of Florida Bay.
- 1961 A Study of Authigenic Dolomite in Modern Carbonate Sediments Along the Southern Coast of Florida.

Publications/Reports/Presentations:

1975. Martin, D.F., and Taft, W.H. Occurrence and Implication of Sedimentary Fluorite in Tampa Bay Florida. In: Analytical Methods in Oceanography: Advance in Chemistry Series, Publisher American Chemical Society, Thomas R.P. Gibb, Jr., Editor, Washington, D.C.
1975. Taft, W.H., and Martin, D.F. Sedimentary Fluorite in Tampa Bay Florida: Environmental Letters, 6(3), pp. 167-174.
1970. Allen, R.J., Martin, D.F., and Taft, W.H. A Study of the Effects of Selected Amino Acids on the Recrystallization of Aragonite to Calcite: Jour. Inorg. Nucl. Chem., v. 32, pp. 2963-2970.
1970. McLester, M.E., Martin, D.F., and Taft, W.H. Effects of Alkaline-Earth Metal Ions on the Transformation of Aragonite to Calcite in Aqueous Solutions: Jour. Inorg. Nucl. Chem., v. 32, pp. 391-399.
1968. Taft, W.H., Arrington, F., Haimovitz, A., MacDonald, C., and Woolheater, C. Lithification of Modern Carbonate Sediments at Yellow Bank, Bahamas: Bull., Marine Science, v. 18, pp. 762-828.
1967. Taft, W.H. Physical Chemistry of Formulation of Carbonates. In: G.V. Chilingar, H.J. Bissell and R.W. Fairbridge (Editors), Carbonate Rocks. Elsevier, Amsterdam, pp. 151-167.
1967. Taft, W.H. Modern Carbonate Sediment. In: G.V. Chilingar, H.J. Bissell and R.W. Fairbridge (Editors), Carbonate Rocks. Elsevier, Amsterdam, pp. 29-50.

ROY R. LEWIS, III

Fields of Competence:

Wetlands Ecology and Management;
Spoil Island Improvement; Habitat
Creation and Restoration.

Summary of Experience:

Mr. Lewis is Founder and President of Mangrove Systems, Inc. and Professor of Biology, Hillsborough Community College. He is the author of 10 research papers in marine biology and wetlands ecology, and is presently editing a book, Creation and Restoration of Coastal Plant Communities, for CRC Press. He is the Convener of an Annual Conference on Wetlands Restoration, now in its ninth year, and has conducted numerous studies of Florida seagrasses and mangroves. Mr. Lewis is a member of the U.S. Army Corps of Engineers Scientific Advisory Committee on Deepening of the Tampa Harbor and was an invited participant and speaker at the U.S. Fish and Wildlife Coastal Ecosystems Workshop. He is presently under contract by the Florida Department of Natural Resources to document historical patterns of habitat loss in coastal environments, including Pine Island Sound.

Present Position:

Founder and President,
Mangrove Systems, Inc.
Tampa, Florida

and

Adjunct Staff Scientist
Mote Marine Laboratory
1600 City Island Park
Sarasota, Florida 33577

Professional Activities

Member, Scientific Advisory Committee to the U.S. Army Corps of Engineers, Tampa Harbor Deepening Project.
Member, State of Florida Environmental Education Advisory Committee.
Member, Citizens Advisory Committee on Coastal Zone Management, Tampa Bay Regional Planning Council.
Member, Scientific/Technical Committee, Biscayne Bay Planning Project.
Convenor and Editor of Proceedings: First Annual Conference on Restoration of Coastal Vegetation in Florida, May 4, 1974.
Convenor and Editor of Proceedings: Second Annual Conference on Restoration of Coastal Vegetation in Florida, May 17, 1975.
Convenor and Co-editor of Proceedings: Third Annual Conference on Restoration of Coastal Vegetation in Florida, May 15, 1976.
Convenor and Co-editor of Proceedings: Fourth Annual Conference on Restoration of Coastal Vegetation in Florida, May 14, 1977.
Convenor and Editorial Advisor of Proceedings: Fifth Annual Conference on Restoration of Coastal Vegetation in Florida, May 13, 1978.
Convenor and Editorial Advisor of Proceedings: Sixth Annual Conference on Wetlands Restoration and Creation, May 19, 1979.
Convenor and Editorial Advisor of Proceedings: Seventh Annual Conference on Wetlands Restoration and Creation, May 16-17, 1980.
Convenor and Editor of Proceedings: Eighth Annual Conference on Wetlands Restoration and Creation, May 8-9, 1981.
Invited Participant and Speaker: U.S. Fish and Wildlife Coastal Ecosystems Workshop. February 18-22, 1980, Big Pine Key, FL. Topics: Mangrove and Seagrass Restoration.
Invited Participant and Corresponding Member, Organization Committee: Second International Symposium on Biology and Management of Mangroves, Papua, New Guinea, July 20 - August 2, 1980.
Co-organizer, Tampa Bay Area Scientific Information Symposium. Scheduled for May, 1982.
Co-organizer, Tampa Bay Area Scientific Information Society.
Chairman, Ad Hoc Education Committee, Society of Wetland Scientists, 1981-82.

Honors

Member, Directory of Experts, Florida Environmental Land and Water Management Study Committee (Marine Wetlands).
Member, Phi Sigma Society, Honorary Biological Sciences Research Society.
Outstanding Educator of America, 1973.
Citizenship Award, Hillsborough County League of Women Voters, 1971.
Conservation Award, Tampa Audubon Society, 1975.
Invited Participant, The Future Leaders Conference, 1979.

Publications

Lewis, R.R. 1969. A comparative study of the pigmentation of the wild type and zanthic forms of the toadfish, Opsanus beta. Am. Zoologists 9(4):1106.

Publications (continued)

- Lewis, R.R., C.S. Lewis, W.K. Fehring, and J.R. Rodgers. 1979. Coastal habitat mitigation in Tampa Bay, FL. Pages 136-140 in W.C. Melander and G.A. Swanson, eds. Proceedings of the Mitigation Symposium. General technical report RM-65. U.S. Department of Agriculture, Ft. Collins, CO. 696 pp.
- Lewis, R.R. 1979. Large scale mangrove planting on St. Croix, U.S. Virgin Islands. Pages 231-242 in D.P. Cole, ed. Proceedings of the sixth annual conference on wetlands restoration and creation. Hillsborough Community College, Tampa, FL. 357 pp.
- Lewis, R.R. In press. Economics and feasibility of mangrove restoration. Proceedings of the Coastal Ecosystems Workshop, U.S. Fish and Wildlife Service.
- Lewis, R.R. and R.C. Phillips. In press. Experimental seagrass mitigation in the Florida Keys. Proceedings of the Coastal Ecosystems Workshop. U.S. Fish and Wildlife Service.
- Lewis, R.R. and R.C. Phillips. 1980. Occurrence of seeds and seedlings of Thalassia testudinum banks ex Konig in the Florida Keys, USA. Aq. Botany 9(4):377-380.
- Lewis, R.R. and R.C. Phillips. 1981. Experimental seagrass mitigation in the Florida Keys. Pages 155-173 in D.P. Cole, ed., Proceedings of the Seventh Annual Conference on Restoration and Creation of Wetlands, Tampa, FL. 294 pp.
- Lewis, R.R. In press. Impact of oil spills on mangroves. Presented at the Second International Symposium on Biology and Management of Mangroves, Papua, New Guinea. 1980.
- Teas, H.J. and R.R. Lewis. In press. Restoration of mangrove ecosystems. Presented at the Second International Symposium on Biology and Management of Mangroves, Papua, New Guinea. 1980.
- Lewis, R.R. and K.C. Haines. 1981. Large scale mangrove planting on St. Croix, U.S. Virgin Islands: Second year. Pages 137-148 in D.P. Cole, ed., Proceedings of the Seventh Annual Conference on Restoration and Creation of Wetlands. 294 pp.
- Courser, W.D., R.R. Lewis. 1981. The use of marine revegetation for erosion control on the Palm River, Tampa, Florida. Pages 125-136 in D.P. Cole, ed. Proceedings of the Seventh Annual Conference on Restoration and Creation of Wetlands, Tampa, FL. 294 pp.
- Lewis, R.R., R.C. Phillips, R. Lombardo. 1981. Seagrass mapping project, Hillsborough County, Florida. Fla. Scientist 44(suppl.):25. Abstract.
- Lewis, R.R. In press. Restoration of a needlerush (Juncus roemerianus) marsh following interstate highway construction. Proceedings of the Eighth Annual Conference on Restoration and Creation of Wetlands.
- Lewis, R.R., editor. Creation and Restoration of Coastal Plant Communities. Book in preparation. CRC Press.

DR. RONALD C. PHILLIPS

Fields of Competence:

Marine Botany: Taxonomy and Ecology
of Seagrasses and Macroalgae;
Seagrass Restoration and Management.

Summary of Experience:

Dr. Phillips is a Senior Adjunct Scientist at MML and a Professor of Biology at Seattle Pacific College. Before joining SPC he was a Research Marine Botanist for the Florida State Board of Conservation, St. Petersburg Marine Laboratory. Dr. Phillips has over 25 years of experience in the ecology of Florida seagrasses and algae, particularly on the Gulf coast. He is the author of 60 professional papers, including studies of marine plants in Lee County. He has written seagrass transplanting guidelines for the U.S. Army Corps of Engineers and is an editor of the Handbook of Seagrass Biology: An Ecosystem Perspective. His most recent publications concern the occurrence of seeds and seedlings of turtle grass (Thalassia) in South Florida, and their responses to sediment loading.

Present Position:

Professor of Biology
Seattle Pacific College
Seattle, Washington

and

Professional Activities (continued)

- Participant, Coastal Ecosystems Workshop. University of Texas. 1979.
(Sponsored by U.S. Fish and Wildlife Service)
- Participant, Coastal Ecosystem Research Workshop. Louisiana State University, Baton Rouge. 1979. (Sponsored by National Office of Sea Grant)
- Participant, Seventh Annual Conference on the Restoration of Coastal Vegetation in Florida, Tampa, Florida. 1980.
- Participant, PASGAP Seaweed Symposium. Hopkins Marine Station, Pacific Grove, California. 1980. (Sponsored by Sea Grant)

Grants and Fellowships

- Research Grant, Society of Sigma Xi. 1962-1963.
- Science Faculty Fellowship, National Science Foundation. 1969-1970.
- Research Grant, International Decade of Ocean Exploration, National Science Foundation. 1974-1980.

Consulting Activities

1. U.S. Fish and Wildlife Service, Research plan for investigations on eelgrass, *Zostera marina*. Cold Bay, Alaska. March 1963.
2. U.S. Army Corps of Engineers. Seagrass transplanting project on dredged spoils. Port St. Joe, Florida. August 1976 - September 1977.
3. U.S. Army Corps of Engineers; U.S. Fish and Wildlife Service. Literature Survey of Seagrasses; Ecology and Man's Impact on Seagrasses of the United States (Participant). 1976-1977.
4. Beak Associates, Inc. Survey of Transplant Site of Eelgrass in Bellingham Bay, Washington. May 1977.
5. U.S. Fish and Wildlife Service. Literature survey on: Estuarine Productivity in Puget Sound, Washington. August-December, 1978.
6. Continental Shelf Associates, Inc. (for Florida Department of Transportation). Seagrass Transplanting Project on Craig Key, Florida. February 1979 - August 1981.
7. U.S. Army Corps of Engineers. Literature Review for Planting Guidelines for Seagrasses. Coastal Engineering Research Center, Fort Belvoir, Virginia. 1979.

Travel Experience

1. Domestic: Research Experience with seagrasses from the Aleutians in Alaska south to California, around the Gulf of Mexico, and up to Maine, and out to the Virgin Islands.
2. Foreign: Research experience with seagrasses in Panama, Nicaragua, England, France, Israel (Gulf of Eilat), Japan, Australia (all coasts), and New Zealand.

- _____. 1960. A report on the sydrography, marine plants, and fishes of the Caloosahatchee River area, Lee County, Florida. Spec. Sci. Rep. No. 5, Fla. St. Bd. Cons.
- Phillips, R.C. and R.M. Ingle. 1960. A report on the hydrography, marine plants, and bottom types of the St. Lucie estuary and adjacent Indian River, Florida. Spec. Sci. Rep. No. 4, Fla. St. Bd. Cons.
- Phillips, R.C. 1961. Seasonal aspect of the marine algal flora of St. Lucie Inlet and adjacent Indian River, Florida. Quart. J. Fla. Acad. Sci. 24(2):135-147.
- McErlean, A.J. and R.C. Phillips. 1961. A technique for direct photography of translucent objects. Trans. Am. Fish. Soc. 90(4):500-501.
- Phillips, R.C. 1962. Distribution of seagrasses in Tampa Bay, Florida. Spec. Sci. Rep. No. 6, Fla. St. Bd. Cons. 12 pp.
- _____. 1962. Observations on the seagrasses of Puget Sound, Washington. Proc. Western Soc. Natural. 43rd Ann. Meeting. (Abstr.)
- _____. 1963. Ecology of floating algal communities in Florida. Quart. J. Fla. Acad. Sci. 26(4):329-334.
- _____. 1963. A model for the study of leaf gaps. Turtox News 41(11):279.
- _____ and A.J. Gee. 1963. Comparison of *Zostera* and *Phyllospadix* roots. Proc. Western Soc. Natural. 44th Ann. Meeting. (Abstr.)
- Phillips, R.C. 1964. Comprehensive bibliography of *Zostera marina* L. Spec. Sci. Rep. Wildlife No. 79, U.S. Dept. Int., Fish and Wildlife Service.
- _____. and S. Grant. 1965. Littoral marine algae of Agate-Crescent Beach, Washington. Adv. Frontiers Plant Sci. 13:103-112.
- _____. 1965. Environmental effects on *Phyllospadix scouleri* Hook. and *Zostera marina* L. leaves. Amer. J. Bot. 52(6, part 2):644 (Abstr.)
- Phillips, R.C. 1967. Preliminary investigation of the benthic marine flora of Hood Canal, Washington. Northwest Sci. 41(1):57. (Abstr.)
- _____ and R. L. Vadas. 1967. Marine algae of Whidbey Island, Washington. J. Inst. Res., Seattle Pacific College, Washington. Ser. A, No. 4. 81 pp.
- Phillips, R.C. 1967. On species of the seagrass *Halodule* in Florida. Bull. Mar. Sci. 17(3):672-676.
- McRoy, C.P. and R.C. Phillips. 1968. Supplementary bibliography on eelgrass, *Zostera marina* L. Spec. Sci. Rep. Wildlife No. 114, U.S. Fish and Wildlife Service. 14 pp.

- Phillips, R.C. 1978. Seagrasses and the coastal marine environment. *Oceanus* 21(3):30-40.
- Backman, T.W. and R.C. Phillips. 1978. Adaptive variation in eelgrass and its effect on the ecosystem. Western Soc. Nat., 59th Ann. Meet.
- Phillips, R.C. 1979. Ecological notes on *Phyllospadix* (Potamogetonaceae) in the northeast Pacific. *Aquatic Botany* 6:159-170.
- McMillan, C. and R.C. Phillips. 1979. *Halodule wrightii* Aschers. in the Sea of Cortez, Mexico. *Aquatic Botany* 6:393-396.
- Phillips, R.C. and C.P. McRoy. 1980. Handbook of seagrass biology: an ecosystem perspective. Garland STPM Press, New York, NY 353 pp.
- Phillips, R.C. 1980. Phenology and taxonomy of seagrasses. In: R.C. Phillips and C.P. McRoy, eds. Handbook of seagrass biology: an ecosystem perspective. Garland STPM Press, New York, NY pp. 29-40.
- Phillips, R.C. 1980. Transplanting methods. In: R.C. Phillips and C.P. McRoy, eds. Handbook of seagrass biology: an ecosystem perspective. Garland STPM Press, New York, NY pp. 41-56.
- McMillan, C. and R.C. Phillips. 1979. Differentiation in habitat response among populations of New World seagrasses. *Aquat. Bot.* 7(2):185-196.
- Phillips, R.C. 1980. Role of seagrasses in estuarine systems. In: P.L. Fore and R.D. Peterson, eds. Proceedings of the Gulf of Mexico coastal ecosystems workshop. U.S. Fish and Wildlife Service, Albuquerque, New Mexico, FWS/OBS-80/30. pp. 67-96.
- Phillips, R.C. 1980. Planting guidelines for seagrasses. U.S. Army Corps of Engineers, Coastal Engineering Research Center, Fort Belvoir, Virginia. CETA 80-2. 28 pp.
- Phillips, R.C. 1980. Responses of transplanted and indigenous *Thalassia testudinum* Banks ex König and *Halodule wrightii* Aschers. to sediment loading and cold stress. *Contr. Mar. Sci.* 23:79-87.
- Lewis, R.R. and R.C. Phillips. 1980. Occurrence of seeds and seedlings of *Thalassia testudinum* Banks ex König in the Florida Keys (U.S.A.). *Aquat. Bot.* 9(4):377-380.

MR. JAMES K. CULTER

Fields of Competence:

Benthic Ecology, Biology and
Taxonomy of Invertebrates, Pop-
ulation Biology.

Experience Summary:

Mr. Culter joined the Mote Marine
Laboratory (MML) in May, 1979. With
the Laboratory, he has specialized
in marine ecology with emphasis upon
the taxonomy and identification of
benthic invertebrates. He is currently
working on the benthic study of the
Northern Pinellas County area, Florida.

Prior to joining MML, Mr. Culter was
employed by Conservation Consultants,
Incorporated (CCI) as a staff biologist.
His duties included the identification
of benthic invertebrates and the
compilation of data for various
environmental impact assessment projects.
As a graduate student and research
assistant at the University of South
Florida, Mr. Culter was also involved
in projects evaluating the environmental
impacts of various natural and human
activities. His education included a
strong background in population biology
and community ecology.

Present Position:

Senior Staff Biologist
Mote Marine Laboratory
1600 City Island Park
Sarasota, Florida 33577

Education:

- 1974 - B. A. (Major: Invertebrate Zoology)
University of South Florida
Tampa, Florida
- 1979 - M. A. (Major: Zoology, Marine
Invertebrate Ecology)
University of South Florida
Tampa, Florida

Research Projects: (continued)	1977	Study of vertical stratification of Benthic Infauna.
	1976-1977	EPA 316 Impact Study of thermal discharge from a Tampa Electric Company power plant.
	1975-1979	A population study of the Inarticulate Brachiopod <u>Glottidia pyramidata</u> .
	1974-1976	Environmental impact study of oyster shell dredging in Tampa Bay.

Publications/Reports/Presentations:

1980. Culter, J.K. The Occurrence of Hermaphrodites of the Inarticulate Brachiopod Glottidia pyramidata. Paper presented at the Florida Academy of Sciences 44th Annual Meeting, March 23-25, 1980.
1979. Culter, J.K. A Population Study of the Inarticulate Brachiopod Glottidia pyramidata (Stimpson). M.A. Thesis, University of South Florida.
1979. Culter, J.K. and S. Mahadevan. A Photographic Guide to Benthic Invertebrates of Tampa Bay. Environmental Protection Agency, Cincinnati, Ohio. (In progress).
1977. Mahadevan, S., and J.K. Culter. A Biological Study of the Big Bend Breakwater Structure. Final Report on the Big Bend Thermal and Ecological Surveys, by Conservation Consultants, Inc.
1977. Culter, J.K., and Mahadevan, S. "Benthic Studies" Chapter IV, Part 4, In Tampa Electric Company, 28th Quarterly Report on the Big Bend Thermal and Ecological Surveys. Contains 25th Quarterly Report by Conservation Consultants, Inc. Edited by R.D. Garrity.
1976. Mahadevan, S., Culter, J., Hoover, S., Murdoch, J., Reeves, F., and Schulze, R. A Study on the Effects of Silt-spill and Subsequent Dredging on Benthic Infauna at Apollo Beach Embayment. A Report Submitted to: The Department of Environmental Planning, Tampa Electric Company, by Conservation Consultants, Inc. R.D. Garrity and W.J. Tiffany, editors. 58 pp.
1976. Culter, J.K. Genetic Variation in a Natural Population of the Lingulid Brachiopod Glottidia pyramidata. The 40th Annual Meeting of the Florida Academy of Sciences, (Abstract in the Florida Scientist 39 1:5).
1976. Conner, W.G., and Culter, J.K. Changes in the Sediment Structure Associated with the Mining of Fossil Oyster Shell. The 40th Annual Meeting of the Florida Academy of Sciences, (Abstract in the Florida Scientist 39 1:2).

MR. ROBERT E. YARBROUGH

Fields of Competence: Marine Geology, Benthic Ecology.

Experience Summary: Mr. Yarbrough joined Mote Marine Laboratory (MML) in May, 1979. With MML he has worked in aquatic ecology with emphasis on marine sediment analysis and benthic invertebrates. He is currently working with the sediment and benthic portion of a marine sampling and measurement program off Pinellas County, Florida (funded by EPA, Region 4), and a benthic fauna and sediments study of the Southwest Florida Continental shelf (funded by BLM).

Present Position: Staff Biologist/ Geologist
Mote Marine Laboratory
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Education: 1979 B. A. (Major: Marine Invertebrate Ecology)
University of South Florida
Tampa, Florida

Past Employment: 1975-1979 Nursing Assistant
Tampa Veterans Administration Hospital
Tampa, Florida

Honors, Societies, Etc.: International Oceanographic Foundation
National Geographic Society

Research Projects: 1980-Present A Study of the benthos and sediment grain size for Charlotte Harbor and Pine Island Sound, Florida.

1980-Present A Study of the benthos and sediment grain size/carbonate for Sarasota Bay, Florida.

Resume

POSITION

Project Manager, Civil, Environmental and Marine Engineering

PROFESSIONAL EXPERIENCE

Has served as the firm's Director of Marine Design to coordinate marina oriented and water recreation projects through all phases of development. Experience includes directing permitting efforts through state and federal agencies and the development of evaluation studies for various environmental considerations. Has also managed the development of feasibility and financing studies to develop marina utilization projections and identify appropriate financing potentials.

Specific projects include the Bonefish Towers Condominium Marina, Marathon, Florida; Key Largo Anglers Club, Key Largo, Florida; Biscayne National Monument Marina, Elliott Key, Florida; Little Duck Key Marina, Florida Keys; City of Miami Beach Marina, Miami Beach, Florida; Punta Gorda Marina Recreation Area, Charlotte County, Florida; the City of Punta Gorda Commercial Docks, Punta Gorda, Florida; Riviera Beach Municipal Marina, Riviera Beach, Florida. Currently serving as the Project Manager for the design and permitting of the City of Miami's proposed multimillion dollar Watson Island marina development encompassing three separate marinas and numerous support facilities.

Experience includes the production of Environmental Impact Statement studies (EISs) and DRIs, Development of Regional Impact studies in accordance with State law. Project efforts have included operational cost analysis, master planning, and conceptual planning. Managed construction administration tasks to ensure construction activities were accomplished on time and within budget. Other marine oriented experience includes design efforts for the entrance and breakwater of Belle Channel Bay on the Grand Bahamas Island, and the entrance channel and navigation channel for Great Harbor Cay in the Bahamas. Involvement included a marina for a 3,000-acre development at Andros Island in the Bahamas and a study for a marina, motel, air strip, golf course, villas, etc. for Portofino on Elliott Key in Dade County, Florida.

Various other civil engineering projects have included land development projects in Freeport, Grand Bahamas Island, Great Harbor Cay, Berry Island, Nassau, New Providence, Treasure Key, Great Abaco Island, Bahamas Beach Estates, and Andros Island, all of which are in the Bahamas. Project management efforts have also included the Deltona Lakes Development in Volusia County, Florida.

EDUCATION

Engineering, University of Miami, 1952; Business Administration, Gustavus Adolphus College, St. Peter, Minnesota, 1949.



Ronald J. Falkey