The Planning and Management of California's Coastal Resources

USC Sea Grant Institutional Program

1980-81 ANNUAL REPORT

UNIVERSITY OF SOUTHERN CALIFORNIA
Institute for Marine and Coastal Studies
University Park, Los Angeles, CA 90007

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Contents

Living Marine Resources

Non-Living Marine Resources

Coastal Engineering

Appendixes

Introduction

Robert L. Friedheim, Director, USC Sea Grant Program

This is a report of the University of Southern California's eleventh year of participation in the national Sea Grant program. The Sea Grant program, funded by the National Oceanic and Atmospheric Administration, supports marine research, education and advisory services at several universities in the coastal and Great Lakes regions. Sea Grant research is primarily applied research, and USC, like every Sea Grant program, has a commitment to work with representatives of the public and industry to solve marine and coastal problems of importance to the region. The theme of our program and the title of this report, "The Planning and Management of California's Coastal Resources," reflects that commitment.

At USC, Sea Grant researchers can draw on substantial facilities and a long tradition of excellence in marine research. The Sea Grant program is one of several marine programs within the university's Institute for Marine and Coastal Studies, founded in 1975. The institute administers a marine science center and a conference center on Catalina Island; a major research vessel, the VELERO IV, and other research ships; a Marine and Freshwater Biomedical Center; a Center for Marine Transportation Studies; a research laboratory on the harbor waterfront; and other facilities. Individual academic units at USC, particularly the Allan Hancock Foundation, have been active in marine research since the early 1900s.

As a measure of the emphasis on state and local problem-solving in carrying out the research, each Sea Grant program is required to match the federal grant with half again as much funding from private, state or local sources. In California, the state government provided $250,000 in 1980-81 for matching Sea Grant funds, which amount we share with the University of California; and cash or in-kind service has also been contributed by USC itself, a local radio station, city and county government agencies and other sources. Their interest makes our work possible and keeps it relevant.

Sea Grant projects run an extensive course of review before funding is awarded. A technical advisory panel makes recommendations to the program managers; academic peer reviewers comment on the professional quality of the work; a panel of state agency representatives comments on the worth of the

projects to the state; and a team of scholars and administrators from around the country makes an on-site inspection of the entire program. Members of the IMCS Technical Advisory Panel and the California State Sea Grant Advisory Panel are listed at the end of this report.

Each year the USC Sea Grant program supports one or more projects in each of the following areas: socio-economic systems, living marine resources, non-living marine resources, coastal engineering, marine education and advisory services. In 1980-81, the USC Sea Grant Program supported the following projects:

Program Development

Continuing. Every year, at the director's discretion, some projects are initiated apart from the regular funding cycle, for various practical reasons. During 1980-81, Program Development provided an advance start for a 1981-82 project on toxic metals in the marine environment, follow-up funds to complete a 1979-80 project on sediment accumulation in San Francisco Bay, and funds for a start-up study of the social value of wetlands.

Marine Education and Training

Continuing. This project seeks each year to enhance marine awareness in the citizenry of California through the educational process. This year, a curriculum guide was accepted for publication; a statewide marine education newsletter was initiated; a graduate level course in the School of Education was proposed and accepted; and marine programs for inner-city minority students were continued.

In a separate project, curriculum materials were finished for a series of courses at the graduate level on port and harbor management, and the final two courses in the series were taught. The courses will now become regular offerings of the university.

The Graduate Student Trainee Program provides financial support for selected students to work on Sea Grant funded projects related to their degree studies.

Marine Advisory Services

Continuing. The advisory services program has as its job maintaining a two-way liaison between marine researchers and marine resource users. Highlights of the work for 1980-81 include publication of a conference proceedings of recreational access to the coast,

a Sea Grant directory for media reporters, and a booklet on the California Coastal Conservancy. Significant services were provided to the coastal planning community, to recreational boaters, to Sea Grant researchers and to media organizations.

The Port Authority as a Public Enterprise

Second of two years. This project is an analysis of how ports respond to the conflicting pressures to both generate revenue, like a private firm, and to act in the public interest, like a public agency. Ports often face this dilemma in matters of environmental regulation, such as dredging new channels or handling dangerous cargoes. This study finds that a port's organizational structure may have a lot to do with how it behaves in these conflict situations.

The State-Local Partnership in Coastal Planning

First of one year. This project investigates how the structure and process of planning have changed as a result of the intervention of state government into land-use planning in the coastal zone. Analyzing cases of conflict where the urban fringe meets the rural coast in Southern California, the investigators coded the public documents for the identification of particular issues. In the next phase, supported by project development funds, these issue attributes will be computer analyzed against the observed changes in planning.

Residential Resources in the Coastal Zone

One year only. This project examined the planning and regulation of housing opportunities in the coastal zone for low and moderate income housing in the local coastal plans; in 1981, the requirement was repealed. This project analyzes the lessons to be learned from the period of regulation and its aftermath. Among the lessons are: that research on how the regulations influenced housing prices is not yet convincing; that providing affordable housing was easier where there was high demand for housing changeovers; and that the coastal act did extend tenants' rights vis-a-vis landowners.

Heterotrophic Metabolism of Marine Dinoflagellates

Third of three years. The data support the hypothesis that marine organisms can metabolize organic compounds in seawater, such as those generated in urban wastes. This project has elucidated the life cycle of dinoflagellates and, during 1980-81, has added new

techniques for following metabolic activity of the organisms. The results are significant for a general understanding of water quality and for a specific understanding of the origins of "red tide" blooms caused by the dinoflagellates.

Nitrogen Transformations Associated with the Discharge of the Terminal Island Treatment Plant

First of three years. This study traces the reactions of dispersal of certain compounds in a major outfall in the Los Angeles-Long Beach Harbor. The compounds studied include nitrates, phosphates and silicates, which are important nutrients for marine organisms.

Southern California's Nearshore Marine Environment: A Significant Fish Nursery?

Third of three years. This project, which complementsd the well-established sampling work further inshore of the California Cooperative Fisheries Investigations as revealed interesting features of the distribution of fish larvae in the nearshore environment. Nearshore areas are relatively more productive than areas further offshore, and different ichthyoplankton dominate the nearshore area. The results are significant for understanding the effects of marine pollution on the ecosystem and for assessing coastal fishery stocks.

Gas Exchange Rates at the Air-Sea Interface in Coastal Waters

First of two years. This project explores the mechanisms governing the exchange of oxygen and other gases between the atmosphere and the ocean. Because dissolved oxygen is a critical component of overall water quality and because the atmosphere is a major source of dissolved gases, understanding the interactions will be important for environmental management.

Waves and Currents in Regions of Sharply Changing Water Depth

First of two years. This project builds on earlier Sea Grant projects by the same investigator, gradually expanding the range of wave and tidal effects near the coast that can be modeled mathematically. Focusing on the changes in wave patterns caused by abrupt changes in water depth (such as dredged channels), this project has shown, among other results, that some wave frequencies are not transmitted past such a channel.

Budget Summary

1980-81 Budget Summary

	Sea Grant Funds	State/Local Match
Program Management		
Administration and Management (M-1)	$ 80,145	$ 87,953
Program Development (M-2)	$ 9,217	$ 5,000
Marine Education and Training		
Marine Education in California (E/E-1)	$ 77,486	$ 33,559
Evaluation of Curriculum Specialization in Port/Harbor Management (E/CD-1)	$ 25,020	$ 22,880
Sea Grant Graduate Student Trainee Program (E/M-1)	$ 37,800	$ 5,400
Marine Advisory Services		
Marine Advisory Services (AS-1)	$130,646	$198,958
Socio-Economic Programs		
The Port Authority as a Public Enterprise (R/CM-12)	$ 37,118	$ 18,132
The State-Local "Partnership" in Coastal Planning (R/CM-15)	$ 17,873	$ 30,371
Residential Resources in the Coastal Zone (R/CM-17)	$ 11,984	$ 27,354
Living Marine Resources Programs		
Heterotrophic Metabolism of Marine Dinoflagellates (R/EQ-18)	$ 38,497	$ 40,848
Nitrogen Transformations Associated with Terminal Island Treatment Plant Discharge (R/EQ-24)	$ 38,250	$ 34,300
Southern California's Nearshore Marine Environment: A Significant Fish Nursery? (R/RD-6)	$ 54,458	$170,639

	Sea Grant Funds	State/Local Match
Non-Living Marine Resources Programs		
Gas Exchange Rates at the Air-Sea Interface (R/EQ-26)	$ 39,014	$ 16,658
Coastal Engineering		
Waves and Currents in Coastal Regions of Sharply Changing Water Depth (R/CE-6)	$ 37,492	$ 22,904
TOTAL	$635,000	$714,956

Program Development

Administration and Management

Robert L. Friedheim, Director, USC Sea Grant Program

Effective November 1980, the management of the USC Sea Grant program changed hands. Robert L. Friedheim replaced Donald L. Keach as director of the Sea Grant program. Both men hold other positions in the Institute for Marine and Coastal Studies: Keach as deputy director and Friedheim as associate director for marine policy.

Also, Stuart A. Ross replaced D. Patrick Hartney as assistant director of the Sea Grant program. Ross serves as director of advisory services, and Hartney continues as director of administration for the Institute.

No major changes of direction have occurred or will occur as a result of the transition; indeed the close cooperation among the four persons provided considerable continuity in the themes and activities of the USC Sea Grant program. The new director and assistant director are focussing on second-order changes in organization and procedure to ensure the continued quality and relevance of the program.

Our general management goals are as follows:

1. To develop, coordinate and implement the USC Sea Grant program and to exercise administrative and fiscal control.

2. To provide leadership to initiate an integrated program to assure that the general guidelines of the National Sea Grant Office will be met by current and projected programs.

3. To work with and assist agencies in California to explore and ultimately define resource management needs and to cooperatively investigate methods of satisfying these needs.

4. To act as a focal point of collaborative programs with other institutions of higher learning, with local, regional and state governments, and with the public.

5. To explore new applications of research, education and advisory services.

Program Development

Robert L. Friedheim, Director, USC Sea Grant Program

Each year Sea Grant sets aside limited funds for discretionary allocation to research projects other than those that pass through the annual review cycle. The purpose of the program development fund is to allow USC Sea Grant management sufficient flexibility to respond appropriately to circumstances that are not easily accomodated under the annual review cycle.

Projects to meet emergencies, projects that are interesting but not yet fully developed, projects that must begin early or end late, and other discretionary situations can be covered by the program development funds if they promise sufficient contribution to the Sea Grant program. Sizeable allocations are approved by the national Sea Grant office before execution.

In 1980-81, program development funds went primarily to these three projects:

1. Sediment Accumulation and the History of Pollutant Accumulation in San Francisco Bay (M-2/11.1). Douglas E. Hammond, Assistant Professor, Geochemistry, University of Southern California.

Pollutants entering the sea may become attached to suspended particles and eventually become buried in sediments after the particles settle. In a 1979-80 Sea Grant project, this pathway was studied in San Francisco Bay using naturally occurring radioactive tracers as pollutant analogs. The results suggested that pollutants take approximately a day to attach to suspended particles, that particles settle to the bottom in eight to 11 days, and that particles may be resuspended 10-20 times before they are deeply buried. Thus, pollutants may be rapidly transferred to the sediments, but remain available for resuspension for several decades.

This program development project was a continuation of the 1979-80 work to allow further research and analysis of data, as well as continued consultation with the United States Geological Survey (USGS) staff in the San Francisco Bay area. Throughout the project, the investigators have worked closely with this government agency to communicate results.

2. Microbially Mediated Entry of Pollutants into Marine Food Webs (M-2/11.2).
Cornelius W. Sullivan, Assistant Professor, Biological Sciences, University of Southern California.

Toxic substances in the marine environment include naturally occurring inorganic elements, such as heavy metals, and hazardous organic compounds discharged from industrial or petrochemical operations. The uptake of these materials by bacterioplankton and phytoplankton at the first levels of the marine food web may be of considerable significance.

It is the accumulation of these hazardous substances by bacterioplankton, phytoplankton and organic detritus that can provide the initial step and momentum for the entry and transfer of toxic substances along marine food webs leading to man.

The overall goal of this program development project, which became a formal project approved for 1981-82, is to begin determination of how and at what rates organic and inorganic pollutants enter marine food webs. A key question, for example, is whether these compounds are detoxified or intensified in their toxicity as a result of their interaction with the marine microorganisms.

3. The Social Valuation of Wetlands (M-2/11.3).
Lowdon Wingo, Professor, School of Urban and Regional Planning, University of Southern California.

Proposals to develop or preserve wetlands have led to very difficult and controversial decisions. Considerable scientific and economic evidence is advanced on both sides. Persons who must make the decisions typically find that no one measure is adequate to the situation.

Professor Wingo used program development funding to begin a synthesis of the economic and scientific issues and techniques involved in wetlands evaluation. He conducted a literature search, interviews with ecologists and social scientists, and a review of wetlands issues in recent official decisions. A bibliography of relevant publications has been assembled.

Marine Education and Training

Marine Education

Dorothy M. Bjur, Director, USC Sea Grant Marine Education Program; Director of Training, Institute for Marine and Coastal Studies, University of Southern California

The education of planners, engineers, nutritionists, politicians, developers, etc., has always been a problem in an industrial society. This education takes on significant consequences where marine education is concerned because these future leaders must be able to resolve the sometime conflicting demands between the evolving maritime and the more traditional terrestrial concerns.

Careers and vocational choices are predicated, to a major extent, on what a person learns in school, usually in grades K-12. To help meet the need for professionals and technicians who have the knowledge and skills for the nation's marine requirements, the USC Sea Grant Marine Education Program developed a series of materials oriented toward the public school student, the university student and the adult decision maker.

The goals: to teach marine factors in the biosphere from all angles and at all levels, to increase awareness and appreciation of the oceans and, at the same time, contribute to exploration, development and conservation of marine resources through the educational process.

Included on the following pages are brief progress reports, outlining the various activities pursued to fullfill the 1980-81 goals of the education programs, funded by the National Sea Grant Program:

1. California and the Oceans (E/E-1).

2. Graduate Student Trainee Program (E/M-1).

3. Curriculum Development in Seaport Management with a New Course in the Application of Systems Analysis and Operations Research to Seaports (E/CD-1).

California and the Oceans

Dorothy M. Bjur, Director, USC Sea Grant Marine Education Program
Jacqueline B. Rojas, Assistant Director, USC Sea Grant Marine Education Program

> ...the great question today is:
> Can the sea help mankind survive?
> What is more, can it help man not only
> survive but lead a full and rewarding life;
> in other words, live rather than exist?
> --Jacques-Ives Cousteau

By the year 2100, the world's population is expected to have reached 11 billion. The needs of these 11 billion -- for food, energy, transportation and recreation -- present an overwhelming problem in a world with finite possibilities. Can the sea help mankind survive? This is probably our most realistic hope, and the need to understand the sea's potential becomes eminent.

"California and the Oceans," USC's Sea Grant Marine Education Program, was developed for California citizens of all ages and it provides an avenue for discovering some of the answers for mankind's continued existence. This program attempts to create a sensitivity toward the marine environment and to cultivate an ocean perspective of a full and rewarding future.

Through a multidisciplinary approach, "California and the Oceans" conveys the importance of the quality of the marine environment and its potential deterioration. The program communicates our past, present and future involvement with the marine environment by way of written materials, teacher workshops and a number of special programs and activities for school children, college students and the adult populace.

It is difficult to evaluate the long-term impact this program will have upon the lives of our future decision makers (today's student populace). It cannot be evaluated in dollars and cents; however, we do know these students' value systems are formed during their school years. It is our desire to have a positive impact on the lives of these students and, thus, their future decisions regarding the environment.

GOALS AND OBJECTIVES

The overall goal for 1980-81 was to enhance marine awareness in the citizenry of California through an education process. This process included use of written curriculum materials and the training of teachers in their effective use. The programs were adapted to the varied needs of the different age groups, including minorities, physically and educationally handicapped, and mentally gifted minors.

Progress toward the goals and objectives will be reported in three categories: Curriculum materials, public school assistance and outreach programs.

Curriculum Materials

1. "Wet and Wild," the 400-page supplementary marine education curriculum guide, was written in English and translated into Spanish. It includes six units, each with an introduction, lesson plans, supplementary materials and a bibliography. The guide is multidisciplinary in approach. It has received positive evaluation by approximately 40 teachers in California and requests for the guide have been received from almost 200 school districts across the nation. The districts have received permission to duplicate the guide for multiple distribution to their teachers.

"Wet and Wild" has been accepted for publication by the National Dissemination and Assessment Center for Bilingual Education at California State University, Los Angeles. It is currently undergoing technical editing for publication in English and Spanish. The estimated publication date is spring 1982.

2. Marine Studies Idea Books were developed for K-6 and 7-12 grade levels. The K-6 Idea Book is approximately 80 pages of graphically illustrated ideas, activities and resource materials. The book was originally developed for use in inner-city schools and is now also being used by classroom teachers throughout the school system. It has been translated into Spanish and is being typed. The introduction is being revised for regular classroom implementation. Originally, the introduction was written to assist USC students in teaching marine studies in the inner-city schools.

The 7-12 Idea Book is similar to the K-6 Idea Book in that it includes activities, ideas and resource materials. This book, also developed for use in inner-city schools, has been expanded to approximately 300 pages. Seven high school teachers are evaluating the book this year. After this revision, the book will be translated into Spanish.

3. Mini Information Booklets were developed by Shirley Hudgins, USC Sea Grant communications specialist. Three booklets of approximately 40 pages each were compiled, complete with graphics. Each booklet is divided into sections and contains a series of short descriptions of marine animals. The text is in both English and Spanish.

4. A Teacher Training Handbook for Marine Educators is being developed in conjunction with the science director of the Los Angeles County Superintendent of Schools. The handbook is to serve as a guide for marine education teachers in conducting effective workshops. National Marine Education Association (NMEA) Conference participants assisted in developing the preliminary outline and worked on various sections of the manual. When completed, the booklet will contain six chapters and will deal with methodologies and techniques for conducting workshops; information on how to effectively use local, state and national agencies; the media; and audio visual maerials. The target date for the completion is 1982. The manual will then be submitted to the NMEA Board for consideration.

Public School Assistance

1. A joint USC/UC Sea Grant Newsletter, the first statewide marine education publication, was sent out this fall. It was developed and written as a joint USC/UC education project and mailed to both universities' mailing lists. The response has been overwhelming with requests for materials and program assistance.

2. Statewide cooperation was achieved in producing a new Environmental Education Guide that included lesson plans and ideas from USC marine education materials. This guide, funded by the California Department of Education, will be used in schools in all 58 counties in California. The USC Sea Grant education staff served on the task force to help develop the guide.

3. A working relationship has been developed between the USC marine education program and the State Department of Fish and Game and the Department of Boating and Waterways. Several meetings have been held and both departments have expressed interest in using the USC-written materials and cooperating in programs.

4. Bilingual programs in both Spanish and Portuguese met with great success during the year:

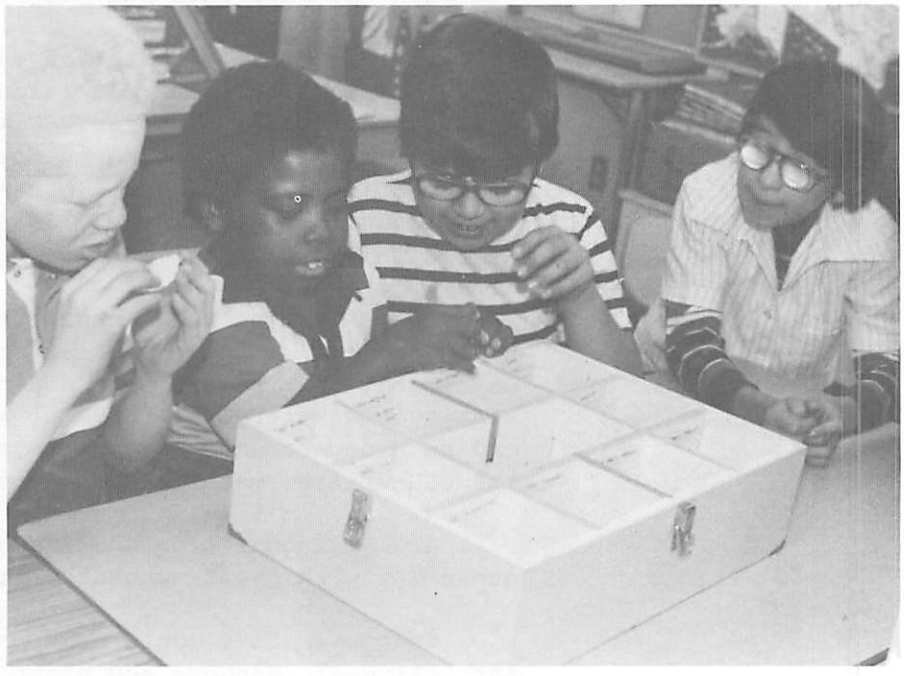
Spanish. Five conference presentations were given for bilingual teachers and eight workshops conducted

with 250 teachers attending. USC bilingual materials and programs are being used by elementary and high school teachers in eight counties in California and internationally.

A proposal for a marine science bilingual training program with community participation has been written and submitted to the Ford Foundation for funding. They have expressed interest but no commitment to date.

Portuguese. The assistant director of USC marine education qualified for the California bilingual certificate of competency in Portuguese. She has conducted workshops in two school districts for Portuguese-speaking teachers. A biologist in Brazil has translated into Portuguese some of USC curriculum materials and these are being used by teachers in the two Portuguese-speaking school districts.

5. The inner-city program uses USC undergraduate students to teach a series of 10 lessons in an elementary or high school located in Los Angeles inner-city. Six workshops were conducted to teach these college students how to develop lesson plans and how to teach the lessons effectively. The marine education director and assistant director meet with professors from departments involved with the program, including biology oceanography and geology to produce a list of topics for teaching kits. This list is available for these undergraduate students in the Marine Education Resource Library.

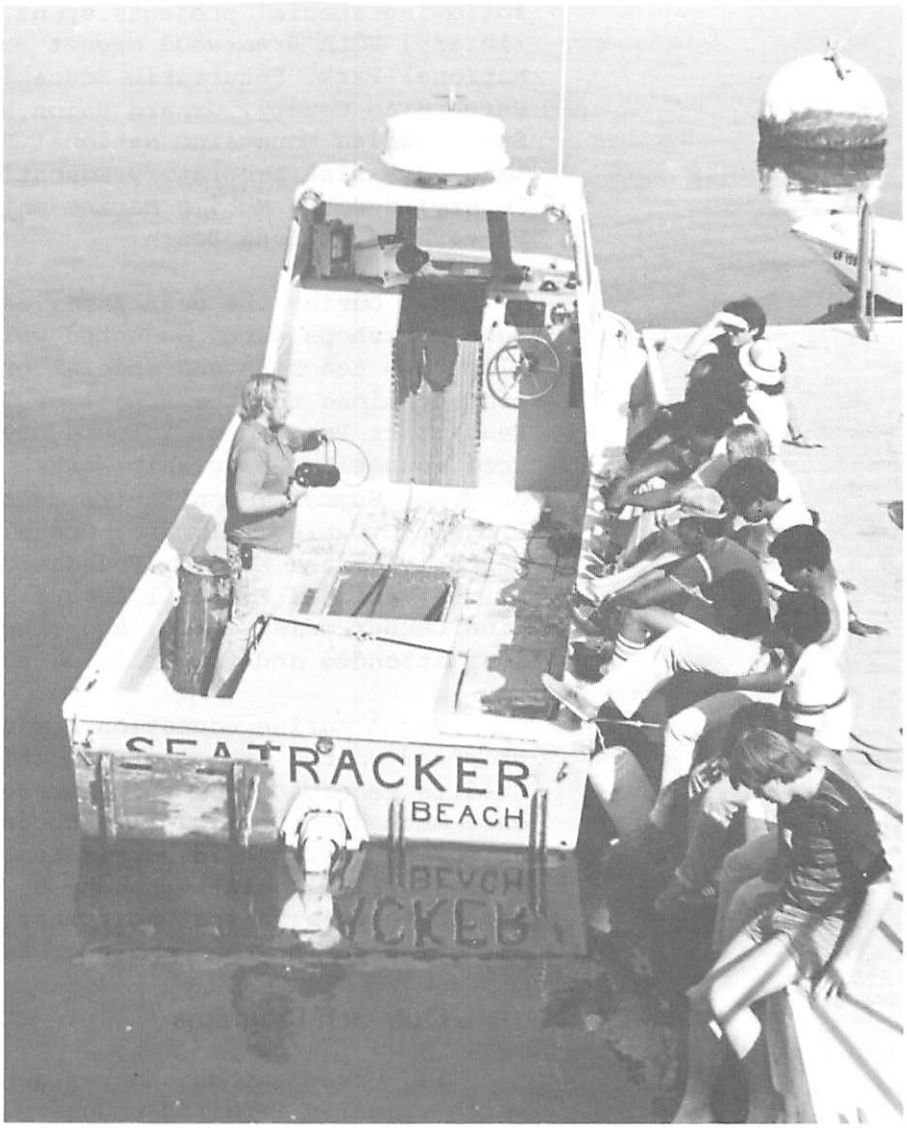


Visually-impaired students delight in handling the shells and other marine specimens included in the specially designed "lending box," which is labeled in Braille and large letters.

In addition, 32 USC students from four disciplines spent an entire semester preparing the marine studies teaching materials, for a total of approximately 9,600 contact hours.

A new program this year permitted 10 black students, chosen for their interest in science, to take a four-day educational excursion to the IMCS Catalina Marine Science Center. The students: a) learn how to conduct oceanographic experiments on board the research vessel; b) listened to lectures by graduate students and scientists; and c) went diving and snorkeling in the waters off Catalina.

Of the 10 students, one student had never before seen the ocean and seven of the students had never been on a ship. This program was so successful we hope to continue it next year.



Greg Pittenger, a graduate student at the Catalina Marine Sciences Center, demonstrates equipment used in his research on sharks in the Santa Barbara Channel—a topic of great interest to the inner-city high school students who participated in a four-day intensive educational excursion.

6. Channel 58 television programs were developed in cooperation with the Los Angeles Unified School District. In addition to developing the scripts for two programs, USC Sea Grant staff accompanied the film crew aboard the Research Vessel SEA WATCH and at the Catalina Marine Science Center to film the programs. These programs will be aired in January 1982 to an audience of more than 344,000. Guides are developed to go along with the series. Approximately 25,000 guides will be distributed to teachers in Los Angeles schools each semester.

7. A Marine Education Resource Library is maintained by a work study student who completed an inventory of all materials available this year and compiled lists for each resource. Using the library's books, audio-visual materials, Spanish materials, etc., USC students prepare their lessons and do their research for lessons in the library. Staff from the following special projects spent full days using the library: UCLA Brentwood Magnet School, Channel Island National Park, Futuristic Education Program in San Bernardino County, Oxnard Union High School (Ventura), Santa Monica Mountains National Recreation Area, Moss Landing Marine Laboratory Education Program (Monterey County) and the Mobile Marine unit of California State University at Long Beach.

8. During the year a series of teacher and student workshops were conducted which included regular classroom teachers and special groups. These included presentations for the School of Education at USC, Head Start Program of Yolo County, Project Learning Tree Education Leadership Workshop, visually impaired program, Summer Youth Environmental Education Workshop, Project C.O.L.D. (Climate, Ocean, Land, Discovery), Mentally Gifted Minors, Foundation for the Junior Blind, National Football League Youth Players Association Career Orientation, and others. Almost 1,800 persons attended and/or participated in these workshops.

9. A marine education graduate-level course was proposed to the School of Education and accepted. Credits received from this course will serve for science methods or bilingual methods requirements, as well as for an elective in curriculum and instruction. The course will be jointly taught by Sea Grant personnel and professors in the Department of Curriculum and Instruction during the summer or fall semester of 1982.

Outreach Programs

1. Great enthusiasm was generated by a program in which visually impaired students were taken from three

Field-trips to the tidepools at Cabrillo Beach permit visually-impaired students to experience the plier-like grip of a starfish.

schools on field trips, and special classroom activities and written materials in braille were prepared. As a result, one of the schools raised money to continue the program and conducted two programs this year for 70 students. The students were instrumental in raising the money through bake sales and other activities.

2. A documentary film about the program for the visually impaired students is being developed. During the past year, existing film was edited, other scenes added, and a fund-raising proposal submitted for the documentary's completion.

3. In cooperation with the Marina Foundation, a day-long program for children from the Foundation for the Junior Blind was conducted in Marina del Rey. More than 300 visual and hearing impaired children attended.

4. This past year, the USC marine education director was selected to chair the Marine Environmental and Resource Section of Los Angeles Town Hall. Luncheons are held monthly and a speaker is selected by the chair for a special presentation. This program provides another avenue for reaching the adult populace with marine education information, and the director's selection is an acknowledgement of the eduction program's success.

5. Participation as speakers and exhibitors at two science fairs, with approximately 6,000 in attendance, provided a means to show the marine education materials and to meet area teachers. As a result, several teachers have acquired USC marine education written materials and others have begun to use the USC Sea Grant Resource Library.

6. The Southwest Marine Education Association, an official chapter of NMEA, was organized in August 1981. The USC Sea Grant marine education directors are acting officers and were chosen to coordinate the first statewide conference in November 1981. The association also will host the NMEA conference in San Diego in 1982.

7. In order to assess the need for marine education to be incorporated into vocational education programs in our area, we formed a joint committee with staff of the Los Angeles Unified School District Division of Career Education. We conducted a survey to determine job opportunities and training needs in marine-related careers by meeting with administrators of occupational centers and interviewing people from marine industry, etc. This information will serve as background for writing a joint proposal for a marine vocational education program.

Evaluation of a Master's of Public Administration Curriculum Specialization in Port/Harbor Management

Willard Price, Associate Professor, School of Public Administration, University of the Pacific; Adjunct Research Associate, Institute for Marine and Coastal Studies, University of Southern California
Gilbert Siegel, Professor, School of Public Administration, University of Southern California

INTRODUCTION

The curriculum development research project in seaport management has completed its third year and accomplished its basic objectives: to develop a concept of seaport management, to design a curriculum specialization, to conduct initial course offerings, to prepare selected teaching materials and, generally, to evaluate the potential for this field of study at USC.

Seaports are public enterprises and, as such, represent an important area of study for public administration. Public enterprises will become increasingly critical as the public sector shifts away from general taxation to more fee-driven programs. Seaports, as the transfer point from a land mode to a water mode of transportation, provide an opportunity for the ocean/marine disciplines of USC's Institute for Marine and Coastal Studies (IMCS) to interact with disciplines such as coastal resource management, environmental management, urban planning and public administration. The principal investigator's background in civil engineering and public works management was especially relevant to work in this area.

GOALS AND OBJECTIVES

The first three years have been conducted as follows:

1978-79: Develop concepts and curricular designs.
1979-80: Develop syllabi and offer initial course.
1980-81: Complete additional course offerings and evaluate academic field.

To date, four course offerings have been completed, 14 teaching materials have been prepared, and several professional presentations and publications have resulted. These items will be detailed in the next section, along with an evaluation of the seaport management field and a plan for future research activities.

RESULTS

The output of this research effort include syllabi and course offerings, supporting teaching materials, professional papers and interaction with other audiences, and as positive evaluation of the appropriateness of addressing seaport management in a university setting.

In this context, the following graduate course offerings were made through USC's School of Public Administration:

1. Spring 1980 - PA 501a. Introduction to Seaport Policy and Management. Instructor: Willard Price. Attendance: 7 students

2. Fall 1980 - PA 501b. Port Performance and Financial Management. Instructor: Robert Waters. Attendance: 13 students.

3. Spring 1981 - PA 501c. Seaport Planning and the Coastal Zone. Instructors: Willard Price, James Fawcett and Peri Muretta. Attendance: 7 students.

4. Fall 1981 - PA 501a. Introduction to Seaport Policy and Management. Instructor: Willard Price. Attendance: 6 students.

Each of these offerings was completed once, with the initial introduction course offered twice. Several students completed the entire series and will receive certificates signed by the School of Public Administration (SPA) and IMCS. While the attendance figures were not strong, our course attendance certainly allowed a successful test of the course content and also has helped determine how to evolve the seaport offerings in terms of content, format and marketing. In the future, additional courses will need to be routinely offered through SPA or IMCS's new Master's of Marine Affairs (MMA) program.

To support the courses, several teaching materials, with readings and exercises, have been prepared to supplement the syllabi. Specifically, the following titles have been prepared and reproduced for distribution to approximately 30 selected seaport practitioners and academics. These materials will be announced to a broader Sea Grant audience through a planned research publication effort.

1. Cry for Independence: A Case Study of the Port of Los Angeles.

2. Port Hueneme: A Small California Port Grapples with its Future.

3. Is There a Federal Port Policy?

4. Marina Management: A Research Study on the Development and Management of Marinas in California.

5. The Influence of Coastal Legislation on Port Development with Application to California.

6. Environmental Mediation: An Alternative to Litigation.

7. Seaport Dredging and Environmental Mitigation: The Case of Coos Bay/North Bend, Oregon.

8. The Cabrillo Project: A Case of Seaport Planning for Public Access.

9. Public Access: An Issue for Seaport Planning.

10. Intermodalism and Seaports.

11. Port Planning and Risk Management.

12. Alternative Service Delivery: A Case Study of the Port of Seattle.

13. Intergovernmental Relations and Seaports.

14. Seaport Management Data Analyses: An Initial Survey.

These teaching materials have emphasized the governance and planning of seaports, reflecting the content of the course series. In addition, course materials in finance and systems management are now being developed. The finance content of the second course in the series, "Port Performance and Financial Management," was supported by existing cases from the American Association of Port Authorities. But, more contemporary research and materials are needed in seaport finance, particularly as ports shift to greater use of private capital for facility development. Regarding systems management, the current Sea Grant funding (1981-82) is directed toward a new course development in "Systems/ Operations Research Applications for Seaports."

The principal investigators continue to maintain contacts with the key academics who are concerned about seaports. Attendance at professional meetings and publications resulting from this research are detailed in the next section on communications.

The future of the seaport management project at USC will involve the continuation of courses, adapted in order to better serve the market. For instance, courses will have an option of 2 or 4 units of credit to serve the demand of seaport practitioners. It is also possible that no-credit workshops should be considered because many practitioners are not degree oriented. If the MMA program attracts full-time or part-time degree students, then regular 4-unit offerings would be more appropriate.

Another market to be pursued is international students, particularly those from nations newly involved in seaport development. These students will likely require some changes in course content, but they do broaden the audience. IMCS recently submitted a proposal to conduct seaport management training for Mexican port authorities. This model could be tested in many countries in Central America, South America, Africa, the Middle East and the Far East.

Future efforts will shift the research focus to specific topics because the curriculum development work has been completed and future course offerings ought to become self-sufficient within regular degree programs. As a result, a proposal for 1982-83 Sea Grant funding addresses an important policy question facing West Coast seaports -- whether to respond to opportunities to export additional coal to the Orient.

PROJECT COMMUNICATIONS

The seaport management area has become increasingly popular with academics as the complexity of seaport development becomes better known. The initiatives in coastal zone management have done much to surface the environmental planning issues in the use of coastal resources. The financial crisis in urban government has raised the awareness of economists, political scientists and public administrators about the financial role that a successful public enterprise, such as a seaport, can play in the overall urban financial crisis. This new attention to seaports has increased the number of opportunities for professional discussions. As a direct result of this research, the following activities and publications have occurred:

Price, W. 1982. Response of West Coast Seaports to the Rediscovery of Coal. Paper presented before the 1982 American Society of Public Administrator's national conference, March 1982, Hawaii.

_____. Accepted for publication. Seaport Management: A Research Agenda. Coastal Zone Management Journal.

Price, W. and P. Muretta. 1979 and forthcoming revision. Seaport Management: A Bibliography. Los Angeles: USC Sea Grant Institutional Program.

Cashman, J. 1982. Seaport Management at USC: An Academic Opportunity for Port and Harbor Professionals. Sea Grant Today 12(1):

Price, W. 1981. "Seaport as Public Enterprises: Some Policy Implications, in Making Ocean Policy, Frank Hoole, et al. (eds.). Boulder, Colorado: Westview Press.

_____. 1981. Seaports, Public Enterprise and Public Policy. Speech before the Marine Environment and Resources Section, Town Hall of California, September 4, 1981, Los Angeles, California.

_____. 1981. Public Enterprise and Public Policy: The Case of Seaports. Panelist for the American Society for Public Administrators/Western Governmental Resaerch Association regional conference, October 1981, Stockton, California.

_____. 1980. Regionalism for Seaports: Selected Concepts with an Example from California. Paper presented before the Regional Port Institutions. Seminar of the New England River Basin Commission, August 1980, Boston, Massachusetts.

Graduate Student Trainee Program

Dorothy M. Bjur, Director of Training, Institute for Marine and Coastal Studies, University of Southern California

The Graduate Student Trainee Program at USC has provided an opportunity for graduate students to work on degree-related research in real-world situations. Concurrently, their research assists Sea Grant principal investigators to fulfill the goals and objectives of their Sea Grant projects.

This continuing program within the USC Sea Grant Program selects its candidates from many disciplines, and each is expected to pursue Sea Grant-related research. Students interested in becoming a Sea Grant trainee must submit an application to the Sea Grant trainee coordinator, accompanied by at least three letters of recommendation, a typewritten statement of intent, and a copy of both their transcripts and graduate record exam (GRE) scores.

A specially appointed selection committee is responsible for identifying the students of highest qualification. Members of this committee represent different departments on campus, including the graduate school, Sea Grant and the Institute for Marine and Coastal Studies.

The trainees have the optimum environment for broadening their intellectual scope, as well as the opportunity for preparing themselves as specialists who can deal effectively with a broad range of social, economic and scientific problems. They work closely with their assigned principal investigator on research, and have the opportunity to interact with the advisory services staff and other Sea Grant-associated professionals to become familiar with the needs of the ultimate recipient of this research -- the public. Sea Grant's applicability to the citizen user is certainly enhanced through the endeavors of the trainee.

During 1980-81, eight graduate students participated in the graduate student trainee program, representing five departments on campus: biological sciences, international relations, geological sciences, urban and regional planning and engineering. One of these eight students has been accepted for another year of traineeship with Sea Grant. Two have received their doctorates in geological sciences, one has finished her master's of planning, and one has taken

and passed his written and oral examinations for his doctorate and is presently writing his dissertation.

To acquaint the trainees with research being conducted through Sea Grant, as well as to provide an opportunity to exchange information with others and with the directors of the program, monthly luncheon meetings were conducted. Trainees were asked to present verbal reports of their research work at each of these meetings, with a discussion period following to involve all those in attendance.

The trainees consider these meetings invaluable for becoming more intimately involved in Sea Grant, for keeping abreast of Sea Grant research, and for keeping the communications open with Sea Grant administration. All suggested this program continue next year.

The following graduate students participated in the 1980-81 trainee program:

Joseph Donoghue, Ph.D. candidate in Geological Sciences - R/EQ-26, Gas Exchange Rates at AirSea Interface in Coastal Waters.

William Gorham, Ph.D. candidate in Biological Sciences - R/EQ-18, Heterotrophic Metabolism of Marine Dinoflagellates.

Barbara Lichman, M.Pl. candidate in Urban and Regional Planning - R/CM-15, The Impact of Major Interest Conflicts on the Evolution of the Coastal Planning "Partnership" Between the Coastal Commission and Local Government.

Marianne Ninos, Ph.D. candidate in Biological Sciences - R/RD-6, Southern California Nearshore Marine Environment: A Significant Fish Nursery?

Seyed Sobhani, Ph.D. candidate in Civil Engineering - R/CE-6, Waves and Currents in Coastal Regions of Sharply Changing Depths.

Scott Thornton, Ph.D. candidate in Geological Sciences - R/RD-12, Mass Movement Processes as Geologic Hazards on Coastal Slopes.

William Westermeyer, Ph.D. candidate in International Relations - Program Development.

James Yumeji, Ph.D. candidate in Urban and Regional Planning - R/CM-17, Residential Resources in the Coastal Zone: Planning and Regulation of Housing Opportunities for Low and Moderate Income Households.

During this past year former USC Sea Grant trainees have been offered and accepted positions at Woods Hole Oceanographic Institute, Office of Technology Assessment (OTA) of the United States Congress Advisory Committee on Reactor Safeguards and Shell Oil Company.

Marine Advisory Services

Marine Advisory Services

Stuart A. Ross, Director, Marine Advisory Services; Assistant Director, Sea Grant Program, University of Southern California
James A. Fawcett, Coastal Planning Specialist, Sea Grant Program, University of Southern California
Shirley J. Hudgins, Communications Specialist, Sea Grant Program, University of Southern California

INTRODUCTION

The goal of Marine Advisory Services (MAS) is to deliver information and expertise needed to help people solve marine resources management and development problems. It seeks to be the link between on-campus researchers and the communities of California -- channelling the ideas and research needs of the community to the researchers and delivering the results of research to the appropriate users of that information.

At USC, as at other Sea Grant institutions, Marine Advisory Services assists Sea Grant principal investigators, other campus offices and groups, and community organizations of many sorts. The progress and activities for 1980-81 will be reported in those categories.

Three changes of note occurred during the 1980-81 year.

1. In October 1980, the harbor offices of the Marine Advisory Services moved to an area of the Los Angeles Harbor known as Fish Harbor, where a new laboratory building was constructed by the Institute for Marine and Coastal Studies (IMCS). The new location provided opportunities for increased Sea Grant interactions with marine user groups and with IMCS researchers. The research ship support facilities and other IMCS activities also will be moved to that location during 1982.

2. The director of Marine Advisory Services was appointed to serve also as assistant director of the Sea Grant program. This change of assignment made continuation of some advisory work to the community more difficult, such as the previous work on marine energy sources, but it facilitated considerably more contact with research activities.

3. In June 1981, Shirley Hudgins left Sea Grant for a job in private industry. After eight years with

the USC Sea Grant program, she left behind a substantial body of good work and good precedents. No replacement was found until October 1981, the start of the next Sea Grant reporting year.

PROGRESS

Sea Grant Principal Investigators

Marine Advisory Services supplies information services to principal investigators, and it helps them establish contacts with community groups. Because USC's advisory personnel are trained specialists in their fields, they are able to relate well with faculty members in exchanging communication and expertise at many levels.

1. Approximately 25 percent of James Fawcett's time was dedicated to his role as co-principal investigator on Project R/CM-15, "The Impact of Major Interest Conflicts on the Evolution of the Coastal Planning 'Partnership' Between the Coastal Commission and Local Government." His role has facilitated close and ongoing contact with the faculty of the School of Urban and Regional Planning and has provided a strong communications link between the Sea Grant program and the faculty and students of the planning school. While that link has always been present, it has been strengthened by his close working relationship on this project with Professor Lowdon Wingo of the school.

The work also has enhanced communication with the staff of the California Coastal Commission because the principal investigators have coordinated their project with the staff of the state agency from initial design to execution.

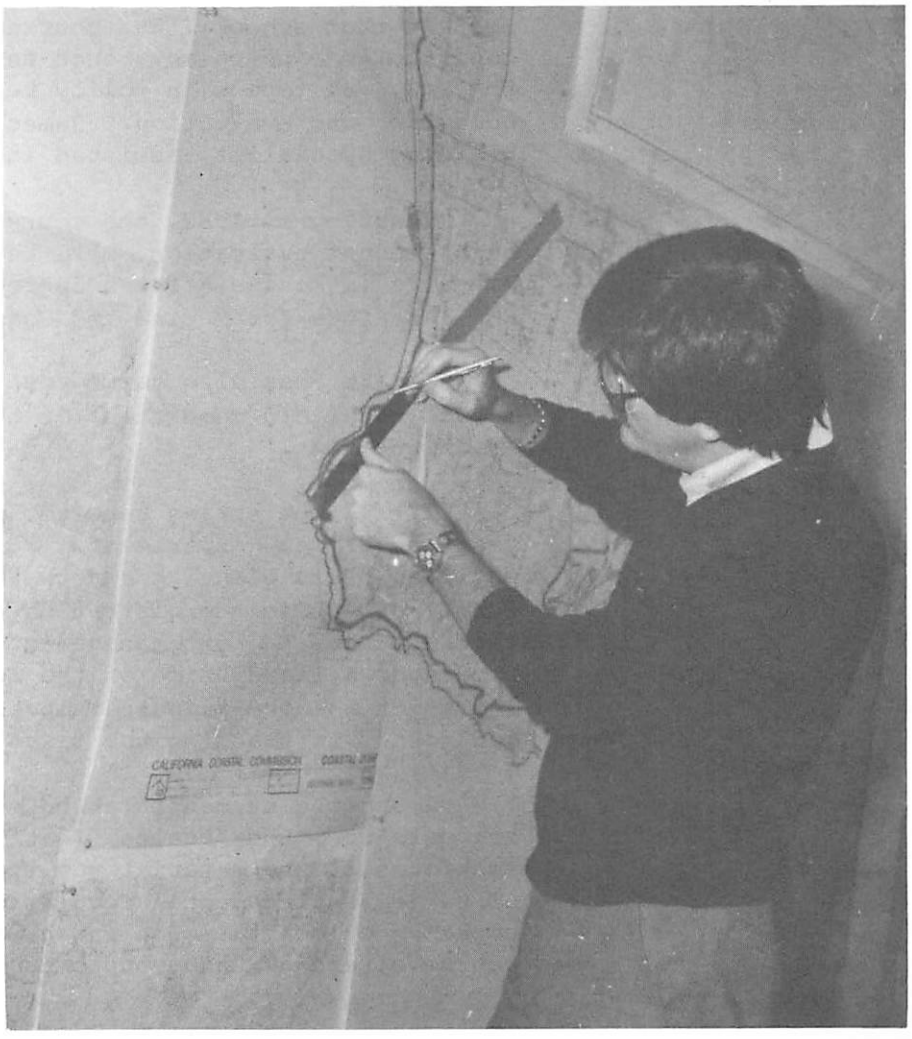
When completed, the project will provide one method for local governments and the commission to evaluate their progress in achieving the goals set out in the California Coastal Act of 1976. Of particular interest to the Marine Advisory Services effort is that the coastal planning specialist will be able to provide insights into how the goals have been achieved. Heretofore, this information has been unavailable from any other source.

Program development funds allocated to this project will facilitate the rapid completion of the project in 1982, in addition to making the results of the research available to local governments and the commission.

2. As in previous years, the advisory staff provided computerized literature search services to Sea Grant investigators and trainees as a means of improving proposals and exploring new topics.

The major effort in this area consisted of several searches completed for Professor Willard Price and his assistant in preparing the second edition of "Seaport Management: A Bibliography," first published by USC in 1979 (USCSG-02-79). Other searches were conducted on topics such as roll waves, crab habitats, nutrient cycling by phytoplankton, the safety of liquefied natural gas (LNG), and river basin planning.

3. Advisory staff also assisted investigators by providing them with network contacts. These efforts included matching co-investigators on an interdisciplinary project, arranging for a prospective investigator to visit industry contacts, introducing an investigator to experts in the California Sea Grant College Program, relaying information from a



James Fawcett provides expertise in the critical area of coastal planning for the many audiences seeking aid from the Marine Advisory Services.

University of California advisor about product markets in Santa Barbara to a USC investigator, and establishing an affiliation between the Sea Grant education staff and a group in need of its services.

4. The communications specialist, Shirley Hudgins, assisted investigators through the publication and distribution of research results. An updated catalog of USC Sea Grant publications was published during the year, two articles were written for Sea Grant Today, and several publications -- theses, dissertations, technical reports and reprints -- were distributed.

One of the articles for Sea Grant Today, on paralytic shellfish poisoning, has generated many responses to the investigators, Bernard Abbott and Maria Ross.

Other Campus Groups

1. The director of the advisory program, Stuart Ross, taught a 4-unit course on marine policy in the School of Public Administration during the fall of 1980, and he received a non-salaried adjunct appointment in that school. The course covered the major topics of marine policy, such as fisheries and law of the sea, and topics in policy research, such as budgeting and evaluation. James Fawcett, coastal planning specialist, assisted in teaching this class.

Starting in 1982, the course, which received very high student evaluation, will become part of the Master's in Marine Affairs degree program offered by the Institute for Marine and Coastal Studies.

Stuart Ross also served on the environmental management field committee for the School of Public Administration.

2. In the spring semester of 1981, James Fawcett team-taught an experimental graduate level class entitled "Port Planning and the Coastal Zone" in the School of Public Administration. This was the third of three courses in port management (see Project E/CD-2). Professor Willard Price of the School of Public Administration was the principal investigator on the project and joined in teaching the class.

Among the students taking the class were port managers from Los Angeles, Seattle and Portland. The focus of the material was the impact on ports of varied environmental regulation with particular emphasis on coastal zone management regulations. The course offered a unique opportunity for the coastal

zone management specialist to deliver information on the coastal zone management process to a group of well-informed professionals and to discuss the material in greater depth than is normally possible with lay audiences.

The ultimate result of the course was that the students in the class emerged with a better understanding of the coastal zone management process and of the literature to which they could refer for additional information.

3. Shirley Hudgins served as a member of the campus-wide Public Information Council, keeping campus publicity groups in touch with marine-related stories.

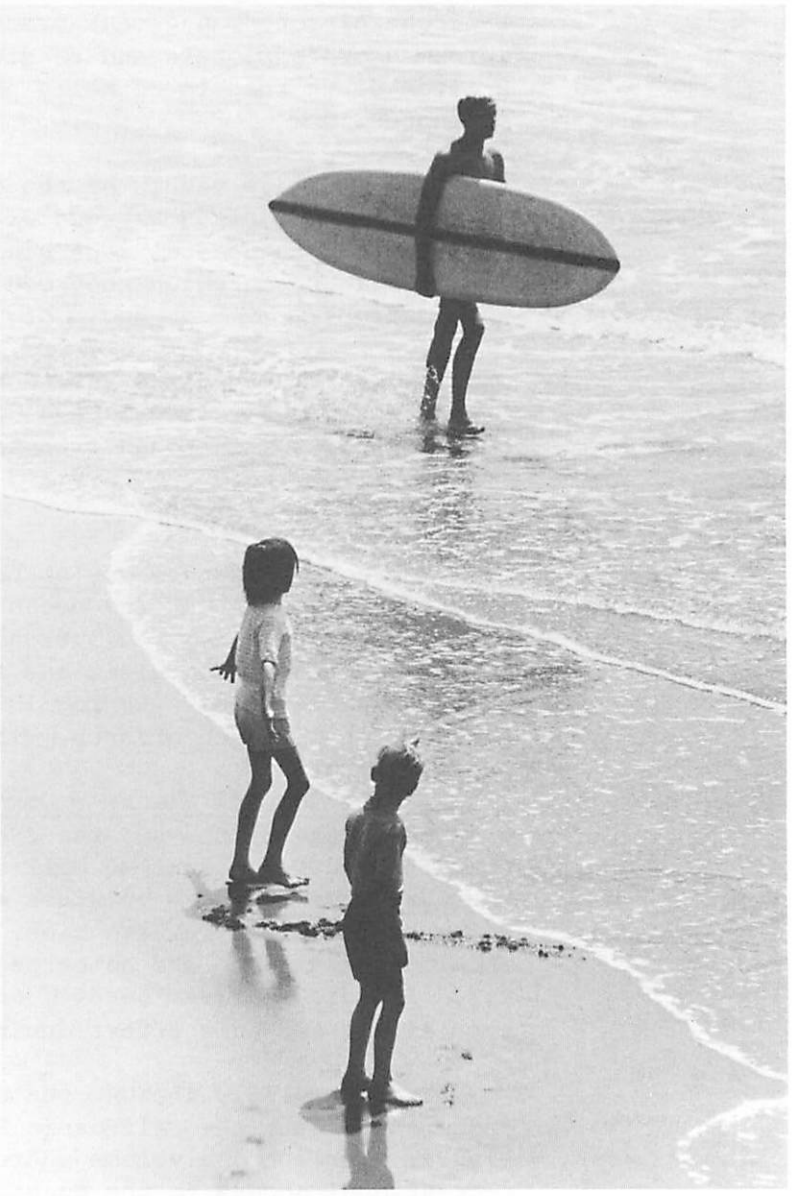
Marine User Groups

Advisory personnel assist persons and groups who need information about the ocean through a variety of means: publications, radio broadcasts, group presentations, personal consultations and participation in community activities. During 1980-81, we maintained a wide variety of such efforts, with positive results.

1. The Coastal Planning Community. In keeping with the theme of the USC Sea Grant program, "The Planning and Management of California's Coastal Resources," the advisory services staff has long placed an emphasis on helping agencies, other organizations and individuals who are concerned with coastal planning in California. James Fawcett, as coastal planning specialist, led this effort during 1980-81.

In early 1981, the USC Sea Grant program, in cooperation with the California Sea Grant College Program, published a volume addressing the issue of recreational access to the coastal zone. The conference from which the papers were derived was held in San Francisco in the spring of 1979 and was sponsored by the Sea Grant programs of the University of California and the University of Southern California, and the Pacific Sea Grant Advisory Program. James Fawcett co-edited the volume with Andrew T. Manus, currently director of the Delaware Sea Grant Marine Advisory Program, and Dr. Jens Sorenson of the California Sea Grant College Program. One thousand copies of the proceedings have been printed, with distribution to the coastal commission, coastal communities and interested citizens. This work represents the first comprehensive effort at addressing the important issue of how people get to the beach, and it is anticipated that the proceedings may spur other researchers to continue developing research in this area.

Recreational access to the coastal zone is addressed in a widely distributed 1981 publication.



During the year, James Fawcett has had ongoing communication with the staff of the California Coastal Commission, providing the state office staffs with information not otherwise available to them. In particular, quantities of the Sea Grant-published proceedings on coastal access (mentioned previously), were made available at no cost to the access coordinator on the state staff. He was particularly interested in having his planning staff read the book to make them aware of the academic viewpoint on the work they are doing and he expressed his appreciation for having received an academic volume on a timely topic of general concern.

In addition to this and other assistance to the state office of the commission, James Fawcett has had frequent contacts with district offices during the

past year. These staff members provide the specialist with assistance on an item of particular concern to him or to a faculty member for whom he is seeking the information. The coastal planning specialist will, in turn, provide staff members with information from campus researchers or from Sea Grant and other publications. For instance a copy of a bibliography, now out of print, published by the California Sea Grant College program, was lent to the South Coast District Office of the commission. The specialist's availability as a resource allows the commission staff to operate in a more efficient manner, a significant concern given limited state budgets.

Planning departments and other agencies in coastal communities also share information with and benefit from the coastal planning specialist. Often a call from the specialist for information will result in the specialist providing assistance to local government planners. This assistance can range from providing publications or reference information to arranging direct communications with one or more campus researchers. This has been an ongoing process and strengthens the relationship between the university and local government. These exchanges co-exist naturally with and supplement the research for Project R/CM-15.

The coastal planning specialist also assists private planners, economists, architects and homeowners concerning the past coastal commission action on development proposals in a given coastal area. This service is in the traditional role of advisory services: recounting past commission decisions in the area of the proposed project, explaining commission procedures for a development proposal, and giving general advice on how to proceed with a project.

For example, Dr. Peter Mlynaryk of Harold Davidson Associates, a Los Angeles real estate consulting firm, called during the year for assistance in determining whether a site upon which he was conducting an economic feasibility study was within the coastal zone. The specialist was able to consult maps and other MAS resources in order to determine that, indeed, the project was within the jurisdiction of the coastal commission. The specialist was then able to provide additional information to Dr. Mlynaryk concerning the issues that would be of particular importance in conducting a feasibility study for residential uses on this site in Venice, California. The information received from advisory services probably saved the real estate consultant several days of effort in evaluating the project proposal.

Some of the specialist's time is taken up by other occasional requests for assistance on coastal planning. Three examples suffice:

-- He assisted Robert Goodwin, the Sea Grant coastal management specialist in the state of Washington, in obtaining boating statistics for California.

-- He was able to provide the director of IMCS with information needed by a member of the National Advisory Committee on Ocean and Atmosphere (NACOA) who was reviewing a project proposal by the Army Corps of Engineers.

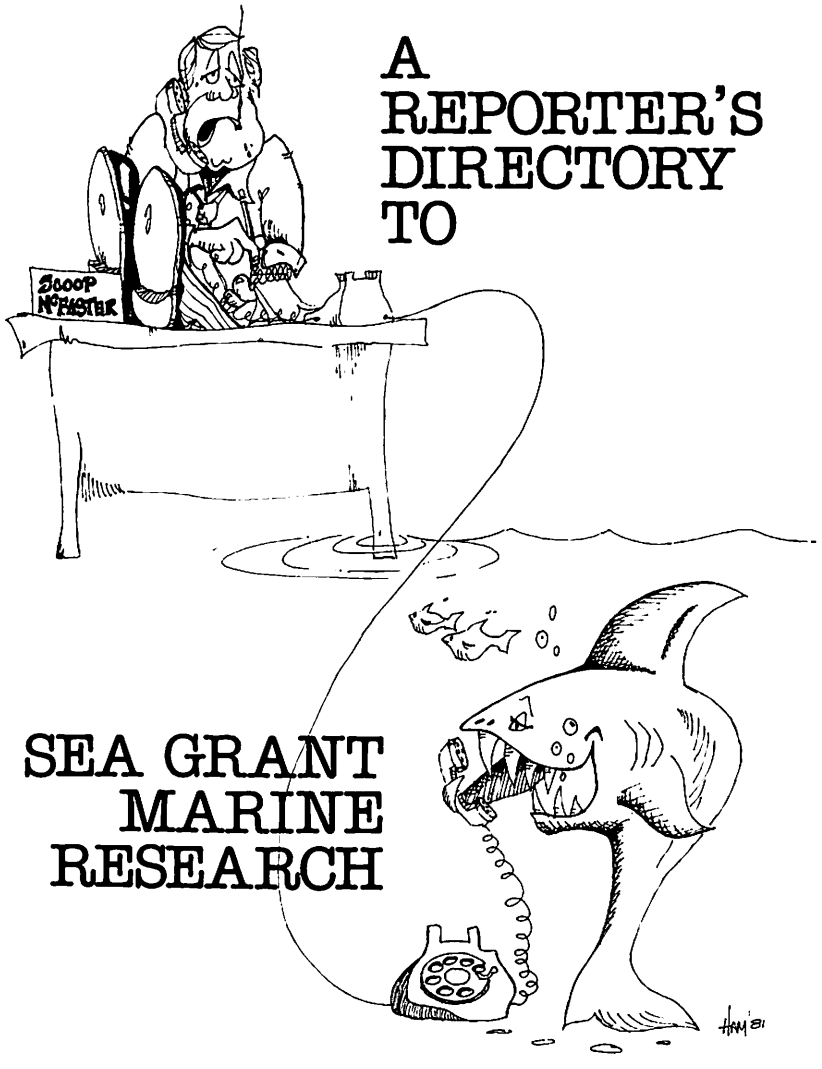
-- He lectured to two classes in the School of Finance at California State Polytechnic University in Pomona, and the instructor stated he will include the specialist's lectures as a regular part of the curriculum.

Local officials and others interested in coastal planning also will benefit from the completion of a booklet summarizing the activities of the California Coastal Conservancy, an agency that strives to restore and enhance the coastline through planning and acquisition of important sites. At the end of the reporting year, the booklet was in production, with release accomplished in early 1982. The booklet is designed as a companion piece to one produced in 1979 by James Fawcett and Barbara Katz (of the California Sea Grant College Program) on the permitting procedures of the California Coastal Commission. The booklet on the Conservancy was researched and written by Peri A. Muretta, a graduate student in Urban and Regional Planning, with the assistance of Stuart Ross and James Fawcett. The work was, of course, reviewed by the Coastal Conservancy staff.

Finally, an effort to produce a documentary film on coastal planning in California was continued from the previous year, but the effort was abandoned when fund-raising attempts were unsuccessful. However, commitments of interest from television stations, commitments for the narration and the music, and the initial drafting of a script had been completed. The film produced in the previous year, "Malibu Lagoon," which describes the values of wetlands and a community clean-up of Malibu Lagoon, was distributed to schools, agencies and other interested citizen groups during the year.

2. Media Groups. Because USC Marine Advisory Services includes and emphasizes communications, one

"A Reporter's Directory to Sea Grant Marine Research" provides leads for media stories.



of its principal targets has always been the media as a conduit to much larger audiences than could be reached directly.

The major accomplishment for media groups was the completion and distribution of "A Reporter's Directory to Sea Grant Marine Research." The directory, compiled by Shirley Hudgins, lists current Sea Grant research investigators, advisory personnel, educators and communicators, both geographically and by subject matter. Thus, reporters interested in a marine story can find Sea Grant expertise quickly and easily. The assembly of the directory required considerable time and effort; it was one of the communications specialist's main projects for the year.

The responses to the directory indicate that it has been used extensively. Two USC investigators appeared in radio interviews as a result of their listing

in the directory; one investigator was contacted by a reporter from the San Pedro News-Pilot. Compliments came in from writers for the Los Angeles Times and the New York Times and from Walter Cronkite's "Universe" TV show. Requests for extra copies came in from the national office of the Oceanic Society and several other organizations.

Short articles on marine topics were supplied in both English and Spanish to approximately 50 newspapers on a biweekly basis. These marine fillers, each a few paragraphs long, were well received by the papers and were, as noted in the report by the marine education staff, used in a bilingual marine education booklet. The writing and distribution of these fillers ceased with Shirley Hudgins' departure in June.

In addition, James Fawcett was contacted by the West Coast office of NBC to assist in finding sources of marine weather information for their new "Teletext" transmissions.

3. Recreational Boaters. Although USC no longer has an advisory specialist in marine recreation, it has maintained a high visibility and usefulness for that marine group.

General and localized marine weather information is broadcast on KNX radio 28 times each weekend to a listenership of 1.4 million persons. The eight-year public service series has been directed by Shirley Hudgins, who coordinated the recruitment and performance of the half dozen reporters. The series was continued without interruption after her departure through the coordination efforts of James Fawcett. Shirley Hudgins and James Fawcett also served as reporters for the series. A useful side benefit from the series has been the name recognition it extends to Sea Grant and its advisory personnel.

"Weather to Go Boating," a booklet developed by advisory personnel several years ago, has continued to be extremely popular. In January 1981, for example, the Ventura Port District ordered 500 copies of the pamphlet. During the booklet's history, it has been reprinted twice, once by KABC-TV in Los Angeles, and once by the Hartford Insurance Company in Hartford, Connecticut. The booklet offers advice to boaters on how to recognize and cope with various weather conditions likely to occur in Southern California.

Marine Advisory Services continues to provide funds for additional telephone answering equipment

that is needed to handle the numerous requests for marine weather information from the National Weather Service.

In the spring of 1981, the 11th Coast Guard District requested assistance for a team of officers from Washington, D.C., who were attempting to determine the level of recreational boating activity, and, thus, the demand for services from the 11th Coast Guard District in the next ten years. In a day's time, the coastal planning specialist was able to provide these officers with a list of data sources and people in various public and private agencies who would be capable of providing the kinds of information sought. In this case, the specialist was a well qualified resource having done similar research in the Southern California area for a number of years. The commander of the 11th District, Admiral Alfred P. Manning, wrote to express his personal appreciation for the assistance rendered these officers.

4. Other Groups. A variety of other groups also benefitted from the activities of Marine Advisory Services.

Seafood consumers in California received, through our distribution, seafood recipes from other Sea Grant programs. The effort, started by Shirley Hudgins in the 1979-80 reporting year, generated very positive responses; early publicity for the recipe distribution resulted in many more requests than the clerical staff could handle. Eventually, regular mailing lists of about 25 persons were maintained for several months. (Several of these recipients sent in names of friends or relatives who also wanted the recipes.) The program was discontinued, however, upon Shirley Hudgins' departure, for lack of staff time to maintain it, and for lack of a USC source of recipes and seafood expertise.

Local clubs and organizations profitted from the availability of advisory personnel for presentations on marine subjects. These included talks to a Sierra Club chapter, a Coast Guard Auxiliary flotilla and the Coast Guard Officer's Club. The Oceanic Society, Los Angeles Regional Section, benefitted from Shirley Hudgins' continuation as a board member and public relations officer.

The newly created Marina Foundation, designed to sponsor marine-related projects and events for the Marina del Rey area and the entire Los Angeles County, benefitted from the participation of the advisory services staff in several projects. These activities

included assembling a list of potential advisors to the board, staffing a booth at the annual local boat show, and assisting at an outing for visual and hearing impaired youngsters.

Groups concerned with the use of the Santa Barbara Channel -- fishermen, oil companies, preservationists and others -- benefitted from USC's expertise through the participation of the advisory services director in a broadly based effort to address multiple-use problems. At the suggestion of the Admiral of the 11th Coast Guard District, the IMCS and the Marine Science Institute of the University of California at Santa Barbara agreed to work with the Coast Guard in planning a major conference on the multiple-use problems of the channel. An advisory committee of 25 persons, representing many user groups, met twice and elicited some commitments of money and in-kind services for the event. Although funding limitations and format problems forced a postponement of the conference, the planning exercises alone produced contacts and discussions among user groups that would not have occurred otherwise. Sea Grant emerged with strengthened ties to several user groups.

CONCLUSION

In sum, Marine Advisory Services continued its record of valuable assistance to important marine communities, ones that it has been serving for many years.

Socio-Economic Programs

The Port Authority as a Public Enterprise: Organizational Adjustment to the Conflicting Demands for Economic Versus Environmental Quality Goals

Herman L. Boschken, Assistant Professor, Sacramento Public Affairs Center, University of Southern California
Ross Clayton, Professor, Sacramento Public Affairs Center, University of Southern California*

INTRODUCTION

Historically, ports and harbors have acted as critical trans-shipment points for the economic allocation of goods and services. With increased interdependence of regional, national and international economies, port authorities have felt enormous pressures to maintain and support economic development values. Moreover, acting as a semi-autonomous enterprise similar to a private firm, the good ports have traditionally provided: a) an enlarged tax base; b) economic development opportunities; and c) a quasi-profit oriented, fiscally independent public agency. On the West Coast, these development activites are likely to become more intense with growing Pacific Rim trade.

Over the last decade, however, the equally important public demands for environmental quality and social planning have been imposed on port authorities. A central orgainzational problem emerges as to whether the structure of port authorities can handle multiple goal implementation or whether organizational adjustments can be made to manage the conflict in goals and still meet the traditional expectations of success as a development-oriented public enterprise.

The idea for this project came from the emerging focus on maritime port activities over the last five years. Competition over containerization facilities, liquefied natural gas (LNG) terminal decisions, the promise of trade with China, Alaskan oil and other developments seem to imply numerous economic benefits for the future, but also raise problems of environmental quality. Ongoing USC Sea Grant research, notably that

* During the first year of the research, the co-principal investigator with Herman Boschken was Louis Weschler, formerly associate professor and director, Sacramento Public Affairs Center, who withdrew from the project when he left USC.

by Willard Price on port management training, indicates to us a problem of administration.

Hence, this study is on port authorities and their changing role in the regional, economical and environmental settings in which they are placed. The goal is to make a comparative examination and analysis of port authority policies, patterns of administration, levels of effectiveness regarding multiple goal attainment, causes for administrative failure and potential avenues for improvement. Specific inquiry is devoted to the legal mandates, authorities and roles of port authorities; policy formation and implementation; and port operations within an intergovernmental setting.

RESULTS

Various works have addressed port management. Yet, few seem to address the issues of interest to us: alternative decision-making processes, considerations of organization structure and the interdependency of environmental factors, administrative tasks and output.

Our approach is different to the extent that we raise new concerns that come from the fields of political economy and organizational theory. These fields specifically provide a frame for analyzing the contingencies and constraints implied by maritime and coastal resources on the administration of harbor development.

Our hypothesis has been that successful management of ports for both economic development and environmental quality is associated with appropriate administrative structure. This interdependency suggests the following questions:

1. To what degree can the port authorities as public enterprises accommodate the conflicting regional demands for economic development, environmental quality and diverse social planning needs?

2. Are appropriate intra- and inter-agency adjustment mechanisms utilized or available to allow port authorities to adapt to these changing regional realities?

3. Which authorities have proven most effective and under what circumstances?

4. What tradeoffs are made by the public enterprise regarding continued financial and economic success vs. achievement of environmental quality and the internalization of adverse externalities?

During the 24 months of this study, we have developed an analytical frame that emphasizes the examination of port authorities as autonomous public organizations. Following a causal sequence where technological change and environmental mandates, in part, determine the setting of ports, the analysis has focused on the impact of these external variables on organizational change. Ports used in the study included Long Beach, Los Angeles, Oakland, San Francisco, Tacoma and Seattle. Six cases of conflict (one for each port) have been developed, in addition to the general comparisons.

To date, the research strategy has included: a) background reading sufficient for understanding the organizational, legal, economic and environmental issues facing port authorities in the United States; b) a documentary search for statutes, regulations, and court and regulatory agency decisions that influence or govern port policy; c) a similar search for state statutes and regulations, municipal ordinances and state court decisions that impact port policies and operations in California and Washington; d) extensive review and analysis of port master plans, public relations material, etc.; e) further specification of the research design; f) design of appropriate tools for describing and cataloging port activities; and g) analysis of six West Coast port authorities and the network of environmental agencies.

Port activities of interest to this study include the following:

1. Dredging. Ports schedule dredging activities, define how deep or how much draft capacity needs to be established or maintained, and determine or contract out what is to be done with the dredged materials.

2. Utilizing Fill. Land fill or dredged materials can be used to generate more dock areas. The ports plan for dock expansion, secure financing, determine source of fill materials, schedule activities, and implement or monitor the development of the docks.

3. Managing Hazardous Cargoes in Port. Ports are recipients and holding areas for a number of hazardous chemicals, explosive materials, and radioactive substances. Consequently, they need to develop structural devices to assure the safe transport of dangerous materials and to respond to emergency situations automatically when they do occur. This can require establishing open buffer zones around industrial uses of these materials, providing fire-fighting and rescue equipment and developing an emergency plan in sufficient

detail so that emergencies are handled immediately and endangered areas are reached and secured quickly.

These actions jointly affect the ports' economic positions and natural environments. The issue of dredging serves to illustrate this interaction. The size of cargo ships has been steadily increasing, and ports are seeking to accommodate containerized ships and neobulk cargo vessels. In addition to the problems of traffic control among large ships (e.g., close passing tolerances, timing for favorable high tides, etc.), ports need to be concerned with the deeper draft vessels requiring deeper channels and harbor accommodations. While the size of vessels is not limitless, it is clear that the existing ships already require deeper water closer to shore, wider channels, and so forth.

The ports' shipping or economic interests do not necessarily merge with environmental responsibilities. Dredging and fill operations can result in significant losses of fish food (biomass), feeding grounds, living space for fish and fauna and nursery areas. While this may be obvious, managing these environmental concerns against the objectives of servicing larger vessels is not obvious. In theory, the environmental considerations and laws are intended to influence dredging behavior by establishing appropriate times during the year for dredging, schedules and/or parameters for frequency, depth and/or closeness to shore, and utilization of dredged materials.

A port's expression of how these two interests merge is frequently manifested in master plans, capital development plans, newsletters, etc. While theory suggests that environmental laws serve as a filter or constraint on port behavior, this may be an oversimplification of the situation.

Ports are often autonomous, self-contained legal and financial entities having to respond competetively to market demands. As a consequence, ports tend to keep disclosures about their actual operations vague, broad and generalized rather than specific, focused and quantifiable. Moreover, we have found that different ports adopt different strategies when interacting with the public and other agencies (i.e., Coastal Commission, Federal Fish and Wildlife Service, Corps of Engineers, etc.).

For example, Long Beach, Oakland and Seattle tend to be more open, facilitative and well organized when collaborating with environmental agencies. Tacoma, Los Angeles and San Francisco tend to be less adaptive and sophisticated in this respect. In part this is due

to the way the administration is structured and controlled. The latter three ports are dominated by the politics of business interests of the city council or mayor while Long Beach, Oakland and Seattle have evidence of professional authority decentralized into project department specializations. We have more analysis to do, but the evidence suggests a relationship between organization structure, behavior and successful adaptation to conflicting public goals and demands.

PROJECT COMMUNICATIONS

Boschken, H. L. Forthcoming. The Demand of Conflicting Change on Public Enterprise: West Coast Seaport Development and Environmental Regulation. Public Administration Review.

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The Impact of Major Interest Conflicts on the Evolution of the Coastal Planning "Partnership" Between the Coastal Commission and Local Government

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James Fawcett, Coastal Planning Specialist, Sea Grant Marine Advisory Services, University of Southern California

INTRODUCTION

A seminar on the topic of policy analysis and evaluation of coastal planning in 1980 concluded that little was known about the changing structure of planning resulting from: a) the intervention of state government in the traditionally local function of land-use planning, and b) the assertion by the state of an interest in the conflict between land development and environmental conservation.

Subsequent contact with senior staff members of the California Coastal Commission about this information gap resulted in encouragement for a study of the situation. Wingo's past work on intergovernmental relations and environmental problems and Fawcett's recent professional work on coastal planning and management were the sources of interest and expertise that went into formulation of the actual project for Sea Grant funding.

GOALS AND OBJECTIVES

This project was designed around four basic goals:

1. To identify the impact on local coastal plans of a) the sharing of planning responsibility between state and local government, and b) the interaction of major political interests in the planning and regulatory arena afforded by California's coastal management program.

2. To design a policy analysis to relate coastal resource issues to the broad program goals of state and local government.

3. To develop a policy information system for the evaluation of public policy in such highly politicized circumstances.

4. To describe a policy analysis prototype useful to other states and agencies involved in coastal planning and management programs.

RESULTS

Progress to date on this project is best described in the original proposal:

1. "...survey of appropriate public records of local jurisdictions, ...the California Coastal Commission, (and) the State Legislature of California, ... to identify an issue set relevant to the domain of research;"

This task was largely completed in the first quarter of the project. For the years 1976-79 and for the California coastal jurisdictions in Ventura, Los Angeles, Orange and San Diego counties, we examined the minutes of state and regional commissions, staff reports, formal correspondence, consultants' reports, appellate files, issue identification statements, official guidelines, workable program documents, hearing resumes and other official documents associated with permit appeals to the state commission and the negotiations for approval of local coastal programs. The California Coastal Act of 1976, the regulations attendant thereon, and amendments proposed also were studied. An "issue lexicon" was compiled containing approximately 200 issue "subjects" or topics and approximately 100 issue predicates. These together make possible roughly 20,000 issue statements.

2. "Identification of a subset of issues within the issue set for aggregate analysis..."

The regulatory phase of this task was carried out during the first half of 1981. It involved a detailed examination of the 102 state commission case files of appeals from regional commission decisions. This was a 100 percent sample of such cases for which the commission found a substantial issue presented. Coding by the "issue lexicon" resulted in 1,205 issue statements associated with 87 "consolidated" appeals. This data set has been coded for computer analysis and linked to a data set of attribute descriptors by case number.

The planning phase of this task began in June 1981 and was about 80 percent complete by Sept. 30, 1981. This phase proceeded more slowly than we had hoped because of the difficulty of acquiring the final installment of planning documents from state agencies, whose ability to assist us was substantially impaired by Proposition 13 and federal coastal management fund reductions in the summer of 1981. Acquisition of remaining documents continues, and we hope to complete this phase in early 1982. Our current estimate is that this phase will produce approximately

3,500 issue statements from 200 planning documents gathered by 69 local coastal plan segments along the Southern California coastal zone.

3. "Full specification of issue attributes for subset issues..."

This task is currently underway. The regulatory issue set has been subjected to some preliminary computer analysis relating the issue data to the case attribute descriptor data. Preliminary findings will be forthcoming shortly. The planning issue set will be entered into disk memory for preliminary analysis as soon as the set can be judged to be approximately complete.

4. "Nonparametric multivariate analysis to relate the planning impact attributes to the substantive and issue attributes to provide us with some specification of the association between content and structure of planning in the coastal zone and the kinds of issues coming forward, the configuration of political interests, and the interest group arguments;"

These analyses have been delayed pending the completion of the planning issue data set discussed above. In anticipation of the full set of data, we are formulating decisions about the most productive analytical format and computer programs to employ for the multivariate analyses.

5. "Utilize such analytical outcome as the basis for an intensive interview program with relevant officials, issue participants and interested observers to extend the detail and depth of the overall analysis."

Initiation of this task has been delayed as discussed above. We are considering reducing the scale of this task to compensate for the time lost in the assembly of the issue data set.

The principal achievement of the project during this period has been the development of a methodology based on semantic structure to translate normal adversary rhetoric into an "issue language." This has made it possible for us to code thousands of pages of relevant documents into machine readable issue statements for computer analysis.

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Frequent discussions on project progress with members of the staff of the California Coastal Commission in San Francisco and three regional commissions in the Southern California area.

Several seminar and doctorate colloquium presentations on environmental issues and the evaluation of public policy for the School of Urban and Regional Planning at the University of Southern California

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Residential Resources in the Coastal Zone: The Planning and Regulation of Housing Opportunities for Low and Moderate Income Households

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Don Bryant, Esq., Director, Los Angeles Lawyers for Housing
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INTRODUCTION

Housing prices in urban coastal communities during the past decades have increased at rates ranging from 50-150 percent above the general rate of inflation. This rapid increase in coastal housing prices is in response to greatly increased demands upon limited residential resources that will continue well into the next century.

Various legislative and judicial actions have been taken to slow this trend. In particular, Section 30213 of the California Coastal Act of 1976 required that low and moderate income housing be protected, encouraged and, where feasible, provided within California's coastal zone. To further these objectives, the act required each coastal city and county to prepare plans and development regulations, which had to be approved by the Coastal Commission.

Though the act provided sufficient public authority to permit design of remedies for affordable housing, their successful implementation was not fully insured. On the one hand, local governments resented this usurpation of control over their coastal zone area by the California Coastal Commission. On the other, the pending transer of administrative authority to local units of government was seen by many as a major opportunity to circumvent implementation of the Section 30213 housing mandate.

Accordingly, we initially sought to analyze economic, legal and administrative aspects of planning and regulatory options for securing affordable housing opportunities in the California coastal zone. More specifically, we sought to analyze the legal context within which local coastal planning and regulation must be designed, to establish criteria against which housing elements of local coastal plans might be evaluated and to identify constraints on securing affordable housing embedded in the current specification of

property rights. But subsequent political events forced a modification in our objectives, although the goals remain the same.

Since 1976, more than 6,000 affordable housing units have been required on development permits issued under the interim authority granted to state and local coastal commissions. Of these, less than one-tenth are now built and occupied. Of the 67 cities and counties that need to prepare local coastal programs (LCP), only 16 had completed the processes by September 1981. Many localities have satisfactorily addressed all planning issues except housing. As an indication, the last local coastal status report issued by the South Coast Regional Commission (July 22, 1981) revealed that, of the 34 LCP segments still under review, 25 have housing as one of the major issues still to be resolved. Though the concept of residential development is generally embraced by local government, the affordable-housing mandate of Section 30213 is an anathema.

Thus, it is of no surprise that the California League of Cities, among others, supports SB 626, introduced March 16, 1981. This bill would remove the Coastal Commission's review over housing, transferring it back to local governments, so that housing policies within the coastal zone need only conform to the goals, policies and objectives of the local housing elements that cover the entire jurisdiction, both in and out of the coastal zone.

The introduction of SB 626 caused us to consider changing our analytical objectives; its passage on Sept. 29, 1981, made this mandatory. The strong legislative mandage in Section 30213, which originally motivated the analysis, had been set aside, and the legal context had been significantly altered.

However, a review of related changes in the legal context indicates that California's brief experiment with affordable housing in the coastal zone may assume an unforeseen relevance in the context of recent changes in planning law.

We refer specifically to the combined effects of AB 2853 and AB 1151 (California Government Code, Sections 65580 et seq and 654534 et seq). AB 2853 details the contents of housing elements required of all local plans and specific plans. AB 1151 creates pressure for local coastal adoption of specific plans. Because specific plans are like local coastal programs, we can identify likely patterns of community response to these bills. This information then aids in the

implementation of legislative provisions and their juridical interpretation.

Such changes in the legal context significantly affect the regulation of affordable housing opportunities and the California coast. Most of our subsequent work addresses basic elements of this changing context.

GOALS AND OBJECTIVES

To date, our investigations have focused on five distinct issues:

1. Policy research - the inferential validity of past research on the impact of coastal zone management policies on housing prices in and near the California coast.

2. Policy context - the basic precepts of coastal zone management as an approach to social choice among alternative modes of control over resource use.

3. Analytic bases for plan design - the components of both the technicial and the analytical bases for the design and evaluation of coastal resource management plans with special reference to the LCP housing element.

4. Legislative requirements - the California Coastal Act's low and moderate income housing requirements and related legislative provision bearing upon the housing mandate, including the likely effects of SB 626 on the provision of affordable housing in the coastal zone.

5. Recent legal developments - the range and limitations in the exercise of property rights from three perspectives--that of the public, the owner, and the tenant--as an issue central to policies affecting the provision of affordable housing.

RESULTS

Policy Research

Statistical research on the Coastal Commission's impact on housing prices bears upon the mutual compatibility of environmental quality and social policy objectives. The quality of this research is still very primitive in its design. We found only three investigations of sufficient methodological sophistication to merit serious evaluation (Frech and Lafferty,

1976; Kneisel, 1979; Frech and Lafferty, 1980). The latter two use an interrupted time series analysis to identify the effects of regulation on price. These are of particular interest because that type of quasi-experimental design is the most appropriate for investigating this kind of question (Cook and Campbell, 1979). However, the validity of their statistical conclusions about the effects of coastal regulation is clouded by the usually surmountable problems of autocorrelation, multicollinearity and heteroscedasticity.

Moreover, the validity of their casual inference is threatened by a failure to control for other plausible explanations of their statistical findings including, particularly, the rapid increase in the demand for clean air, an increase in the demand for housing as an investment commodity and the interaction of these two changes on the price of coastal housing.

In short, we do not yet possess valid empirical evidence on the purported incompatibility of simultaneously pursuing environmental quality and social policy objectives. In the absence of such research, we would do well to consider the issue of providing affordable housing in its broader context.

Policy Context

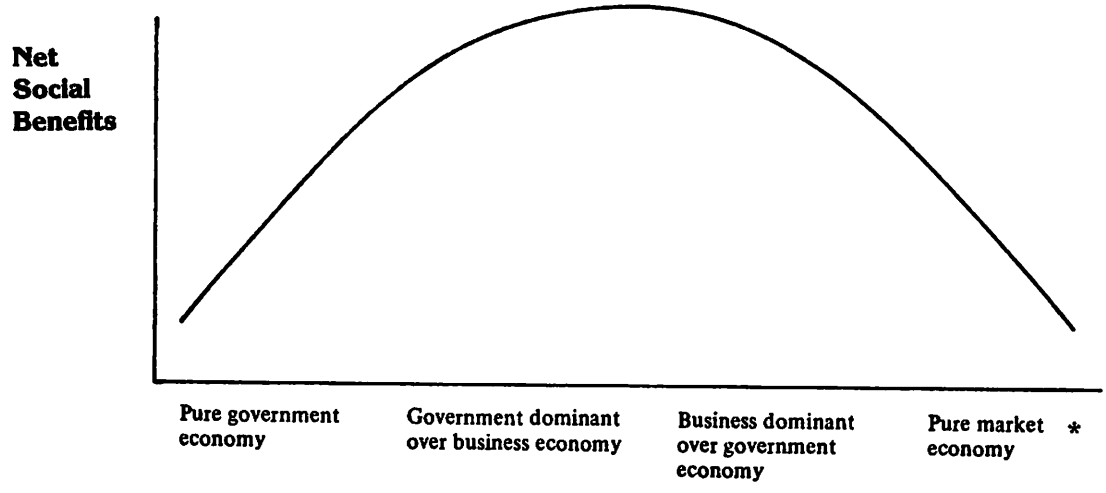
Housing policy in the coastal zone cannot be dealt with in isolation from other issues. Formulation of basic precepts of coastal zone management sets the housing issue into a broader policy context. This context also covers issues of community development, land management and environmental quality. The policy context of coastal zone management, therefore, is sufficiently broad as to present classic problems in social choice.

Problems in social choice have to do with the aggregation of individual preferences to serve as a guide to public decisions. Archetypically, aggregation is done either through a market mechanism or a political mechanism -- or in short, a pure market economy or a pure public economy (Ditton, Seymour, and Swanson, 1977).

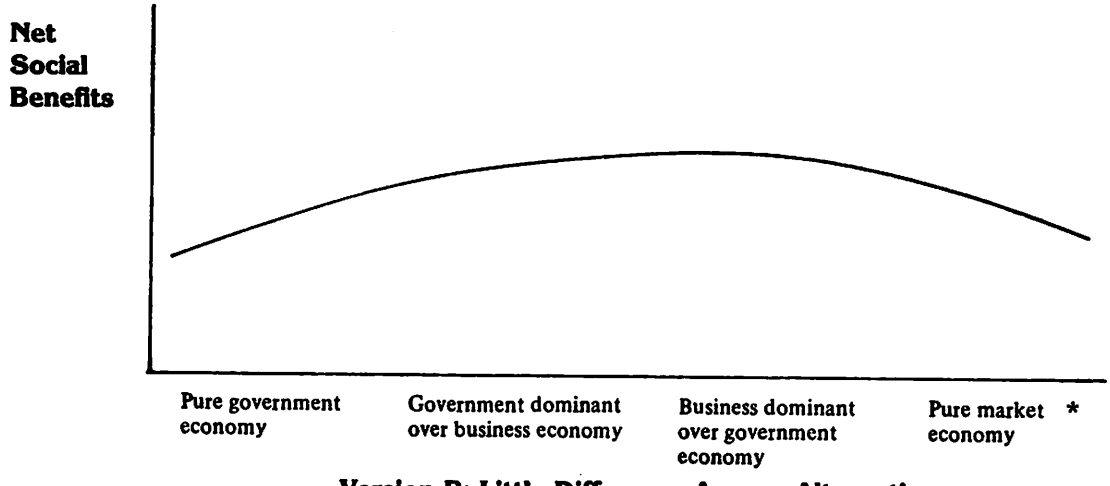
However, both of these extremes are generally thought to be inefficient; net social benefits are maximized at some intermediate mode that contains facets of both (Figure 1). Coastal resource management, then, can be thought of as a problem of choosing one of these intermediate modes of control over coastal resources in an effort to maximize the net social benefits generated by their use.

Figure 1

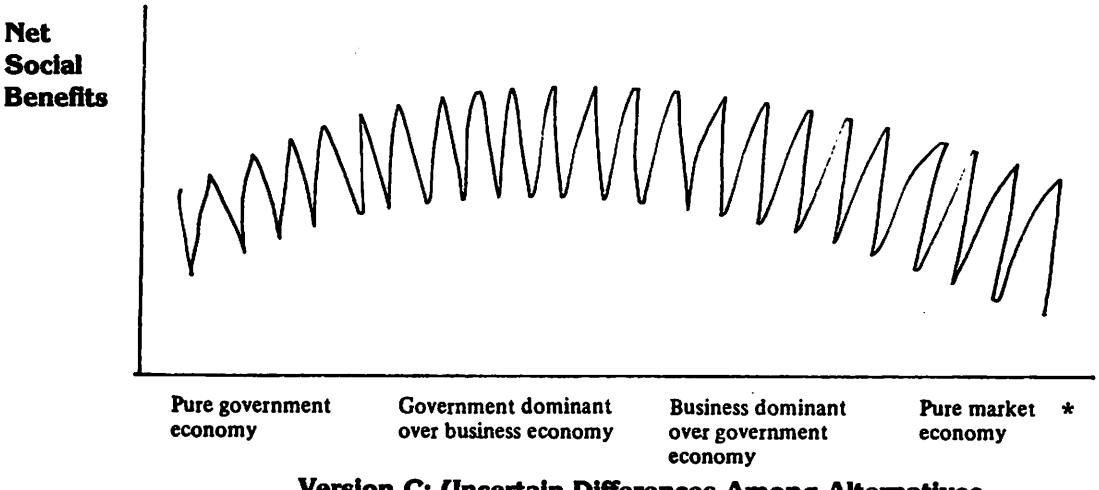
Net Social Benefits of Alternative Modes of Control Over Resource Use



Version A: Important Differences Among Alternatives



Version B: Little Difference Among Alternatives



Version C: Uncertain Differences Among Alternatives

*Horizontal axis after Ditton, Seymour and Swanson (1977:185).

Movement toward a more beneficial mode entails a respecification of property rights between owners of coastal zone land, the rental tenantry and the public. But the choice of the most beneficial mode also is influenced by constantly changing claims on these rights. These claims change with awareness of beneficial and harmful effects of development and with shifts in the relative value placed on these effects. The continuing contest for power among groups with conflicting claims will move the dominant mode of resource control back and forth along the continuum between private and public economics. Perfecting the technical aspects of these modes of control and finding the right balance between them is a fundamental task for those concerned with coastal resource use and management.

Analytic Basis for Plan Design

Moving from one mode of resource control to another requires political action, legislative direction, local discussion, analysis, compromise, agreement, administrative decision and a plan. The design and evaluation of planning options for coastal resource management requires at least two kinds of analysis: the technical and the politico-economic.

Analysis of the technical basis is the simpler of the two. Taking the following steps will help identify an appropriate blend of roles and responsiblities for both private and public sector institutions:

1. Identify domains of public/private conflict (i.e., issue areas) and their interrelationships.

2. Identify norms and standards of behavior.

3. Identify the impacts of typical actions in each issue area on the exercise of private, state state, and communal property rights (i.e., learn what values are at stake and how they are affected).

4. Identify technical possibilities for the resolution of conflicts in the exercise of property rights as currently specified.

5. Design and evaluate planning options.

6. Identify the dominant options.

Analyzing the politico-economic bases of management planning is a more complex task. Its purpose is to improve upon the modes of coastal resource control so as to shift upward the net social benefit curves

of Figure 1. The method of analysis identifies probable dimensions of institutional failure and aids in the design of appropriate coping mechanisms. A sampling of coping mechanisms relevant to the allocation of residential resources among alternative coastal uses might include: a) tenant, neighborhood and homeowners associations; b) alternative modes of property ownership such as the limited equity cooperative; c) self-enforcing regulatory mechanisms such as unit pricing of services, changes in the burden of proof and changes in liability rules; d) a housing court; and e) clarified responsbility of private developers, vis-a-vis the relocation of displaced persons.

Legislative Requirements

Under authority provided by Section 30213, the California Coastal Commission promulgated regulations controlling dwelling unit demolition, condo/co-op conversion and new construction. Programs for the relocation and inclusion of low and moderate income households were economically feasibile wherever the demand for inventory change remained high. A major conclusion to be drawn from this four and one-half year "experiment" is that the stock of affordable housing need not be entirely threatened during periods of high demand and constrained supply. In times of a stagnating economy, however, this conclusion may not hold.

The "experiment" has shown that what is at issue is not our technical ability but, rather, our political will. The modifications contained in SB 626 relax the strict standards of providing affordable housing within the coastal zone by permitting placement within a larger three-mile zone. Moreover, the requirement for low income housing has been weakened to allow provision for moderate income housing only.

Perhaps more significant from our perspective is SB 626's deletion of administrative mechanisms for resolving disputes among owners, tenants and the state. Now, the only resort in cases of conflict will be to more expensive and time-consuming litigation. Moreover, the courts traditionally have not been willing to closely scrutinize local planning and plan implementation.

Thus, we conclude that the important issues that remain to be decided concern the procedures, standards and scope of appellate court review concerning the adequacy and implementation of the housing element to a local general plan and the housing element to a specific plan. It appears that protection and provision of affordable housing opportunities in California

presently rest heavily upon the resolution of this rather small set of juridical issues.

Recent Legal Developments

Finally, the possibility of moving to a superior policy position is often limited by constraints embedded in the current specification of property rights. We have, therefore, examined the concept of property rights as they relate to the provision of affordable housing from three perspectives: the public's, the owner's and the tenant's.

The basis and extent of regulatory authority, as well as the constitutional constraints to the exercise of that authority, are fundamental to the public's perspective on property rights. Issues considered include: a) use of the police power to promote public health, safety and welfare, and b) the taking issue as it relates to exactions/dedications, inverse condemnation, inclusionary programs and voluntary participation in density bonus programs.

The right to the benefits of use, sale and capital gains are fundamental to the owner's perspective. Legislation (including the California Coastal Act), legal precedents and custom are considered as are their implications for achieving social objectives. We further found that the housing "experiment" authorized by Section 30213 clarified the disposition of many overlapping rights which, when exercised, used to be mutually incompatible.

Conflict over the disposition of property rights from the tenants perspective have historically been resolved in favor of either the public or the owner. Under the coastal act, we found that tenant rights were extended in several ways: a) tenants were allowed to participate in decisions affecting the supply of affordable housing via the permit hearing process; b) their right to security of tenure was enhanced by requirements to provide relocation and replacement housing; and c) to the extent that coastal regulations discouraged property speculation, the rental tenantry was spared the neighborhood instability occasioned by such behavior.

PROJECT COMMUNICATIONS

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Testimony before the California Coastal Commission regarding low and moderate income housing performance, June 1981.

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Living Marine Resources

Heterotrophic Metabolism of Marine Dinoflagellates

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INTRODUCTION

The marine dinoflagellates are among the most important members of the phytoplankton, the producers of the primary biological material that supports the rest of the ocean food web. They are also a common cause of phytoplankton blooms in enriched areas because they are often autoheterotrophs. This means that while they can photosynthesize their supplies, they are also opportunists and will ingest metabolites available in the sea water. Blooms that occur in the Los Angeles-Long Beach Harbor are often below the visible discoloration level, which can be evidenced by taking cell counts of water samples; however, blooms do lead to red tides. At the level of primary productivity, the occurrence of red tides has been an unpleasant indicator of uncontrolled levels of high productivity.

The accepted view of sincerely interested conservationists has been that the effluent, other than natural run-off, is potentially damaging to the marine ecosystem. The occurrence of a series of major oil spills in the ocean triggered this awareness of marine pollution dangers. We believe that not all waste effluent is harmful and that waste material discharged under supervised conditions can enhance the natural resources of the sea. We interpret the continuing sequence of blooms to be due to the presence and utilization of useful nutrient materials in the water from urban run-off, as well as from waste discharge. This belief led us to ask the question, "Are marine dinoflagellates able to switch from autotrophic to heterotrophic metabolism when challenged with organic substrates?" We, therefore, proposed to test the hypothesis of marine dinoflagellate heterotrophy. Using radioactively labelled substrates under varying illumination conditions and in total darkness so that photosynthesis could not proceed, we obtained positive results with three dinoflagellates species taken from the Los Angeles-Long Beach Harbor and isolated from bloom conditions: Gonyaulax polyedra, Scrippsiella trochoidea and Gymnodinium sanguinium.

We realize that it is probable that much of the organic material is processed through bacteria in harbor waters; however, some recent work from two schools (Wheeler, et al, 1977, and Khailov et al, 1978) suggest strongly that the uptake of organic materials may be greater in the phytoplankton than in small bacteria.

In addition to the overall goals of the project, side issues of axenicity, which arose during the course of the study, have also been pursued. The study of heterotrophy and the incorporation of amino acids has been completed (Ross and Abbott, 1979). The effect of antibiotics on the incorporation of organic substrates by the experimental species was studied (Ross and Abbott, 1980). To obtain bacteria-free cultures for the heterotrophic uptake studies, antibiotics were used to completely inhibit bacterial contaminants but no reports exist on the problem of permanent alterations, if any, of the dinoflagellates. Droop (1967) alludes to the fact that algal cells exposed to antibiotics may be altered.

RESULTS

The experimental organisms, Gonyaulax polyedra, Scrippsiella trochoidea, Gymnodinium sanguinium, were isolated from bloom conditions in Los Angeles-Long Beach Harbor by Morey-Gaines (1976). Each was identified as the dominant species of the particular bloom condition. The unialgal cultures were made axenic by antibiotic treatment (Droop, 1967), as modified by Ross (1979). The axenic unialgal cultures are maintained in our laboratory and are continuously monitored for bacterial contamination. The incubation temperature is 18° C, which simulates in situ conditions (Morey-Gaines, 1976). Sea water enriched with F/2 metals and vitamins is used as the growth medium (Guillard and Ryther, 1962). Cultures for the experiments are used 18 hours after innoculation (young culture) and five days after innoculation (old culture). Total volume for experimental cultures is 25 ml. Labeled substrates used are 4,5 ^{3}H-leucine and ^{14}C-phenylalanine, which are added to the cultures at a final concentration of 2.15×10^{-7}M; 0.1 µCi/ml of medium; specific activity 460 µCi/µmole.

Time of incubation and illumination conditions are varied for the three species of dinoflagellates.

One-milliliter samples are removed for: a) cell counting with a Coulter Counter Model B-100µ window; b) protein determination using bovine serum albumin as a standard; and c) incorporation measurements (Byfield and Scherbaum, 1966) as modified by Ross (1970) on

Whatman glass fiber (GF/A) filters to be counted in a Beckman scintillation counter Model LS 100 using the external standard ratio method.

Results are expressed as cpm/cell as a function of incubation time in hours or cpm/μg protein vs. incubation time in hours.

The incorporation of the amino acids phenylalanine and leucine by Gonyaulax polyedra, Scrippsiella trochoidea, and Gymnodinium sanguinium was examined: Phenylalanine, because it is directly incoporated into protein, equilibrates rapidly with intracellular pool and is not converted to other amino acids (Morgan, et al, 1971); Leucine because while it is rapidly incorporated for protein synthesis, it is also readily metabolized into other fractions of the cell.

We have only measured that portion which is incorporated into the trichloroacetic (TCA) precipitable and ether-ethanol insoluble fractions. The results from the incorporation studies with ^{14}C-phenylalanine and leucine, under all conditions of illumination. The dark incubated cultures incorporated these amino acids at a much greater rate and concentration, which further supports our hypothesis.

The difference in the rates of incorporation and the change in preference of amino acids between the young (18 hours old) and old (5 days old) cultures suggests, perhaps, synthesis of different kinds of proteins during the life span of the cultures. The lower incorporation observed in the older cultures suggests that metabolism may slow down with age and/or byproducts of metabolic processes into the growth medium (Fogg and Nalwaijko, 1964; Hellebust, 1967a; and Hellebust, 1967b) are inhibitory to the organisms.

Although Droop (1967) alludes to the fact that algal cells exposed to antibiotics may be altered, no reports dealing with this problem are available. In order to test the hypothesis of heterotrophy, the cultures must be unialgal and axenic (i.e., free of bacterial symbionts). Bacteria can alter incorporation results, growth study results and enzyme kinetic data. The effect of antibiotic treatment on both the growth and the incorporation of the amino acids phenylalanine and leucine was studied. The results of these studies suggest that the cultures incorporate the amino acids to a much lesser degree in the presence of antibiotics irrespective of illuminating conditions. The incorporation with nontreated cultures is always higher, as expected, because both bacterial and dinoflagellates incorporations are additive.

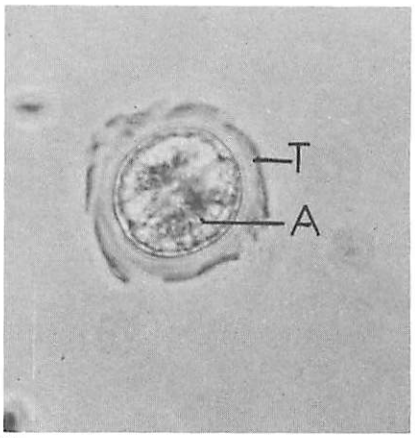
When the experimental cultures are completely axenic and the antibiotic concentration has been diluted to an asymptotic zero level, the incorporation resumes at a higher rate. If there is true inhibition caused by the antibiotic treatment, it appears to be temporary. The growth studies support the temporary inhibition, which is obviated by a lag period in the growth cycle. From the data obtained so far, our hypothesis of dinoflagellate heterotrophy is again confirmed. To be completely certain that our cultures are axenic and remain axenic after antibiotic dilution, sterility tests are performed with bacterial broth at 18° C, which is the normal growth incubation temperature for the cultures, and at 30° C, which accelerates the proliferation of the bacterial symbiont. We have demonstrated that some cultures that proved to be bacteria free in bacterial broth medium at 18° C for many weeks were shown not to be free of bacterial contamination when a duplicate set of cultures was incubated at 30° C. From growth studies with the experimental organisms at 30° C our results clearly show that the dinoflagellates are destroyed and any endobacteria present would then be released into the medium. This could be supportive evidence for endonuclear bacteria (Silva, 1978); however this does not relieve us of the necessity and obligation to prove that our cultures are absolutely bacteria free.

Due to these findings, we adopted more stringent criteria for axenicity of our experimental cultures so that cultures claimed to be axenic would remain clear indefinitely when incubated in bacterial broth at 18° C and 30° C. It was and remains quite a task to maintain stringent axenicity for long periods.

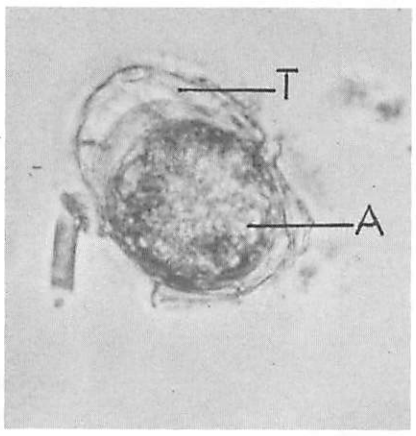
Through an unfortunate situation, our cultures became contaminated once again. This time, to our horror, the contamination was not because of what we had presumed to be endobacteria. Instead, unforeseen contamination of our cultures had introduced a foreign bacterial contaminant that was extremely difficult to eliminate. This halted our incorporation studies because bacterial heterotrophy would cloud the results for the dinoflagellate species. The enzyme studies, which we had proposed as one of our goals, could not be carried out as long as the bacterial association was present. It became imperative for us to begin with the isolation and identification of the bacteria, as well as testing for a proper antibiotic against the bacteria. This study is still going on and will continue until we obtain axenicity once again. In the meantime, we have looked into other procedures and methods that will allow us to test the heterotrophy hypothesis in the presence of bacteria, but without interference by them.

In order to study intracellular incorporation directly using autoradiography, we have studied the morphology of the cell cycle of the experimental Gonyaulax polyedra and photographed each stage in the cell cycle (Figures 1a-f, 2a-f and 3a-f). The cell


1a



1b



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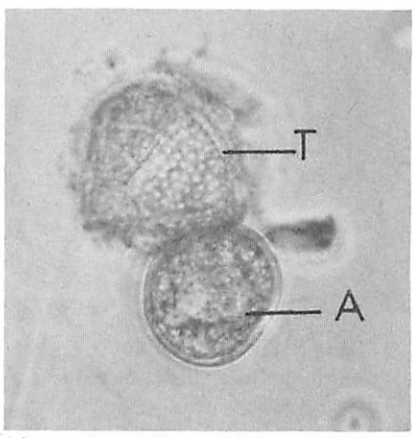

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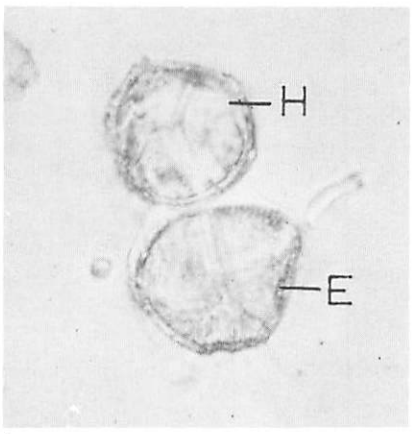

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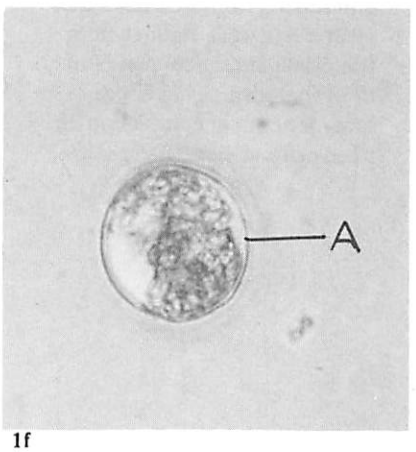
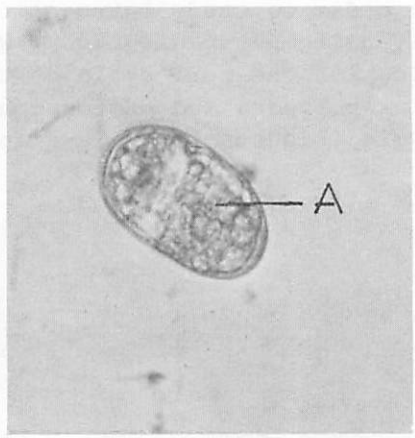


1f

Figure 1: Formation of asexual, nonmotile Gonyaulax polyedra cell (T=theca; A=asexual nonmotile cell). 1a: normal motile cell. 1b: initiation of ecdysis, loosening of thecal plates. 1c: cell begins to emerge from theca. 1d: ecdysis of cell nears completion. 1e: discarded theca (E=epicone-apical fragment; H=hypocone-antapical fragment). 1f: freed resting cell.



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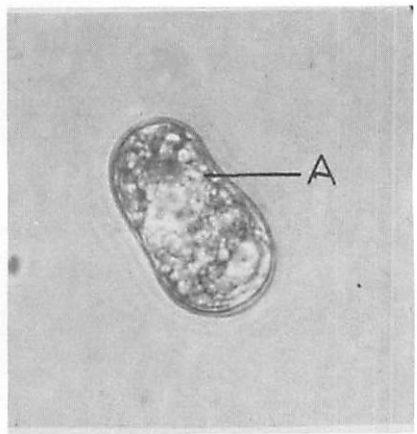

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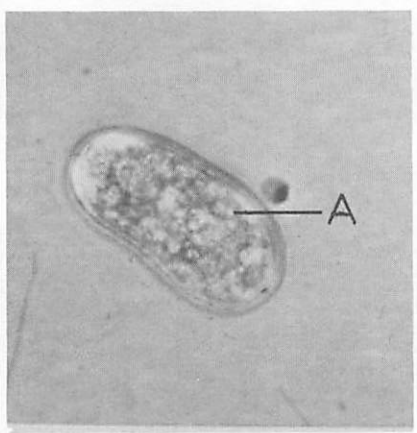

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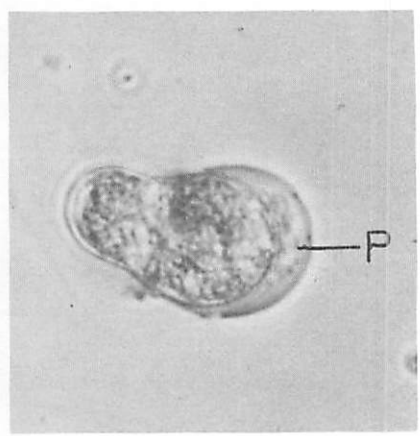

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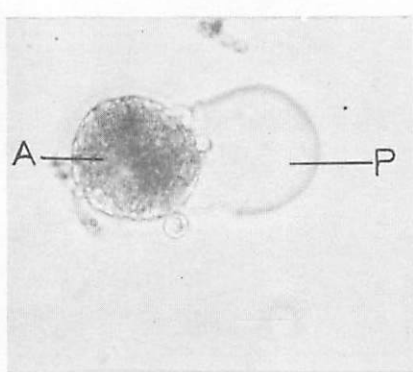

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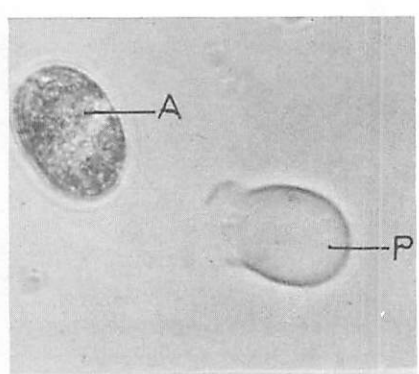
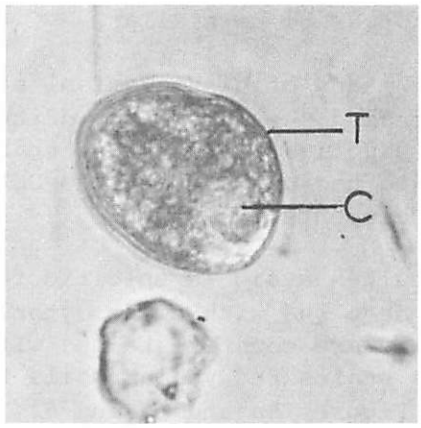


2f

Figure 2: Development of nonmotile Gonyaulax polyedra cell and pellicle production (A=asexual, nonmotile cell; P=pellicle). 2a-c: elogation of resting cell 2d: initial stage of emergence from pellicle, a thin clear outer wall, distinct from the cellulosic thecal plates of the vegetative cell. 2e: cell emergence near completion 2f: freed cell and discarded pellicle.



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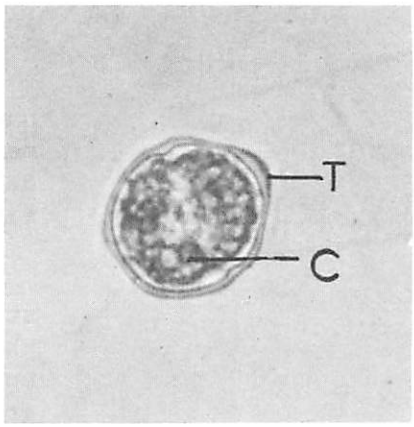

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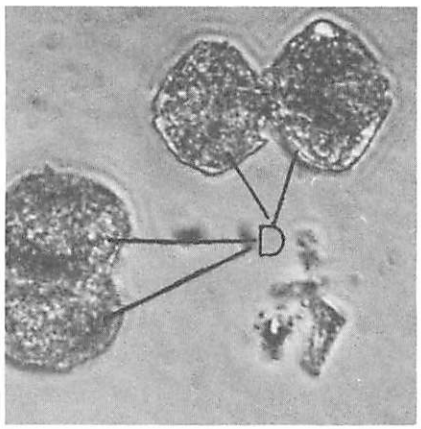

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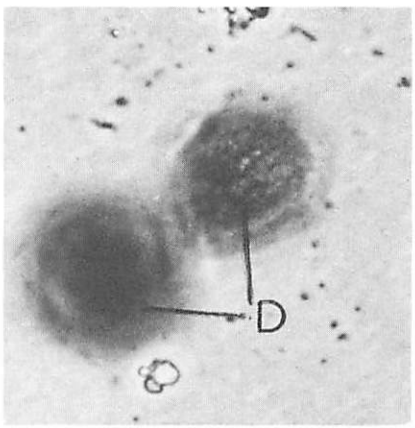

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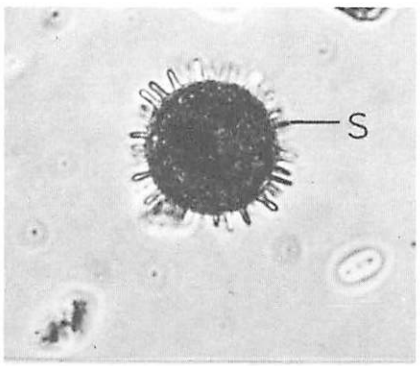

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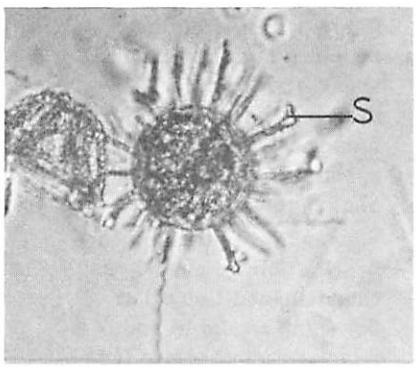


3f

Figure 3: Division of motile vegetative Gonyaulax polyedra cell (T=theca; C=cytoplasm; D=daughter cells). 3a: vegetative cell after losing flagellae in preparation for cell division. 3b: cytokinesis and synthesis of new thecae. 3c: cytokinesis nears completion. 3d: cell division completed (blurred images are result of active motion of daughter cells).

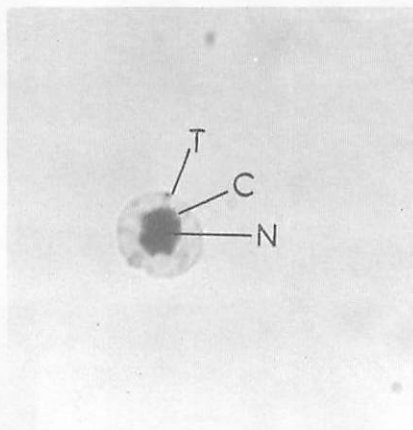
Resting Gonyaulax polyedra cysts from Santa Monica Bay surf zone during 1981 red tide conditions (S=spines). 3e: partially developed. 3f: fully developed.

cycle of Scrippsiella trochoidea and Gymnodinium sanguinium appear to be similar.

By means of histochemical stain techniques, we have studied the morphology of the nuclei of the experimental dinoflagellates. The specific stains used delineate the nucleus and the DNA from other cytoplasmic tissue elements.

Feulgen stain is specific for nuclear DNA, which stains deep red with clear cytoplasm (Figure 4). When the cells are counter-stained with fast green dye, the nucleus stains red violet while the cytoplasm appears green (Figures 5a and b, and 6).

Hematoxylin, another vital stain, identifies the nucleus, the nuclear DNA and cytoplasm by differential staining. Within a very pink cytoplasm, the nucleus and nuclear DNA are stained deep blue (Figures 7, 8a and b, 9a and b, and 10a and b). In all three species of dinoflagellates, nuclear DNA activity can be observed and stages of mitosis are clearly demonstrated.



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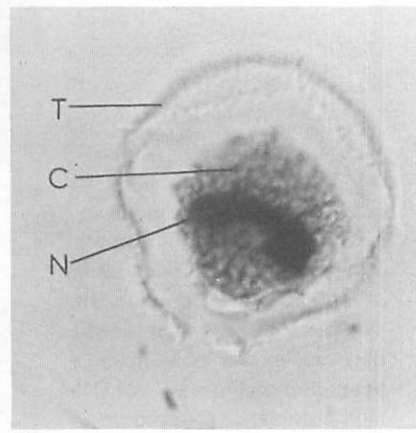

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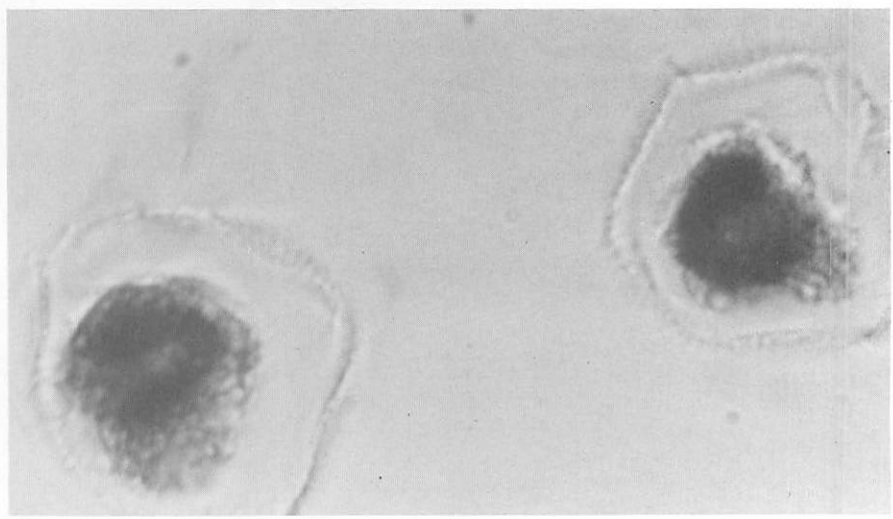
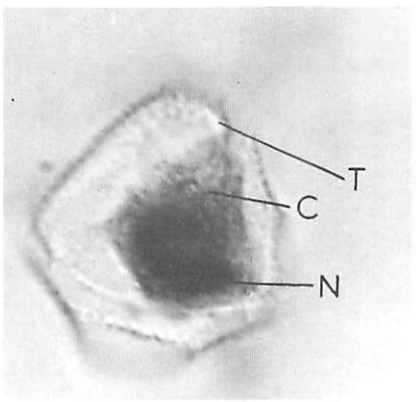


5b

Figure 4: Feulgen stained Scrippsiella trochoidea shows DNA containing nucleus (N) stained deep red; cytoplasm (C) remained clear; only periphery of theca (T; not stained) can be seen. DNA synthesis can be followed with use of radioactively labeled substrates by photoautoradiography.

Figures 5a and b and 6 (on page at right): Feulgen-Fast Green stained Gonyaulax polyedra (5a and b) and Scrippsiella trochoidea (6) shows nuclear DNA stained red violet (changes in nuclear shape and position of nucleus within the cytoplasm during cell division can be followed); cytoplasm stained green (vegetative cell emerging from its theca can be observed); theca does not stain but is visible (opening of the plates of the theca and the emergence of the vegetative cell can be followed).



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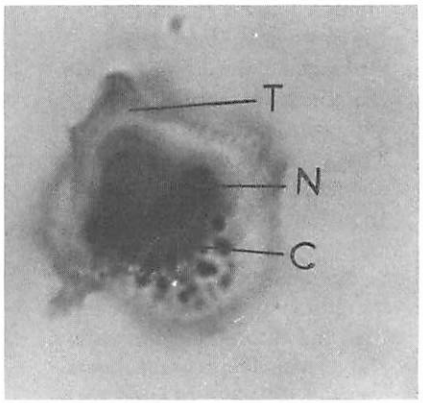

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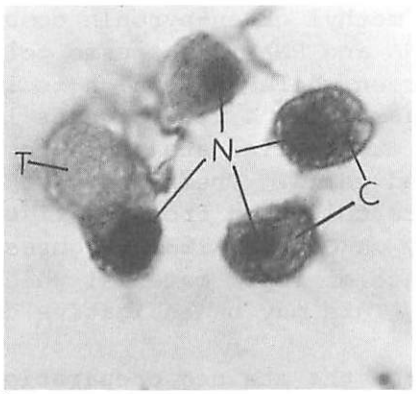
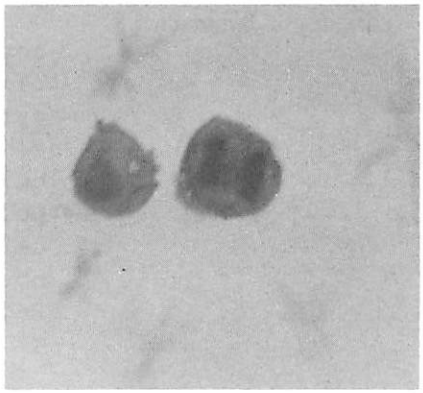


8a



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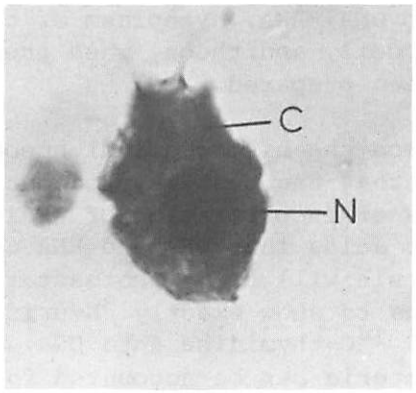

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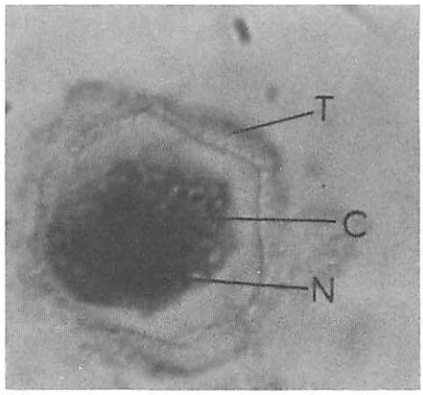

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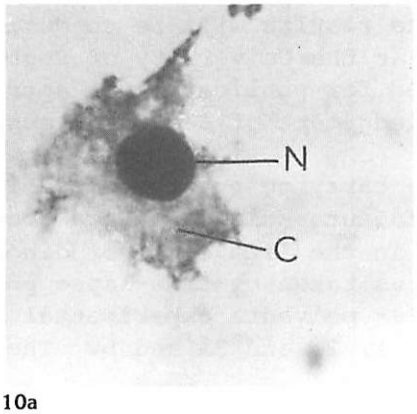

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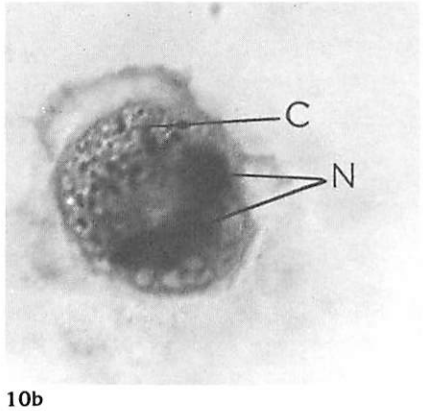
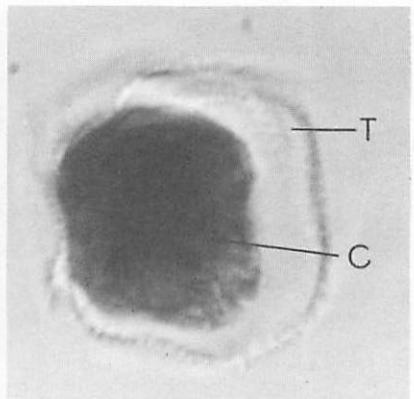


10b

Figures 7, 8a and b, 9a and b, 10a and b: Hematoxylin stained Scrippsiella trochoidea (7 and 8a and b), Gonyaulax polyedra (9a and b), and Gymnodinium sanguinium (10a and b) shows nucleus (N) and any other DNA present stained deep blue; cytoplasm (C), deep pink; and theca (T), light pink. 7: changes in nuclear shape can be followed; vegetative cell can be observed within its theca; thecal plates observed opening to allow vegetative cell to emerge and continue its division cycle. 8a: vegetative cell is observed as it emerges from the theca. 8b: chromosomes seen in late anaphase and early telophase also stained deep blue; mitotic figures can be observed during cell division cycle. 9a and b: changes in nuclear shape and position of nucleus within cytoplasm can be observed. 9b: opening of theca and emergence of cell is seen. 10a and b: a single nucleus is present in 10a, but two nuclei within the cytoplasm are observed in 10b; because Gymnodinium sanguinium is not a thecate dinoflagellate, no theca can be observed.



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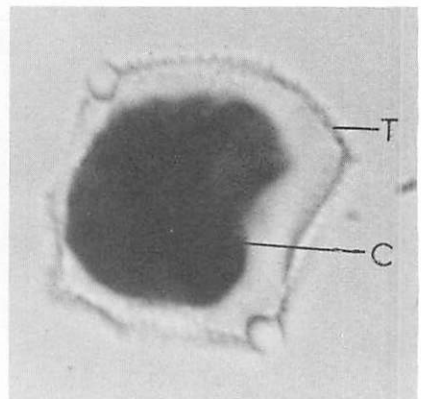


12

Figures 11 and 12: Methyl Green-Pyronin stained Gonyaulax polyedra (11) and Scrippsiella trochoidea (12) show cytoplasm (C) containing RNA stained red; theca (T) not stained, but visible; nucleolus should also stain red, but none can be seen. 11: cell appears to be synthesizing RNA; staining method distinguishes between RNA and chromatin; chromatin should stain bright green, but is masked here due to large amounts of RNA. 12: large amounts of RNA also block observance of chromatin.

A methyl green-pyronin combination distinguishes both DNA and RNA in the same cell. Nuclear DNA stains blue-green while RNA, which is less polymerized in the cytoplasm, stains red (Figures 11 and 12). We have also tested other vital stains to locate lipids in our cultured cells. Preliminary studies using Gonyaulax polyedra collected from red tide conditions in Marina del Rey on October 1981 (Figures 13a and b), reveal an abundance of lipid material which was stained with Oil Red O. This may be indicative of an aging culture.

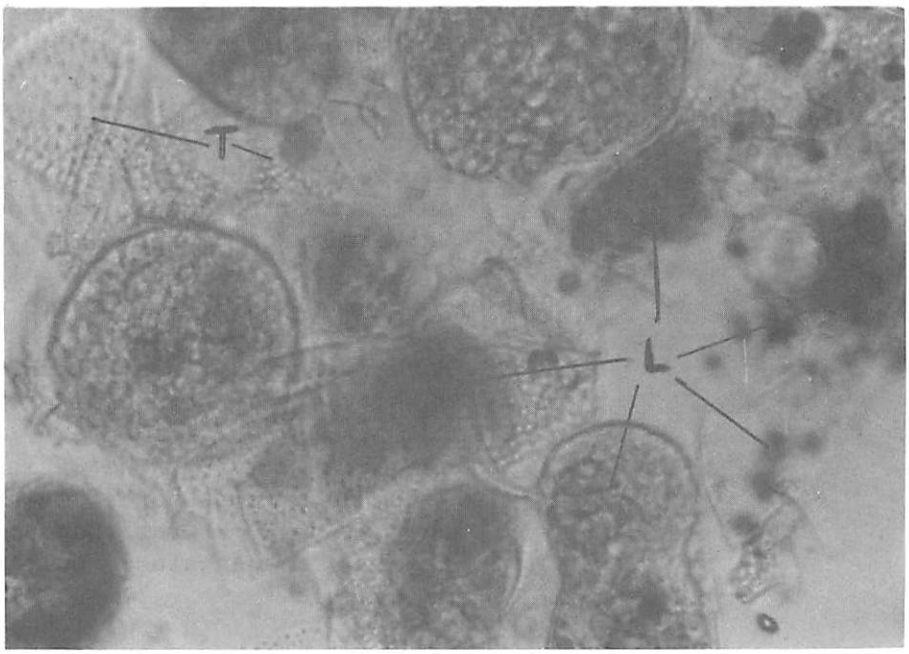
From the stained preparations of the cultures, we have identified the shape of the nucleus, its location within the cell cytoplasm, stages of nuclear division, nuclear DNA, RNA, cytoplasm of the cell, lipid content in the cell, and theca, when present. Photomicrographs have been prepared.

From the histochemical preparations, we are convinced that the best way to continue and complete our studies of incorporation of radioactively labeled nucleic acids into DNA and RNA as further test of our hypothesis will be by photoautoradiography. This will allow us to show exactly ^{3}H-uridine incorporation into RNA and ^{14}C-thymidine into DNA. The incorporation by the bacteria can be accounted for and will not interfere with the results.

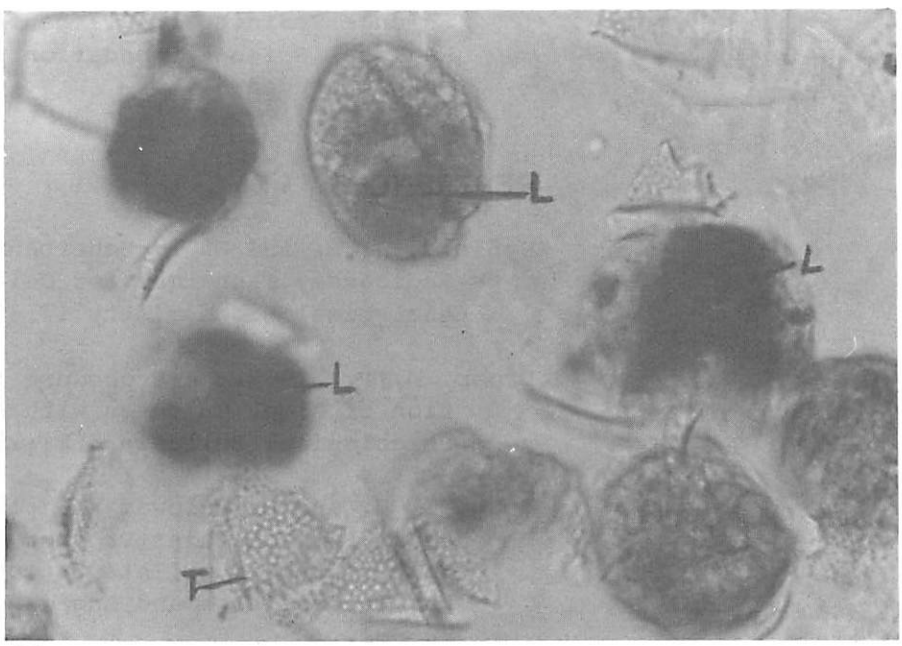
The results will be communicated to the Sea Grant Office at the University of Southern California and prepared for publication in appropriate journals with acknowledgement of Sea Grant support.

In carrying out the morphological studies preparative to autoradiography, we observed a number of stages in the life cycle of dinoflagellates. A series of plates taken by time-lapse photography of a single Gonyaulax polyedra experimental cell is shown in Figures 1, 2, and 3a and b. The escape from the theca

and subsequent escape from the temporary pellicle are illustrated. Subsequent cell division, although taken from a different cell, is illustrated in Figures 3c and d. A cell will divide and swim away if nutrients are available and the temperature conditions are favorable. On the other hand, if unfavorable conditions prevail, the cell will form a resting cyst, sink to the bottom where it will remain or be carried by water currents to other locations to excyst under favorable conditions. Resting cysts from a sample of Gonyaulax polyedra taken from a patch of red tide are seen in Figures 3e and f.



13a



13b

Figures 13a and b: Gonyaulax polyedra cells collected from a red tide condition in Marina del Rey, September 19, 1981, stained Oil Red O for lipids (L). Lipids stain orange-red or brilliant red, depending on the lipid molecules present during the particular stage of the cell cycle; cells observed at different stages in cell cycle; empty thecae (T) not stained, but discernible in both samples.

PROJECT COMMUNICATIONS

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Nitrogen Transformations Associated with the Discharge of the Terminal Island Treatment Plant, Los Angeles Harbor

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Dale A. Kiefer, Assistant Professor, Biological Sciences, University of Southern California

INTRODUCTION

The discharge of the Terminal Island Treatment Plant (TITP) contains high concentrations of nitrogenous compounds, including organic nitrogen, nitrate, nitrite and ammonia, the concentrations of such compounds being several orders of magnitude higher than in the coastal waters of the Southern California Bight. Studies have shown that the effluent from the tuna canneries provides a major nutrient input to the Los Angeles-Long Beach harbors (Allan Hancock Foundation, 1976).

Recently, secondary treatment of sewage from the canneries has been instituted. In effect, secondary treatment increases the supply of inorganic nitrogen that is used readily by phytoplankton. Particularly important blooms of phytoplankton in the harbor are those produced by dinoflagellates. Red-tide forming dinoflagellates, although beneficial as food to higher trophic levels, become a problem when they are: a) of a toxic variety or in a toxic phase, even in low concentrations, or b) in such large concentrations that they are unsightly and can deplete the oxygen of enclosed harbor waters. Secondary treatement will likely lower heterotrophic populations of bacteria because of decreased organic nitrogen. On the other hand, the conditions for bacteria that can use nitrate for respiratory purposes (for electron acceptors) are improved, and the nitrate produced during secondary treatment may be converted to nitrate, ammonia or volatile nitrogen compounds.

The other primary phytoplankton nutrients -- phosphorus and silicon -- also are supplied in the discharge of the treatment plant, and the final nutrient environment results from mixing concentrations of primary nutrients in the disharge. In the receiving waters, the response of the phytoplankton and bacteria depends largely on the resulting concentration of the primary nutrients in the euphotic zone, on the preexisting phytoplankton population, and on the advective regime of the harbor.

The purpose of this project is to determine the fate of inorganic nitrogen within the first two days of discharge and acquire sufficient quantitative data to model the processes involved. The measurements being made in the harbor by this project should:

1. Identify the limiting nutrient regime.

2. Describe the relative rates and characteristic uptake kinetics of photosynthetic inorganic nitrogen assimilation.

3. Expand our knowledge of the association between inorganic nutrient supply and dinoflagellate blooms.

4. Determine the extent of inhibitory effects of secondary-treated effluent on inorganic nitrogen uptake by phytoplankton.

If outfalls are ever to be managed for the benefit, instead of the detriment, of receiving waters, these kinds of data are urgently needed.

RESULTS

Four two-day cruises have been completed in this study. During this period, the configuration of the Terminal Island Treatment Plant (TITP) outfall has changed considerably because of a landfill project in the harbor. On the first cruise (March 1980), access to the point of outfall discharge was limited by its location in shallow water; on the second and third cruises (December 1980 and April 1981, respectively) access was further restricted by dredging activities in the area; by the fourth cruise (October 1981), the extension of the TITP outfall beyond the landfill project had been completed and direct access to the point of discharge was possible.

In spite of the vasried access to the point of discharge, the resulting maps of surface nutrient concentrations indicate that the outfall is the major nutrient source in the area and that the discharge is rich in nitrate, ammonia, silicate and phosphate (Figures 1 through 5). Within the study area, almost all the nutrients measured are sometimes depleted to concentrations near zero away from the outfall. The only exception is silicate with minimal concentrations of about 4 µg-at/liter. Approximate maximal concentrations observed during the four cruises were, in µg-at/liter, 31 of nitrate, 1 of nitrite, 31 of ammonia, 2 of phosphate, and 21 of silicate. The high ammonia

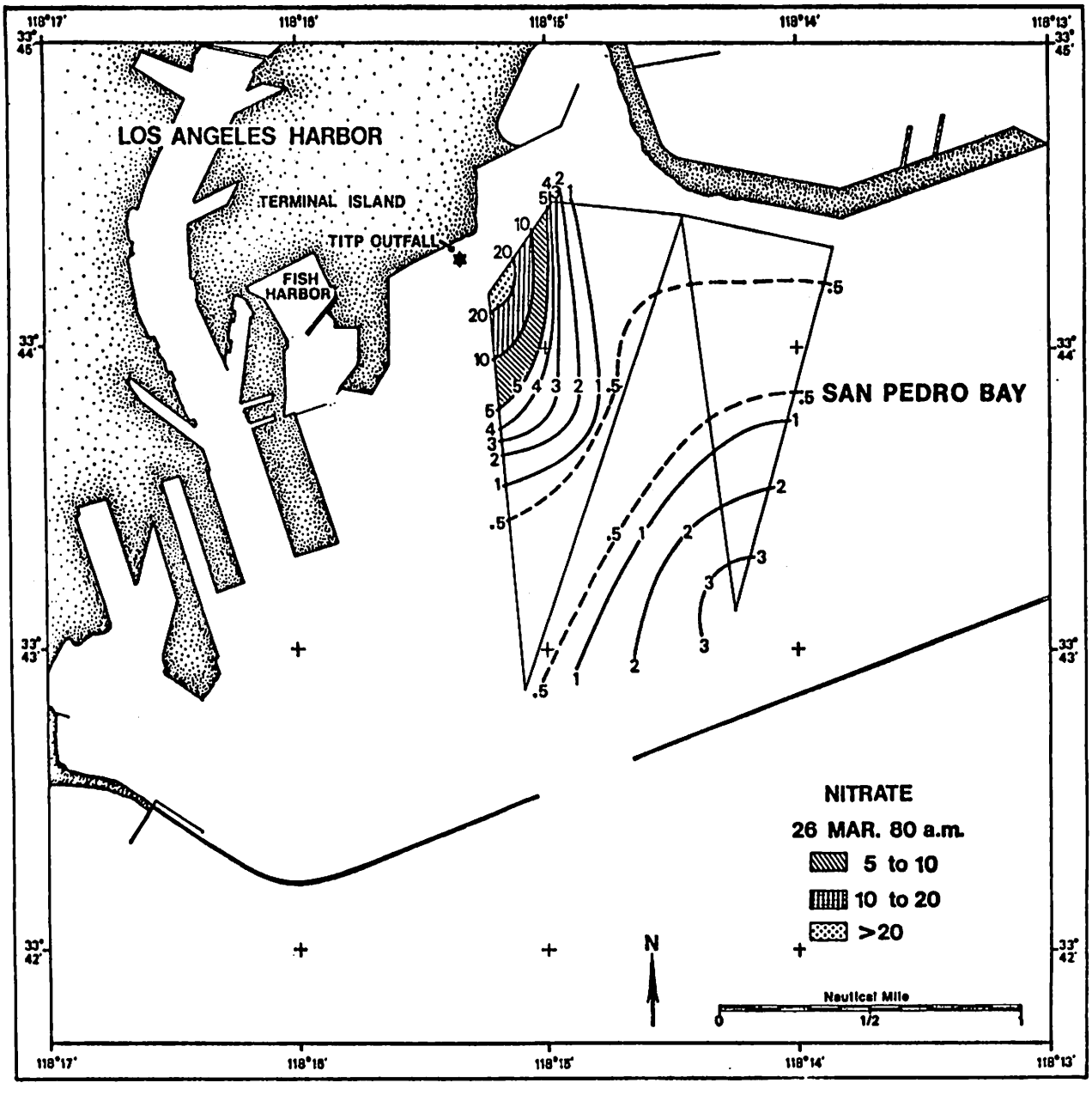

Figure 1: Nitrate distribution in surface waters around the Terminal Island Treatment Plant (TITP) outfall in its original location and with southwest winds.

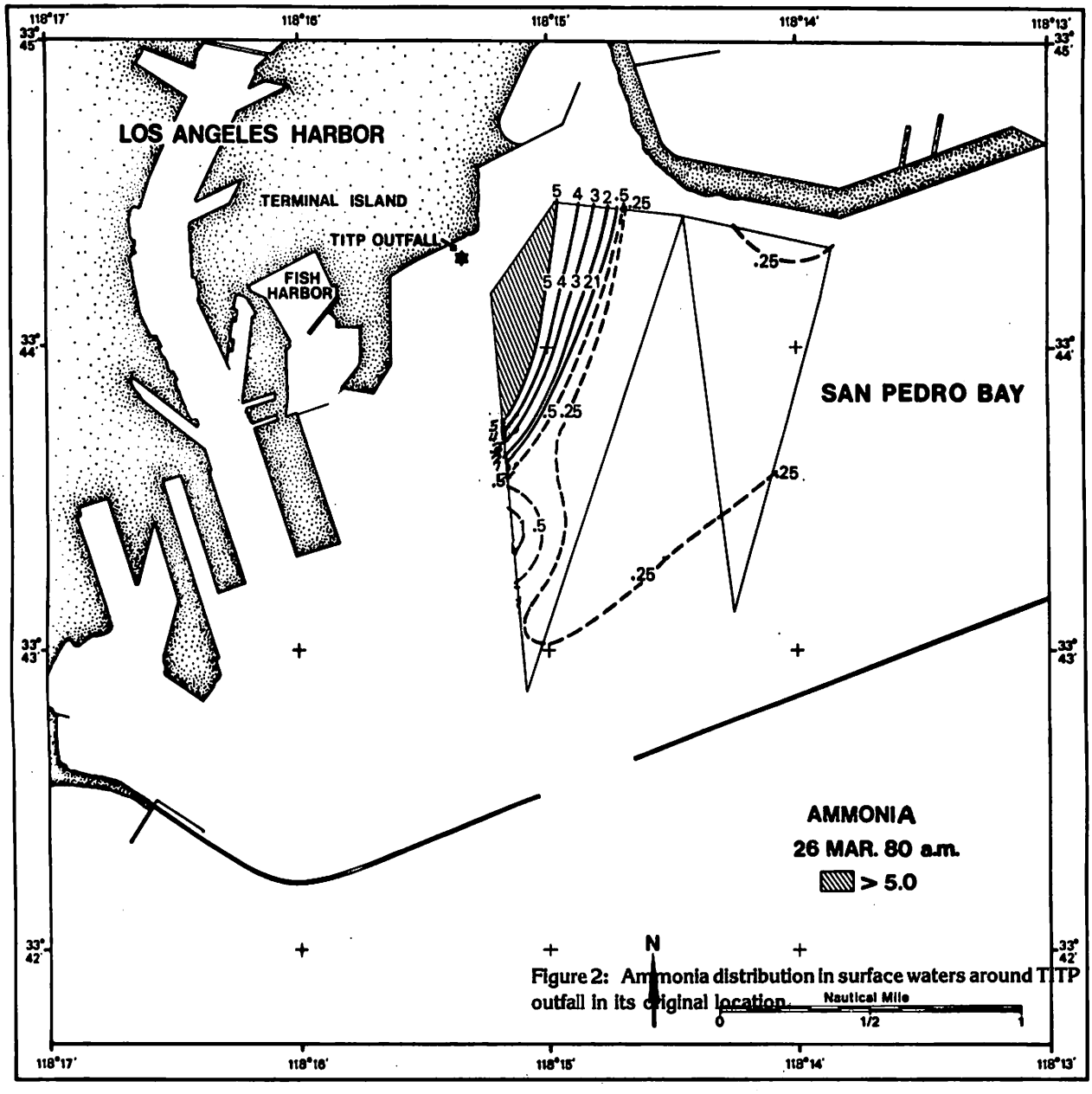

Figure 2: Ammonia distribution in surface waters around TITP outfall in its original location.

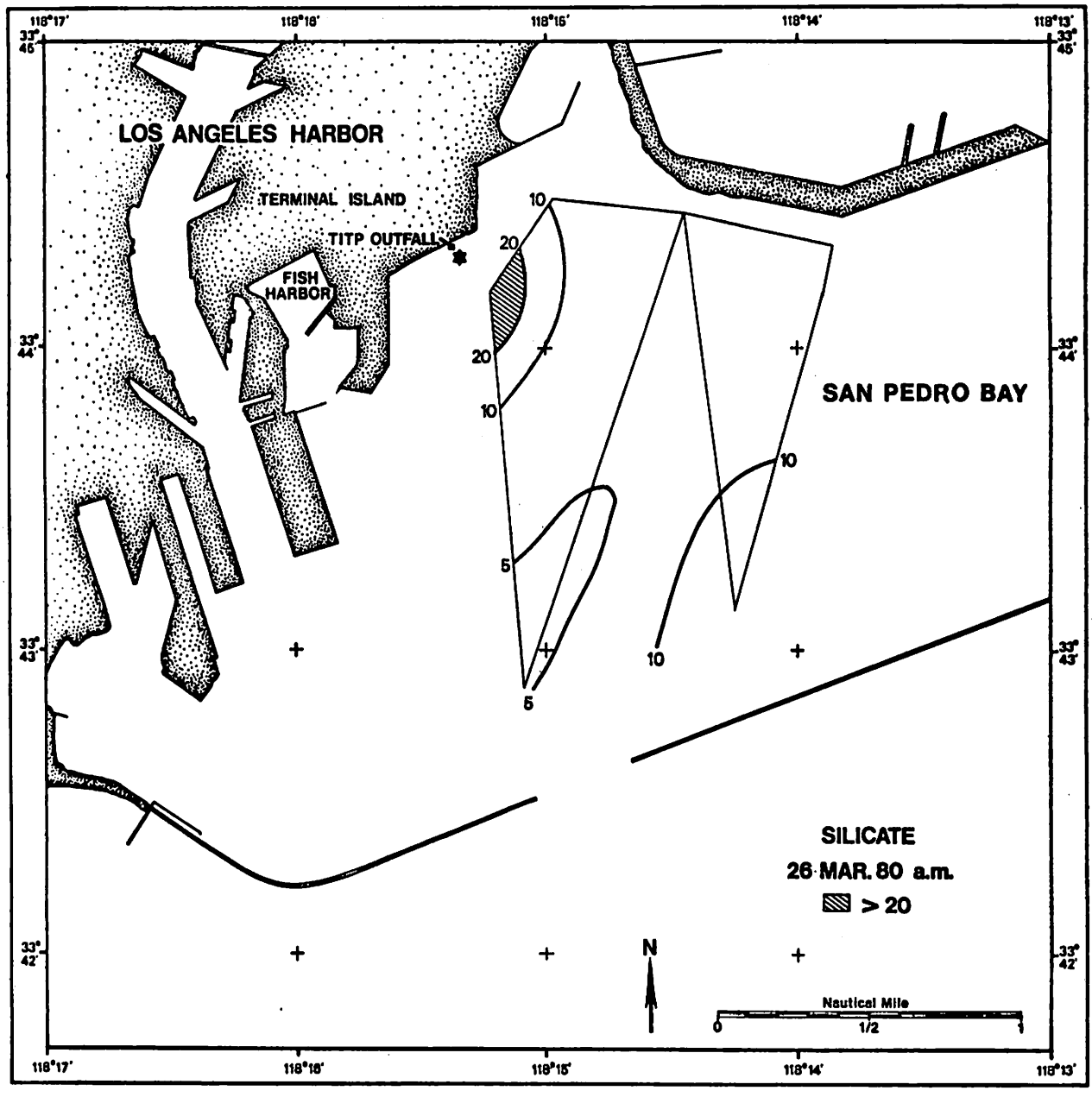

Figure 3: Silicate distribution in surface waters around the TITP outfall in its original location.

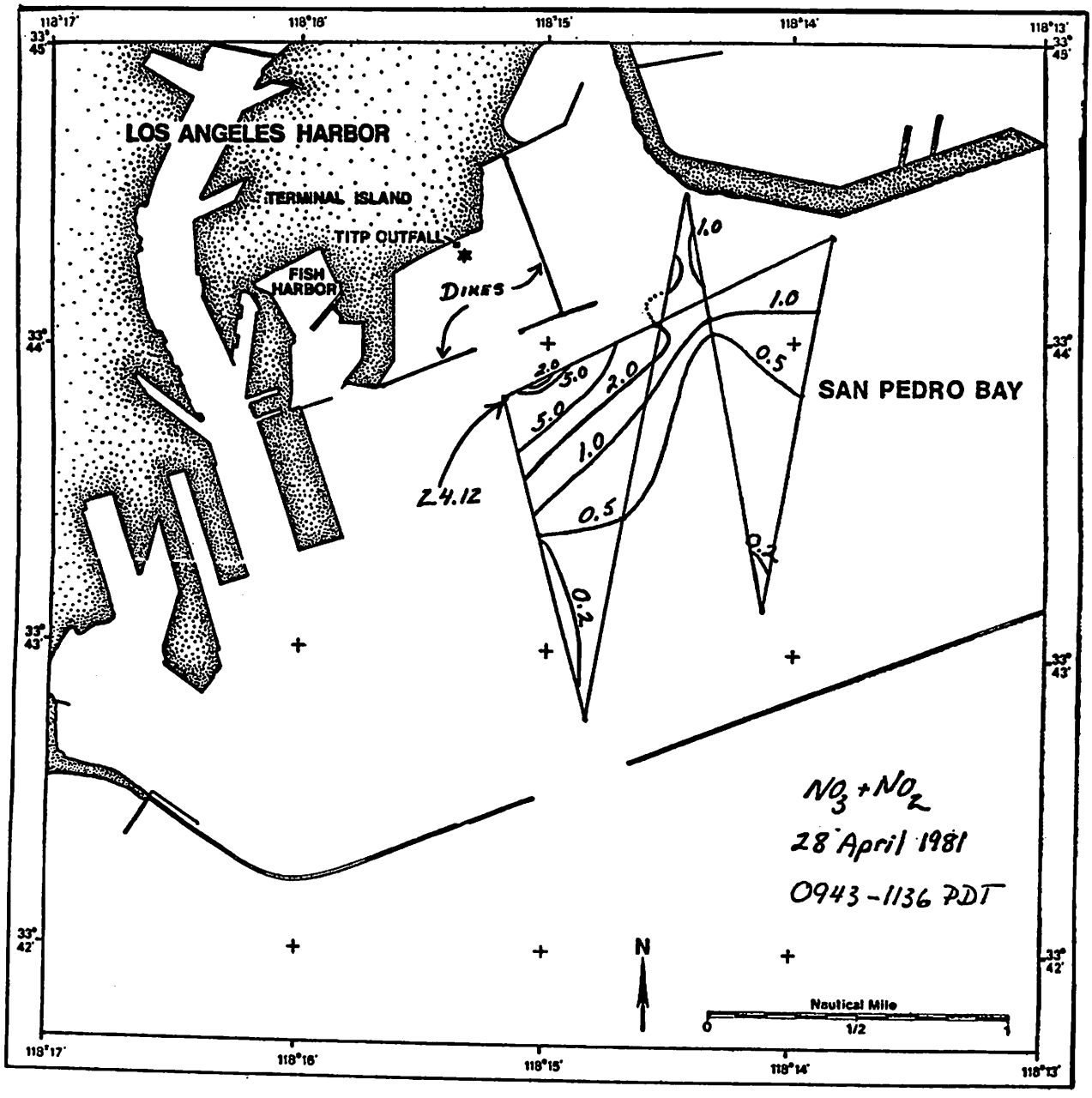

Figure 4: Nitrate-plus-nitrite distribution in surface waters around the TITP outfall during the period the outfall was located within the landfill dikes.

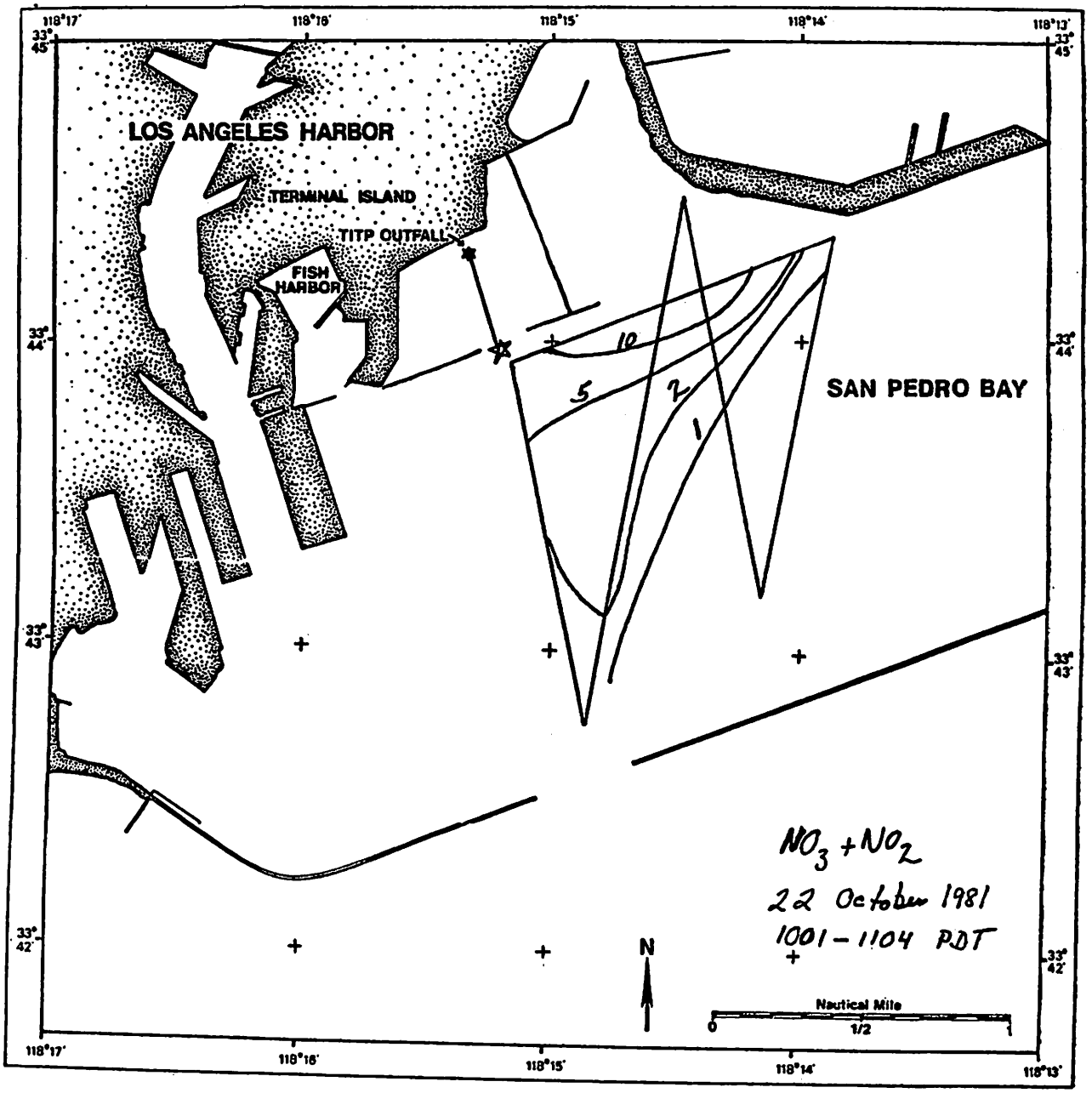

Figure 5: Nitrate-plus-nitrite distribution in surface waters around the TITP outfall in the outfall's new location.

concentrations suggest that the secondary treatment is not entirely effective.

The shape of the nutrient plume resulting from the outfall is influenced strongly by local winds and currents. For example, the change in nitrate distribution between March 26 and 27, 1980 (Figures 1 and 6, respectively), is associated with a wind shift from southwesterly to southeasterly. The uptake of nutrient phytoplankton also influences nutrient distributions. A red tide, dominated by the dinoflagellate Gymnodinium

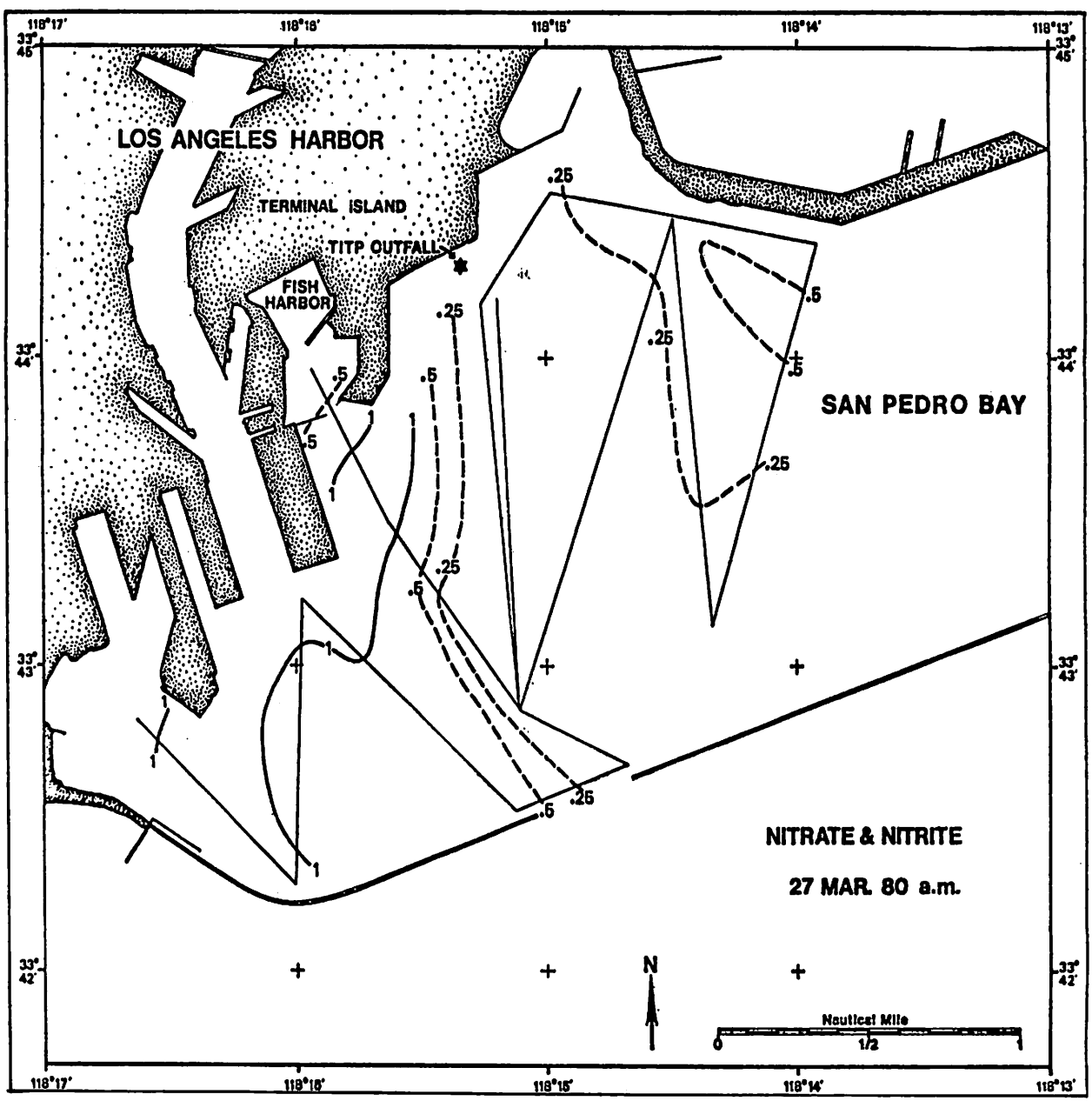

Figure 6: Nitrate-plus-nitrite in surface waters around the TITP outfall in the outfall's original location and with southwest winds.

sanguinium (personal communication, G. Kleppel), was encountered on the third cruise (April 1981). These intense concentrations of phytoplankton removed nitrate from the water at a rate of about 4 µg-at/liter/hour during the day, and in less than 24 hours removed almost 2 µg-at/liter of phosphate (Figure 7). The details of inorganic nitrogen utilization in the harbor are contained in sets of experiments done with ^{15}N labelled nitrate and ammonia. The mass spectrometric analysis of these samples is complete for the first three cruises and underway for the fourth. The analysis of these data is not complete. Bacterioplankton biomass was measured at specific stations during the October 1981 cruise. In terms of carbon, the measured values ranged from 10.3-20.5 µg/liter. Chlorophyll-a and adenosine triphosphate (ATP) concentration also were measured on this cruise. Inside the harbor, but downstream somewhat from the direct area of outfall discharge, the chlorophyll values ranged from 10.6-15.2 µg/liter and correlated well with ATP values (personal communication, G. Taylor). These results indicate that at those stations phytoplankton was the major component of the biocarbon. However, at the outfall station, chlorphyll was relatively low (2.87 µg/liter). Because the ATP values did not show the same relative decline, less of the

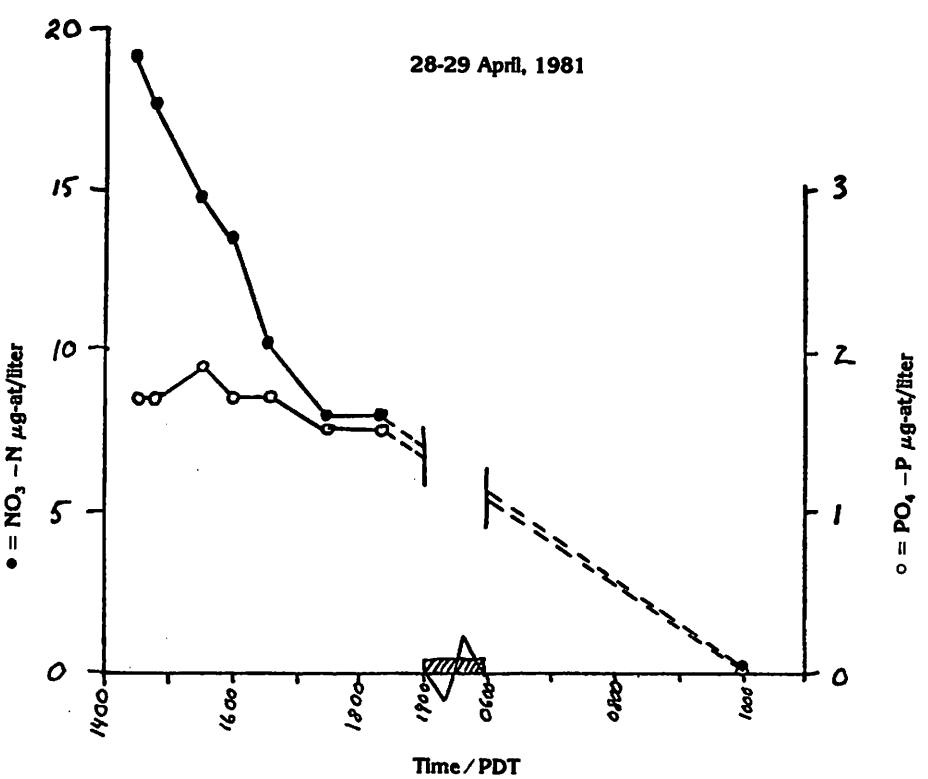

Figure 7: The decline of nitrate and phosphate in the presence of a dense population of dinoflagellates.

particulate carbon at this station may be attributed to the phytoplankton than at the other stations in the harbor. It is not clear at this point whether phytoplankton growth is inhibited by components of the discharge, but now that direct access to the discharge point is possible, experiments are being done to determine if such inhibition takes place.

PROJECT COMMUNICATIONS

At this stage of data collection and analysis, no formal communications have been produced from this project. Certain of the specialized data having wide and basic biological significance are being used to complement larger data sets that are being prepared for publication, and all of the data processed at this time are ready for inclusion in a data report. The time-series nature of the project prevents a full analysis of the data until all the cruises have been completed.

Southern California's Nearshore Marine Environment: A Significant Fish Nursery?

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INTRODUCTION

The oceanographic characteristics of the pelagic zone off Southern California result from a blend of water masses from the north, south and west, and from upwelling. The product of these seasonally variable influences is an ecological transition region, characterized by relatively high productivity and a rich, diverse fish fauna that is exploited by both commercial and recreational fishermen. Coastal habitats within the Southern California Bight are even more complex as a result of nearshore phenomena that include boundary effects, shoreline topography, local wind conditions, runoff from sporadic rainfall and anthropogenic influences. Municipal, industrial and thermal wastes from at least 24 discrete outfalls are discharged within the bight.

Prior to this Ichthyoplankton Coastal and Harbor Studies (ICHS) project, which began in 1978, virtually nothing was known about the relative importance of shallow coastal habitats off Southern Calfornia as spawning and nursery grounds for sport and commercial fishes. Data on the species occurrence and abundance of fish eggs and larvae were simply not available to those responsible for managing fishery resources. Baseline data on ichthyoplankton from a variety of nearshore habitats are required before environmental impacts from coastal industries (electricity generating) and construction (harbors, marinas) can be assessed.

The importance of ichthyoplankton data cannot be overemphasized. Such data are vital to life history studies of economically or ecologically important fishes. Because the eggs and larvae of fishes are generally more amenable to quantitative sampling techniques than are juvenile or adult stages, the data on egg and larvae abundance can be used in fishery stock

estimates. The presence of a variety of spawning adult fishes, as indicated by the presence of their eggs, and the subsequent growth and survival of their larvae are indicative of a balanced, healthy ecosystem, and an excellent indicator of good water quality.

While the California Cooperative Oceanic Fisheries Investigations (CalCOFI) has surveyed offshore waters for fish eggs and larvae for three decades, the data can not be extrapolated into shallow waters where different environmental conditions occur.

The ICHS project was initiated in 1978 to assess the significance of nearshore habitats in Southern California as spawning grounds for coastal marine fishes. We planned a field survey that would make it possible:

1. To study the kinds, abundance, distribution and seasonality of the fish eggs and larvae at transects along the coast directly inshore of existing latitudinal CalCOFI stations and at stations in the Los Angeles-Long Beach Harbor and San Diego Bay.

2. To standardize quantitative catch data from plankton tows to equivalent estimates of egg and larvae abundance under unit areas of sea surface (i.e., complement existing CalCOFI data analysis).

3. To correlate the distribution of eggs and larvae with selected biological, chemical and physical parameters including chlorophyll, zooplankton, nutrients, temperature, salinity and oxygen.

4. To compare and contrast the abundance and age structure of larval fishes between existing CALCOFI stations and the proposed inshore stations.

5. To estimate egg and larval mortality and assess recruitment potential between inshore and offshore waters.

6. To understand and, if necessary, mitigate impacts of entrainment losses for power plants and other coastal industries using significant volumes of sea water when data from this proposed study are used in conjunction with systematic, on-site analyses.

The objectives of ICHS during the past 12 months were analysis, interpretation and summarization of an unprecedented data set based on 26 consecutive monthly sampling periods (June 1978-July 1980) in the nearshore Southern California Bight.

RESULTS

The geographic extent and basic sampling scheme of the nearshore studies are illustrated in Figures 1 and 2. For purposes of this report, the ICHS stations represent a nearshore region that extends from just above Point Conception to just below the United States-Mexico border and offshore to the 43 m isobath. This area encompasses about 2,650 km^2, or about 3.8 percent of the area within CalCOFI Region 7 (Figure 2). Data from CalCOFI Region 7 have been used for comparing ichthyoplankton densities with data from the shallow ICHS region.

The ICHS computer data base includes information on the onshore-offshore, longshore, vertical and temporal structure of temperature, dissolved oxygen, pH, and chlorophyll-a concentration from June 1978 to July 1980. Similar data on nitrate-plus-nitrite concentrations are available, but only for the first 12 months of our survey. The parameters listed above were recorded to characterize the spawning habitats of coastal

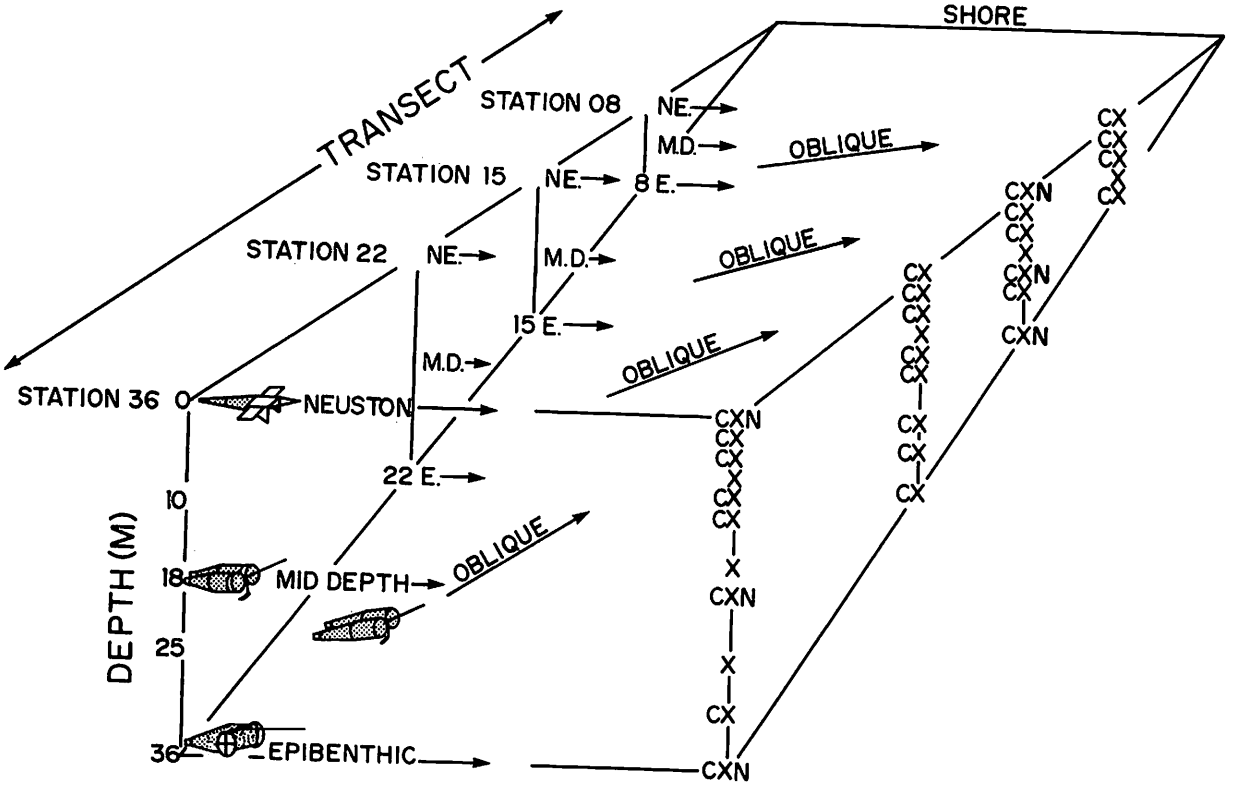

Figure 1: Ichthyoplankton Coastal and Harbor Studies (ICHS) sampling strategy for the Southern California Bight (NE=neuston tow; MD=mid-depth tow; C=chlorophyll-a sample; X=temperature, salinity, dissolved oxygen, pH record; E=epibenthic).

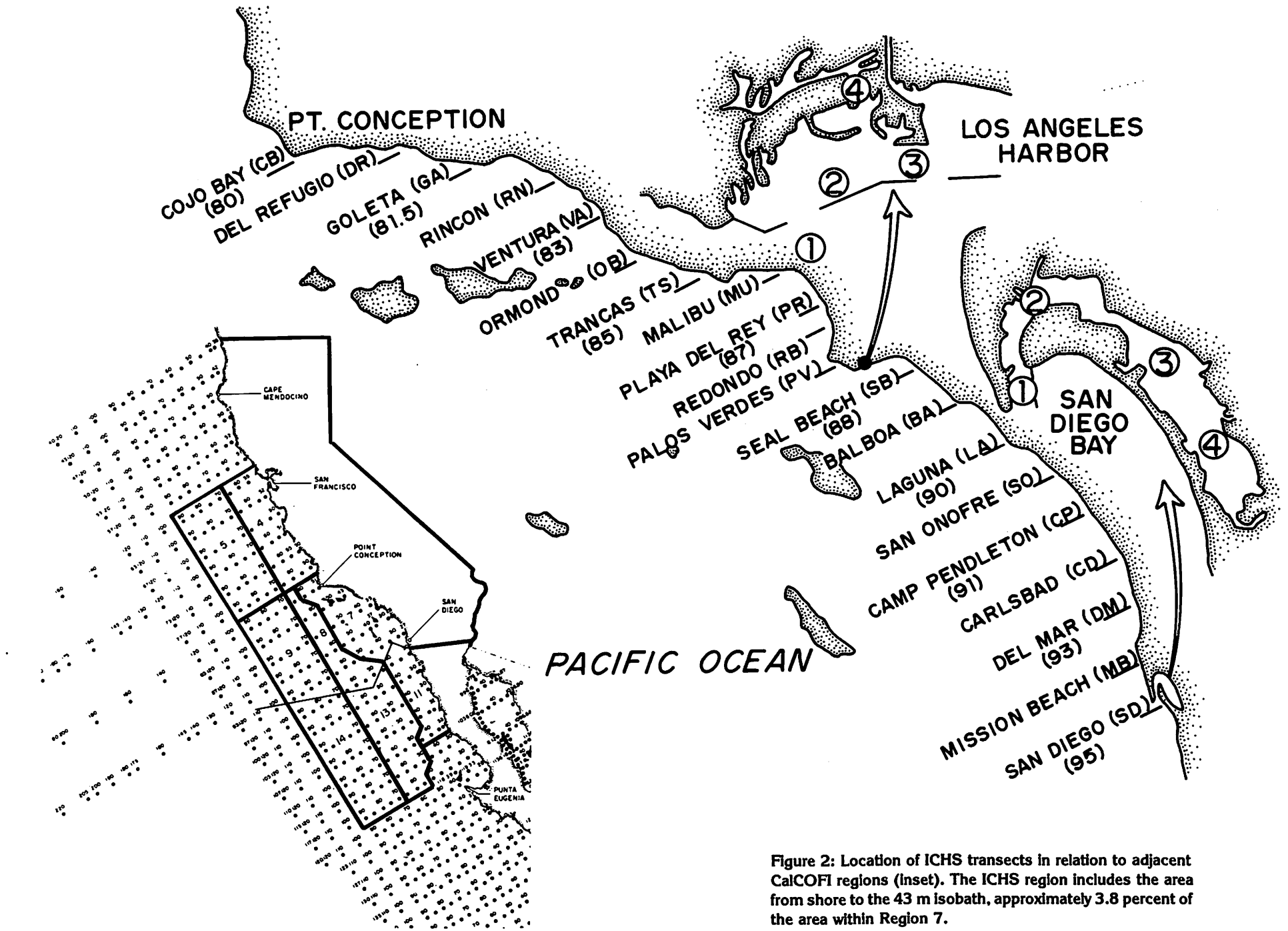

Figure 2: Location of ICHS transects in relation to adjacent CalCOFI regions (inset). The ICHS region includes the area from shore to the 43 m isobath, approximately 3.8 percent of the area within Region 7.

fish populations. We hoped to achieve some perspective on the degree of variability in both time and space scales within the Southern California Bight, and ultimately interpret how the variability (or lack of it) correlated with spawning fishes and the survival of their larvae.

Figure 3 graphically summarizes the surface water temperatures recorded by ICHS during a 12-month sampling period. This three-dimensional, computer-generated picture spotlights major features and does not determine precise temperatures at a given station each month. Noteworthy is the homogeneity of the bight-wide sea surface temperatures during the winter and the extreme variability during the spring and early summer. Santa Monica Bay (transects MU,87, and RB) stands out as particularly warm. The "valleys" probably indicate localized upwelling plumes. While peaks in chlorophyll-a (i.e., plant biomass) as shown

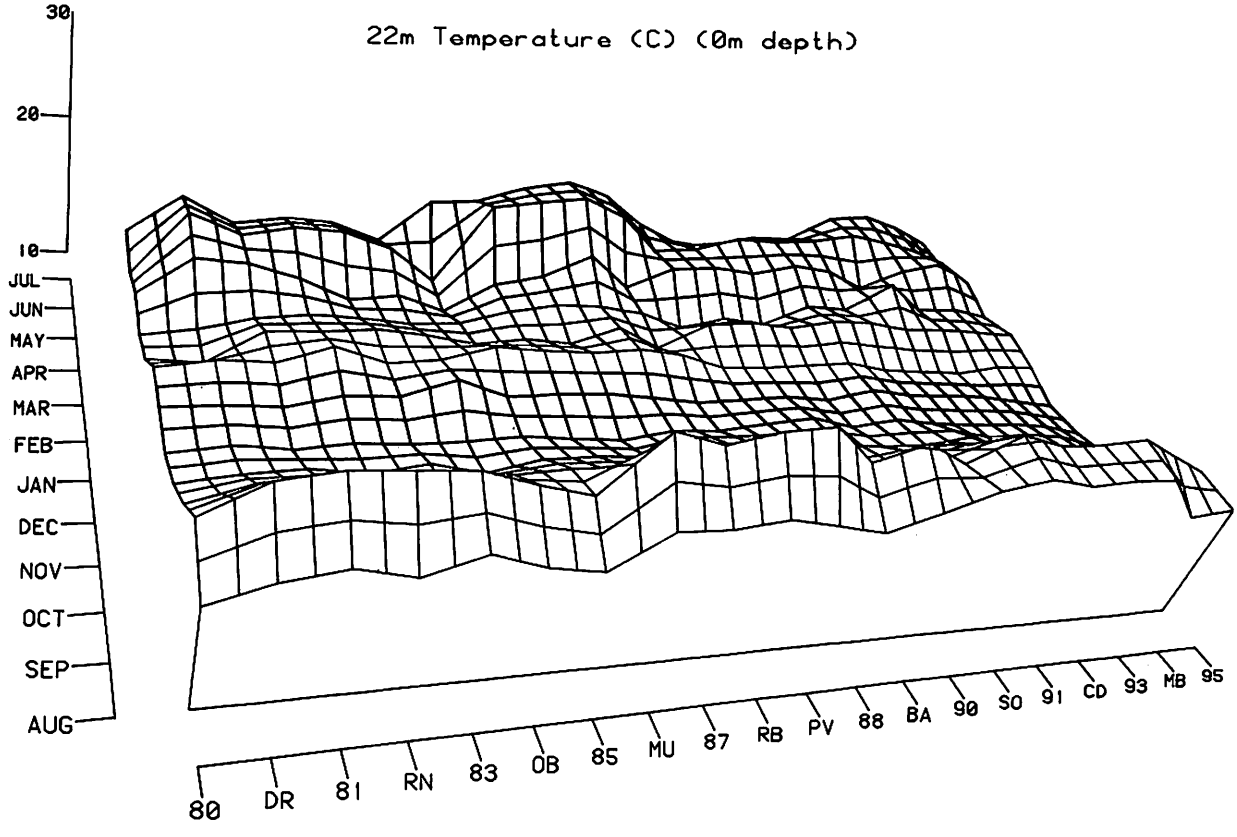

Figure 3: Surface temperatures at stations over the 22 m isobath. This three-dimensional illustration gives transect (abscissa), month (August 1979-July 1980, ordinate), and temperature (vertical dimension).

in Figure 4, coincide in time with upwelling periods, the concentration of chlorophyll does not coincide in space (i.e., by transect) with nitrate concentrations (if we assume that nitrate distribution in 1978-79, illustrated in Figure 5, is typical). Most of the nitrate in surface waters is believed to be associated with upwelling. Nitrate concentration is known to be the major controlling factor in plant production.

Ichthyoplankton off Southern California was most abundant in late winter and early spring when temperatures, chlorophyll and zooplankton biomass were increasing. This trend did not hold for all taxa. Pacific sardine larvae occurred most frequently during the fall when temperatures were decreasing, and chlorophyll and zooplankton concentrations were low.

The ichthyoplankton data includes more than 900 fish larvae samples collected by Bongo nets towed obliquely during 20 months. The vertical distribution of the eggs and larvae is being determined on the basis

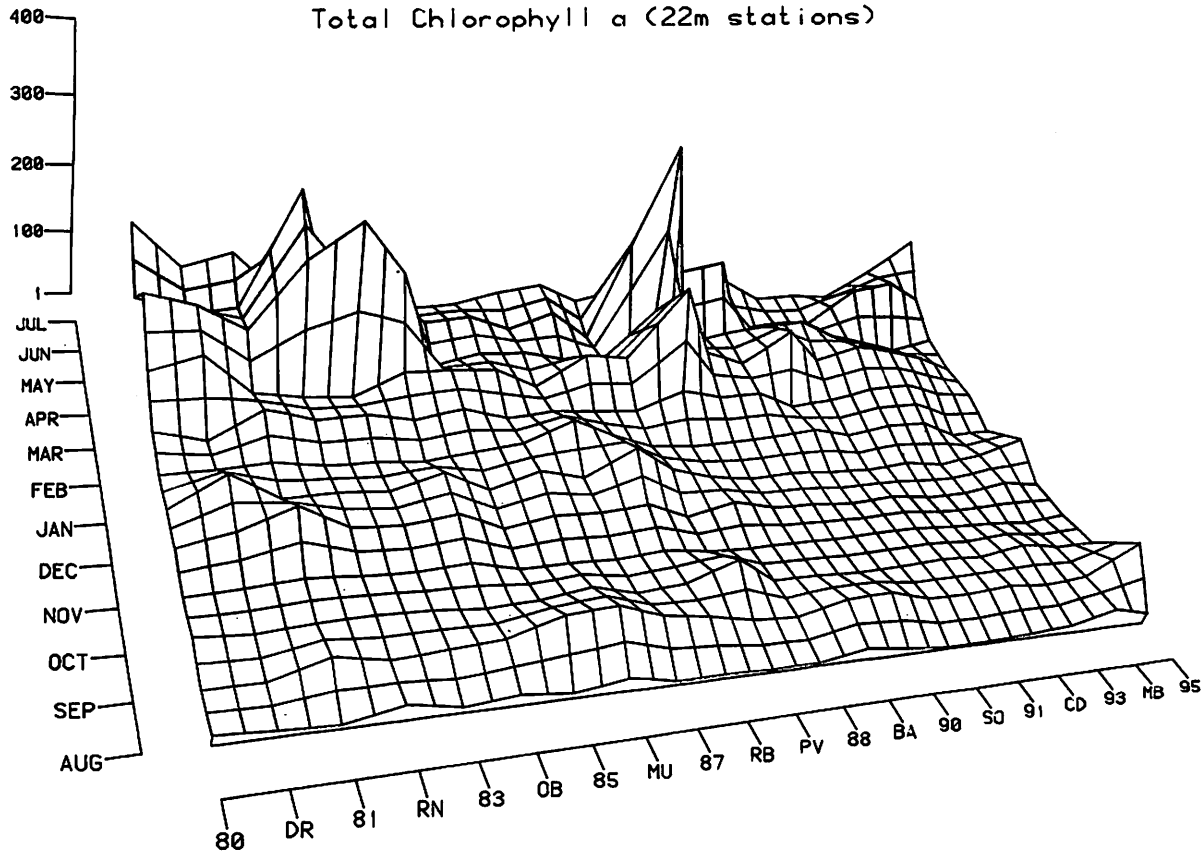

Figure 4: Average chlorophyll-a concentration over the 22 m isobath. Dimensions as in Figure 3, with chlorophyll in the vertical dimension.

of another 900 samples taken with neuston, middepth and epibenthic plankton samplers. This information is summarized by taxa as numbers of larvae per unit volume of water filtered and per unit area of sea surface. When expressed as numbers per unit area, the abundance of larvae within the ICHS region can be estimated and compared directly with CalCOFI data. Such comparisons are making it possible to evaluate the importance of the coastal ICHS region versus offshore areas as spawning grounds for many species.

As a specific example, ICHS and CalCOFI data on northern anchovy (Engraulis mordax) and Pacific sardine (Sardinops sagax caeruleus) were presented recently at the annual CalCOFI conference. Table I summarizes the estimated abundance of these taxa with-

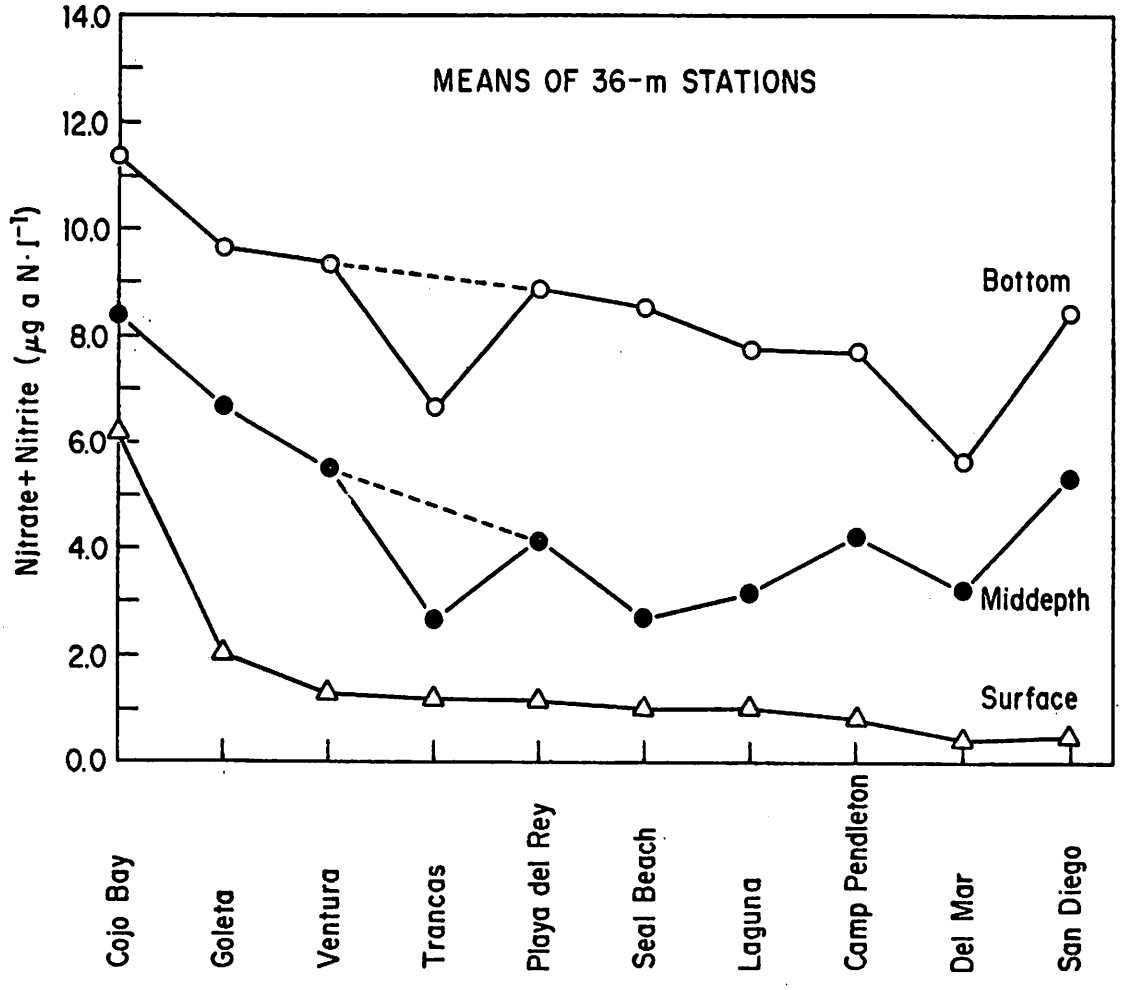

Figure 5: Nitrate-plus-nitrite concentrations along the 36 m isobath (data collected between June 1978-July 1979). The data recorded for the Trancas transect excludes one month's data, which was missed because of bad weather; the dashed line estimates the probable values.

Table 1: Summary of egg and larvae abundance of northern anchovy and larvae abundance of Pacific sardine from ICHS cruises during 1978-60.

		Engraulis larvae				*Engraulis* eggs				*Sardinops* larvae			
Cruise	Dates	#Sta./ Positive	$\bar{x}$ larvae $\cdot m^{-2}$	Std.Dev.	Est.#larvae ICHS region ($\times 10^9$)	#Sta./ Positive	$\bar{x}$ eggs $\cdot m^{-2}$	Std.Dev.	Est.#eggs ICHS region ($\times 10^9$)	#Sta./ Positive	$\bar{x}$ larvae $\cdot m^{-2}$	Std.Dev.	Est.#larvae ICHS region ($\times 10^9$)
1	12-24 Jun.	38/36	24.47	38.93	64.89	38/16	9.18	41.78	24.35	38/06	0.10	0.33	0.27
2	10-21 Jul.	37/33	8.78	13.52	23.27	37/20	21.27	76.31	56.41	37/03	0.06	0.25	0.16
3	14-25 Aug.												
4	18-29 Sep.	39/35	12.76	18.93	33.85	39/18	11.67	44.27	30.95	39/03	0.04	0.13	0.10
5	16-27 Oct.	39/33	16.98	36.73	45.03	39/22	492.25	2878.47	1305.40	39/04	0.04	0.14	0.11
6	06-17 Nov.												
7	04-15 Dec.	39/36	32.18	45.64	85.33	39/27	14.69	54.12	38.96	39/01	0.01	0.09	0.04
8	08-19 Jan.	39/39	27.54	27.10	73.05	39/25	8.04	20.08	21.32	39/04	0.05	0.14	0.12
9	12-28 Feb.												
10	12-23 Mar.	39/38	75.49	104.98	200.19	39/35	172.96	333.73	458.69	39/07	0.18	0.56	0.47
11	02-21 Apr.	39/38	55.15	65.95	146.27	39/31	119.75	332.27	317.58	39/01	0.01	0.05	0.02
12	14-25 May												
13	11-22 Jun.												
14	10-18 Jul.												
15	13-24 Aug.	46/45	19.83	35.51	52.58	46/29	37.69	160.60	99.96	46/15	0.18	0.72	0.48
16	10-21 Sep.	46/46	15.05	27.60	39.90	46/24	2.61	6.90	6.93	46/21	0.31	0.66	0.83
17	08-18 Oct.	46/39	4.20	6.45	11.13	46/18	22.21	63.93	58.91	46/23	1.45	3.94	3.85
18	05-16 Nov.	46/25	2.73	9.66	7.25	46/25	15.11	46.76	40.07	46/12	0.18	0.44	0.49
19	03-13 Dec.	46/36	9.36	15.67	24.83	46/33	69.49	121.86	184.28	46/11	0.61	1.70	1.62
20	07-19 Jan.	46/42	80.55	149.11	213.62	46/42	69.65	159.18	184.72	46/11	0.28	0.65	0.75
21	11-28 Feb.	46/46	91.49	121.13	242.63	46/43	191.09	717.70	506.76	46/05	0.04	0.11	0.10
22	10-22 Mar.	46/45	195.18	196.46	517.63	46/44	294.88	651.95	782.02	46/09	0.13	0.33	0.36
23	07-17 Apr.	46/46	49.90	54.38	132.34	46/40	124.21	367.51	329.41	46/06	0.12	0.42	0.31
24	12-25 May	46/43	22.17	38.47	58.79	46/33	33.92	117.21	89.96	46/10	1.93	11.43	5.11
25	16-26 Jun.	46/40	7.07	11.86	18.75	46/24	5.73	16.97	15.21	46/03	0.04	0.16	0.10
26	14-25 Jul.	46/30	1.63	2.24	4.31	46/15	4.26	23.54	11.29	46/00	0.00	0.00	0.00

in the ICHS region. Figure 6 compares the abundance of northern anchovy larvae in the ICHS region versus CalCOFI Region 7 from nine concurrent cruises during 1978-1980. These data suggest that the abundance of northern anchovy larvae in the ICHS region reflects their overall abundance in a much larger offshore area. The density of anchovy larvae were comparable between the two regions; hence, we concluded that the nearshore region off Southern California was not a preferred habitat for the adult spawning biomass. However, additional data suggest that the importance of the coastal zone as a nursery ground for northern anchovy may not be a direct function of numbers of eggs spawned. The ratio of anchovy eggs to anchovy larvae and the length frequencies of the larvae within the ICHS region may indicate passive or active movements of the early life stages toward shore, or higher mortality rates at stations over deeper isobaths. In cooperation with Dr. Paul Smith and Roger Hewitt of the National Marine Fisheries Service, Southwest Fisheries Center, we are working to clarify these relationships. Specifically, the sizes of anchovy larvae are being compared as a measure of survivorship between the two regions.

One surprising outcome of these studies was the occurrence of relatively large numbers of Pacific sardine larvae in coastal waters. There was an

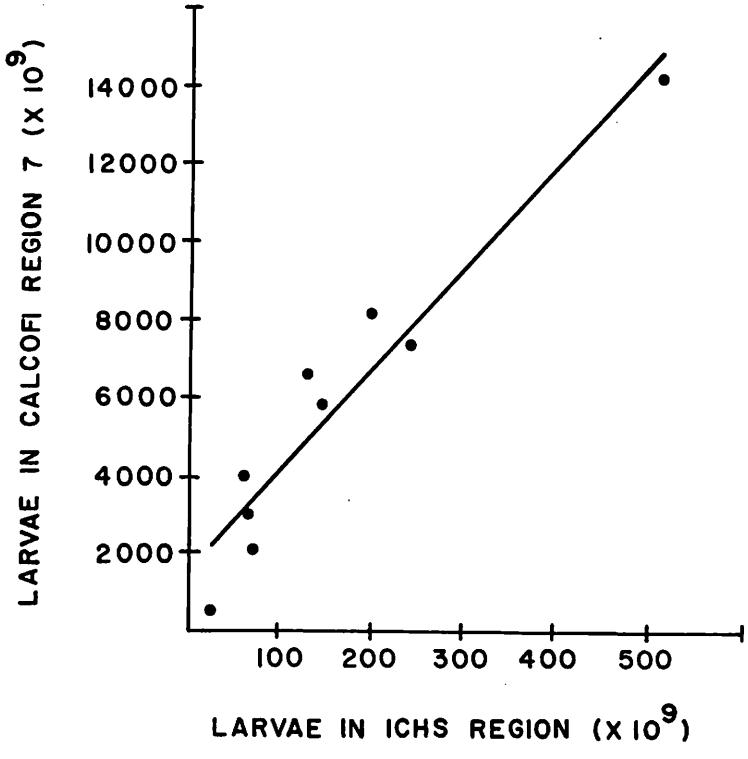

Figure 6: Monthly estimates of northern anchovy larvae in the ICHS region vs. CalCOFI Region (y=1530.0+25.65(X); r^2=0.92).

apparent increase in the numbers of Pacific sardine larvae between 1978-79 and 1979-80. Collections of sardine larvae offshore were infrequent.

Similar analyses are in progress for other economically and ecologically important species. Clearly, the wealth of data accumulated by ICHS necessitates a major ongoing effort to communicate the information to other interested scientists. We will utilize the USC Sea Grant Technical Report Series and peer-reviewed journals to describe, in detail, the results of our studies. Four manuscripts are in various stages of completion, and still others have been outlined.

Another outstanding result of the work, sponsored by Sea Grant and Southern California Edison, has been the development of an ichthyoplankton reference collection of Southern California coastal fishes. The collection, which includes contributions from consulting firms and other universities, is curated at the Los Angeles County Museum of Natural History. This resource has provided and will continue to provide an invaluable collection of comparative material for taxonomic studies and ecological surveys for all qualified investigators interested in the ichthyoplankton of the nearshore Southern California Bight.

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Non-Living Marine Resources

Gas Exchange Rates at the Air-Sea Interface in Coastal Waters

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Douglas Hammond, Associate Professor, Geological Sciences, University of Southern California
James Kremer, Assistant Professor, Biological Sciences, University of Southern California

INTRODUCTION

The motivation for this project is a widely recognized need to predict the dynamics of several dissolved gases in aquatic environments. Information on gas dynamics is needed by the general community involved in aquatic environmental engineering and water quality management.

For example, dissolved oxygen levels are critical to the health of aquatic systems. In many systems, these levels will depend largely on the balance between biological oxygen demand (BOD) loading and the exchange rate of oxygen across the air-water interface. Predictive models for the response of dissolved oxygen to changes in BOD loading cannot be made without accurate estimates of gas exchange rates.

A second example is the problem posed by constructing budgets for nitrogen. In coastal waters and in some estuaries, productivity is limited by the availability of nitrogen. Yet accurate budgets cannot be constructed because of a lack of information on the air-sea exchange rates of nitrogen (N_2) and nitrous oxide (N_2O). Without such budgets, decisions to establish acceptable levels of nutrient loading cannot be made.

The exchange rates of dissolved gases at the air-sea interface are presumed to be controlled primarily by turbulence in the upper portion of the water column and by waves. Few direct field measurements of gas fluxes have been made, and many of those have used expensive techniques. Various theoretical and empirical models have been proposed to estimate gas exchange rates, but the lack of information concerning turbulence in the water column has led to disagreement. If this is to be resolved, the relationship between intensities and length scales of turbulence and the flux of dissolved gases across the air-sea interface must be determined. Only then can we

improve the prediction of exchange rates of dissolved gases for coastal and estuarine waters.

Few direct measurements of gas fluxes have been made, with varying success, and none of these have been accompanied by an adequate description of the turbulence regime. Due to the difficulty in making such measurements in the field, development of a theory allowing predictions of the exchange rate based upon a reasonable number of fairly easily measured turbulent quantities would be a valuable achievement.

GOALS AND OBJECTIVES

The overall goals of this project are:

1. To develop a model that will enable the prediction of gas exchange for a broad range of turbulent parameters. Initially, this model will be based on laboratory measurements.

2. To make field measurements of gas exchange rates and turbulence in the water column in order to test the predictive model under various environmental conditions (i.e., in estuaries, lagoons and coastal waters under different wind and current forcing conditions). Modification of the model may result from the analysis of field data.

3. To attempt to resolve the theoretical disagreement about the functional dependence of gas fluxes on molecular diffusivity. Surface renewal models predict a square root dependence, while stagnant film models predict a linear dependence. Work to date has suggested that neither is satisfactory alone, and we feel that a laboratory study with a detailed description of the turbulence may allow the formulation of a composite model.

During the previous 12 months, laboratory experiments were emphasized and field work was initiated. The goals for this period included:

1. Constructing a tank capable of generating turbulence at various scales under controlled conditions.

2. Determining the flux of gases (oxygen, nitrogen, nitrous oxide, carbon dioxide and radon) in relation to the turbulence field.

3. Initiating development of a model capable of predicting exchange rates for a broad range of turbulent and mean flow parameters.

4. Establishing which flow and environmental parameters must be measured in the field in order to predict gas exchange rates accurately.

5. Assessing the accuracy of floating chamber techniques for determining gas exchange rates in the laboratory and in the field.

RESULTS

As indicated on our proposed work schedule, the construction of an experimental tank system was the goal of our first four months of funded research. The experimental tank has been constructed of plexiglass (Figure 1). The design and construction of a precision turbulence-generating grid mechanism has been completed. The optics and optical accessories are mounted on a metal support system. A camera and tripod, mercury vapor lamps, and a light power supply have been obtained to complete the streak photographic system. Neutrally buoyant beads, which act as tracers, also have been received. A light-chopping wheel, power supply and DC motor have been assembled to control the light exposure. The pump and storage tanks

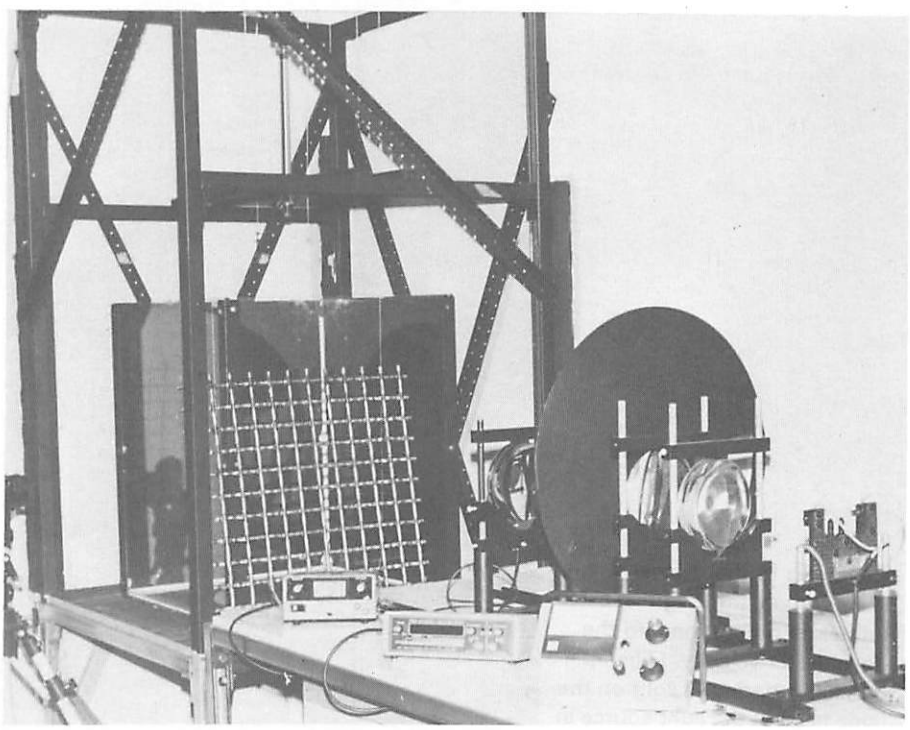

Figure 1: Experimental apparatus includes (from front to back) the light source, the lenses and light chopping wheel, the grid and the tank, and the framework used to support and oscillate the grid inside the tank. As set up, photographs are taken from a direction perpendicular to the light beam.

used for filling the tanks also are ready for use. Preliminary stirring experiments have led to our final design of the grid stirring system.

A series of jet experiments were completed and the streak photographic method was refined (Figure 2). A set of oscillating grid experiments has led to an optimization of the system parameters (e.g., light intensity, bead streak length, etc.). The complete turbulence-generating system is now ready for production runs. The data reduction scheme for analyzing the streak photographs is ahead of schedule. Our GTCO digitizing machine is now operational; interfacing with the IBM-370 university computer has been established.

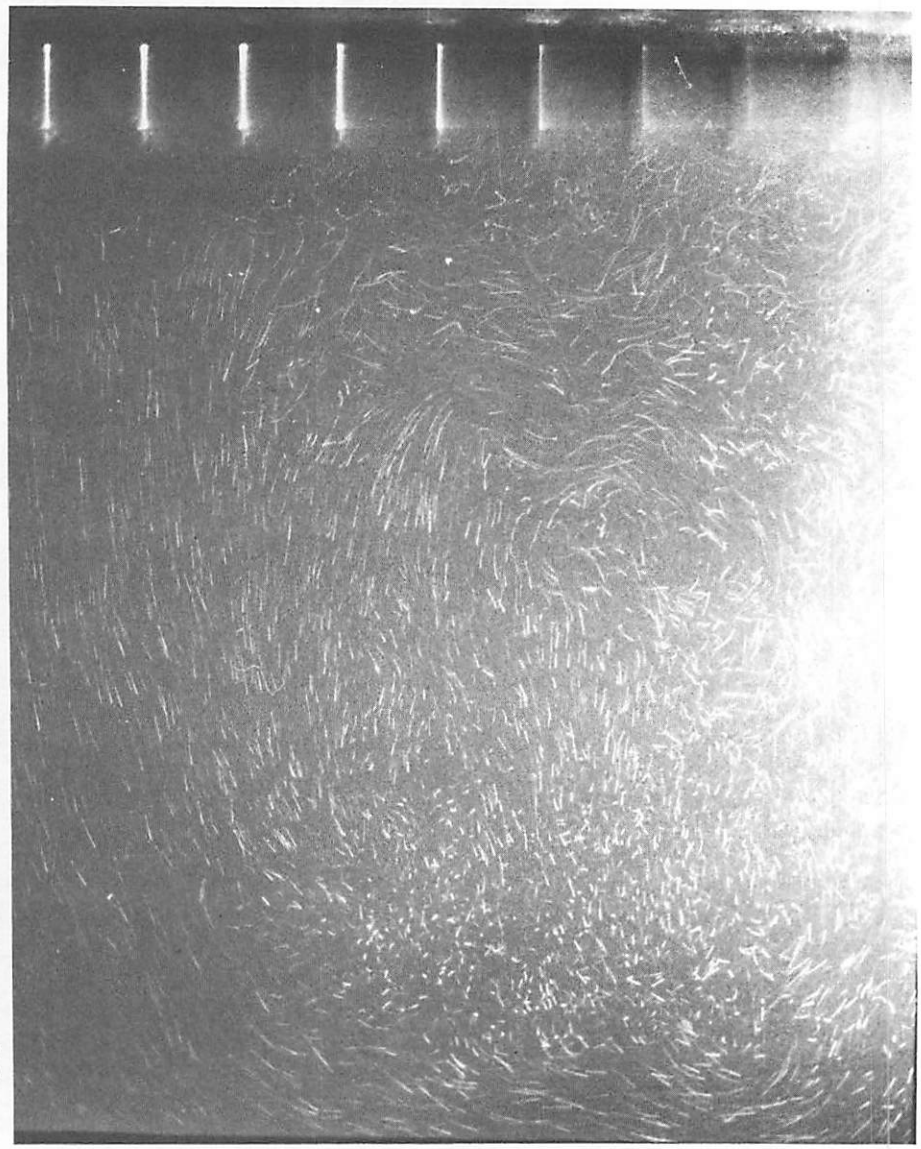

Figure 2: In this typical streak photograph, the length of each streak is proportional to the local water velocity. (The intense scattering of light on the side nearest the light source in this early photo has since been eliminated.)

Analytical techniques to measure the fluxes of five dissolved gases (nitrogen, oxygen, carbon, methane and radon) have been developed. These consist of alpha scintillation counting for radon and gas chromatographic analysis of 1 ml water samples for nitrogen, oxygen, carbon dioxide and methane.

Five laboratory experiments of gas exchange rate have been performed to date using the turbulence generating system. The data from one of these runs are shown in Figure 3. These data enable the mass transfer coefficient for each gas to be calculated for the turbulence conditions generated by the grid. Experiments now in progress are investigating the relationship

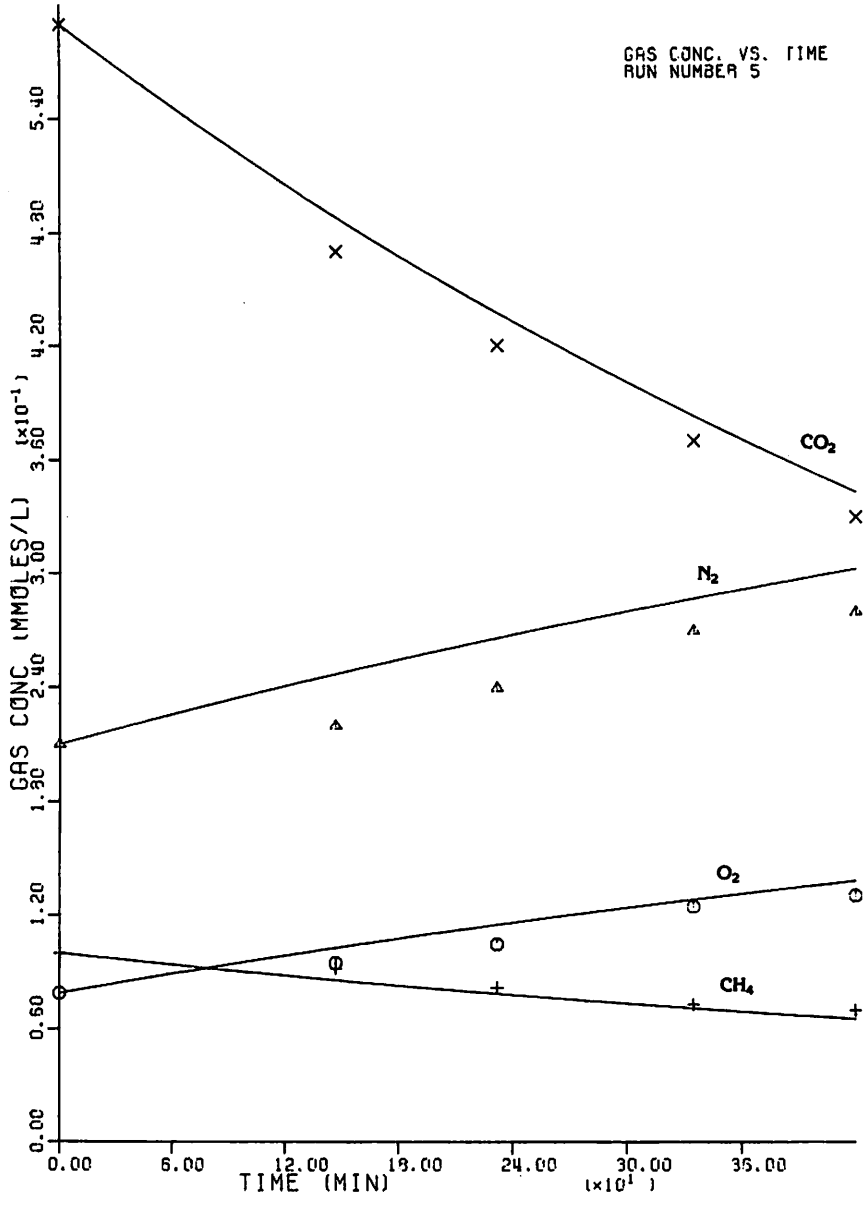

Figure 3: Changes in concentration of four dissolved gases in the experimental tank during one run. The mass transfer coefficients for gases can be determined simultaneously under a specified turbulent regime. The data were obtained at a grid oscillation rate of 3.5 Hz with an amplitude of 3 cm, and with the grid 6 cm below the air-water interface. The lines represent the fit of a model used to obtain the mass transfer coefficient for each side.

between the mass transfer coefficient of each gas and the turbulence of the tank water.

Field verification of techniques developed in the laboroatory is another portion of our program. We have made two expeditions to San Francisco Bay to estimate gas exchange rates using the radon technique. This technique requires the deployment of benthic flux chambers to determine the input of radon from sediments to the water column. A mass balance for radon in the water column can then be constructed to estimate the rate of gas exchange. The modeling of our results is not yet complete, but preliminary calculations indicate the rate of gas exchange in this system is characterized by a mass transfer coefficient that ranges between 0.7 and 1.2 m/day, depending on wind speed. We have also deployed floating chambers in the bay to determine the validity of this approach in the field. These chambers indicate comparable gas exchange rates at low wind speeds, but rates that are too large at high wind speeds. A manuscript summarizing these results is in preparation.

On the theoretical side, we feel that some of our related research will be applicable to the final model of gas exchange rates. A series of recently completed papers (Dickey and Simpson, 1981; Simpson and Dickey, 1981a, and Simpson and Dickey, 1981b) has centered on the development of a high resolution numerical model which will better simulate vertical mixing in the upper ocean, an important element for establishment of the gas exchange rates.

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Coastal Engineering

Waves and Currents in Coastal Regions of Sharply Changing Water Depth

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Landon C. Wellford Jr., Associate Professor, Civil Engineering, University of Southern California

INTRODUCTION

To design harbors and other coastal facilities, it is necessary to be able to predict the behavior of waves and currents propagating in the coastal region. This coastal wave and current propagation has been known to be the most complicated phase of the general propagation process because the coastal region has an irregular topography that is complicated by the construction of coastal structures in the nearshore region. When the water depth is slowly varying, techniques exist for defining the wave propagation process. However, in many instances, the water depth varies rapidly and sometimes discontinuously. Harbors with dredged channels are an obvious and important example. The problem of predicting the behavior of propagating waves and currents in regions with rapidly varying depths is difficult and is the subject of this research activity.

GOALS AND OBJECTIVES

For this study, four overall goals and objectives were established:

1. To study through analytical and numerical means the response of harbor basins and coastal regions to incident waves and currents. The flow region considered would involve sharply discontinuous water depth. The direction of the propagation of waves and currents would not be restricted to one preferred direction. Both periodic and random waves will be considered.

2. To discover the mechanism of energy trapping associated with regions of rapidly varying water depth and horizontal plane form.

3. To conduct experiments for verification and modification of the analytical and numerical techniques developed.

4. To explore the use of the developed techniques in application to problems of the design of harbor modifications. For example, to assess the impact of

channel dredging on the wave and current environment in a harbor region.

1980-81 Objectives

1. To develop analytical and numerical models for the prediction of the steady-state response of harbors to incident wave trains. The harbor considered would have discontinuous depth variation. The direction of wave propagation would be arbitrary. Therefore, the problem considered would be three-dimensional.

2. To conduct experiments to verify the results of the analytical models.

RESULTS

Significant progress has been achieved to date in the study problems involving the propagation of waves into harbors or coastal regions with sharply discontinuous water depth. An effective and versatile analytical and numerical method for treating problems of wave propagation over arbitrarily shaped submarine channels has been developed. Results of this application have been included in the written version of the Proceeding of 17th International Coastal Engineering Conference, American Society of Civil Engineers (Lee, et al, 1980). For this application, an analytical solution based on eigen function expansion and a boundary integral equation method are matched at an imaginary common boundary. With this method the problem of assessing the impact of a submarine channel on the propagating wave field can be readily made. Most importantly, the shape of the sharp discontinuity can be arbitrary; therefore, one can compute as close to the prototype geometry as desired. This is a very relevant engineering problem. For example a natural trench leading to the harbor area of Botany Bay near Sydney, Australia, protects the harbor area much like a breakwater because a significant portion of the incoming wave energy is reflected by the trench. With the present method, this phenomenon can be computed by theoretical means without using the hydraulic method tests.

Figure 1 shows the effect of a trapezoidal-shaped submarine channel on the propagating waves. The ordinate of Figure 1 is the ratio of the transmitted wave height to the incident wave height. The abscissa is a dimensionless number representing the ratio of water depth (h) to wave length (λ). Therefore, a different value of h/λ would correspond to different wave period. The result shown in Figure 1 is obtained by computer.

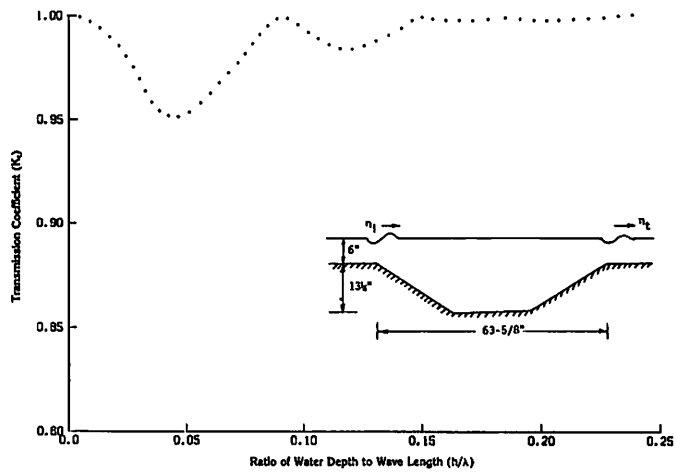


Figure 1: Transmission coefficient as a function of relative wave length, predicted by the computer model or the relative dimensions of the trench shown.

Confirmation of the computer-generated result with experimental data has been done for other submarine channel geometry (Lee and Ayer, 1981, and Lee, et al, 1980).

In another aspect of the problem, progress has been made on an analytical and numerical method of determining the wave field generated by an impulsive bed motion in three dimensions involving a discontinuity in the bottom (as might be caused by a submarine earthquake).

Figure 2 shows a different three-dimensional wave field obtained by a special computer graphic technique developed in the study. Figures 2a and 2b show some samples of the wave patterns from different viewing angles at both the frontside and the backside of the coastal boundary. These are wave patterns for two specified times (t) after the initial bed motions have been completed. (The symbol g is gravitational acceleration; h is the water depth.)

It is evident from the computer plots shown in Figure 2 that the focusing effect of the coastal boundary contributes to large variations of the wave amplitude along the coastal boundary. This aspect of the results is in full agreement with many historical data that showed large variations of recorded wave heights along the coastal boundary whenever a tsunami is generated in the offshore region. The detailed technical presentation is in the Ph.D. dissertation of J.J. Chang, (1981). This work is the first to model such a problem in three dimensions.

For a detailed analysis of how a harbor basin responds to a steady-state incident wave, an effective finite-element numerical model for computing the response has been developed by Dr. L. C. Wellford and

M. Ganaba, his doctoral student (Ganaba, forthcoming). The model solves the linearized momentum equation, including the laminar and turbulent (eddy) viscous effect. An arbitrary harbor shape is considered. The water depth in the harbor can be either constant depth, variable depth or piecewise discontinuous depth. Therefore, this computer model is capable of considering both dissipation and discontinuous depth variations in harbor response problems. This work on the response of harbors to incident wave trains clearly supplements and elaborates upon the earlier USC Sea Grant project on currents induced by tidal action (Project R/CE-4, 1978-80).

Some conclusions of the work can be drawn as follows:

1. Both dissipation and discontinuous depth can be considered in harbor response models.

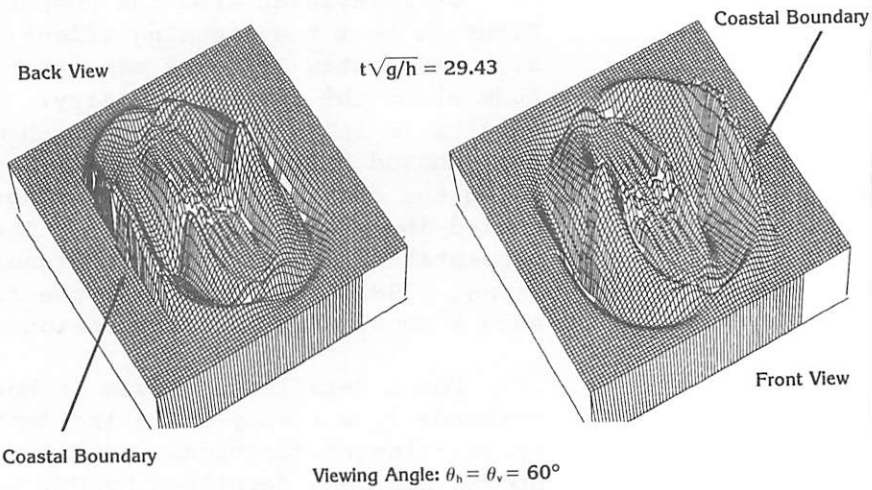
2. Harbor frequency response can be determined using efficient finite-element computer programs.

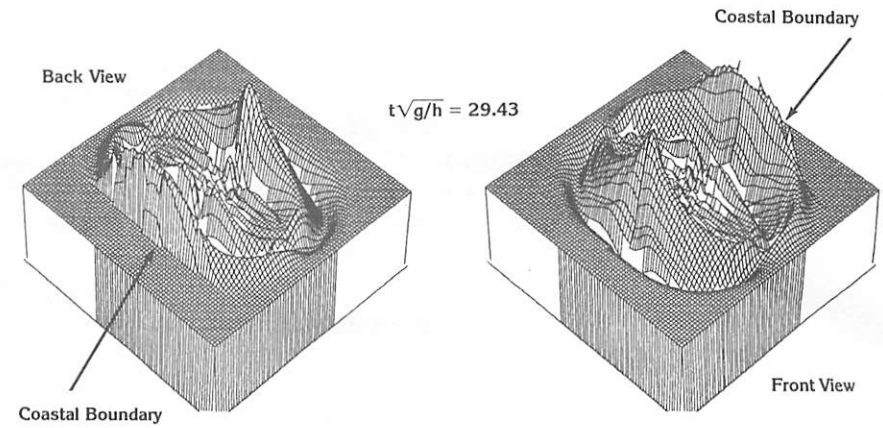
3. In shallow harbors, the laminar viscosity effects on dissipation will be the dominant viscous dissipation mechanism.

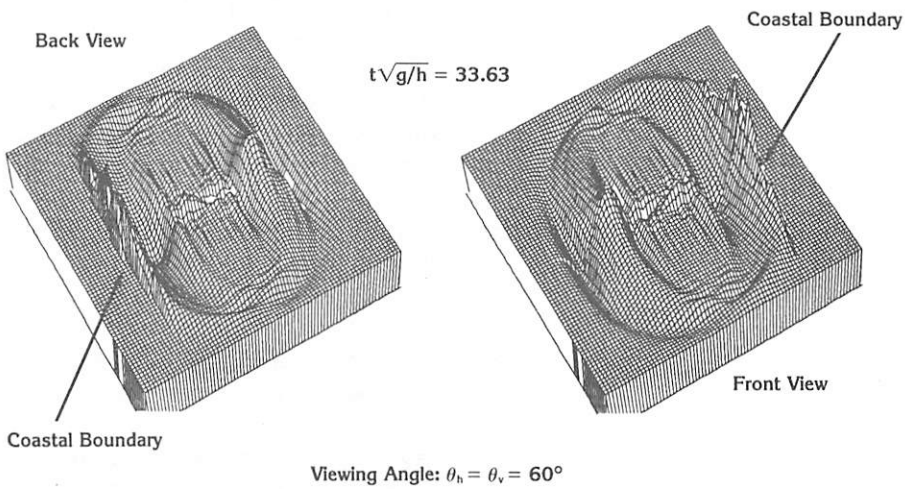
4. To in deep harbors, the contribution of eddy viscosity is often more important than the laminar viscosity in the total viscous dissipation.

CONCLUSIONS

Significant progress has been achieved to date on a series of interrelated coastal engineering problems in regions of sharply changing water depth.







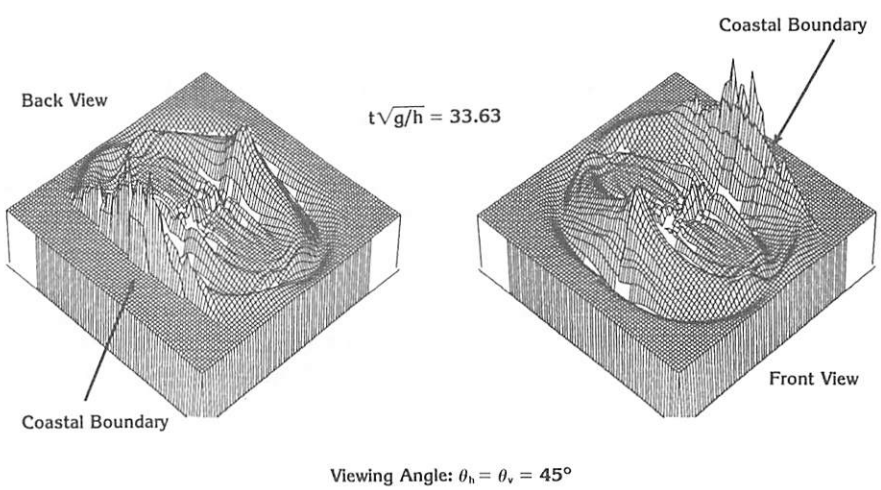


Figure 2: The eight computer graphics (left and right) show three-dimensional pictures of water pattern from dipole dislocation bed motion (A/B=2) under the effect of an irregular coastal boundary.

Wave patterns generated by impulsive bed motion (which would result in sharp discontinuity of water depth of a three-dimensional nature) was first studied. The linear dispersive wave theory and the special computer graphic techniques developed in the study would allow one to compute the wave field all the way to the region closest to the harbor basin where there often exists a submarine channel or man-dredged navigation channel. Efforts in this study have been successful in developing a method of analysis as these waves propagate over the dredged channel. This series of efforts is connected and interrelated in an efficient manner not only from the point of view of the problem itself, but also the method of approach of the analysis technique. Such a successful link, together with further exploration, is essential for achieving the final goals, items 2 and 4, of the project.

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Appendixes

Institute for Marine and Coastal Studies Technical Advisory Panel

Collectively and individually, these persons provide valuable counsel on the programs of Institute for Marine and Coastal Studies. One of their principal functions is to review the Sea Grant proposals each year.

Victor Adorian, Director, Los Angeles County Department of Small Craft Harbors.

Gary L. Bane, General Manager, Ocean Engineering Department, Interstate Electronics.

Richard A. Geyer, Professor Emeritus, Texas A&M University.

Captain Jack Boller, Executive Director, Marine Board, National Research Council.

Colonel Ted Gillenwaters, Attorney, Newport First Investment Services.

George Hatchett, President, Hydro Products.

Robert Kleist, Director of Trade Development, Port of Los Angeles.

Robert Krueger, Esq., Nossaman, Krueger and Marsh.

Captain William C. Lynch, Professor, California Western School of Law.

George Mueller, President, Systems Data Corporation.

Wheeler J. North, Department of Environmental Science, California Institute of Technology.

Richard J. Seymour, State of California, Department of Boating and Waterways.

Howard Talkington, Head, Ocean Technology Department, Naval Oceans Systems Center.

Captain T.K. Treadwell, Professor, Department of Oceanography, Texas A&M University.

Rear Admiral O.D. Waters Jr., USN (Ret.).

Donald E. Wilson, Director, Teacher Education, University of Southern California.

Donald B. Bright, Donald B. Bright and Associates.

Ex Officio Member

Don Walsh, Director, Institute for Marine and Coastal Studies, University of Southern California.

California State Resources Agency Sea Grant Advisory Panel

This panel also reviews Sea Grant proposals each year and provides counsel to the State Resources Agency, which administers State-authorized funds to match federal monies.

E.C. Fullerton (Chairman), Director, Department of Fish and Game.
Representing that department.

Tom Tobin, California Coastal Commission.
Representing that agency.

Jeffrey D. Frautschy, Assistant Director, Scripps Institution of Oceanography.
Representing the University of California.

Tom Gay, Chief Deputy State Geologist, Department of Conservation.
Representing that department.

Wilbur M. Thompson, Manager, Long Beach Operation, California State Lands Commission.
Representing that commission.

Don Walsh, Director, Institute for Marine and Coastal Studies, University of Southern California.
Representing private institutions participating in the national Sea Grant program.

Richard Ridenhour, Humboldt State University.
Representing the California State University and Colleges.

Marty Mercado, Director, Department of Boating and Waterways.
Representing that department.

Elmer Wheaton, Vice President (Ret.), Lockheed California Corporation.
Representing the ocean engineering industry.

Rob Ross, Northern California Seafood Institute.
Representing the fishing industry.

Hugh Staton, Vice President, California Marine Associates.
Representing the aquaculture industry.

Research-Related Publications

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