UNIVERSITY of SOUTHERN CALIFORNIA

SEA GRANT ANNUAL REPORT 1974-75

INSTITUTE FOR MARINE AND COASTAL STUDIES

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INSTITUTE FOR MARINE AND COASTAL STUDIES

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PROGRAM ADMINISTRATION AND MANAGEMENT

Ronald B. Linsky
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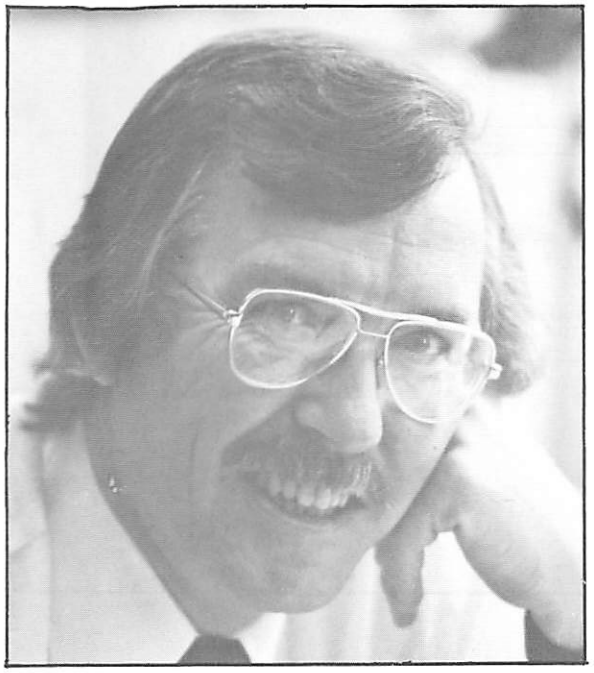


Expansion is the word that best characterizes the USC Sea Grant Program's fifth year of existence. However, it wasn't just an internal expansion within the University structure, but a community-wide one as well.

Sea Grant, by the very nature of its Congressional mandate, represents science and technology in action . . . with a purpose. Action for its own sake, without an ideological framework, and perpetuated in a vacuum, is not a *Good* in and of itself. This is why the University of Southern California's Sea Grant Program, in directing the thrust of its 1974-75 fiscal year activity to the identified coastal zone management needs of southern California, addressed the following goals:

- To establish a broad-base, multidisciplinary Sea Grant Program addressing the needs of the State of California and, more particularly, the southern California coastal region.
- To develop criteria, guidelines and specific management procedures and to investigate new resources and technologies which will lead to more effective development utilization and optimization of coastal and oceanic resources by the general public, government and industry of California.
- To develop an information delivery system designed to meet the needs of the user community of the California coastal zone.
- To support and encourage the further development of a broad range of educational activities for University, public and industrial communities of southern California.

These goals also reflected the programmatic structure: management, research, advisory services and education, respectively.

Just as the structure of each Sea Grant Program in the nation reflects the expressed needs of its particular area, so too the USC Sea Grant Program. Located in Los Angeles, it falls within the southern California coastal region which contains one of the most rapidly expanding urban complexes in the United States.

Proximity to the Pacific Ocean has been a key factor in southern California's growth. The ocean's influence on the weather of the region results in a temperate, subtropical climate that has drawn people from all parts of the country. Natural resources have made possible the development of such industries as oil, power production, transportation, commercial and sport fishing, mineral extraction, and tourism. The coastland has become a center for science and advanced technology and is valued for its excellent recreational facilities and scenic beauty. At present, it sustains a population of 11 million and its continued growth seems certain. Inevitably, the demands on ocean resources will also increase.

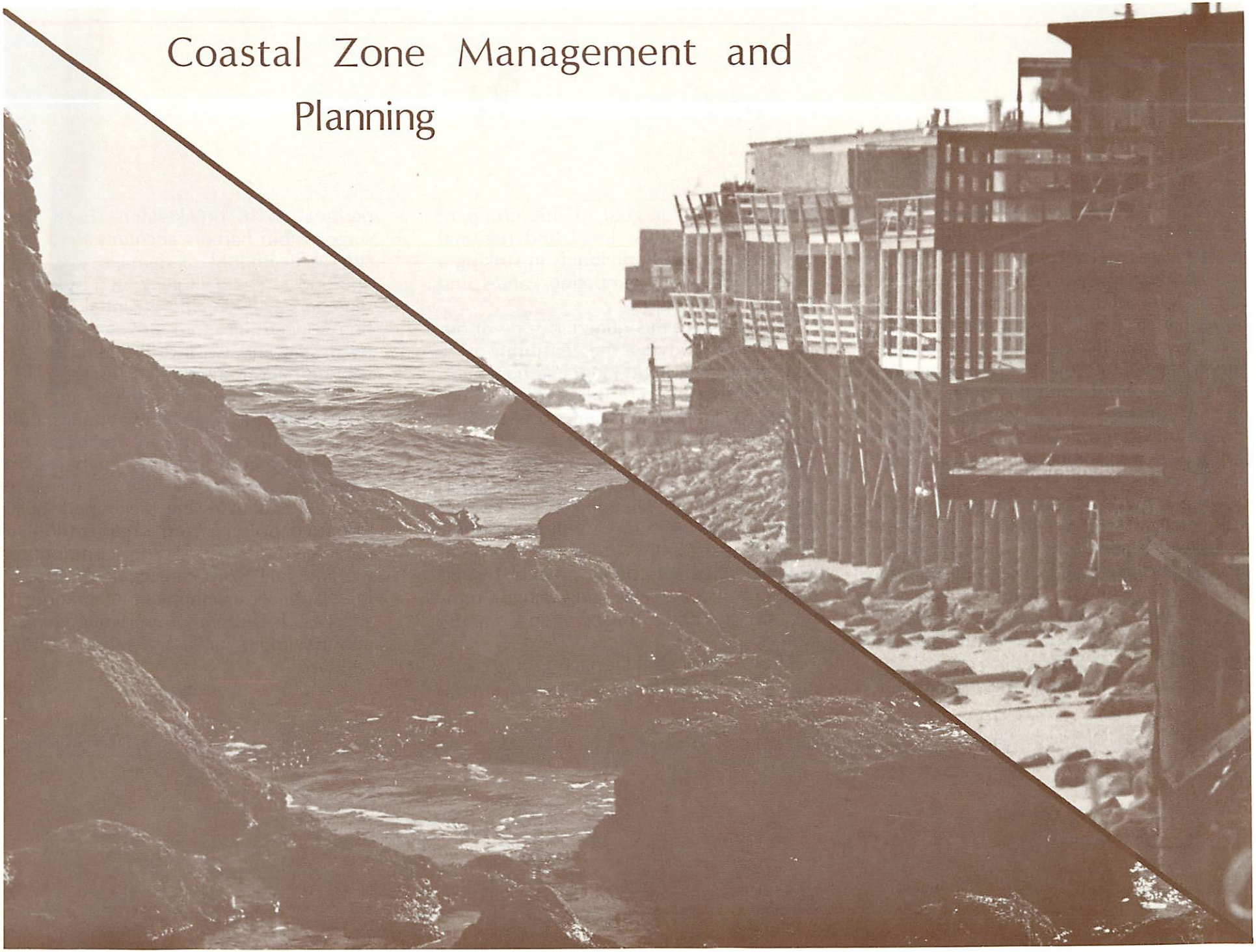
The waters within a few kilometers of shore are perhaps most directly influenced by the intense development in the coastal region. There are both negative and positive aspects of man's influence on these nearshore waters. On one hand, marine ecosystems may be severely stressed or permanently altered as a result of human exploitation. Conversely, technology and knowledgeable planning and management may enhance the marine environment for its inhabitants and permit replenishment of important marine resources. If the ocean is to continue to satisfy the often conflicting demands of the human population, the environmental quality issues must be considered . . . the coastal water environment must be both protected and enhanced.

Since the USC Sea Grant Program draws its strength for action from the University's collective areas of marine-related expertise, there has to be a strong faculty involvement for the Program to be effective. During the 1974-75 fiscal year, 270 persons contributing a total of 51 man years of experience, participated in the Program as Principal Investigators, co-principal investigators, technicians, and consultants. These people represented 11 disciplines from six Schools, four Departments and two Centers.

Marine activities in the coastal zone have historically been the exclusive domain of biological and geological scientists. However, during the past decade, increasingly important research in the coastal zone has been done by social scientists, engineers, lawyers, and others. Social science research has been conducted in the areas of political structures, as formed under the California Coastal Zone Conservation Act; in economics; in demography; on social values; and other such "soft science" areas of interest. Ocean engineering pertaining to nearshore and coastal construction has been complimented by an increasing interest of engineers concerned with the types and quantities of pollutants that are reaching coastal waters.

As interest in these newer areas quickened, a need became evident for an interrelating of areas of expertise to permit research on the coastal zone as a *system* rather than in a series of fragmented micro-studies. The USC Sea Grant Program now exhibits some of the characteristics of interdisciplinary functioning. The process of molding the several disciplines into a meaningful cooperation has not been easy and the periods of birth and infancy have sometimes been painful. But it has happened, and the effectiveness and impact of the USC Sea Grant Program to the local, regional and State needs is increasing as this Program matures.

Coastal Zone Management and Planning



Coastal Zone Management and Planning is another facet of the USC Sea Grant Program. The vital, heavily taxed land and water resources in the southern California coastal zone are of paramount importance to the urban population. Pressures from public agencies and private enterprises for increased exploitation and use of the coastal zone has been triggering the construction of deepwater ports and small-craft harbors, beaches and parks, and apartment houses and residential subdivisions.

While it may be true that the capacity of the coastal zone to support the various activities demanded by the urban population may be expanded by careful administration of existing and future legislation; it is also a fact that the passage of federal, State and local legislation intended to constrain and regulate use of coastal resources has made management a difficult activity. A major goal of this group of projects is to assist local and regional governments and individuals in striking a balance between competing values and goals.

In addressing this quandary, one of our projects is studying the feasibility of a semi-protected, hand-launched boat facility to relieve some of the congestion encountered in marinas and ports up and down the coast. Two more groups of researchers are examining aesthetic indicators for land use planning and appearance and design planning in the coastal zone. Results from these will be used directly to assist in the guidelines for one of the Plan Elements being created by the Region V (Los Angeles and Orange Counties) Coastal Zone Conservation Commission.

Then, from the Department of Engineering comes the study of wave energy permeation of breakwaters. Each year, surge within harbors accounts for a considerable amount of damage to vessels and docks. The data generated by our researchers will provide essential information concerning more effective breakwater design and ways of reducing or preventing harbor surge.

Though the projects in this group come from disparate University departments, their overall concerns are for improving the performance of local agencies, increasing access to and use of coastal resources, and assessing the impact of alternative policies and organization arrangements. These, in turn, contribute to the National Sea Grant goals of improving national development of marine resources, including proper management and maximum social and economic utilization.

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INTERDISCIPLINARY STUDY FOR A SEMI-PROTECTED, HAND-LAUNCHED BOAT FACILITY

Richard Stone
R/CM-3

The natural condition of the southern California coastal region makes it difficult to meet rapidly increasing recreational demands, particularly those of the recreational boater. Wide, sandy, year-round beaches are plentiful but they are under constant attack by moderately sized waves. Natural harbors and protected waters are scarce and those which do exist, are presently overcrowded. The only other current alternative is the construction of artificial harbors which can be both costly and often detrimental to the biological, geological and urban ecologies. The question is no longer one of natural vs. artificial environments or of alteration of the environment vs. no alteration; the very existence of recreators on the beaches alters the natural equilibrium.

Undoubtedly, new recreational facilities will be built, but the major concern of any design which attempts to accommodate the increase in coastal recreational demand should be to minimize and/or avoid adverse environmental impact and, where possible, provide beneficial ones. The best utilization of this scarce regional resource, the reversibility of any construction and compatibility with other beach uses should also be parts of proper environmental planning.

Given this particular set of circumstances, and in order to alleviate some of their accompanying problems, a multidisciplinary team of Sea Grant researchers representing the Departments of Geology, Zoology and Urban Planning initiated a one-year project to determine the feasibility of developing semi-protected, hand-launched boat facilities using Topanga Beach as the case study area.

When the study was begun, it was, of course, known that southern California faced a shortage of space for recreational boat storing and launching, but the full scope of the problem had never been closely examined. The project's Urban Planner unearthed some rather interesting facts.

Approximately 84% of the State's population lives within 30 miles of the coast; therefore, shoreline recreation is within reasonable reach of much of the population. However, because of lack of access due to private ownership of large areas of coast (644 miles of the 1072 miles of coastline are in private ownership), the shoreline, with its many opportunities for a variety of recreation activities is a limited resource, particularly in large concentrated metropolitan areas such as the south coastal region. Of the 270 miles of good swimming beach in the south coast region, 124 miles are in private ownership. In Los Angeles County which has 50.7 miles of good swimming beach, approximately 24 miles are privately owned—thus, the need to utilize to the fullest capacity those beaches which are available for public use. Add to this the steadily increasing demand for marine-oriented recreation opportunities—the result of increased leisure time—and the magnitude of the problem is increased. The primary factors involved in continued growth of beach use are: 1) the increasingly crowded conditions under which people live in metropolitan areas forcing them to seek more open space for recreation pursuits; 2) rising personal income, coupled with increased mobility; and 3) the rapid growth of marine technology which introduces new forms of marine sports.

Of all recreational activities, boating, in particular, is on the upswing in popularity. In Los Angeles County, the number of boats registered has increased from 10,848 in 1963 to 17,927 in 1972. This trend in boat ownership continues as evidenced by sales figures in the boating industry. The areas of greatest boat ownership are directly along the coast, particularly the Marina del Rey/Venice area where 224 registered boaters live; the Palos Verdes Peninsula; Manhattan Beach, and Long Beach. These areas are also the site of multiple boating facilities. In the northwestern section of the Santa Monica Bay, boat ownership is less, although still high, since this area lacks a marina or adequate launching facilities. Nevertheless, the concentrations are high enough to show a great interest in boating in spite of the fact that facilities are lacking. Based on this data; the fact that no public moorings, storage facilities or boat ramps exist north of Marina del Rey or south of Oxnard in Ventura County; and the existence of the relatively heavy concentration of boat ownership in the immediate vicinity of Topanga Beach as well as in the San Fernando Valley, a demand for such a launching and storage facility in the northwestern section of the County seems apparent.

In addition to verifying a definite need for such a proposed facility, the Urban Planner: 1) calculated a cost-benefit analysis for construction; 2) gathered information on the physical parameters, environmental requirements, legal constraints, plans for the area by governmental agencies, and requirements of other coastal recreational users; and 3) drew up and mapped such a facility as it would apply to Topanga Beach to demonstrate the feasibility of multi-recreational activities occurring in close proximity.

It fell to the geologist/sailor to develop the concept of this facility in its detailed form, along with assessing Topanga Beach's geomorphologic characteristics to see if, in fact, this would be a reasonable place to construct such a launching facility.

The basic concept and the specific design application was developed with the following objectives in mind: 1) minimal environmental impact, 2) best utilization of a scarce regional resource, 3) reversibility, 4) compatibility with other beach uses, and 5) economy.

To fulfill these objectives, one must have knowledge of the environment in which the concept is to be applied. The geologist's 13 years of boating experience in southern California and abroad provided the base upon which the generalized concept was developed. The research which led to the formation of the concept was nonmethodically accomplished over the years and will not be presented in the final report; but the *in situ* research necessary for the application of the concept to a specific test site was recorded.

The primary function of any open-water boat launching facility is to provide an area where boats can be successfully transported from the water's edge to beyond the surf so that they may be sailed freely on the open ocean. Retrievability, the ability to return a boat to its dry-land base, is also implied in this primary function.

The trend in facility design in southern Califor-

nia has been towards maximum alteration of the surf to provide a quiet body of water in which to launch boats. There *are* viable alternatives to this standard design. Certain boat types do not need quiet water and can be launched on open beaches with no alteration in surf dynamics or surf dynamics can be partially altered by submerged or floating breakwaters. The proper choice of facility sites can assure more favorable winds and lower natural surf, and educational programs with on-site experience can raise the general level of sailing skill of the facility users.

For the needs of the boaters, the proposed facility would ideally be an open beach, small boat launching area with on-site storage for a limited number of boats. Launching would be accomplished with the aid of a flexible ramp which would be rolled out like a mat when the facility is in use and rolled up at night and during stormy weather. It could be constructed of wood, plastic or steel slats tied together with wire or rope. Such a ramp would allow the beach to change its profile but would be inexpensive and easy to remove from the site should it prove to be undesirable.

After a thorough examination of Topanga's underwater geomorphology and current characteristics done by, diver transects and dye studies respectively, it was found that this beach would be most suitable for a boat launching facility because it has a sandy beach, low surf and along-shore winds. Only minor environmental alterations would be needed at the Topanga Beach site. Since wind velocities and directions are hard to change, the only major physical parameter capable of being altered is the surf size and form. The objective then would be a compromise between patron use (maximum range of skill levels, not number of users *per se*) and concern for the environmental effect of the alteration. For this study site, a tethered float system was found to be the most ecologically compatible because it would allow for: 1) unrestricted water circulation; 2) minimal visual, biological and geological impacts; and 3) assured reversibility. What this means for recreational boaters is that the breakwater would reduce the size of the surf (50% for waves of 8 second periods) for an easier launch. The installed facility could exist side by side with tidepooling, surfing and swimming without infringing upon these already ongoing activities.

It is a fact that if a tethered floating breakwater were to be constructed offshore it would reduce the amplitude of the surf, thus providing a safer and easier means of launching small craft from the beach. However, for environmentally sound planning, it could not be assumed that the presence of this breakwater would not have *some* impact on the marine animals and plants presently in the area. Therefore, the project's participating biologist conducted a biological baseline survey of the area, and based on the information gathered, possible effects on the biota were postulated.

Implementing diver transects, it was found that the dominant organisms on the sandy substrate were the two polychaetes (marine worms), *Diopatra ornata* and *Diopatra splendissima,* and both are tube builders. The tube serves a protective function in a sandy substrate which is generally considered unstable or subject to rapid changes in depth in response to changes in wave and surge intensity.

In turn, the relatively high density of these worm tubes helps to stabilize the shifting substrate and provide a habitat for the variety of fauna which live on the tube and also the variety of marine algae which attach to the tube. Other areas which had a more rocky substrate serve to provide a stable anchoring point for the variety of algae. The most abundant species included the brown algae *Chondria midifica* and the red algae *Stenogramme interrupta.* The most dominant animal on the rocky intertidal habitat was the barnacle *Tetraclita squamosa rubescens.*

The possible impacts of a breakwater on the marine plants and animals presently found in the intertidal and subtidal zones of Topanga Beach must be considered in two aspects. First, the effect on the marine life inhabiting the soft bottom or sandy substrate and second, the effect on those organisms living on the hard bottom or rocky substrate.

The major physical parameter to consider from the construction of any type of breakwater is the resulting increased sedimentation due to reduced current or surge activity. Those organisms living on a soft bottom substrate would be able to cope with increasing sedimentation. The population density of deposit feeding organisms may increase in response to the increased sedimentation of organic particulates.

The effect of increased sedimentation on the dominant organisms found in the soft substrate would not be of any major consequence. It has been shown that a closely related species of marine worm is adept at extending the length of its tube in response to increased sedimentation. The other species of organisms found within the first few inches of the soft bottom substrate are generally mobile species and able to maintain their respective depth preferences within a shifting level of substrate.

The plants and animals found on the hard bottom or rocky substrate would, however, be more vulnerable to increased sedimentation. Sessile organisms, i.e., barnacles, which are fixed to the rock would, for the most part, be unable to survive if they were covered with sediment for any period of time.

The rocky habitat at the test site was confined to the upper, northern reaches of the beach. While the prevailing current along southern California beaches is generally in a north to south direction, the surge pattern in the study area was the major circulation influence and occurred perpendicular to the beach. When considering the direction of the generally prevailing current and the surge pattern, it is herein suggested that the major amount of sedimentation resulting from the presence of an offshore breakwater would take place directly inshore and south of the breakwater. In this case, most of the sedimentation would settle south of the rocky habitat and would for the most part leave the organisms in this area unaffected.

Whether or not a boat launching facility will ever actually be installed at Topanga Beach remains to be seen. However, this multi-disciplinary study—whose final report is the last stages of compilation—has developed a viable alternative to the present design and development of marine recreational facilities; and one that not only can be made applicable to other test areas, but one that takes into account the total environment involved.

Photo courtesy of Long Beach Chamber of Commerce

AESTHETIC INDICATORS FOR LAND USE PLANNING: APPLICATION TO THE COASTAL ZONE

Tridib Banerjee
R/CM-4

The interest in this study grew out of the Principal Investigator's involvement in the development of the "Appearance and Design" Element of the South Coast Regional Plan of the California Coastal Zone Conservation Commission. The Commission was established by a popular initiative known as "Proposition 20," introduced in the ballots of the November 1972 elections in California. The initiative mandated the preparation of a coastal zone plan for the entire State by 1976, and specifically called for restoration, enhancement and preservation of scenic resources of the California coastline.

It became apparent during the process of preparing the plan that there were very few known mechanisms to assess the scenic qualities of the coastal landscape. It was believed that such mechanisms would be particularly necessary to evaluate the effects of the appearance and design policies of the proposed plan. Therefore, the broad objective of this study was thus seen as one of developing a set of critical, aesthetic indicators of the visual quality of the coastal landscape derived from user perceptions and evaluations. It seemed that these indicators could serve many useful purposes in coastal planning and management: identifying areas of the coast that were in need of preservation, restoration and enhancement; assessing aesthetic impacts of future developments; monitoring changes in aesthetic quality over time; and so on.

The study was based on the premise that a fundamental step in the development of an objective assessment methodology is the identification of components or indicators of the environmental quality being assessed. The measures and aggregation schemes can only follow once the indicators are established.

While there are many different ways of establishing environmental quality indicators, most of them are arbitrarily chosen, or at best, based on judgments of experts or technical staff of agencies usually responsible for managing the quality of our environment. The proclaimed objectivity of such procedures are often suspect, and untenable particularly when such intangible environmental qualities as aesthetics are involved. Hence, this study was designed to identify the indicators of aesthetic quality on the basis of responses of a cross-section of users of the environment.

The initial phase of the project was devoted to a comprehensive and exhaustive literature search covering both theoretical and professional work. The literature search, while being useful in terms of gaining an insight into the "State-of-the-Art" in this area, did not yield much in terms of substance. At this point, the Principal Investigator decided to go after primary data on how the public views the coast, and what they like or dislike about the coastal landscape in urban areas.

In searching for a suitable method of assessing environmental preferences, the Principal Investigator realized that probably some version of a visual display of different types of coastal settings may be an effective way of eliciting responses from the subjects of this study, whoever they would be. Further consideration of visual medium suggested that motion pictures would offer a greater versatility in representing a wider range of the ambient qualities and activities of an environmental setting. Through the use of a movie camera, it was possible to capture a 360° panoramic view of a particular place. Furthermore, in addition to capturing the dynamic qualities of the environment, it was also feasible to record the ambient sounds, thereby making a

more sensitive and complete simulation of the setting than would otherwise be possible.

Based on previous experiences with the "Appearance and Design" Element, the Principal Investigator was able to identify four locations along the Los Angeles area coastline which represented some of the broad categories of coastal development. They ranged from low intensity natural settings to high intensity urbanized settings. Respectively, these locations were Leo Cabrillo Beach, Marina del Rey, Playa del Rey, and Long Beach. In addition to representing the broad categories of coastal development, these settings also manifested a wide variety of activities, structures, natural features, and activity settings.

A standard system of photography was developed for filming the locations in order to minimize any "journalistic" biases of the researchers or the cameraman. The level of the tripod was kept constant and a uniform, clockwise "panning" sequence was used for all four settings. Filming always began with a randomly selected focal point and by this 360° panorama system, the visual sense of the environment could be adequately conveyed in about 2½ minutes.

After the film was developed, a content analysis of the segments was done using instant recall of several different groups of viewers. Totaling 50, the viewers came from different backgrounds, ranging from students and secretaries to professors and the professional staff of a regional planning organization. Each group was instructed to view the film paying close attention to the content. Following each film, the reviewers were asked to write down everything they remembered seeing in the film, and their impressions of what they saw. The free recall responses proved quite useful, for they represented an exhaustive range of elements perceived to exist in those films. However, from the sum of the open recall responses, it was possible to extract 44 specific elements or element categories that seemed to provide a reasonably exhaustive checklist to describe the contents of all four film segments. This checklist was used as part of the larger audience evaluation of the film segments.

Each item on the check list had a "beautiful-ugly" rating option, so that a respondent could not only check what he/she saw in the film, but could also evaluate the element checked as beautiful or ugly. In addition to the aesthetic judgment regarding each of the elements, four other broad evaluative judgments were solicited on the questionnaire. These pertained to a respondent's perception of the total environment. On five-point rating scales, the respondents were required to rate the environments in terms of development (intensely urban—rural), beauty (extremely beautiful—extremely ugly), complexity (extremely complex—extremely simple), and interest (extremely interesting—extremely dull).

Photo courtesy of Long Beach Chamber of Commerce

To assess the relevance of demographic and locational characteristics of the sample population on their responses to the environmental display, the researchers also designed a demographic questionnaire.

After having created the film, the content checklist and the questionnaire, the researchers now went in search of an audience. In trying to optimize the costs of doing a statistically valid study, the researchers utilized the services of A.S.I. Market Research, Inc. This organization operates a market study complex known as the "Preview House" in Hollywood. This "Preview House" processes over 3/4 of a million respondents through its theatre yearly. It has a skilled staff of demographers, data analysts, experiment designers and engineers. Every night, two or three clients pay to use a block of the 2-hour testing time with over 400 respondents in the theatre. The respondents that comprise the audience are recruited in the Los Angeles area by trained interviewers, who initially select the sample in the field by means of quota samples, based on desired characteristics. Statistically, the sample is not totally representative of the population of the Los Angeles metropolitan area; it is usually biased toward younger age group, higher median income and higher educational level. In general, however, the sample represents a reasonable cross-section of the metropolitan population.

At the "Premiere," the audience was asked to fill out the preliminary location-activity-attitude questionnaire. These were then collected and everyone was asked to watch the following short films about the coastal area and following the film to respond to the first questionaire (check-list and ratings). During the films, a selected sub-sample of 150 selected persons were assigned to seats in the theatre which were equipped with dials for the Instantaneous Reaction Profile (IRP) Recorder which were attached to the armrests. These respondents were instructed to manipulate their dials during each of the film sequences and to register their opinions of what they liked and disliked in each film. As the films were shown during the experiment, the IRP Recorder integrated and recorded the selected audience's instantaneous reactions to the film content in the form of profile curves.

The data has been transferred to the USC Computer Center and is still being analyzed to see if there are any trends in indicators from this test group. Thus far, only the data from the Long Beach setting has been tabulated, but some most interesting results have been found. First of all, the

Long Beach film segment portrays a highly urbanized coastline with a number of highrise apartment, office and hotel complexes. The remaining skyline consists of almost a solid wall of medium-rise buildings which are mostly residential. The film was taken at a point where a recently finished coastal highway meets Ocean Avenue. The film segment also included views of a number of offshore oil islands, vast expanses of sandy beach, parking lots, and some vacant areas. The Queen Mary can also be seen in this film segment, along with the derricks and cranes of the dock area, and the civic auditorium which looks like a giant oil storage tank. These elements can be recognized in an uncontrived, 360° panoramic view.

Some general trends in the reaction profile could be identified fairly easily from a quick inspection. First, it was clear that as the film progressed the negative reactions increased for the audience as a whole and all other demographic groupings, with the exception of the older age group (50 and over). It also appeared that as the water, water-related activities and the beach became first visible, there was an upturn in the audience reaction profile curve; however, with the appearance of the islands and parked cars in the foreground, the negative reactions continued to increase. Next, and significantly, there appeared to be no major difference among those respondents with an income over $1,250 per month and those whose income was under that amount, in terms of overall reaction profile. Fourth, the male respondents seemed to be a little more critical of the environment than the female sector. Finally, and perhaps most significantly, the difference between the three age groups was quite dramatic. The youth (under 25) appear to be most critical and the old (over 50) least critical . . . in fact, almost indifferent. The middle age group (25-49) seemed to lie in-between. This difference seems to indicate that perhaps there *is* a "generation gap" in critical attitudes and levels of tolerance toward high intensity development in the coastal area. We don't know the extent to which this may reflect difference in fundamental value orientations of the younger age group in contrast to the older age group. Perhaps it merely reflects the fact that the youth of southern California treasure the coast more dearly than others, for they are most actively involved in the enjoyment of this resource. At any event, the difference in tolerance level toward man-made adaptations of the coastal zone certainly makes the task of indicator building difficult.

The next step for the researchers is to keep tackling the data they have stored in computer tapes. They have begun to examine the reactions to specific elements in the settings to see if similar elements consistently evoke positive or negative reactions. If such consistent patterns can be found, a case for identifying those elements as the key aesthetic indicators can be made with some degree of confidence.

APPEARANCE AND DESIGN PLANNING IN THE COASTAL ZONE

Margarita McCoy and Tridib Banerjee

R/CM-5

The public debate on the future environmental quality of the coastal areas of this country, current legislation notwithstanding, has been and will continue to be along a continuum of two extreme values. On one end of the scale are those who believe that any use of the coastal area threatens to degrade and defile nature, while at the other end, there are many who believe that the coast is a resource for human consumption and should be planned to maximize that consumption. The most committed citizen participants in coastal zone planning are polarized in their beliefs at either end of this continuum with the unfortunate result that, to date, interest in coastal aesthetics has concentrated on conservation measures for the yet underdeveloped shorelines with little effort directed at the design of existing and future development which could restore and enhance the urbanized areas of our coasts. Conservationists tend to regard these areas as already lost, while the majority of spokesmen for commercial and industrial interests in urban coastal areas are intent only on preserving their access to coastal resources.

Nonetheless, the question of aesthetics in the urbanized coastline is one of the most frequently debated planning issues in the public forum. Aesthetics, which underlies issues of design and appearance, is one of the fundamental values implicit in the California Coastal Zone Act. The subject is frequently discussed in public hearings held by planning commissions, city councils and Coastal Commissions. Growing public awareness of the visual appearance of the everyday physical environment has been documented and though these aesthetic values are difficult to articulate, legislate or implement, the public demand requires an institutional response.

The Principal Investigators found the framework for that response to exist in the Appearance and Design Element of the California Coastal Zone Comprehensive Plan; unwritten at the time. An ideal test area for the application of policies developed in that Element existed in California's Coastal Region V, consisting of the coasts of Los Angeles and Orange Counties and containing a full spectrum of land use ranging from open and undeveloped to the most intensive commercial and industrial development. Therefore, in an effort to achieve a fully functional and operational Appearance and Design Element for the California Coastal Zone Comprehensive Plan that would be politically viable and economically feasible, developmental plans were divided into three phases.

The first step was to create a methodology for developing a visual quality index for the coastal zones. This was achieved through data gathered from extensive field trips through Region V during early summer in conjunction with the California Coastal Zone Conservation Commission planning staff.

Once a visual quality assessment and an evaluation of resources and aesthetic values of Region V had been developed, researchers were then able to apply their developed methodology.

The second phase was the development of planning policies for preservation and protection of suitable areas, and for reclamation, enhancement and augmentation of public experience in urban areas of the coastal zone.

In this phase, the application of design techniques supported by planning policy and, in turn,

operationalizing those policies, began. While this process continued and became more specific in the final implementation phase, its introduction here was most important.

The intent was not simply to preserve or develop public open space areas in the coastal zone. While open spaces are valued and should

be preserved, particularly in urbanized areas of the coastal zone, there is also perceived value in many urban land uses that occur at the sea's edge. The drama and excitement of these areas can be enjoyed by visitors and residents of all shore cities. Providing safe access to these areas is often difficult, but it is precisely here that policy and design can make significant efforts to enhance the appearance and experience of the coastal zone in urban areas. In this way, compatibility of coastal land uses can be expanded, existing facilities can be aesthetically improved, and new public areas which are economical in space can provide rich opportunities for visual enjoyment by coastal residents and visitors.

The last phase was the implementation of these planning policies for visual improvement and protection of coastal aesthetic values. Earlier in the year, the Principal Investigators, speaking with the USC Sea Grant staff, explained that planning for aesthetics has been difficult, and the implementation of such planning has also been relatively untested in this country. It was foreseen that, while public participation in the planning process was important throughout the progress of this work, it would be most essential in its implementation. "Public understanding and support of the policy objectives will be necessary, and the continual testing of policy and design against public response will be required to ensure that support. Administration and enforcement of programs in support of policy will probably reveal some error in initial work, and it is important that support of the effort continue unabated until the necessary adjustments are made, and the Plan operationalized."

In retrospect, the Appearance and Design Element's existence was due to these Sea Grant Principal Investigators' efforts which included: (1) the creation of the methodology, (2) the writing of the explanatory text, and (3) the drafting of the goals, objectives and policies. They also attended all hearings, spoke for the Element and answered questions. The criticisms, recommendations and support for the Element which were written and/or voiced at the hearings were evaluated by them and used in policy and text revision.

What they had sensed about the intensity of the work came to pass, for their schedule looked something like this: methodology used in the Element was developed following extensive field trips during the summer; first of four drafts of the Element was accomplished by July 1, for technical review; revised and expanded and distributed for public hearing by July 15th; after the first public hearing on August 2nd, intensive work on amendments and revisions of policies continued throughout the summer, culminating in two or more hearings on September 13 and 24th, the date of its adoption.

The goals of the Appearance and Design Element for the South Coast Region are to:

PRESERVE the coastal aesthetic amenities which already exist,

RESTORE those coastal aesthetic amenities, natural or man-made, which have been obscured, deteriorated or eroded, and

ENHANCE the aesthetic experience of the coastal zone for all who live there, work there, and travel there.

From Preamble: A Statement of Purpose
Appearance and Design Element
South Coast Regional Coastal Zone
Comprehensive Plan

The USC Sea Grant Program is justifiably proud of the outstanding achievement of this project, for it proves that Sea Grant can function within the community as a non-partisan, yet creative force.

WAVE ENERGY PERMEATION OF BREAKWATERS

Jiin-Jen Lee
R/CE-1

The San Pedro breakwater, which is used to protect the Los Angeles-Long Beach Harbor from the attack of ocean waves, is an example of rubble-mound construction made up of randomly-shaped and randomly-placed rocks protected with a cover-layer of selected stone. Although the breakwater undoubtedly provides essential wave protection for the main harbor and various branch basins for waves of shorter periods, this type of breakwater is still liable to wave energy penetration, especially with waves of longer periods. Harbor surging (also called seiche) has repeatedly been reported to occur in the main Los Angeles-Long Beach Harbor and its branch basins. The surging wave periods are longer than ordinary wind waves and are on the order of minutes or longer. Such harbor surgings have caused damage to ship mooring lines and adjacent structures as well as interruptions or delays in ship loading and unloading activities. In the past, problems of surge have been analyzed by assuming wave energy enters the harbor through the entrance, resulting in resonant motion within the basin; prior to this study there had been no attempt made to relate the portion of wave energy transmitted through the breakwater to the surging action in the harbor. Because of the significant, practical implication of a long-period wave penetration through the breakwater in relation to harbor surging and the lack of detailed knowledge of the effectiveness of the San Pedro breakwater with regard to long-period wave energy dissipation, this research project was initiated. Now, at the end of its third and final year of Sea Grant support, some rather interesting information has been produced.

To generate the necessary data, field experiments were conducted at the center section of the San Pedro breakwater, Los Angeles, California. Six wave sensors were mounted in pairs on three anchor blocks which nested on the sea bottom at three different sites, both inside and outside of the breakwater. The reason for placing two sensors at each block site was to assure that they would measure the same water surface elevation. Thus, when each of the wave sensors were used to form sensor arrays, confidence in the wave records was assured.

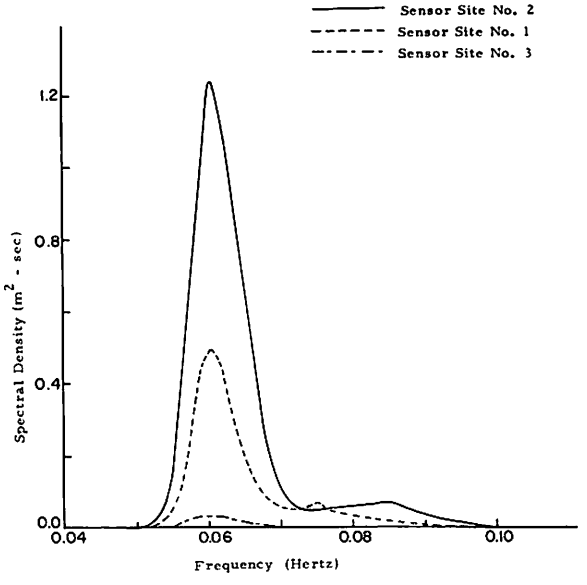


Fig. 1 - Spectral curves at three sensor sites at low tide condition.

Locations of the three sensor stations were as follows: station no. 1 was on the ocean side at a distance of 770 feet from the breakwater; station no. 2 was also located at the ocean side and 370 feet away from the breakwater; and station no. 3 was on the harbor side of the breakwater. To accompany the sensors, a breakwater electronic unit on top of the breakwater and a shore station electronics unit—all connected by undersea cables—were utilized. Information concerning the transmission characteristics of ocean waves through the breakwater and possible sources of wave energy through the breakwater that contribute to water surface oscillation within the harbor were gleaned from these measurements. The sensors, along with their associated electronic systems, were both developed and installed by the project's researchers.

Typical results are presented in Figures 1 and 2. In Figure 1, the observed data were taken during low tide condition, and it shows the power

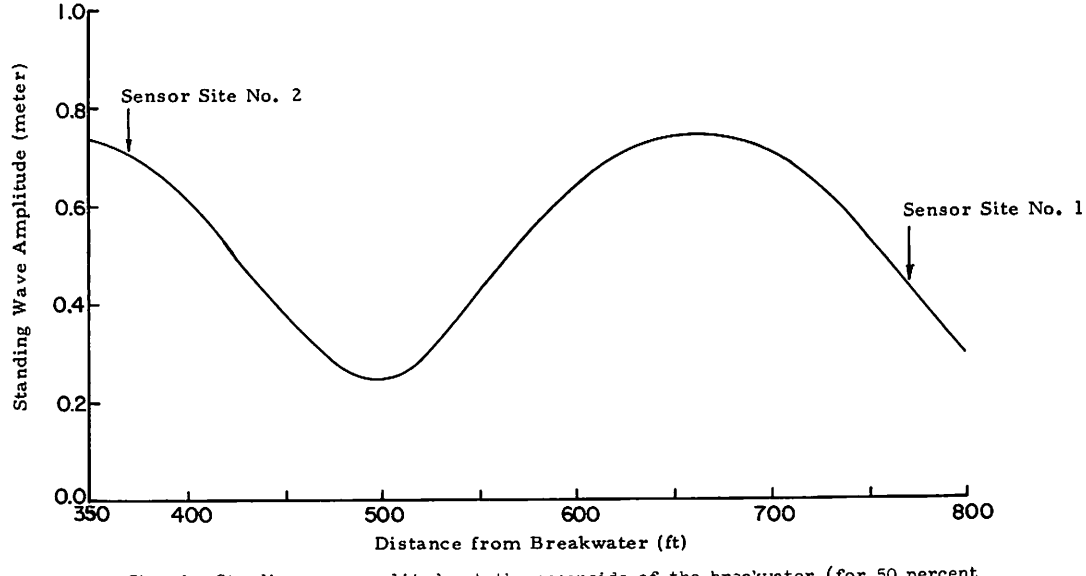


Fig. 2 - Standing wave amplitude at the oceanside of the breakwater (for 50 percent reflection coefficient).

spectra at the three sensor locations at the ocean bottom. It can be seen that the energy spectra have quite narrow frequency bandwidth with the maximum density center on wave frequency 0.06 Hz which is equivalent to wave periods of 16.6 seconds. By analyzing the area of the spectral curves as well as the standing wave pattern for the partially reflected waves at the ocean side location, it was determined that 50% of the incident waves of a 16.6 wave period were reflected back to the ocean; 30% of the waves' energy was transmitted to the harbor side; and 20% of the waves' amplitude was dissipated by the breakwater as the waves passed through the porous spaces of the rocks. In figure 2, data taken during high tide condition is noted. Although the major difference between Figures 1 and 2 is the absolute value of their spectral density, it is interesting to note that the relative values among the three stations are approximately the same.

All the data that were gathered proved consistent, but there were far more interruptions of information collection than were planned on. These instrumentation problems arose in several areas. The initial design philosophy for the instrumentation system was based on the premise that gradual failure of the seafloor cable insulation would occur with time. This would degrade the data in an undetectable fashion if voltage or current levels were used to transmit the information. In order to provide reliable transmission of sensor readings through poorly insulated cables, the frequency modulation technique was used. However, all cable problems experienced, except for a single case, were due to catastrophic failure rather than gradual degradation of cable insulation. Both the array to shore station and the breakwater to wave sensor cables were broken with monotonous regularity, probably due to ship anchors snagging the cable and pulling it until it broke. To eliminate this unavoidable problem of cable breaking, an alternative system was installed which utilized radio transmission between the data gatherer at the breakwater station and the shore recording station at Battelle. Measurements recorded by this new system were not completely analyzed before the project funding was exhausted.

The second portion of this project was to develop an analytical model for harbor resonance studies that included the effect of wave energy transmission through the permeable breakwaters. The method developed can be summarized as follows: for a given breakwater, the transmission coefficient (amount of energy transmitted) can be approximately calculated based on the hydrodynamic analysis of waves passing through the breakwater. After plugging the collected data into the model, it was found that for the same transmission coefficient, the computer-simulated breakwater should consist of a series of small segments of solid boundary with some openings between them.

All complicated modelling studies are built upon the theorist's most basic facts. For this model, the Principal Investigator knew that the wave periods associated with harbor resonance (surge) are quite long; therefore, the linearized, shallow water wave equation for wave amplitude within the basin was utilized. The domain of interest for the analytical problem was divided into two regions: the region in the open sea and the region circumscribed by the boundary of the harbor. The wave amplitude inside the harbor was expressed in terms of its velocity at the harbor entrance and at the opening between the segments of the computer-simulated breakwater. Similarly, the solution at the open sea region was also expressed in terms of its velocity at these common boundaries. Finally, by using the natural continuity condition—that the wave amplitude and velocity at these common boundaries must be the same for both regions—the velocity at the harbor entrance, as well as that at the opening between breakwater segments, could be determined. The final result can be expressed in terms of the amplitude response curve showing wave amplification at any location as a function of wave period.

It has been found that although large energy transmissions through porous breakwaters have a tendency to increase the chances of harbor surge, they also, at the same time, decrease the maximum wave amplitude for a particular wave oscillation. A detailed presentation of the theory and the results of modelling efforts is now under preparation. Altered to fit the specifications of individual harbors, this theory will be quite useful for harbor and breakwater planning and design.

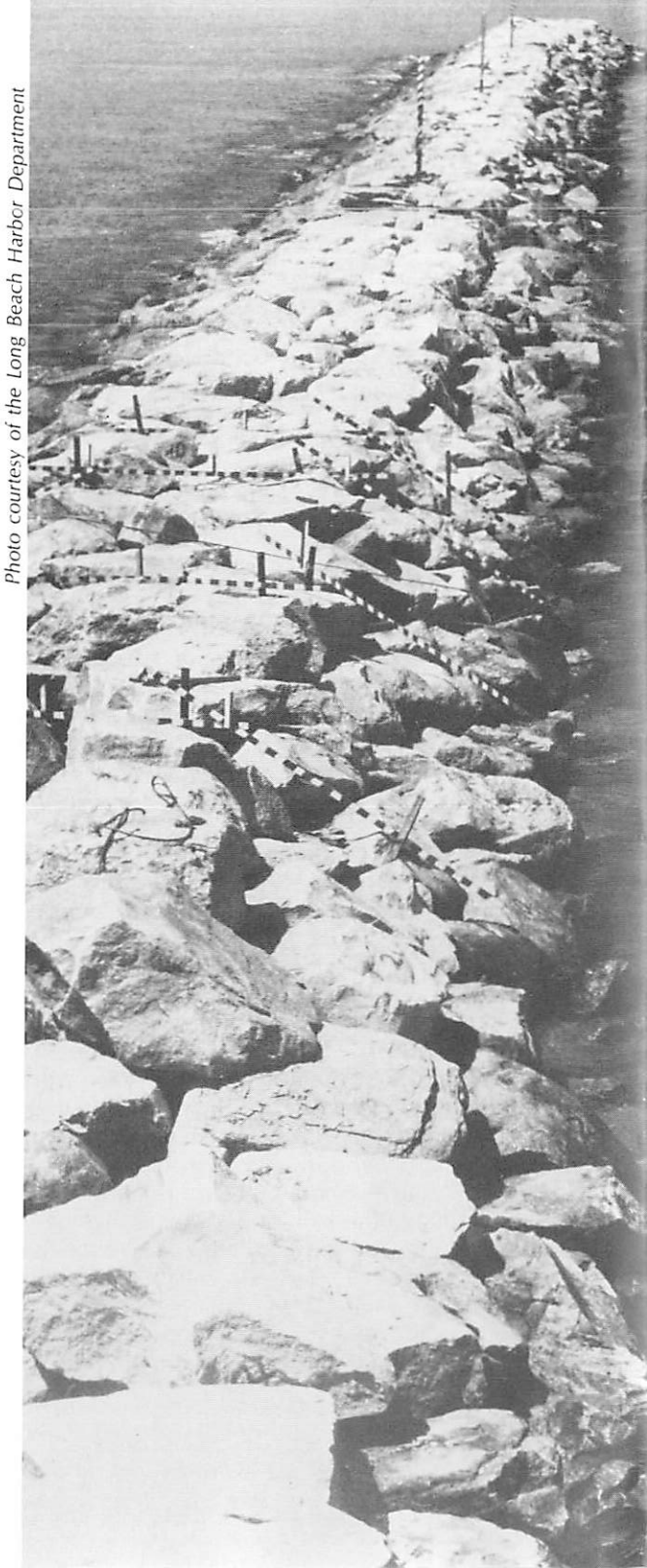
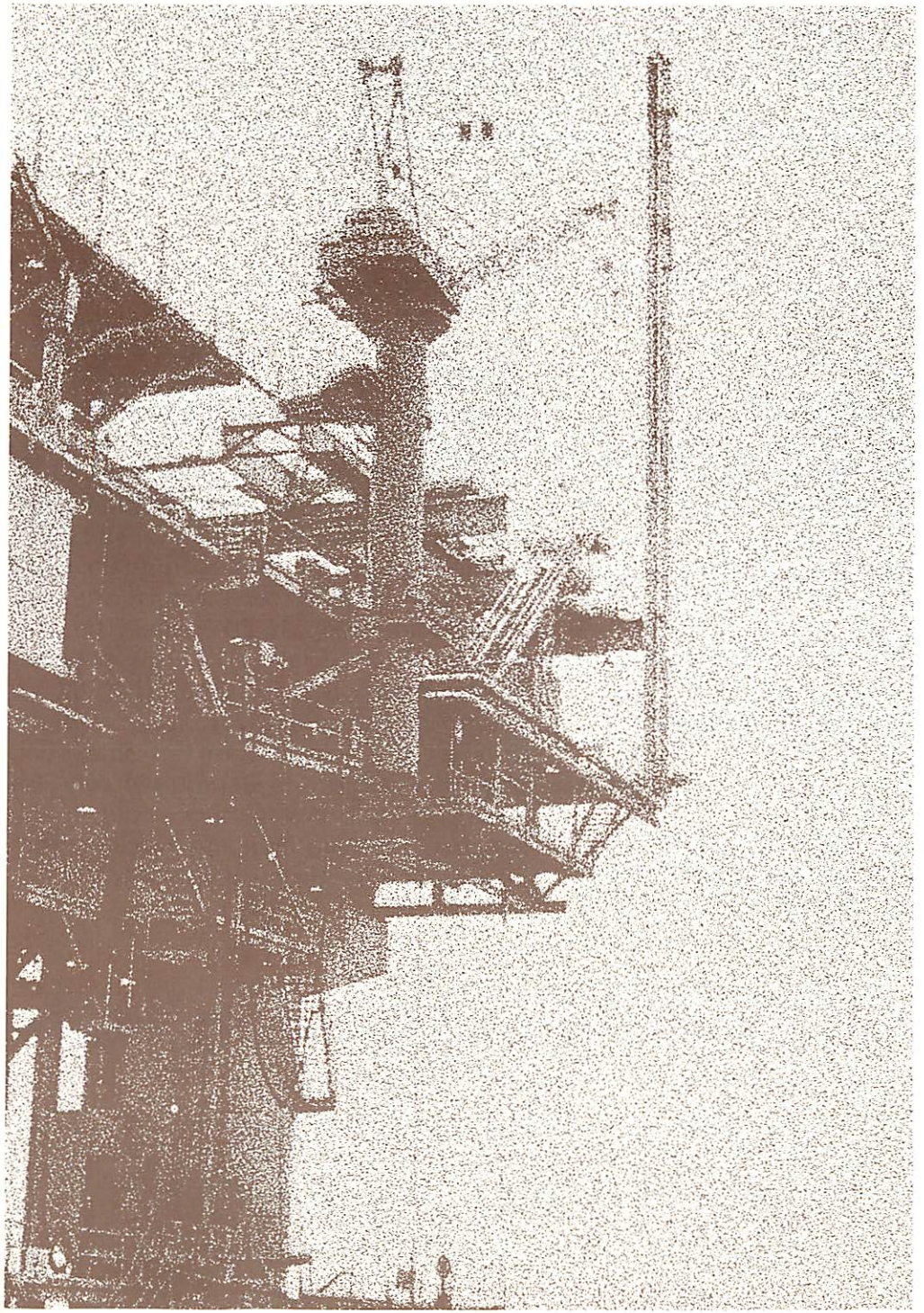


Photo courtesy of the Long Beach Harbor Department



Coastal

Resource

Development

As the problems of coastal zone management and planning become more complex, so does the terminology surrounding the issues. "Coastal resources" no longer refer only to the living resources with a home in the biological sciences. A "resource" now assumes a myriad of forms and can include:

- lithic and chemical constituents from the sea floor
- energy supplies from below the sea floor
- the coastal seawater column as a source of energy
- biomass as a source of food from the water column (commercial, recreational, etc.).

The increasing demand for resources in southern California to satisfy a growing and diversifying population's need for energy, construction materials, protein, and recreation attests to the timeliness of the Coastal Resource Development Program component. Active involvement in this area of concentration comes through the various multidisciplinary projects which the Program funds. From the biological to the sociological, Sea Grant is getting things done for southern Californians.

Currently underway is a project examining the geologic characteristics of oil and tar seeps off the shelf of southern California. Research has uncovered a previously unknown gas-seep province offshore and produced an up-to-date, active fault and seismicity map of the coastal zone.

Another ongoing project is tackling the prospect of offshore sand and gravel resources in California and the feasibility of its active utilization. Both of these projects fulfill immediate needs expressed by the State Lands Commission, Division of Mines and Geology and the California Coastal Zone Conservation Commission in their efforts to develop wise, comprehensive resource planning and management strategies.

The last project in this package deals with the study of surf grass habitats as a nursery for juvenile spiny lobsters; an animal much in culinary demand, but whose numbers have drastically decreased in the past 20 years. The surf grass, heretofore ignored in any environmental plans, is an essential habitat for these economically valuable animals. Knowledge gleaned from this study will help the California Department of Fish and Game to both effectively manage the resource and preserve the habitat itself, thereby enhancing local fisheries.

OIL AND TAR SEEPS ON THE SHELF OFF SOUTHERN CALIFORNIA

Thomas Henyey and T. F. Yen
R/RD-2

Due to the reopening of oil and gas leasing on the southern California outer continental shelf, the importance of recognizing the environmental effects of man-induced petroleum spillage versus that which is a result of natural causes, has been amplified. One very important aspect deals with the interaction of floatable oil and tars with commercial and recreational facilities such as beaches. The problem is innately two-fold: environmental and aesthetic.

Earlier Sea Grant sponsored studies have investigated the relationship of natural seepage and geologic structure on the shelf between Point Conception and Newport Beach using high resolution seismic profiling. Results indicated that most seepage could be associated with geologically youthful structural trends which are fault-controlled and generally occur in areas with little or not cover by unconsolidated sediments. In such areas, faults and/or truncated strata often intersect the seafloor.

We have extended the structural studies to include the relationship of seismicity to regions of active seepage. Inasmuch as areas of seepage are prime targets for offshore drilling, the seismic data is particularly useful in assessing earthquake risk (ground slippage, shaking, slumping, etc.) and blowout potential associated with drilling and platform deployment in such areas.

Regional coastal zone seismicity maps with a scale of 1:250,000 have been prepared using stations operated by the California Institute of Technology, California Division of Mines and Geology, U.S. Geological Survey, and the University of Southern California. Wide variability exists in the precision of epicenter location due to station distribution. Specifically, the paucity of stations west of the coastline rapidly degrades epicenter locations seaward. Following are the important conclusions:

- The general level of seismicity in the coastal zone is not appreciably different from that of greater southern California. Thus, the regional seismic risk is equally as high.
- The general level of seismicity appears to decrease westward across the outer continental shelf. A portion of this trend may not be "real" due to poor station control.
- The Los Angeles Basin and eastern Santa Barbara Channel—two major petroleum provinces—shows a higher than average level of seismicity.
- An east-west alignment of M(Magnitude) 4-5 events lies 5-10 km offshore and parallel to that portion of the Santa Barbara coastline along which the major offshore seeps exist.
- The recurrence interval for potentially destructive events (M 6-6.5 or larger) in the coastal zone is probably on the order of one every 25 years between Point Conception and Newport Beach.
- The recurrence interval for potentially destructive events (M 6-6.5 or larger) in the coastal zone is probably on the order of one every 25 years between Point Conception and Newport Beach.
- Based on fault length and past experience, earthquakes of Magnitude 7 are possible along NW-SE tending faults in the southern coastal zone (San Diego to Santa Monica) and outer continental shelf (south of the Channel Islands), while a Magnitude of 8 is possible along the E-W trending faults of the northern coastal zone (Santa Monica to Point Conception).

The primary emphasis of our work on oil and tar seeps during the past year has been directed toward the identification of the sources of beach tars, including whether they are man-induced or from natural seeps. Our approach has been through the chemical characterization of oils and tars from the marine coastal environments of southern California.

Oil and tar samples are obtained from three types of sources:

- Natural seeps, primarily in the Santa Barbara region, but also including seepage as far south as Redondo Beach;
- Southern California beaches between Point Conception and the Palos Verdes Peninsula; and
- Producing wells in the offshore coastal zone between Santa Barbara and Huntington Beach.

Inasmuch as tars on beaches may have spent a significant time in the marine environment between source and beach (perhaps weeks or months), many of the low molecular weight compounds are not preserved and, therefore, many of the standard analytical procedures such as gas chromatography are not particularly useful. This is shown through the accompanying figures which clearly illustrate gas chromatograms made at varying times after initiation of a controlled, laboratory experiment. Therefore, our analyses differ from those previous workers in that we are focusing our attention on the long-lived asphaltenes and their refractory components. In particular, we have been analyzing for sulfur and nitrogen content and specific trace elements including nickel and vanadium. A major part of our chemistry involves extraction and preparation of the asphaltenes.

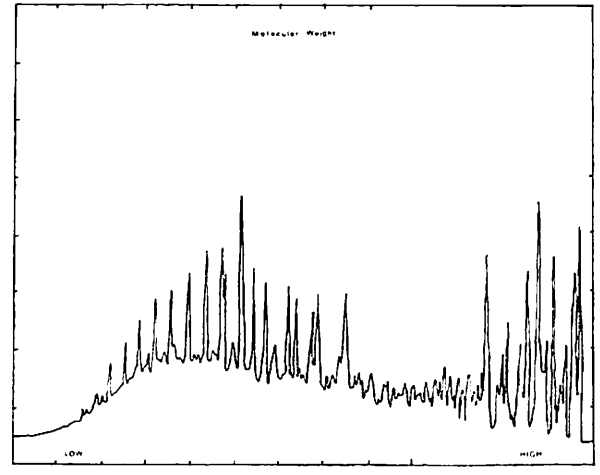


FIGURE 1. GAS CHROMATOGRAM OF CRUDE PETROLEUM

To date, more than sixty samples of oils and tars from approximately fifty dives on natural seeps have been collected. One hundred and forty beach tars have been collected on a dozen collection trips between Point Conception and Redondo Beach. Thirty crude oils from producing wells have been obtained with the help of the California State Lands Commission. Analyses on more than seventy asphaltene separates suggest the following conclusions to date:

- Total nitrogen content does not appear to be particularly useful for characterizing asphaltenes vis-a-vis source oils and tars.

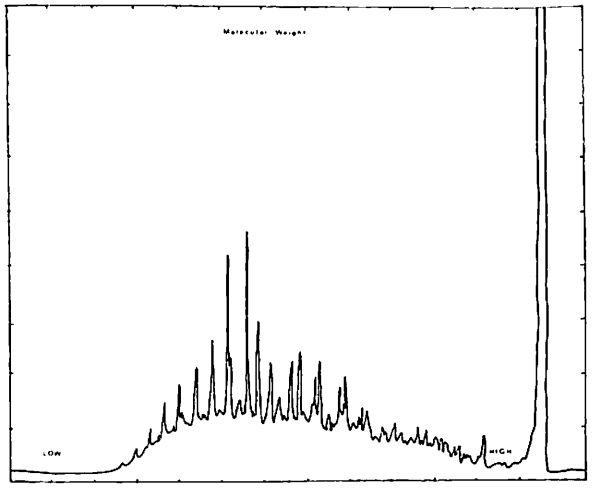


FIGURE 2. AFTER 24 HOURS OF CONTROLLED WEATHERING

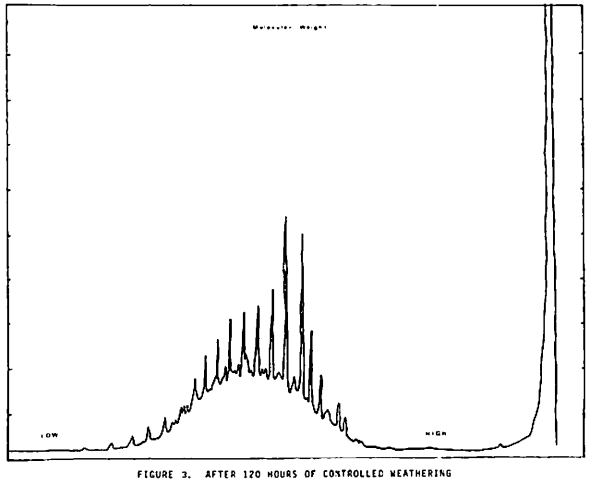


FIGURE 3. AFTER 120 HOURS OF CONTROLLED WEATHERING

• Total sulfur does show characteristic differences between petroleum provinces and beach tars can be shown to have sulfur contents characteristic of neighboring provinces. However, producing wells and seeps within the same province appear indistinguishable on the basis of sulfur alone.

• Trace element concentrations in asphaltenes appear to offer the best chance of success for identification of the specific sources of beach tars. It is this phase of research which is being actively pursued at present.

This study has focused solely on oils and tars from the southern California coastal zone. This

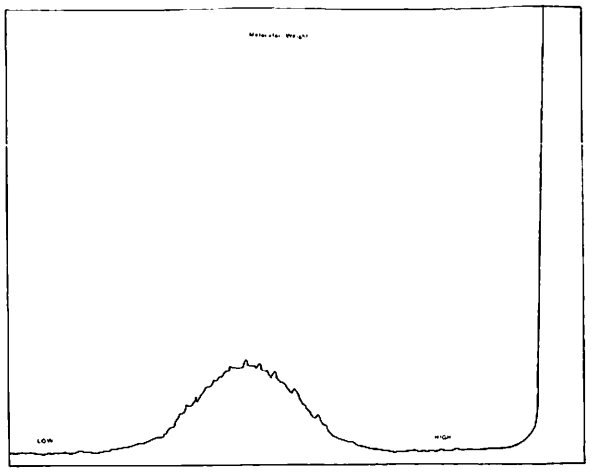


FIGURE 4. AFTER 360 HOURS OF CONTROLLED WEATHERING

fact must be borne in mind with respect to specific conclusions reached. However, it is quite clear that the general findings and methodology garnered from this work are exportable to other environments.

OFFSHORE SAND AND GRAVEL RESOURCES IN CALIFORNIA

Thomas Henyey and Robert Osborne
R/RD-3

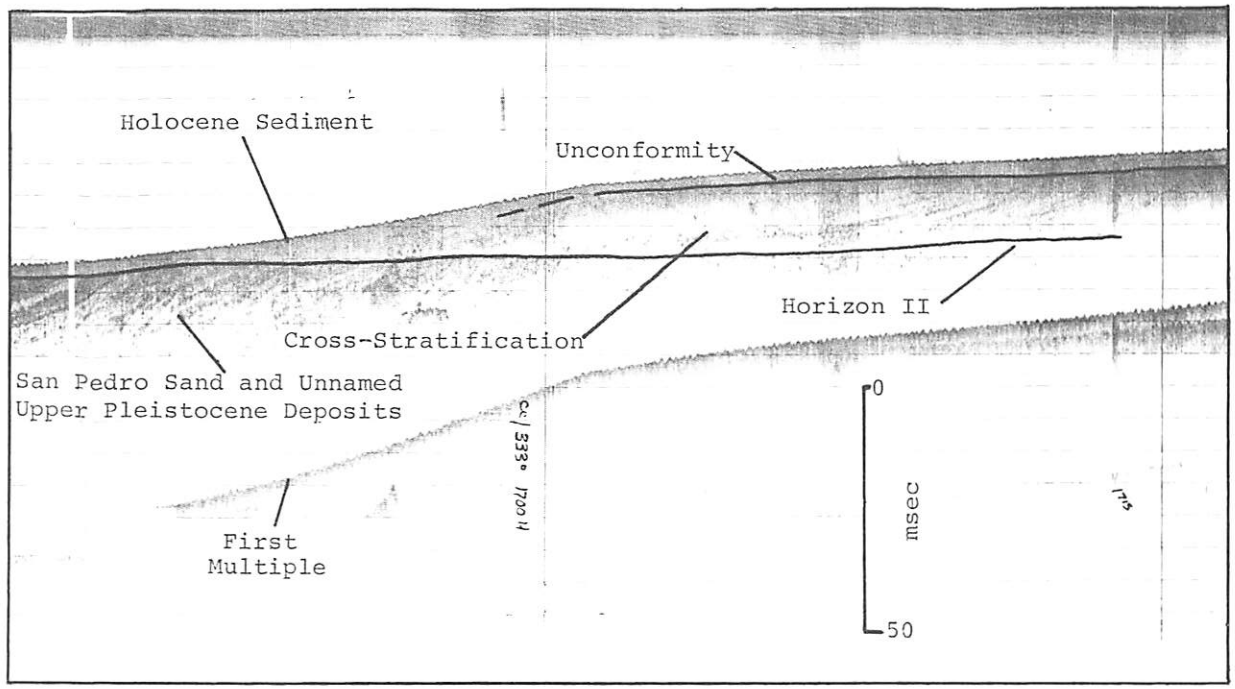
State and local agencies have forecast shortages in sand and gravel aggregate as well as sand for beach replenishment in the southern California coastal zone within the next 10-15 years. These shortages are not so much the result of dwindling resources, but rather due to environmental pressures and land use conflicts in regions of existing supplies, coupled with the high cost of transportation. These economic and sociological pressures make the idea of alternative sources attractive. The scope of this project over the past fiscal year has been the assessment of sand and gravel potential on the southern California shelf adjacent to metropolitan Los Angeles. Specific areas under study have included the Santa Monica and San Pedro shelves. In addition, two special purpose sands have been investigated: a glass sand in Monterrey Bay and a carbonate shell sand (used for building purposes) on Cortes Bank in the southern California borderland.

The sand and gravel potential on the Santa Monica and San Pedro shelves has been investigated using a combination of bottom samples and 3.5 kHz high resolution, seismic profiling, coupled with a general geologic analysis of the shelf and adjacent coastal lands. Late Pliocene and Quaternary sedimentation in the area has been largely controlled by both faulting along the Palos Verdes and related faults, and the formation of associated *eneschelon* folding.

Tectonic and eustatic sea level changes during Quaternary times have exerted a profound influence on the most recent sediments. An important source of sediment to these shelves has been the ancestral and modern mouths of the Los Angeles, San Gabriel and Santa Ana rivers.

Using the high density 3.5 kHz profiles, isopach maps of the Pleistocene and Holocene unconsolidated deposits of the two shelves have been prepared. As an example, internal sedimentary structure as revealed on the seismic records permitted the delineation of at least four sedimentary units on the Santa Monica shelf south of the City of Santa Monica. Figure 1 clearly shows this internal structure. At least one unit appears indicative of a prograding, nearshore deposit formed in response to a regressing sea. Additional evidence suggests that during much of Pleistocene time—perhaps into the Holocene—seaward uplift of the offshore segments of the Palos Verdes fault resulted in a damming of sediments on both the Santa Monica and San Pedro shelves, perhaps resulting in a relatively thick wedge of relict sands on portions of these shelves.

This project has also prepared maps of the surface sediment distribution in Santa Monica and San Pedro Bays which were compiled from both existing data and from grab sampling during the course of our work. These maps are, at best, marginally useful in identifying sand and gravel prospects; the upper few tens of centimeters sampled by the typical grab sampler reflects, to a large degree, present day oceanographic and sediment

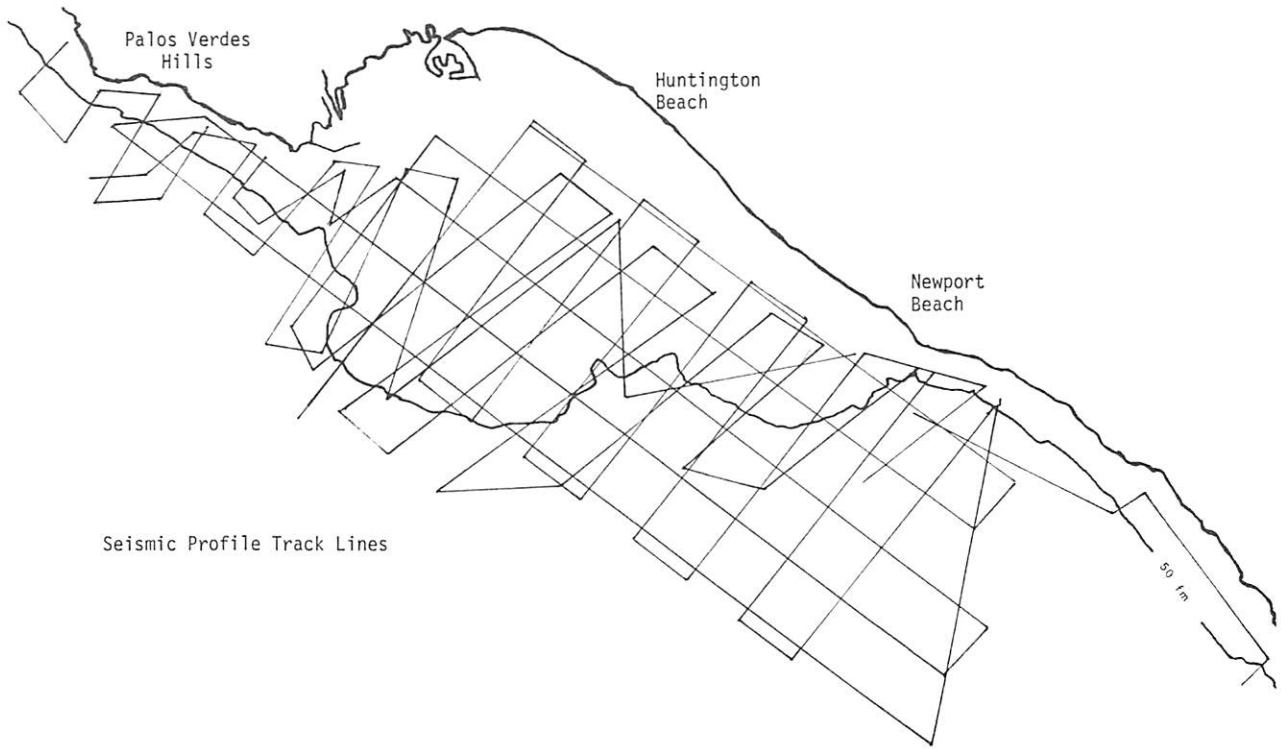


supply characteristics. Thus, a veneer of very young or reworked older sediments may overlie material of potential interest. A used vibracorer has just been acquired and is being refurbished for deeper penetration into target areas delineated on the basis of both the sediment distribution maps and high resolution seismic profiles.

Conclusions to date are as follows:

- Targets for potential sand and possibly gravel include the ancestral and present day mouths of the major drainages—Ballona Creek, Redondo Beach and Huntington Beach, and relict sands on the inner shelf—principally that unit showing progradational cross-stratification.
- The abundance of gravel on the shelf is probably small but may be important locally, particularly at river mouths or where older Pleistocene deposits (San Pedro Sand?) are preserved.
- Relict sands may be a good source of supply for beach replenishment.
- The nature (extent and character) of deposits will remain virtually unknown until depth and sample control is provided by vibracoring.
- Economic feasibility will depend on location and nature of the deposits, coupled with capitalization costs. Engineering factors probably do not present important constraints, but environmental factors do.

Recently, a spin-off study has been completed on the source of high-grade, silica sands in Monterrey Bay. These sands are used extensively in the manufacture of glass, and are rapidly dwindling. From examination and comparison of grain size parameters, lithologic composition, and surface features of sand from beaches of southern Monterrey Bay and from all potential sand source areas, it was concluded that the most important sources of medium and coarse grained sand for the southern Monterrey Bay beaches are erosion of coastal dunes and landward migration of sand from relict or modern offshore surficial deposits. The Salinas River may be contributing appreciable quantities of medium to course grained sand to the southern beaches, but only during floods. The studies stress the large differences in possible sand budgets for the area and suggest that an accurate knowledge of sand budget is requisite to sound management of this resource.



Finally, a study in the final stages of completion deals with carbonate sands on the Cortes Bank of the outer continental shelf. Preliminary geophysical data suggests that this bank is covered by a 1-2 meter veneer of unconsolidated sediments which may locally thicken. Chemical analysis of these materials shows that a significant percentage of them are in excess of 95% calcium carbonate ($CaCO_3$). The commercial value of carbonate sands increases exponentially with each percentage point of $CaCo_3$ content over 95%. Maps depicting textural characteristics and petrofacies of the surficial sediments are being prepared from samples collected for USC by the U.S. Geological Survey. The vertical extent and character of these deposits will remain unknown until a vibracoring program can be carried out.

Funding for this project ceased with the fiscal year; however, research is still going on because of cooperative efforts with the oil and tar seep study.

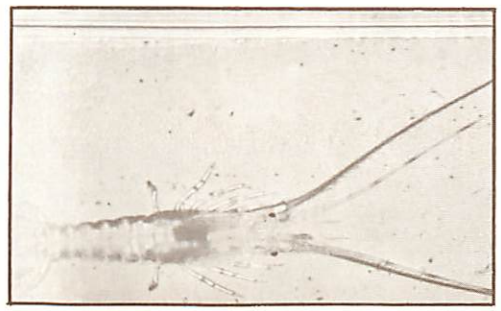
THE SURF GRASS HABITAT AS A NURSERY FOR JUVENILE SPINY LOBSTERS

Kristian Fauchald
R/RD-6

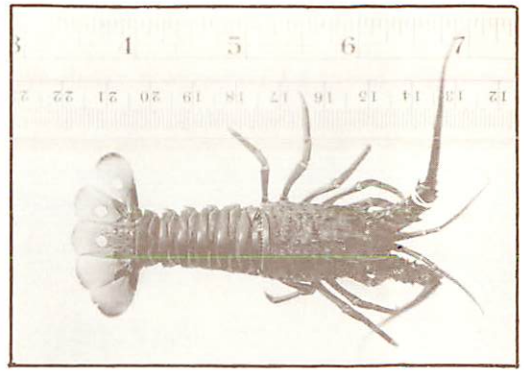
California's spiny lobster (*Panulirus interruptus*) fishery was once a valuable enterprise; however, the 1974 harvest was the second smallest since 1888. The severity of the decline in commercial production prompted the California Department of Fish and Game to investigate the fishery and to attempt to devise several means for increasing the number of marketable lobsters. However, most of these studies emphasize adult lobster ecology, seemingly forgetful of the fact that the survival of the juvenile stages will determine the adult population size in future years.

Surf grass (*Phyllospadix* spp.) is a submersed, marine vascular plant found in dense beds on surf-swept rocks just below the 0.0 tide level. Recent studies indicate that these grass habitats are occupied by juvenile lobsters. Surf grass can provide food, concealment and environmental protection for juveniles, allowing them to grow rapidly in the warmer, well-oxygenated surface water. Demonstration of the importance of surf grass for juvenile lobsters will provide data necessary for a proper management program for both resources so that surf grass and lobster will not be adversely affected by coastal zone modifications and that both sport and commercial lobster fisheries can be enhanced (for example, by the creation of new surf grass habitats through transplantation programs). As McRoy stated in his concluding remarks at an international workshop on sea grass: "The significance of the overall contribution of sea grass ecosystems to the ecology of the coastal oceans can not be adequately evaluated on the basis of available knowledge. The evidence, although scattered, is sufficient to emphasize the timeliness of the need to document and understand the role of sea grass ecosystems before the pressures of an overpopulated world's technological expansion unwittingly destroy the living marine resource of the sea grass meadows."

The objectives of this three-year pilot program are divided into four phases: 1) coastal diving surveys to establish the distribution and abundance of juvenile lobsters and surf grass; 2) controlled laboratory studies in combination with field mark and recaptures to ascertain the natural growth rate and population density of juvenile lobsters; 3) laboratory and field investigations to determine the activity patterns, feeding habits, and predators of juveniles; and 4) puerulus larvae capture phase to determine the time of settlement and to evaluate benthic habitat selection.



Puerulus larva of spiny lobster



Juvenile spiny lobster

During the 1974-75 Sea Grant year, 407 juvenile lobsters were captured by hand during 118 hours of diving at Santa Catalina Island. Despite searches in non-surf grass areas, all but 25 of these were caught in *Phyllospadix* beds. A marking system consisting of punched uropods, clipped pleopods and cut spines was developed for individual lobster recognition. Of 295 juveniles marked and released, 132 were subsequently recaptured one or more times throughout the year.

Several trips to Baja California, center of the geographic range of *Panulirus interruptus*, revealed extensive surf grass areas, some extending hundreds of meters offshore. Survey dives there were limited by harsh surf conditions and limited access to the water.

Fecal content analyses of 200 juveniles showed that molluscs are the most frequent and most abundant recognizable food organisms in their diet, followed by coralline algae, fish eggs, crustaceans and surf grass. The gastropods *Amphithalmus* and *Barleeia* are the most important individual food items. Preliminary analyses of fecal material from juveniles captured in non-surf grass areas indicate that different species of molluscs are eaten. A sample program analyzing live molluscs present in both habitats has shown that more genera (34 vs. 9) and more individuals (2210 vs. 79) are available as food for juveniles within the surf grass habitat.

For 31 juveniles raised in light-controlled laboratory aquaria, increase in length and weight per molt were found to be directly proportional to the size of the premolt lobster. Carapace length in-

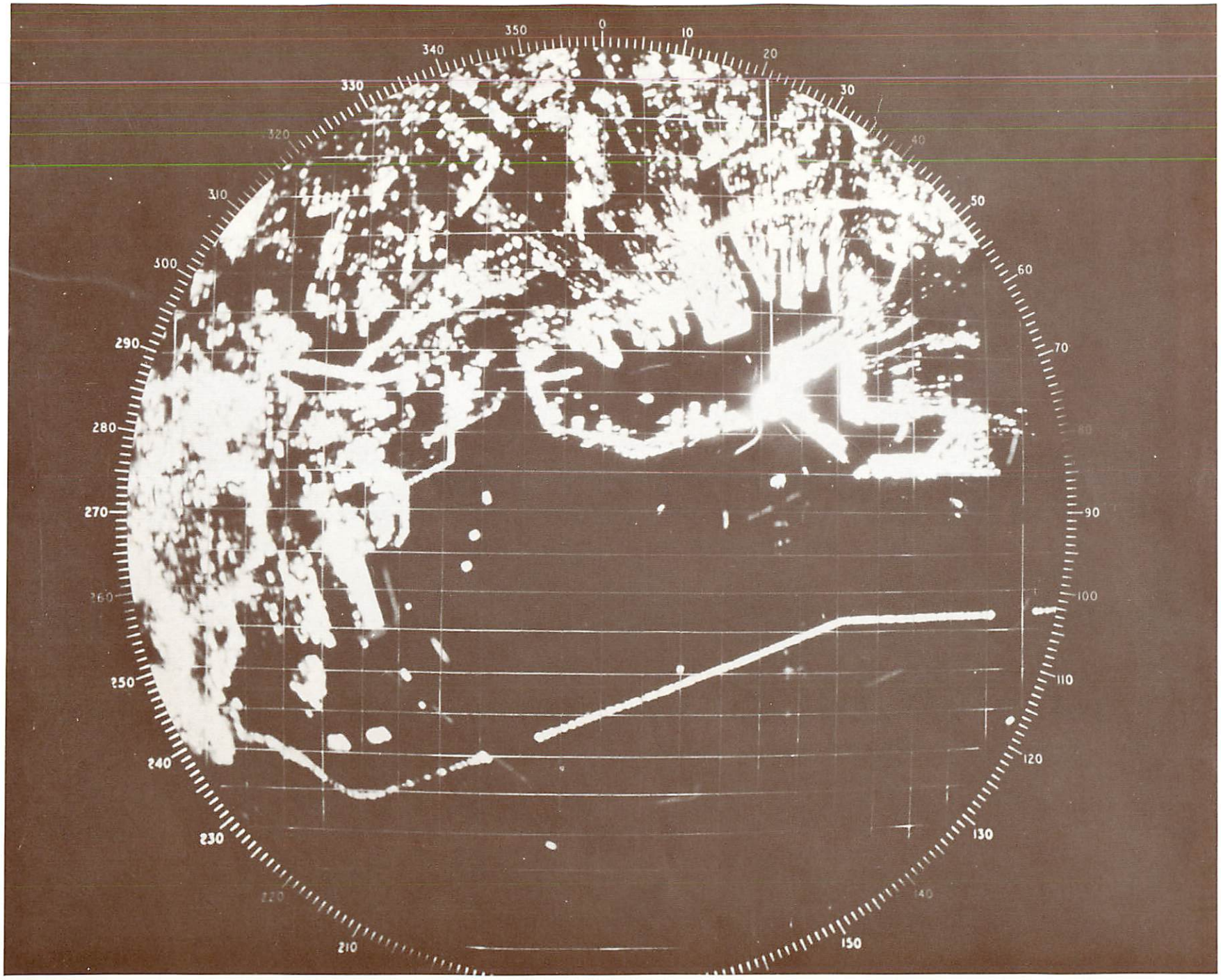
creased roughly thirteen percent each molt. Intermolt time was found to be directly proportional to the size of the lobster and inversely proportional to the water temperature. For 500 lobsters, the power curve relationship of carapace length to weight is:

Weight = (0.0008) (Carapace Length) 3.021.

Growth parameters of laboratory juveniles were not significantly different from those of field juveniles when compared using size-frequency analyses, individual molt increments and mark-recapture data. The acquisition of additional growth information will permit construction of a model of lobster growth for the first two years of benthic life.

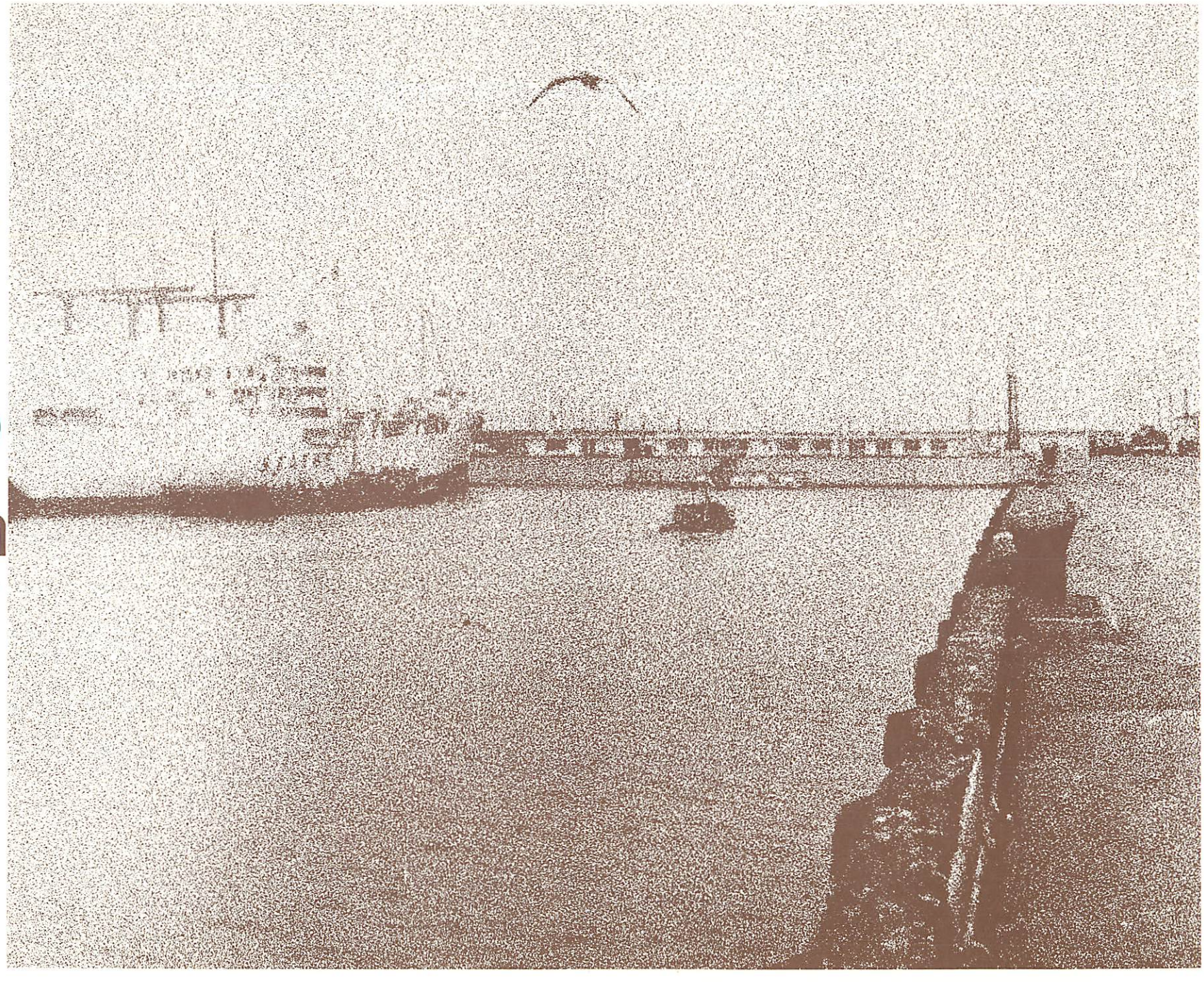
With one year of results gathered, it is being realized by biologists and legislators alike, that sound biological data on the growth, food, population density, mortality, and habitat of juvenile spiny lobsters—largely lacking at the present time—will become an extremely useful tool for fisheries enhancement.

Coastal



Zone

Environmental Quality



Another portion of Sea Grant research is directed towards Coastal Zone Environmental Quality with its emphasis on the measurement and prediction of the effect of urban development on nearshore marine environments such as semi-enclosed bodies of water, i.e., estuaries and harbors. One project involves the study of the environmental quality of storm drain water runoff to the ocean in conjunction with land use characteristics. The object? . . . to learn how these runoffs influence the marine organisms.

A cluster of research groups constitute the Sea Grant *Harbor* projects. As a team, with the Los Angeles-Long Beach Harbors as its geographical area of concern the researchers identify problems and design lab or field research for the users, i.e., U.S. Army Corps of Engineers, Tuna Research Foundation, to name a few. One group has been examining the presence of coliform bacteria and other organisms having a public health significance. They also keep tabs on Red Tide occurrences and the BOD (Biochemical Oxygen Demand) of the water—an excellent *harbor health* indicator. Another group is analyzing harbor health using the benthic organism, *Tharyx* (marine worm) as a possible indicator. Since different animals have definite levels of pollution they can tolerate and still survive, the examination of benthic life can pinpoint problem areas. Another component is studying the effects of pollution on the Harbors' fish population. Incidences of tail rot and bone, gill and fin deformities have been noticed. Since the installation of LNG, fossil fuel and nuclear power plants are afoot in the Los Angeles Harbor, their effluents would carry a substantial volume of chilled and heated water. The next group of researchers are examining the thermal tolerances of the economically valuable anchovy within the Harbor. After all, it's not just pollution that can destroy an organism.

Wrapping up this group of projects is the on-going, four year study of the sewer outfall at Avalon, Santa Catalina Island. Here is a unique case where for years, essentially raw sewage (transported by seawater) has been discharged into the ocean. Over the years, the biota have adapted to the nutrient-rich water and now, with EPA standards, a new, fresh water, highly chlorinated treatment system will be effective soon. What will be the effect on the marine life? Chlorination . . . for better or for worse . . . ?

The activities within this programmatic area are conducted by research teams from the School of Engineering, the Departments of Physics, Chemistry, Biological Sciences and Geological Sciences, with the direct assistance and cooperation of socioeconomic areas such as the Graduate Program of Planning and Urban Studies and the School of Public Administration. Therefore, even though the projects represent scientific and technological fields, the multidiscipline team approach makes it possible to address the needs of resource management both from an industrial and a public agency point of view.

STORM WATER QUALITY AND LAND USE CHARACTERISTICS

Frank R. Bowerman and Kenneth Y. Chen
R/CE-4

In response to a mid-year request from the California Coastal Zone Conservation Commission for information regarding the quality of storm water discharge from small drainage systems, the Los Angeles County Flood Control District (LACFCD) and the USC Sea Grant Program jointly undertook an effort to investigate the environmental quality of storm runoff to the ocean from small drains.

The water quality of big drainage systems had been studied to a limited extent by the District, its designated contractors and the USC Sea Grant Program. However, information on the water quality of small systems was not available. Preliminary analysis by LACFCD indicated there would be limited environmental effects from storm water discharge; however, more extensive data and comparison were deemed necessary to evaluate any potential effects.

The problem rested in the fact that as a regulatory agency charged with responsibility for the protection of the coastal environment, the California Coastal Zone Conservation Commission required scientific data on possible water quality effects in order to act on applications for construction in the coastal zone. However, it was up to the Los Angeles County Flood District, the operational agency with specific responsibility for flood control, to upgrade these types of facilities, especially in areas that were not served by large drains or channels.

In order to assist both governmental parties, an 18-month study was conducted on the characteristics of surface runoff — both dry weather stream flow and storm water runoff — and their possible ecological impacts on the southern California coastal waters in terms of pollutant loading.

In terms of specific research milestones, the Principal Investigators wanted to examine: land use and population; transport of surface pollutants by runoff; precipitation and river low patterns; characteristics of sediments in rivers; settling characteristics of storm water; interaction between storm water and seawater; transport phenomena of trace metals in a river system; and mass emission rates of pollutants.

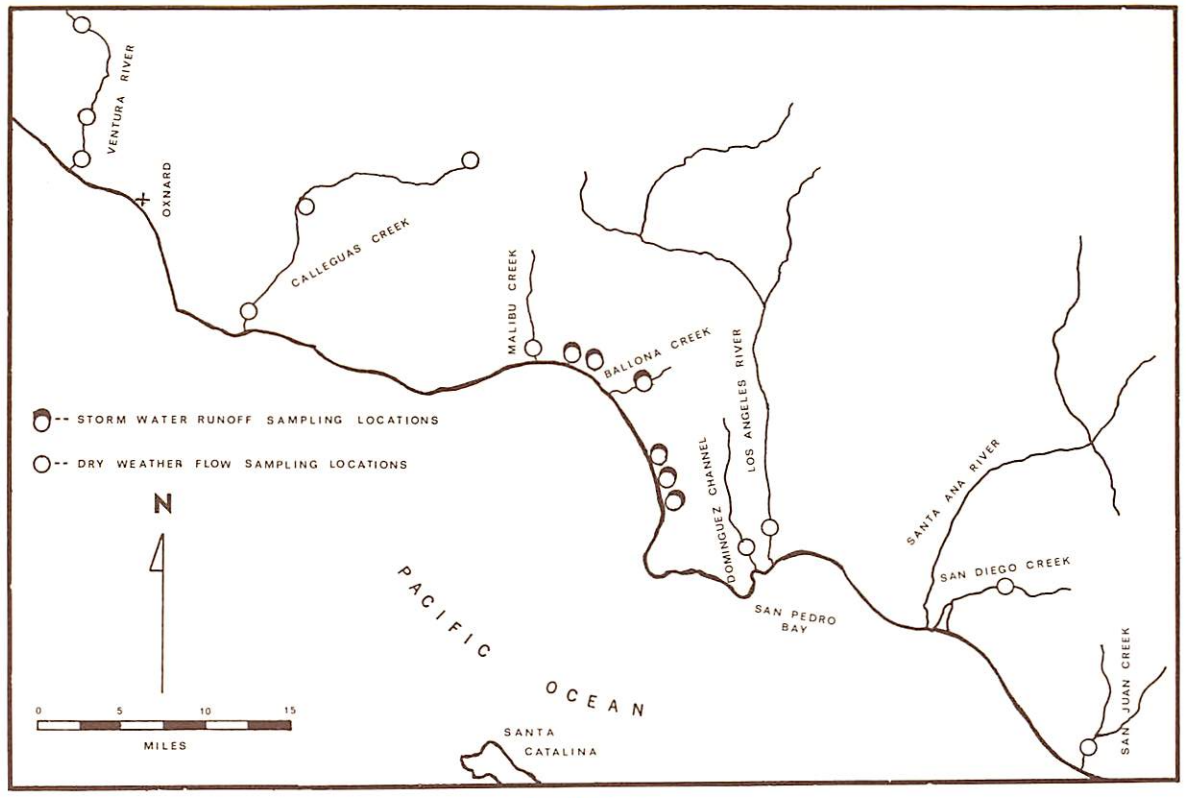


FIGURE 1

SAMPLING LOCATIONS IN THE STUDY AREA

During 1974, eight major rivers in the drainage basin of Ventura, Los Angeles and Orange Counties were investigated. Figure 1 presents the sampling locations in the study area. Surface water samples from the eight rivers were collected each month during 1974. Most of these rivers are used mainly for flood control purposes, and therefore, have relatively low flow rates during the dry season. During the storm season, from October 1974 to March 1975, a total of seven sets of storm water samples were collected with the assistance of the LACFCD for laboratory analysis. The tests run on the samples were performed for the determination of the following characteristics:

- General characteristics: pH, dissolved oxygen, turbidity, conductivity.
- Oxygen consumption effects: chemical oxygen demand, five-day BOD, total organic carbon.
- Aesthetic effects: oil and grease, floatable and settlable substances, total and volatile suspended solids.
- Toxic effects: mercury, lead, cadmium, arsenic, copper, chromium, nickel, and zinc; PCB (arocholor 1242, 1254 and 1260), lindane, BHC, heptachlor, aldrin, heptachlor epoxide, methoxchlor, chlordane, toxaphene, dieldrin, DDE, DDD, O and P DDT, and endrin; sulfides; hydrocarbon; cyanide; and phenols.
- Biostimulants: Nitrogen (various forms), phosphorous (Phosphate), and dissolved silica.

The mass emission rate of each parameter was obtained by the concentrations and hydrograph data and each rate has been used to evaluate the possible pollutant contribution from small drains in comparison with other dischargers such as: sewage lines, storm channels and rivers, and industrial input drains. Sediment samples were also collected from several rivers for comparison with

marine sediments to try to determine their basic differences. From that information, certain theories on how they react to and with various possibly polluting elements might be determined.

Table 1 is illustrative of the various tests performed and the conclusions which have been drawn from the study results may be summarized as follows:

- Storm water runoff during 1974-75 contributed more than one-half of the total pollutants discharged into the coastal waters of the Los Angeles Basin, with highest total mass emission rates from the storm drain system in the Santa Monica Bay area.
- Storm water concentrations of suspended solids in Ballona Creek and the Santa Monica Canyon channel presented the greatest problem.
- Concentrations of suspended solids during dry weather flow, in most cases, met the California State Water Resources Control Board (CSWRCB) limit of 50 mg/1.
- Concentrations of NH_3-N in all surface waters were well below the CSWRCB limit of 40 mg/1.
- Total identifiable chlorinated hydrocarbons in all storm water runoff samples exceeded the CSWRCB limit of 0.002 mg/1.
- Total concentration of trace metals in dry weather streams, and concentrations of soluble trace metals in both dry weather and storm water flow, met CSWRCB limits, with the exception of chromium.
- Total concentrations of trace elements (especially Cr, Hg, Pb, and Zn) in many storm water samples did not meet CSWRCB standards. However, there appeared to be little difficulty in complying with the 50 percentile value (concentration not to be exceeded more than 50% of the time) for any consecutive 30-day period.
- A potential problem regarding the water quality impact of surface runoff is the association of trace contaminants with suspended particulates. Although there was no direct evidence of adverse ecological impact, the potential of increasing uptake of contaminants by filter-feeding organisms and certain species of algae cannot be minimized.
- The ecological impact, if any, of pollutants discharged into coastal waters would be an intermittent, short-term effect. It is expected that total concentrations of contaminants would be rapidly reduced to acceptable levels by tidal action and prevailing ocean currents.
- Land use patterns are believed to have an impact on the character of the storm waters. Directions indicated for further study might include collection of water samples from street surface runoff in different areas, as a means of further evaluating contaminant loading from the various land use patterns.

This information, now resting with the Los Angeles County Flood Control District, has been used to set guidelines for permit applications to construct drainage systems in the coastal area and as design criteria for planned storm drainage projects.

TABLE 1

Analyses performed on Surface Water Samples and Sediment Samples

Analysis	Surface water sample	Sediment sample
Temperature	yes	no
pH	yes	no
Turbidity	yes	no
Specific conductance	yes	no
Total suspended solids	yes	no
Total dissolved solids	yes	no
Moisture content	no	yes
Total volatile solids	no	yes
NH_3-N	yes	yes
Org-N	yes	yes
COD	yes	yes
TOC	yes	yes
Total phosphorus	yes	yes
Dissolved silicate	yes	no
Sulfide	no	yes
Chloride	yes	no
Trace metals (Cd, Cr, Cu, Fe, Hg, Pb, Ni, Zn)	yes	yes

INSHORE MARINE ENVIRONMENTAL RESEARCH

R/H-1-7

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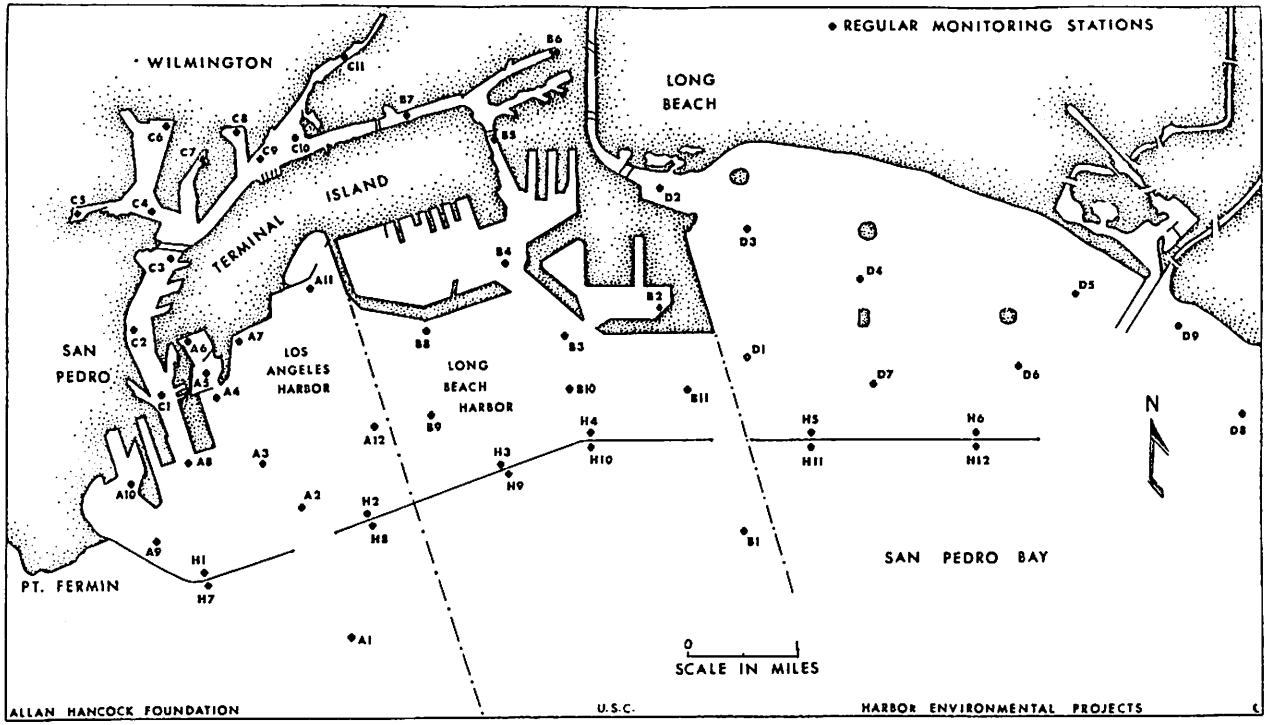
The Los Angeles-Long Beach Harbors had never had extensive biological, physical or chemical surveys until the initiation of the studies by Harbor Environmental Projects of the University of Southern California Sea Grant Program, in spite of the fact that it is one of the major ports in the United States and houses a Navy base. Under the impetus of the National Environmental Policy Act and subsequent legislation, private industry and public agencies found a need for environmental information that did not exist or was unavailable to them. Accordingly, a baseline survey and monitoring program was begun by the University for the outer Los Angeles Harbor in 1971, under sponsorship of Pacific Lighting Service Corporation and expanded in 1972 under the USC Sea Grant Program (Department of Commerce—NOAA) and contracts with the Los Angeles Board of Harbor Commissioners. The U.S. Army Corps of Engineers, Los Angeles District, in 1973 contracted to extend the program to cover the entire harbor, and added parameters to be studied.

In order to determine the probable impact of port development, the expanded cooperative effort has permitted the gathering of abiotic data on temperature, salinity, oxygen, pH, and turbidity through the water column, on nutrients such as ammonia, nitrite, nitrate and phosphate, on sediment character and the incidence of trace and heavy metals, and circulation patterns. Biotic measurements included phytoplankton, benthic organisms, microbiology, water associated birds, and ichthyology, as well as evaluating the biotic quality of the water column with settling racks.

Following field collection, weight or volume density determinations, identification of organisms to species level was carried out. All data were en-



tered in IBM 370 computer, and analytical techniques were performed to determine the significant relationships between the biotic and abiotic parameters.

A total of 43 stations was selected to be monitored for this study (see Figure 1). The locations selected were chosen to permit the optimal coverage of areas and expected patterns of variability within the scope of our facilities. These stations were divided into regional groups for convenience in dealing with the operational time and work load constraints involved in the program of sampling and data analysis. Group A, consisting of 12 stations, covers Outer Los Angeles Harbor, including Fish Harbor and the Los Angeles Harbor sea buoy. These stations were occupied during the first week of each month. The B group of stations was routinely sampled during the second week of each month. These stations were located in Long Beach Harbor at the Long Beach sea buoy. Stations in Inner Los Angeles Harbor were designated the C stations and were occupied during the third week of each month. The D stations, in the area to the east of Pier J, Long Beach, were sampled during the fourth week of each month. The usual day of the week when the sampling was carried out was Wednesday.

Monthly sampling at each station included instrumental measurement of water temperature, salinity, pH, dissolved oxygen and turbidity at one meter intervals through the water column. Surface water samples were collected for analysis of dissolved oxygen by Winkler titration, BOD, NO_3-N, NO_2-N, NH_3-N, PO_4-P and sulfide. Biological sampling included collection of surface water for determination of bacterial populations including coliforms, phytoplankton productivity and chlorophyll *a*. A surface tow was also made for zooplankton, using a 253 micron mesh ½ meter net equipped with a flow meter. Settling racks were deployed monthly at 24 stations throughout the harbor to sample water column fauna. Separate sampling operations were conducted for fish collections implementing gill nets and trawling procedures.

At approximately quarterly intervals each station was sampled for determination of sediment grain size and benthic fauna, using either a modified Reinecke box corer or a small Campbell grab.

Data records and samples were returned to the laboratory for further processing and analysis.

In the first years of the USC Sea Grant Program, the emphasis of the Harbor Environmental Quality Projects was placed on baseline studies of the local harbors, where no data base existed and the need was critical. This program, now completed, succeeded in drawing diverse participants into a comprehensive investigation which furnished each public and private entity with information according to their needs. Participants included the U.S. Army Corps of Engineers, the Pacific Lighting Corporation (Southern California Gas Company, Pacific-Alaska LNG, PakTank Pacific), the Los Angeles Harbor Department, the Long Beach Harbor Department, Tuna Research Foundation, StarKist Foods, and many other industries based in the Harbor. Another harbor area studied was very different from the heavily commercial Los Angeles-Long Beach area; it was the small recreational harbor at Avalon, Santa Catalina Island.

The final report of the Harbor Environmental Projects group has now been released which contains voluminous amounts of accumulated data based on individual project efforts and their respective methods of approach. To attempt to report each project's activities and findings separately in this document would not be possible. Therefore, a bird's eye of the group's findings, based on subject matter will be presented.

Abiotic Characteristics of the Harbor:

Overall, the patterns shown by the surface and benthic abiotic parameters reflects the importance of currents and flushing. The relatively limited water turnover in the waters of the channel, along with the input of various materials, is probably the cause of the consistently lower levels of oxygen, higher levels of nutrients and higher temperatures in the area. On the bottom, the currents in the vicinity of the dead ends of slips would be minimal and this is where very heavy deposits of heavy metals, pesticides and organics were found along with very low levels of oxygen and the associated COD, IOD and sulfide levels.

Mixing occurs due to ship traffic, resuspending the sediment. Wind-driven mixing occurs in the

outer harbor, but is less important in protected channels and slips. A seasonal thermal inversion leading to turnover has been measured in the fall months, also leading to resuspension of sediments. The toxicity of some of the materials adsorbed on sediments, along with the low oxygen levels, would be expected to have significant effect on the biota attempting to settle in these areas.

This situation is in contrast to the area around A7 and A11, which is in the vicinity of a sewage outfall and cannery effluents. The currents in this area are evidently sufficient to prevent a large build-up of toxic materials and maintain constantly low oxygen conditions. Stations D2 and D3 are also in the vicinity of an input of materials (the Los Angeles River). Evidently, the bottom currents here are not sufficient to prevent a considerable build-up in the area.

Phytoplankton Productivity: San Pedro Bay is subject to sporadic outbreaks of intense phytoplankton blooms, including red tides. These blooms vary in intensity and areal extent, and usually, but not invariably, occur during the warm weather months.

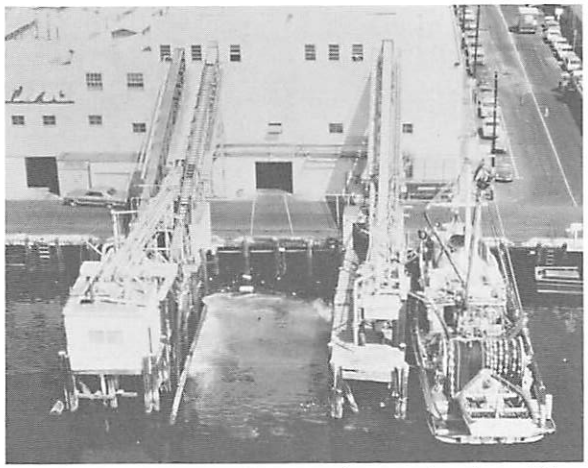
The effluents discharged into San Pedro Bay and their distribution by the currents and stirring in the area are major factors in establishing the overall patterns of phytoplankton abundance. The restricted flushing rate of San Pedro Bay, coupled with the nutrient inputs, results in the high levels of population and primary productivity and the frequent occurrence of the red tide blooms.

It is most interesting to note that the seasonal variations in chlorophyll a concentration and productivity within the Harbor coincide with the variations outside the Harbor, but show a far greater magnitude.

When this data is considered in the light of the proposed Harbor expansion, the results are not all that encouraging. The proposed alterations will result in reduced water area, increased channel depths and the creation of dead-end slips. The resultant changes in phytoplankton productivity and pigment concentration will vary considerably.

Reduced water area and increased channel depths tend to reduce productivity and chlorophyll concentrations by reducing the total input of light available for photosynthesis. If greater current velocities prevail in the inner harbor, the improved flushing will further promote a reduction in these parameters.

The dead-end slips presently in existence represent problem areas in the Harbor. They are subject to periodic blooms of different organisms whose occurrence is probably triggered by the release of some material discharged in the immediate vicinity. The poor flushing characteristics of those slips prevents the material from dissipating.



Canneries after stopping dumping of wastes into inner Fish Harbor

Zooplankton—Spatial and Temporal Distribution: With the amount of oceanographic work done off the California coast, it was surprising to note that virtually no planktonic research had been conducted in the Los Angeles-Long Beach Harbor prior to the present study. Because of this void, it was essential to start research toward establishing baseline information on zooplankton populations of the Harbor.

The objectives of this research were multiple. First, the distributional patterns of zooplankton were studied, on a gross basis comparing and contrasting zooplankton associations found with the geographic localities of the Harbors; and on a finer basis associated with points of particular interest, such as areas of chemical pollution, or eutrophication. The effect of seasons on the zooplankton population and distribution, and the degree of diversity within the Harbors were all investigated.

The zooplankton in the Los Angeles-Long Beach Harbor is dominated by the Crustaceans, especially the calanoid copepod, *Acartia tonsa*, whose mean numbers amount to 50% of all plankton animals. There are no other organisms in the zooplankton of the Harbor which approximate this degree of dominance.

The distribution of the dominant zooplankters divide the Harbor generally into two parts: the inner Harbor and the outer Harbor. The inner Harbor is represented by the C station series and certain of the B stations (B4-B7). The rest of the sampling stations are considered to be outer Harbor stations, although there are considerable differences among some of them.

As might be expected, environmental conditions in the inner Harbor are different from those in the outer Harbor. The strongest and most consistent differences are pH and dissolved oxygen. The inner Harbor has a lower reading for both parameters than does the outer portion. These and other conditions tend to limit species diversity within the Harbor; and if, as postulated, diversity is mark of community stability, it appears that the inner Harbor possesses a lower diversity and a less stable zooplankton community than the outer Harbor.

If much of the outer Harbor is filled as planned, this will decrease the total zooplankton content of the outer Harbor simply by eliminating much of the open water area. Since the zooplankton appear to be sensitive to levels of dissolved oxygen, dredging activities which would disturb anoxic sediments and distribute them throughout the water would probably temporarily affect the zooplankton in those areas dredged.

Water Column Fauna Sampled by Settling Racks: The water column of harbors and other marine areas with polluted bottom sediments may have a richer fauna than standard bottom sampling techniques may indicate. For this reason, settling racks were placed at 24 A, B and C stations throughout the Harbor during 1973 and 1974. The greater diversity of species and also of higher taxa collected by this technique indicated that it offers a means of evaluating the biological quality of the water column. The early stages in the life cycles

are generally more sensitive to stress, and thus, information from the newly colonized surfaces is particularly valuable in assessing the potential for recolonization where dredge and fill operations are anticipated.

Settlement activity of fouling organisms within the Harbor area has a definite seasonal pattern which was evidenced in both the temporal and spatial aspects of this study. The summer period of June, July and August represented the period of maximum settlement activity in the Harbor.

A quantitative survey of the polychaetes associated with the fouling organisms at monthly intervals for 17 months was conducted at five stations in Los Angeles Harbor. The survey indicated a gradient of pollution from the outer to the inner Harbor in respect to increasing discharge activity, decreasing dissolved oxygen and salinity, and increased turbidity and temperature. Each station was characterized by at least one unique dominant polychaete in an attempt to evaluate the degree of pollution in terms of indicator organisms. The most contaminated stations C7 and C10, were characterized by *Schistomeringos longicornis* and *Polydora ligni*, respectively. Polychaetes which indicated the "healthy" channel and outer Harbor stations included *Ctenodrilus serratus* and *Halosydna johnsoni*.

Previous studies of the Los Angeles-Long Beach Harbor area have generally been in agreement as to the nature or condition of the abiotic parameter on the Harbor. Abiotic gradients, which include lower dissolved oxygen, higher temperature, increased turbidity and decreased salinity occur in the inner Harbor. The major abiotic parameters which contribute to the environmental gradient within the study area were temperature and dissolved oxygen. Higher temperatures and lower dissolved oxygen levels contributing to the high stress environment within the inner Harbor, are modified with the amount of incoming seawater from the outer and outside Harbor areas. Secondary factors contributing to the abiotic gradient within the study area included turbidity and salinity. Higher temperatures and lower salinities in the inner Harbor environment are ameliorated by increased circulation of the waters from the outer and outside Harbor.

Proposed landfills and the eventual reduction in the major central seawater gyre, will greatly reduce the amount of circulation occurring in the outer and inner Harbor areas. A reduction in the influence of the outer Harbor and seawaters with their higher dissolved oxygen and lower temperatures, will result in an abiotic shift in the channels and inner Harbor. The presently defined high stress areas probably will be extended into the outer Harbor in response to limited water circulation.

The long term effects of the proposed construction on the fouling organisms would range from reduced numbers of individuals and species to complete exclusion of the presently defined low stress species now in the study area. A major shift in the biota would include an increase in the number of sites presently settled by those stress species.

Benthic Ecology: Consideration of the benthos is especially appropriate when dredge and fill operations are anticipated. First, it is benthos itself which is most directly affected by the removal of sediments in some places and deposition in others. Second, many pollutants tend to accumulate on or in the surficial sediments, either because they are heavier than water or because they adsorb onto particles that are heavier. Finally, the organisms which inhabit the benthos are generally immobile; if an area is adversely affected, such organisms cannot move to a more suitable environment, and they die or cease reproducing. It follows that the community structure among benthic organisms reflects conditions which have prevailed at a given site for some time before actual sampling.

The analyses performed produced a general picture in which the infaunal community closely reflected the abiotic conditions mentioned earlier at each site. The outer stations supported a relatively diverse and abundant infaunal community; abiotically, these stations were characterized by higher levels of dissolved oxygen and relatively low levels of a host of pollutants—heavy metals, DDT, PCB—and indicators of a low oxygen environment, sulfide and IOD.

The inner group supported a relatively depauperate infauna, noteworthy for the fact that several of its regular inhabitants were frequently used as indicators of polluted or otherwise highly stressed environments. Abiotically, stations in this group characteristically had a low level of dissolved oxygen and high levels of the above-mentioned pollutants and indicators of low dissolved oxygen. In addition, the organic load in the inner stations was generally higher than elsewhere, as was the amount of oil and grease in the sediments.

The channel group of stations was intermediate between the other two groups in most respects. Faunistically, it supported an assemblage which is transitional between that of inner and outer station groups. The levels of pollutants were generally between the inner and outer extremes, as was the DO level.

The available evidence indicates that the differences between outer and inner Harbor are two-fold in origin: high input of pollutants and generally poor circulation.

There is considerable difference between the impact of toxic trace and heavy metals, pesticides and refined petrochemicals, and natural wastes such as sewage and cannery effluent. Natural wastes impose heavy oxygen demands but can be assimilated readily into the food chain. Toxic wastes may inhibit, destroy or prevent certain faunal groups from inhabiting a given area.

If toxic inputs ceased, the present circulation would, with time, probably allow for eventual oxidation of contaminants and/or their removal from the immediate area. On the other hand, so long as input continues, dramatically improved circulation would be required before benthic conditions in the inner regions would come to resemble those of the outer Harbor.

The effects of dredging on the marine benthos are of several sorts. They may be direct or indirect, immediate or delayed, permanent or temporary.

The dredging process itself will disrupt the benthos and affect benthic communities in one or all of three ways:

- The processes of dredging and filling will resuspend quantities of bottom sediment; deposition of the fines in adjacent areas will eliminate species well removed from the actual site. Sessile infauna will be smothered and epibenthic organisms may suffer death from suffocation or the release of toxins by resuspension of contaminated sediments; burrowing species will be least affected.
- Landfill will irrevocably eliminate all indi-

viduals covered.

• All animals will be eliminated from the dredge sites proper by the dredging.

Icthyology: It appears from a preliminary study (1973) that the fauna of Los Angeles-Long Beach Harbor and the adjacent sandy or sand-mud shelf are basically similar. The degree of interchange between fish stocks of these two areas is of great importance in any speculation concerning recruitment to the Harbor or the use of Harbor waters as a nursery of shelf fishes.

The diversity and richness within the Harbor also approximates that recorded for similar depths outside of the Harbor. Three areas of distribution have been recognized within the Harbor: an area rich in flatfishes, an area of high croaker abundance, and an area demarcated by the presence of rockfishes. The area rich in croakers seemed to correlate with nutrient enrichment (sewage) and perhaps relatively low oxygen tension. The ecological parameters of Harbor species are possible factors in abundance and distributional statistics. Changes in seasonal abundance were documented, showing fewer fishes present in winter than in summer. From this data the standing crop of fishes in the Harbor is estimated between 700,000 and 1,600,000 kg. The annual productivity is estimated at 56 percent of the standing crop of 392,000-896,000 kg. Breaking this down in terms of identifiable species, 132 species in 48 families frequent or inhabit the area. The dominant species within the Harbor is the white croaker, *Genyonemus lineatus,* which makes up over 50% of the trawl catch. The remaining 7 species are much less abundant. *Engraulis mordax,* the anchovy, ranks number 2 overall. This species is relatively rare in most trawl samples during late summer and early fall each year.

In order to assess the importance of the Los Angeles-Long Beach Harbor as a fisheries nursery, a study of the abundance, distribution, and seasonal occurrence of fish eggs and larvae in San Pedro Bay was made, based on 561 plankton trawls taken in the Los Angeles-Long Beach Harbor and San Pedro Bay between February, 1973 and September, 1974.

Over 100,000 fish eggs and larvae were captured during the 20-month trawling period. The catch was dominated by fish eggs, but only anchovy *(Engraulis mordax)* and sardine *(Sardinops sagax caeruleus)* eggs were specifically identified. Among the larvae, at least 45 taxa, representing 19 families, have been distinguished. Until comparative material is obtained, specific identification of a number of undescribed forms is impossible. The very rapid increase in egg and larval abundance in February coincided with the increasing temperatures and photoperiods of late winter; this may be the key triggering factor for reproduction by harbor fishes.

Perusal of accumulated data showed conclusively that the Los Angeles-Long Beach Harbor is an important spawning area for a variety of fishes. Although spawning by several families of fishes including the Engraulidae, Scorpaenidae, Pleuronectidae, and Bothidae was most intense in areas outside the Harbor breakwater, significant numbers of larvae were taken within the Harbor where proposed dredge and land fill operations will occur. These families of fishes have significant commercial and/or sport fishing value. It seems likely that land fill within the Harbor will exclude many of these desirable fishes.

In specific reference to the bait (anchovy) industry housed in the Harbor, several noteworthy facts should be mentioned. First, the anchovy is a key component of the Harbor's ecology as a major consumer of zooplankton and as an important forage item in the diets of a variety of invertebrates, fishes, birds, and mammals. Secondly, the inshore environment off southern California, including the Harbor, is an important nursery ground for juvenile anchovies. The protected nature of the Harbor waters creates ideal conditions for capturing, transporting, transferring, and holding bait-fish. The behavior of the fish in the confined, shallow Harbor waters makes them vulnerable to the bait fisherman's nets. A successful live-bait fishery is able to take advantage of these unique conditions. Another point to be considered is that through field and laboratory observations, it has been learned that temporary dredging operations will not adversely affect anchovy development from eggs and would not exclude the juvenile fish from the Harbor. However, proposed landfill would cause a substantial reduction in habitat available to the fish. This would, of course, increase the difficulty of the fishing effort and their concurrent operating costs.

It was also apparent that several species in the families Sciaenidae, Blenniidae, and Gobiidae are restricted to near-shore habitats and find the confined waters of the harbor a very suitable habitat to live and reproduce. These families will probably suffer some from habitat elimination in the outer Harbor; however, these are the families that will populate and dominate the fish fauna within the restricted channels and shipping lanes in the proposed, landfilled habor.

There is little doubt that the fish populations of Los Angeles Harbor are very rich. The richness of its ichthyofauna appears to be the result of the protected nature of the waters, the richness of food, or the high productivity of these surface waters due partially to nutrient enrichment, and the diversity of bottom types (i.e., mud, sand, rock, level of organic deposits, etc.). The present structure of the outer Harbor insures adequate circulation and there are, therefore, few limitations besides space and nutrient levels on fish production.

The suggested Master Plan for outer Los Angeles Harbor should result in a drastic change in fish population; the combination of dredging and filling should destroy all existing ichthyofauna. No species are liable to extinction from this modification, but by destroying the important nursery function of the Harbor, many local species may show population decreases. Further, the important recreational shore and skiff fishing and the bait industry of the Harbor would be eliminated.

Microbiological Investigations: This three-year investigation of microbial activity biochemical oxygen demand (BOD), dissolved oxygen (DO), and certain nutrient parameters has provided data which show that predictive correlations do exist in the interactions between the biotic and abiotic constituents of waters in the Los Angeles and Long Beach Harbor. Deviations from the normal marine bacterial flora at different stations appear to reflect the nature of the non-marine or mixed waters being currently intro-

duced into the harbors. Particularly stressed conditions have been observed in those areas of the harbor that are semi-enclosed, where flushing is poor. The data indicate that two of the most significant factors involved in exceeding the oxygen budget of the receiving waters in these areas are the cannery effluent and the frequent heavy bloom and die-off of phytoplankton.

No one variable, with the possible exception of fecal coliforms, can be used to estimate the presence or level of microbial pollution. Fecal Coliforms are that portion of the Total Coliforms which originate in warm-blooded animal feces, including man. Fecal coliforms indicate recent, warm-blooded fecal contamination, whereas Total Coliforms may indicate recent or remote contamination and also organisms of limited sanitary significance. Standard plate counts (SPC) must be evaluated in terms of water circulation, extreme levels in abiotic parameters and species distribution within a given population. Other factors which must be considered are BOD and DO. The BOD is an expression of the organic load present in the receiving waters. The DO at any given time is an immediate indicator of the turnover of this organic load, water circulation, and oxygenation by phytoplankton. Therefore, the DO is most significant on a day to day basis in most areas and indicates the dynamics of the system.

Some of the difficulties encountered in establishing correlations in data obtained from monthly samples can be anticipated from SPC, DO, and BOD data which resulted from weekly samples taken at station A3 between November, 1973 and June, 1974. These data demonstrate that SPC can have a ten-fold fluctuation in a two-week period.

Instances of human contamination, indicated by a high fecal coliform—fecal streptococcus ratio, periodically occurred in certain areas, even though other indices of pollution were not present. In other instances, depending on the time lag between the introduction of the material and sampling, only total coliform, or total coliform and fecal streptococcus, may be found. The infrequency of these occurrences suggested that they may result from ship traffic coupled with a disregard for disposal regulations. Alternately, if total coliforms are demonstrated with any frequency in a given area then an explanation must be sought for both the introduction and persistence of these organisms.

Nutrients in Surface Waters: Of the myriad chemical substances found in San Pedro Bay, the compounds of phosphate and nitrogen are of particular interest because of their major role in the metabolism of plants and animals. These nutrients also demonstrate the various physical processes of an area as well as the potential productivity during temporal sequences. A deficiency of nutrient substances can be associated with possible low-productivity of organic matter, since phytoplankton utilize nitrogen and phosphate to form amino acids, proteins and other complex compounds necessary for life processes.

The chemistry of the Harbor sediments and waters is complex, containing entities, some of which are unknown and will probably remain so. Levels of nutrient concentration change from day to day and are very heavily influenced by the surrounding environment. Thus, there can't be a "normal" level of nutrients in the Harbor because concentrations there are so much higher than those outside the Harbor area. Station B1 was a "normal" station or a baseline for comparison, because its nutrient levels were similar to the

levels of normal southern California surface seawater of this area. Therefore, upon consideration of the B1 data, the following conclusions can be drawn:

- Although *Phosphate* is relatively stable as far as seasonal fluctuation is concerned, summer values tend to be low and there is a seasonal winter rise in concentration. The normal reduction in phosphate during spring is associated with the outburst of phytoplankton growth which occurs at that time. The building up of PO_4 during autumn to an eventual winter maximum is also associated with phytoplankton activity.
- *Nitrate* was always the most abundant chemical entity measured. Close inshore, concentrations may tend to increase and this may be partly a result of land drainage. Early spring concentrations are low until the end of August, after which there is a gradual build-up to the winter maximum.
- *Ammonia* is a very stable entity at the stations, although there were usually very low quantities present during most of the year with only small peaks at various intervals.
- The maximum levels of *Nitrate* usually appear in June-September, with the minimum at January-February.

Sediment Distribution: The sedimentary regime of the Los Angeles Harbor area has been greatly modified by man. Dredging, filling, and the construction of the breakwater all effect the depositional characteristics of the area by modifying the energy patterns that effect the size and distribution of the sediment in the Harbor area. The dredged areas provide sediment traps that interrupt the flow of bed load sediments. Filled areas obstruct sediment movement, can cause deposition or erosion of areas adjacent to them, and may themselves be a source of sediments. The breakwater reduces the amount of energy available to transport sediment. This means that the area will have finer sediment than would otherwise be the case.

Distribution of sediments are one factor in the distribution of benthic organisms. Thus, a change in the distribution of sediments may be expected to cause a corresponding shift in benthic populations, all other factors remaining equal.

There is little previous work on sediment distribution in the Los Angeles/Long Beach Harbors. This makes it difficult to assess what is occurring to sediments. Sedimentary processes are, with some notable exceptions, generally slow. Response to a change in environmental conditions may not be clearly recognizable for thousands of years.

In this study, data from 34 stations in the Los Angeles Harbor area were analyzed in detail, and one of the more important parameters examined was grain size.

The mean grain size of sediments is dependent on several factors. The first is the size of available material, and the second is the amount of energy available to transport this material. In general, the higher the energy, the larger the grains that can be moved. The energy for transport in the case of marine sediments comes from wave action, currents, and turbulence of the water. Topography also plays a part in the distribution and size of sediments. Coarser sediment will be deposited in topographic highs than will be deposited in topographic lows.

A curious decrease in mean grain size is found around the cannery and sewer outfalls (A7). This may be the result of coagulated protein either trapping fine sediment grains, or of fine sediment grains adhering to the surface of the protein and being carried to the bottom. Once on the bottom, the coagulated protein mass could keep waves and currents from removing the fine sediment. Dumping of dredge spoils and shoreline fill has also occurred in the area in recent years.

Sorting is the result of a complex interaction between the sediment grains and the transporting medium. Flat or light mineral grains are favored in sediment moved by suspension, while heavier or spherical grains are favored in movement by traction. This difference in transport leads to selective sorting of the sediment grains. Sorting is also dependent on the constancy of the energy at the site of deposition. In general, if the energy level is fairly constant in a given area, then good sorting will result, while large fluctuations in energy levels will result in poor sorting. Finally, sorting is dependent on the source area of the sediment. That is, if the area of erosion is well sorted, then the sediment derived from that area will be well-sorted. This is generally true only near the site of erosion.

Sorting values for the Los Angeles Harbor are generally slightly lower than shelf sediments in the southern California area. The lower values in the Harbor are most likely the result of the admixture of terrigenous clay, deposited because of the reduced wave and current energy in the harbor area.

Textural maturity is dependent on the percentage of clay, the sorting, and the roundness of a sediment. Since all the areas in the harbor have more than a 5% admixture of clay, the sediments are classified as immature.

If the filling of the outer harbor results in a decrease in circulation, then it is likely that finer sediment will accumulate. If the energy patterns are altered there is the possibility that present areas of erosion will become areas of depositon and vice versa.

Physical-Chemical Study of Sediments from the Proposed Dredging Channel in the Los Angeles Harbor: The objectives of the physical-chemical study of the abiotic environment of the proposed dredge channel were threefold:

- to evaluate the pollutional status of the sediments.
- to assess the potential water quality effect if the sediment is to be disposed of in open waters

- to study the methods of mitigation if unfavorable environmental impacts exist.

In order to achieve these objectives, a series of experiments were carried out. Sediments were characterized in great detail with regard to the composition and concentration of contaminants. With the exception of very few localities, most surface sediments in the Los Angeles-Long Beach Harbor are grossly contaminated. The fate of these substances in the sediments and their long-term effects are not well understood at present. The question of whether sediments act as a sink or as a source of pollutants may depend greatly on the changes of environmental variables. There are very few remedies available to undo the pollution of the past, as the selective removal of pollutants from sediments is almost impossible.

In view of the proposed LNG channel and the dredging that will be required, several suggestions on procedures have been submitted. The direct treatment of seawater-sediment mixture with flocculants followed by underwater discharge of dredge spoil from hydraulic dredging pipes to the water column will not cause any detectable level of water quality deterioration. Given one or two hours' retention time in a confined disposal area, the water quality parameters from the proposed dredging operation should fall within the ocean water discharge requirements.

The following recommendations are made in accordance with the results obtained:

- The direct treatment of seawater-sediment mixture should be adopted to reduce the quantity of polymer used, as well as to eliminate the mechanical agitation needed in the case of treatment of returned effluent from the diked disposal area.
- A special hydraulic dredger should be designed to allow the addition of selective flocculants immediately followed by the injection of air. The application points of air and flocculants should be placed before the suction pump to allow maximum mixing, so that the particulates from the dredged sediment can be flocculated

along the transport pipeline prior to discharge.

• The discharge pipeline should be placed immediately above the bottom sediment to facilitate the sedimentation of flocculated particles. In the case of submerged disposal, the high and low tide periods should be avoided, to allow sufficient settling of suspended solids behind the confined dike area.

Giving attention to the design of dredging equipment and construction of a confined dike to allow sufficient settling time, the proposed dredging operation of the LNG route and subsequent dike disposal of dredged sediment will not cause any significant problems in water quality in the receiving water.

Avalon Sewer Outfall Study: In their 1969 Resolution No. 69-18, the Los Angeles Regional Water Quality Control Board also stated that " . . . the intent of this Regional Board is not to allow the discharge of raw sewage into the waters of the State and that the City of Avalon is instructed to bring to the Board—a plan and timetable for the provision of treatment facilities for the discharge of its sewage --." At that same time the City was given a set of requirements for an environmental monitoring program on the existing outfall, to include studies of the benthic biota.

In late 1970, responding to the Water Quality Control Board's request for plans for a treatment facility, a "Master Plan of Water and Sewerage for Avalon, California" was submitted to the City by Engineering-Science, a California consulting firm. That plan offered several alternatives for waste disposal, including the possibility of water reclamation, designed around the basic requirement for effluent treatment. The type of treatment considered most practical was at the secondary level, which includes, among other things, sterilization by chlorination, a method which has come under close scrutiny by the Environmental Protection Agency due to its effects on the biota. Also, if water reclamation for subsequent recharging of the water table were implemented, there would be need for complete conversion of the flushing system to fresh water, to avoid "poisoning" the water table. In short, the presently planned waste disposal system, destined to go into effect in 1976, could result in the presently untreated, partially seawater-carried effluent being suddenly replaced by a chlorinated, freshwater-carried discharge.

Whatever the eventual treatment and/or reclamation, it is inevitable tht the composition and quality of the discharged effluent will be changed and that that, in turn, could cause some change in the benthic biota lying within the sphere of influence of the outfall. Documentation of those biological changes has been the primary goal of the present study, to be accomplished in two phases. Phase I (the recently completed, OSG-funded study from 1972–75) includes an historical account of Avalon's domestic waste disposal, and a descriptive biological "baseline" for the sea floor lying within the influence of the present discharge. However, due to delays in planning and construction of the treatment facility, the termination of the study and the beginning of the new discharge did not coincide so we could phase into the monitoring mode. In order to maintain continuity between the two phases it will be necessary to continue the established sampling schedule at the baseline level until the new discharge begins (around mid-1976). Phase II, the monitoring study, will be implemented at that time and will document any biological changes occurring as a result of the new discharge. When the investigation switches from baseline to monitoring, a detailed report of the Phase I Historical and Baseline Study will be published, to serve as a working guide for detection and documentation of any changes in the marine benthos.

Although final biological results await completion of the baseline phase, analyses to date permit some preliminary conclusions:

• The effect of the effluent on the benthos does not extend past 30 meters from the point source, except during the peak of summer activity when there may be some H_2S found slightly further out.

• There are no permanent abiotic or "sludge" areas formed even during periods of highest volume.

• It appears that, using certain selected species of worms and crustaceans, we can define a gradient of bottom disturbance from the terminus

outward, thus defining the major "sphere of influence" of the outfall.

- Samples taken at the terminus indicate that the temperature, salinity, residual chlorine and pH components of the discharged plume are attenuated to nearly ambient within two meters of the discharge point.
- Outside the 30-meter-radius prime-sampling area there is no visual, chemical or biological effect of the discharged effluent.

In keeping with the philosophy of establishing an accessible "field laboratory", several projects not directly related to the OSG-oriented goals have used the study site. Reports on those studies are currently being written for the final report, as well as for separate publication, but are also worthy of brief note here.

- A short-term study was done on the longevity of fecal coliform bacteria on sport fishes caught around the outfall. It was found that on the species caught there were significant numbers of coliforms remaining throughout cleaning and preparation, but that they were all killed by adequate cooking.
- Studies were initiated on the meiofauna found in the sediments, with the idea that members of this aberrant fauna could serve as ideal "indicators" of bottom health. Although this study has just begun, it showed enough promise to be included as a major part of the Phase II Monitoring Program.
- A student at Scripps College, Claremont, is completing a study on the debilitating effects of heavy concentrations of raw sewage on some of the resident fishes in the outfall area.
- A pre-doctoral student at UCLA has recently discovered the Avalon study site to be ideal for examining the mechanics of H_2S and methane production around outfalls. She is able to place special gas sampling devices in the area and to collect accessory sediment samples for lab analysis, taking advantage of the accessibility of the site and the aid of Sea Grant project personnel.

In addition to those satellite projects already completed or in progress, a number of inquiries have been made regarding use of the area for other types of studies. In all cases, the accessibility of the site; the fact that there are permanently marked stations; and the availability of the physical and biological data already collected by the Sea Grant Project have been the prime interest factors.

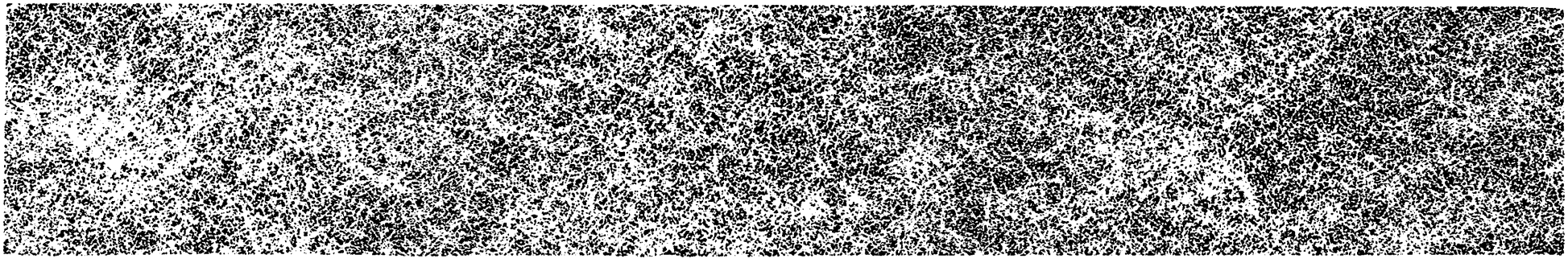
To attempt a recounting of each project's accomplishments within the scope of this document would not be possible, but a brief rundown of their cumulative impact on the user communities would certainly be worth the effort. To begin with, the information generated has been used by local, State and federal agencies and private entities in planning for the modernization of facilities and installations within the Harbor complex. While attempting to establish baseline data on the various biological components of the Harbor, new and standardized techniques were developed for these surveys, and in the process of correlating biotic and abiotic information, new computer and analysis methods were developed. For the first time in the local area, an adequate data base is now available on retrieval for future planning and developmental needs.

Based on cumulative expertise, the Principal Investigators within this project cluster have been asked to give public statements to the National Water Quality Commission, the California and regional Coastal Zone Commissions, and the State and Regional Water Quality Control Boards.

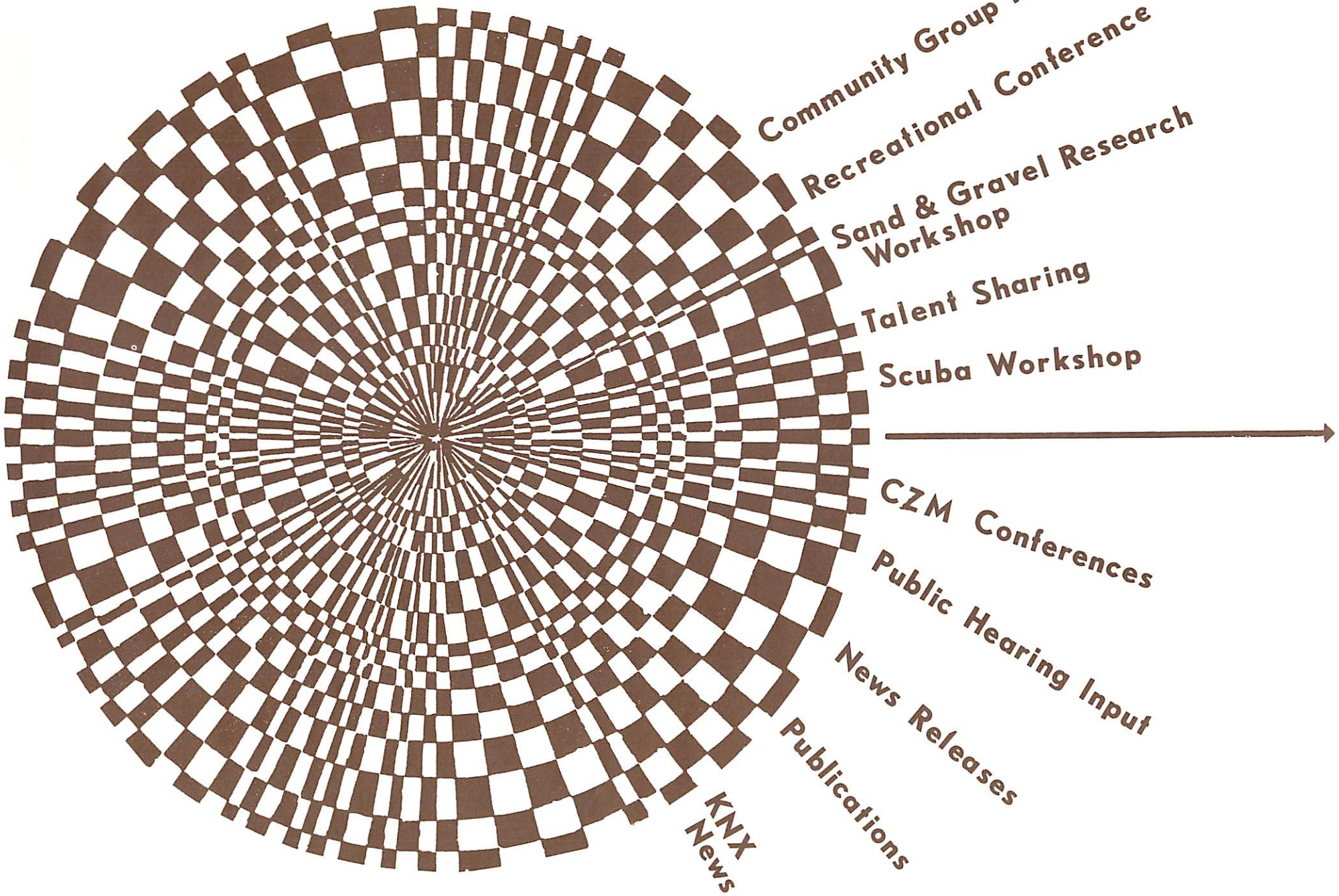
Even now, after the Project's conclusion, the Port of Long Beach and many of the above participants are still using the information extensively in Environmental Impact Reports (EIR's for the State of California), Environmental Impact Statements (Federal EIS's), Federal Power Commission applications for the State and local Regional Water Quality Board requirements, and for compliances with EPA regulations.

However, it was not simply the outside user groups that benefited from the Harbor Projects' activities . . . the academic, University-oriented community also drew added strength. A publication series, "Marine Studies of San Pedro Bay," was initiated and 10 volumes were produced so that information could be located readily on field and laboratory biology, oceanography, sedimentology, microbiology, and pollution. Over the course of its life span, more than 100 individuals have worked with the Harbor Projects including USC biologists and engineers, and faculty from four California State Universities and three private colleges. Even the technicians trained for the research have obtained positions in both industry and private agencies.

During the four-year life span of the research, these projects have made significant contributions to the basic understanding of the intricacies of a harbor environment. Under the direction of Dr. Dorothy F. Soule, this group of scientists have represented the spirit and direction of Sea Grant research; they have enhanced the bodies of knowledge in their respective fields and have been of direct service to the community in which they are based.



Marine Advisory Services



The Marine Advisory Services of the USC Sea Grant Program function to disseminate and feed back scientific and technical information between the University and the users of this information. However, the creative origin of this information need not be limited to Sea Grant funded research, for it's part of Advisory Services' duty to unearth any other sources of information which would be pertinent to the solution of the broad range of coastal zone management problems that pose themselves to Californians.

Several projects are geared to accomplish this goal, each under the purview of an Advisory Specialist. For instance, our Marine Resources Specialist, besides being a resource to local and State planning and management groups in his own right, has access to an information retrieval and transfer system which can tap into several data banks (CHEMCON, GEO-REF, etc.), to rapidly transmit comprehensive, pertinent information from sources outside Sea Grant to identified users.

Another project was initiated to assist our Region V Coastal Zone Conservation Commission. "Scorecard" is its name and it is an information management tool designed by Advisory Services to delineate developmental patterns and trends within the region, based on the data obtained from each permit decision.

The topic of marine recreation has not been overlooked in the Marine Advisory Services' scope, for recreation in southern California is not just an activity, it's an industry. Therefore, a Marine Recreation Specialist has joined our team and a project has been established to begin to identify the various sectors concerned with marine recreation and to convey management and technological strategies for increasing the coastal carrying capacity to the local governments.

The last project within Advisory Services is the most directly involved with marine information dissemination. The Editor, functioning as the Program's communications arm, serves all of Sea Grant by editing and having printed the results of our researchers' efforts: by producing newsletters that deal with topical issues within the coastal zone; and by generally "spreading the word" that Sea Grant is alive and well in southern California.

MARINE ADVISORY SERVICES

Byron J. Washom
A/S-1

The primary objective of the Marine Advisory Services at USC is the education of the public and private sectors in matters of coastal resources management and planning. The education of these sectors is accomplished by University personnel who advise, assist, stimulate, translate, and deliver available information. The overall goal of the Marine Advisory Services is to educate and advise those individuals concerned with coastal resources with the most current information and techniques available.

The primary audiences are the *proximate* decision-makers who concern themselves with the coastal resources management and planning process of California. The secondary audience is the affected commuinities who eventually feel the impact of these decisions, and the tertiary audience is the general public who needs to be kept abreast of how the California coastal resources are being managed and planned.

Although the southern California region has more than its share of problematic issues, the USC Sea Grant Marine Advisory Services has chosen the areas of energy, marine recreation, coastal zone management, and marine information dissemination as its focus. This selection is made on the basis of the University's resources, our geographic location, Sea Grant's theme, and the user community's encouragement. This selection, however, places the Marine Advisory Services into a dynamic process compared to many other advisory services efforts, with audiences who have a greater cause-and-effect relationship. By a dynamic process, it is meant that the management and planning decisions are usually the result of a multitude of inputs and persuasion by influential sectors.

The Marine Advisory Services, A/S-1, has the administrative and coordinating responsibilities for the other three Advisory projects; information retrieval and transfer, marine recreation and marine information dissemination. The most important role of this Coordinator is to be of guidance to the Advisory Services personnel in their projects and to free as much of their time as possible from administrative or inefficient uses of their time. The guidance that the Coordinator lends the personnel is reflective of the USC Sea Grant Program management committee on which he serves and the integrated needs of the user communities with which he interacts.

Secondly, the Coordinator must be involved and personally interact with these user communities on a weekly basis, for there is no substitute for direct interaction with the people which the program attempts to serve. To this end, the Coordinator has been involved in the following activities *outside* of the University:

- Formed and chaired the Marina del Rey subregional planning group, thereby directly interacting with another ongoing Sea Grant project, *Participatory Planning for Coastal Zone Decision-Makers*. Sea Grant was able to create the non-advocate forum and supply the group with expertise that will hopefully materialize into an operable subregional plan.
- Received an $8,000 contract to inform the southern California public of the Coastal Commission's policies and recommendations. This was done through newsletter format and it turned out to be the only vehicle for this information to reach the public-at-large.
- Stimulated the Los Angeles Chamber of Commerce to form a task force to respond to the California Coastal Zone Conservation Commission Plan Element.
- Served as Pacific Sea Grant Advisory Program (PASGAP) co-chairman.

Within the University, some of the Coordinator's activities included:

- Fed back research opportunities to the University in fields of marine recreation, information management, OCS development, and ocean energy resources.
- Provided research community with *current awareness* items from the *Federal Register* and scientific periodicals.

In concert with the efforts of the other Advisory Services components, A/S-1 will continue to ensure that the objectives of the Program are fulfilled by actively seeking out new research areas and advisory services projects for the future. The optimal result of these efforts will hopefully be that the ultimate decisions regarding coastal resources will be made with the benefit of scientific and socioeconomic information, and that those individuals who either encourage the decision or are affected by it will be thoroughly cognizant of the motivations and the corresponding costs and benefits.

INFORMATION RETRIEVAL AND TRANSFER

Lawrence C. Leopold
A/S-2

The ever increasing coincidence of resource demands upon the coastal zone and demands of coastal resource regulation require that the Sea Grant Program continue to remain an increasingly recognized source of reasoned and need-tailored information to decision-makers as well as to the affected communities. In this, its first full year as an individual Sea Grant project, Information Retrieval and Transfer has decidedly expanded its scope of activities and contacts to meet this challenge.

During the first months of its existence—in the form of our Marine Resources Specialist—this project developed a computer-aided literature review capability which could successfully answer specific, need-tailored requests in a timely fashion. As the project and the Principal Investigator rnoved into the 1974-75 fiscal year, the literature surveys were conducted in support of on-campus research projects in the living and non-living resource areas and for off-campus research needs in private industry, State-level government and public interest groups. A listing of a few search requests would read like this:

- Using the CAIN File, a bibliography on Recreation Land Use Planning Options was delivered to the Element Planners at the Region V Coastal Zone Conservation Commission.
- A search on Land Use Patterns and Land Use Regulations provided 130 citations to Senior Consultant, California Assembly Committee on

Natural Resources.

- A search on Oil Spills and Containment provided 110 citations to Senior Consultant, Assembly Committee on Coastal Zone Resources.
- A 143 citation search from CHEMCON file delivered to Sea Grant assisted Environmental Engineering Project concerning removal of metallic tons from industrial waste water.

It must be noted at the outset that this valuable service function, while expanded in its proficiency, was significantly reduced in its total percentage of overall A/S-2 activities and functions towards the end of the 1974-75 fiscal year.

The very nature of the whole A/S-2 project requires that a portion of the Principal Investigator's time be free to respond to individual, specific, short time frame information requests. The cross-flow of facts and conclusions are constant among the described activities. In effect, the focusing of the sum of information available on every changing set of information needs is one of the most valuable products of this project.

The best obtainable data and facts have always been available on a right-now basis whenever possible. The program has demonstrated an ability to initiate collection and assimilation of information in areas of future critical resource decisions so that delivery of focused, refined information occurs when needed.

The topic of greatest activity has been the many conflicts revolving around the question of energy development and facility siting in the coastal zone. In addition to the obvious problems resulting from direct physical conflicts, there are numerous policy and planning problems. This program provided direct technical and scientific assistance to the major assemblage of local, county and city governments concerned with responding to federal Outer Continental Shelf petroleum leasing plans offshore southern California. This assistance was a part of the Council of Concerned Governments' adopted policy and also included in their testimony at federal Bureau of Land Management hearings held during February, 1975.

Other major instances of advisory interaction during the 1974-75 fiscal year have been:

- Advisory information and background in offshore petroleum contingency response planning provided to Technology Development Corporation of Sunnyvale, California, enabled it to competitively enter a bid for work in regards to Alaska tanker traffic anticipated for Prince William Sound.
- This project became vitally involved as an information resource to the San Pedro Bay Conservation and Development Committee. The accurate and detailed information enabled the members, representatives of five Chambers of Commerce, to effectively enter into, and become working protagonists with the coastal planning dialogue in California.
- The Principal Investigator was invited to Washington, D.C. to co-author the format and program detail for the Sea Grant Advisory Service portion of the National Coastal Zone Management Conference sponsored by NOAA's Office of Coastal Zone Management.

The purpose of A/S-2 falls clearly within the prescribed functions of all advisory service activities. It has, and will continue to serve as a multi-directional flow of information and information needs between the University and the communities. Since this project represents Advisory Services in its purest form, the interactions *are* the project. It can easily be seen that our Marine Resources Specialist is a resource in his own right to the various identified user groups within the southern California area.

SCORECARD PROJECT

Byron J. Washom
A/S-3

> . . . Federal funds that were anticipated by the sponsors of Proposition 20 have not yet been made available. These funds were expected to total $2.5 to 3.0 million, and their absence has severely hampered the work of the Commission. We are, therefore, vigorously pursuing efforts to guarantee for California its fair share of whatever Federal funds may become available.

It was this statement made by Melvin B. Lane, Chairman of the State Coastal Zone Conservation Commission and the quite real management need of this organization that precipitated this particular Sea Grant project's creation. Prior to NOAA funding, work on the *Scorecard* was financed through a contract between the USC Sea Grant Marine Advisory Services and the South Coast Region Coastal Zone Conservation Commission.

When the South Coast (Region V) Coastal Commission began functioning, it assumed a two-fold responsibility . . . regulatory/planning. It was with superhuman effort that the small cluster of Commissioners and their staff reviewed and passed judgment on all of the permits submitted. But with the inundation of over 2,400 development permit applications in 1973 alone, the Region V Coastal Commission (Los Angeles and Orange Counties) found it practically impossible to keep track of what kind of a coastal zone they were creating. Within the voluminous files there were key items of valuable management and planning information, if they could just be put in some kind of format that would lend itself to simple interpretation. To help ease this problem, the Sea Grant Marine Advisory Services and the Region V Coastal Commission created a management and planning tool known as *Scorecard*.

The concept behind the tool is quite simple. Basically, 26 pieces of information pertaining to each permit are placed into a computer format. The following is a breakdown of these variables.

- Physical Location: by jurisdictional city, subregion, census tract and proximity to the mean high tide line.
- Physical Characteristics: by nature of the project; present use of the land; total square footage; lot coverage; number of housing units, bedrooms, and parking spaces; building height; and net number of acres.
- Economic Characteristics: anticipated rent, anticipated sales prices and cost of construction.
- Administrative Characteristics: month, day and year of permit application submission; type of permit; California Environmental Quality Act Classification; staff recommendations; Commission action; conditions imposed for approval; State action if appealed; and month, day and year of permit application decision.

The real key to the Scorecard is the utilization of the computer, for the capabilities of the computer allows for a comprehensive "file management system" of this voluminous information. The

SCORECARD ON COASTAL COMMISION PERMITS 01/11/74 PAGE 32

FILE L.A. (CREATION DATE = 01/11/74) COUNTY FEB.-DEC. 1973 ACTIONS

CROSSTABULATION OF SUBREG SUBREGION OF PERMIT PARCEL BY PRESUSE PRESENT USE PAGE 1 OF 3

SUBREG	PRESUSE	VACANT 1	AGRICULTURE 2	SINGLE FAMILY RES 3	MULTI-FAMILY RES 4	DUPLEX 5	COMMERCIAL 6	INDUSTRIAL 7	RECREATIONAL 8	UTILITY 9	ROW TOTAL
1 MALIBU	COUNT	147	0	30	5	2	10	0	4	7	205
	ROW PCT	71.7	0.0	14.6	2.4	1.0	4.9	0.0	2.0	3.4	21.4
	COL PCT	29.6	0.0	20.0	13.5	11.8	11.6	0.0	11.1	8.9	
	TOT PCT	15.4	0.0	3.1	0.5	0.2	1.0	0.0	0.4	0.7	
2 PACIFIC PALISADE	COUNT	8	0	4	0	0	0	0	1	0	13
	ROW PCT	61.5	0.0	30.8	0.0	0.0	0.0	0.0	7.7	0.0	1.4
	COL PCT	1.6	0.0	2.7	0.0	0.0	0.0	0.0	2.8	0.0	
	TOT PCT	0.8	0.0	0.4	0.0	0.0	0.0	0.0	0.1	0.0	
3 SANTA MONICA	COUNT	19	0	11	2	0	9	0	1	4	46
	ROW PCT	41.3	0.0	23.9	4.3	0.0	19.6	0.0	2.2	8.7	4.8
	COL PCT	3.8	0.0	7.3	5.4	0.0	10.5	0.0	2.8	5.1	
	TOT PCT	2.0	0.0	1.1	0.2	0.0	0.9	0.0	0.1	0.4	
4 VENICE	COUNT	39	0	10	6	3	5	2	3	5	73
	ROW PCT	53.4	0.0	13.7	8.2	4.1	6.8	2.7	4.1	6.8	7.6
	COL PCT	7.8	0.0	6.7	16.2	17.6	5.8	3.8	8.3	6.3	
	TOT PCT	4.1	0.0	1.0	0.6	0.3	0.5	0.2	0.3	0.5	
5 MARINA DEL REY	COUNT	13	0	3	3	1	13	0	1	3	37
	ROW PCT	35.1	0.0	8.1	8.1	2.7	35.1	0.0	2.7	8.1	3.9
	COL PCT	2.6	0.0	2.0	8.1	5.9	15.1	0.0	2.8	3.8	
	TOT PCT	1.4	0.0	0.3	0.3	0.1	1.4	0.0	0.1	0.3	
6 PLAYA DEL REY	COUNT	18	0	3	1	0	1	2	3	3	31
	ROW PCT	58.1	0.0	9.7	3.2	0.0	3.2	6.5	9.7	9.7	3.2
	COL PCT	3.6	0.0	2.0	2.7	0.0	1.2	3.8	8.3	3.8	
	TOT PCT	1.9	0.0	0.3	0.1	0.0	0.1	0.2	0.3	0.3	
7 EL SEGUNDO	COUNT	8	0	3	0	0	0	2	0	1	14
	ROW PCT	57.1	0.0	21.4	0.0	0.0	0.0	14.3	0.0	7.1	1.5
	COL PCT	1.6	0.0	2.0	0.0	0.0	0.0	3.8	0.0	1.3	
	TOT PCT	0.8	0.0	0.3	0.0	0.0	0.0	0.2	0.0	0.1	
COLUMN TOTAL		497 51.9	2 0.2	150 15.7	37 3.9	17 1.8	86 9.0	53 5.5	36 3.8	79 8.3	957 100.0

(CONTINUED)

utility of the Scorecard is endless in the management and planning of the coastal zone because for the first time the developing patterns and trends are empirically documented.

In the management process, the Scorecard compiles, cross tabulates, correlates, profiles and/or charts any combination or permutation of the above variables. Some examples of the regular tables computed are:

- Nature of project by city by Commission action (What types of projects are being approved or denied and where)
- Nature of project by present use of the land (What types of projects are going on what type of land)
- Turnaround time for permit applications (How long it takes to obtain a permit)
- Cumulative number of housing units approved thus far in each city or subregion
- Correlation between number of housing units per acre to Commission action
- Profile of one or two subregions
- Plotting of net acreage approvals by month
- Updating 1970 Census Tract by compiling data on a census tract basis

Lack of information is not as major a problem as inefficient utilization of existing information. The Scorecard has provided the staff and Commissioners with a synthesized, empirical and accurate accounting in perspective. The Scorecard takes no position of impact or compatibility, it merely provides the information in a tangible form whereby each Commissioner may weigh and decide the impact or compatibility.

In the planning process, the Scorecard has specifically delineated both where and what types of development pressures are occurring. If the staff planner is cognizant of mutually exclusive pressures occurring in relative proximity of each other, the planning decision is thus necessary to permit or deny one activity or another. The same goes for controlling the rate of development. Cognizance of the type, location and rate of development are absolutely essential to the staff planner. Our 25 months of Scorecard data coupled with the Census tract information has given staff planners these figures.

Another positive feature of Scorecard is that it has been most inexpensive to operate. Initially, the Statistical Program for Social Sciences (SPSS), a canned program, was modified to the Scorecard needs.

The Commission staff exist as the major users of this information in preparation of both their permit recommendations for Commission action and their draft planning elements. The public, legislators, news media, agencies, and interest groups have also appreciated the objective, empirical data available for scrutiny.

In brief, the accomplishments of the Scorecard project to date have been:

- Monthly and year-to-date of all permit activity. Consists of tables and graphs that delineate the evolving patterns and trends.
- Profiles of selected coastal areas as requested by Coastal Commission staff, city agencies, news media, and interest groups.
- Output for State commission staff use on permit fee structuring and intensity of Development Planning Element.
- Corresponding with agency representatives outside of California who would possibly be interested in incorporating the Scorecard elsewhere.
- Thirteen descriptive items sought by the Scorecard but unasked by the Commission's permit application were made "supplemental information required for permit process" by the Commission effective March 6, 1974.

RECREATIONAL OPPORTUNITIES IN COASTAL DEVELOPMENT

Susan H. Anderson
A/S-5

According to the Stratton Commission's Report, *Our Nation and the Sea*, "recreation ranks at least a close second to the offshore oil and gas industry in economic importance in marine areas." Yet,

traditionally, marine recreation has been viewed as a variety of activities, dependent on the presence of large bodies of water that require monitoring but no special professional planning considerations. However, increasing numbers of people seeking access to the marine environment for their leisure activities have caused an important impact in the coastal zone requiring careful planning for recreational utilization and management of coastal areas.

Within 30 miles of the seemingly vast coast of California lives 80% of the population, or approximately 16 million people. On Newport Beach alone, there are an estimated eight million beach user-days each year. The estimated demand for boat berthing and mooring spaces in California in 1980 is 97,522; although the estimated supply will be 85,600. The increase of 1980 demand over 1970 supply is 22,861 berths! In 1972, according to a report to the State by Gruen and Gruen Associates, sport fishing contributes $100-$200 million to California in total income. The availability of these many activities is the basis of a major tourist industry in California.

Within California, and in fact, along the entire West Coast, there is no other project or organization addressing the needs of marine recreation at the working level. In order to fill this very obvious void, the USC Sea Grant Program brought a Marine Recreational Specialist on board about mid-fiscal year. This Principal Investigator's work has carried with it a broad responsibility to communities and groups within the State, and other areas when possible, to identify areas of needed baseline data on recreational use of the coastal zone, to educate others in the importance of marine recreation as a planning issue, to provide insight concerning a balance of recreational uses based on research information on carrying capacities, demand and economic impact, and develop awareness of new technologies that may influence the planning alternatives.

During the initial year of this project, it was noted that the coastal areas of Los Angeles and Orange Counties in southern California are almost entirely developed, with continuing pressure for increased density of development. Although the majority of the population lives in close proximity to the coast, the intensity of development makes access to recreational facilities and allocation of facilities for swimming, surfing, diving, boating, fishing, sunbathing, looking and general relaxation significant problems.

Recreational users represent diverse and often parochial attitudes concerning appropriate coastal allocation and access. Often, because of lack of understanding of the intent and implications of coastal planning, the user attitudes are negative toward suggested changes, controls, and legislation. Regulatory bodies, on the other hand, are often not fully aware of the constituency needs which they are affecting. Where the impact on marine recreation is a secondary effect, the pending impact may not even be considered. Particularly with the emphasis on the California Coastal Plan, other regulatory agencies frequently overlook more subtle impacts on the marine community that may result from agency activities. There is a tremendous need for continuing work with the many agencies and industries affecting marine recreation to develop greater understanding and appreciation for coastal zone problems.

Through the Sea Grant Marine Advisory Services, there is a viable opportunity to reach public decision-makers, private developers, recreation industry operators, and the general users of recreational facilities, to develop understanding of the issues of marine recreation and call for substantive input into the criteria to be considered. There is further opportunity to assist communities and user groups in careful implementation of planning recommendations. In areas of development, this would include bringing information of up-to-date technologies to the users and making related research findings available to them. It also includes providing educational opportunities to a variety of users so that maximum enjoyment can be obtained with limited infringement on the enjoyment of others.

The problems involved with marine recreation are imposing and multifaceted, so when our Marine Recreational Specialist came on board, she "hit the deck running." In order to bring a broader perspective to the California program, several weeks were spent in the Northeast to assess the methods and approach of marine recreation-oriented advisory services personnel there. This was done because much of the existing research on carrying capacities, economic assessment of marine industries, demand for recreational use of the coastal zone, and environmental impact of recreational use has been developed in the Northeast. The Principal Investigator also reviewed several plans for recreational development on harbor islands and metropolitan shore fronts in the Northeast that have tremendous applicability to California's offshore islands and to southern California's heavily populated shoreline.

In order to be of assistance, areas of concern must be identified. This process was begun by identifying 1,800 marine recreational firms in California. Through interaction with these firms, the Principal Investigator has been able to pinpoint areas of concern that might provide the basis for future educational workshops.

The Newport Beach Chamber of Commerce has already worked with the Advisory Service Marine Recreation Specialist, and meetings to consider planning problems have been held weekly in Newport Beach. Similar meetings with planning committee staffs will be encouraged throughout the area. In each situation, resources within the University will be used to provide necessary background on specific area planning and coordination with other planning activities in the area. Literature search capabilities of the Sea Grant Office will be employed as appropriate to provide further background material. Every effort will be made to tie together planning considerations of adjacent towns by bringing together personnel from these areas, especially when the Recreational Specialist notes an overlapping or a conflict in considerations.

1975 was the year of controversy concerning SCUBA regulations. The Principal Investigator developed communications among affected parties and held a successful brainstorming session/workshop to attempt to resolve problems limiting safety of the sport in a manner that is acceptable to both the industry and the government.

Because of the increasing recognition by NOAA and the Bureau of Outdoor Recreation of the importance of marine recreation, as partly evidenced in the National Marine Recreation Conference being planned for October 1975, it seems timely to call together representatives of those working in marine recreational planning and advisory work in the Pacific Basin to form a regional communication network for sharing of expertise and for provision of regional consid-

erations in development of coastal recreation. The Principal Investigator will initiate the network and act as Coordinator for continuing interaction among those initially identified, as well as continue to seek new representatives to be included in the communication network.

By increasing interaction with University research staffs, and other Sea Grant resource personnel, this project will establish a growing base of valuable information for furthering communication with the many publics concerned with recreational opportunities in the coastal zone. New channels of communications to and among these diverse publics will be explored and implemented to increase their awareness of marine recreation opportunities and issues and to enable development of maximum recreational potential in the coastal zone.

MARINE INFORMATION AND DISSEMINATION PROGRAM

Shirley J. Hudgins
A/S-6

This past fiscal year was the first year that the communications arm of Sea Grant received separate funding. Originally, it was a subset of A/S-1. This shift in communications' position and its concomitant expansion into a separate entity reflects the growth of the overall Program.

The Marine Information and Dissemination Project, besides being interdisciplinary by nature, also reflects the directional emphasis of all Sea Grant research . . . outward. The basic motivation behind this research is that it be applicable in solving real and current problems. It is goal- and user community-oriented. Sometimes the data generated, although pertinent, is not written in the most *digestable* form. Therefore, it is the task of this project to *translate* this information so that it can be consumed by the appropriate audience. This process entails selecting the correct level of sophistication for each publication and the most appropriate printed media to use in making it available to the public.

The basic objectives of this newly-created project are as follows:

- To continue documentation and dissemination of Sea Grant research and advisory information.
- To ensure that the information delivered is of the highest quality and reaches the largest and most appropriate audience.
- To provide editorial services to all Sea Grant publications.
- To create a public awareness locally and nationally of the USC Sea Grant Program's activities, services and achievements.

The information dissemination process operates through several media within the USC Sea Grant Program. First there are our formal publications and, depending upon the user group and the type of information, the publications take on different formats. However, all are subject to the three-tiered USC Sea Grant Publication Policy in which they are critiqued for: quality of writing; usefulness of information, i.e., timeliness, professional knowledge, technical content and general content; and general appearance.

The second mode of communications has been the newsletter, and it is within this format that the USC Sea Grant's thematic concern for the proper planning and management of California's coastal resources is most actively reflected.

First, there is *Coastal Studies Information Communique* (CSIC). As stated in the first issue, the need for accurate and current information concerning coastal resource management and planning has never been greater. Therefore, it is the goal of the Communique to serve as an informational advisory to all those individuals concerned or interested in the events which either take place in or affect the coastal zone of Califor-

Photo courtesy of Greg Wenger

nia. The articles range from topical issues, such as the coastal bike path to OCS drilling, with contributing authors from local governments, environmental organizations, industry and our own Marine Advisory Specialists. During the 1974-75 fiscal year, three issues were generated.

The two remaining newsletters have, by their very nature, a limited life span since both deal directly with some aspect of the South Coast Regional Coastal Zone Conservation Commission's activities.

Having obtained the copyright for the monthly *Coastline Letter,* the Marine Advisory Services (MAS) now distributes this publication to a mailing list of over 1,500 subscribers. The major thematic thrust of this newsletter is to keep the readers abreast of the latest State and Region V (L.A. and Orange Counties) Coastal Commissions' meetings.

The third newsletter, emphasizing public participation, has been *Changing the Future of the Coast.* Each issue (four in all), consists of a discussion and digest of the individual Plan Elements now being drafted by the South Coast Regional Coastal Zone Conservation Commission, along with a tear-off questionnaire asking for public response at this critical revision stage. Since the creation of the Commission was done through a public initiative and not a legislative motion, it is most essential that the public become actively involved in the planning process. This is the purpose of the newsletter. Their production was initiated by the South Coast Regional Coastal Zone Conservation Commission through a contract with the USC Sea Grant Marine Advisory Services to print and distribute them.

Also under the purview of the Editor has been the maintenance of the Sea Grant mailing list, now 13,000 strong. This is MAS's major dissemination tool along with being one of the clearest indicators of the success of the communications effort.

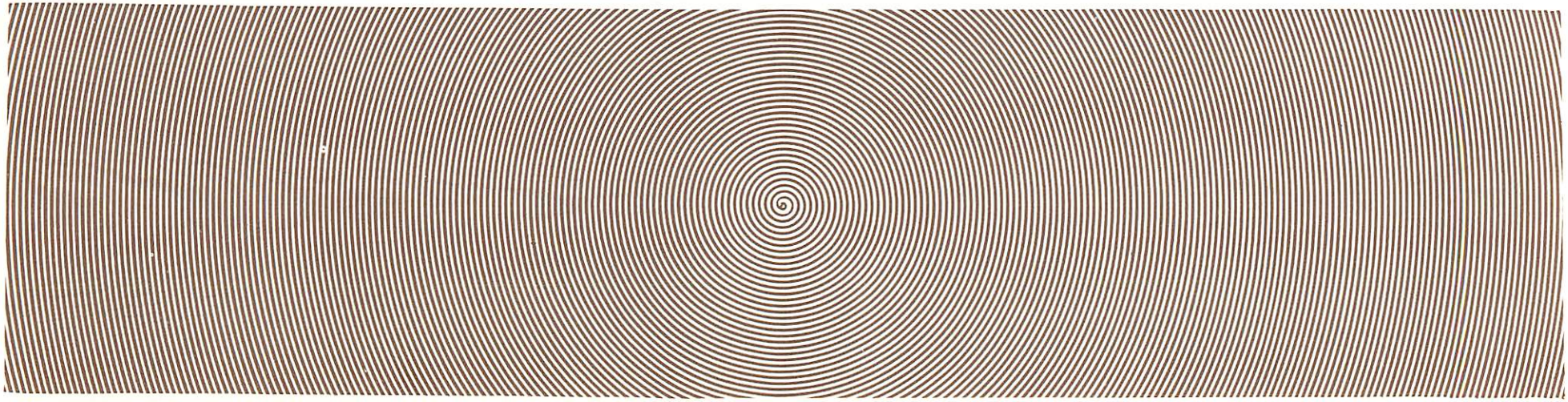
Above and beyond the *printed word,* this project also has a responsibility of supporting the other facets of Sea Grant activities, making them known to the local user community. Therefore, the news release is another avenue of communications. As Satellite Editor for the USC News Bureau, the Sea Grant Editor submits releases on various Sea Grant research projects, activities of note concerning our Principal Investigators, the Sea Grant Lecture Series, our Oceanographic Workshops, and the various diving classes that we sponsor.

For expanding visibility, the *Marine Recreational Watch* on KNX News Radio will be continued.

It's true that the communications arm of MAS has developed more activities this fiscal year, but it is quite difficult to measure the success of the efforts. The only way would be to ask a few pertinent questions such as: Is our information reaching the proper audiences? Is it recognized as a significant contribution to the field? Are we in fact, disseminating information which fulfills current, identified needs? Then comes the task of comparing the questions to the reality of the situation. Beginning with formal publications; five were produced, while one document from the past fiscal year, *The Urban Marina,* has been adopted as the textbook for an engineering seminar sponsored by the University of Wisconsin Sea Grant Program. On a slow day, the Editor's office receives at least 25 requests for documents. There doesn't seem to be a lack of audiences, but have we been reaching the right ones? Perhaps a quick look at the top ten interest groups requesting our publications will clarify matters: University Departments, Engineers, Coastal Zone Businesses, Private Citizens, Private Environmental Labs, Ports and Harbor Departments, State Agencies, Federal Agencies, Industry, and County Agencies. These groups are, in fact, the very user groups—the proximate decision-makers—that our information is best suited for.

The same conditions prevail concerning our three newsletters, for requests to be added to the mailing list for all three publications arrive daily.

Judging the success and effectiveness of the news release is most difficult, but this much can be said. This year marked the first time that a formal program of news releases was initiated on a regular basis and the USC Sea Grant Program received more news coverage this past year than during any other previous one.



Marine Education and Training

During the 05 year, our Marine Education and Training component developed a new look within the Sea Grant Program. As in the past, each project addressed various aspects of our programmatic theme, "The Planning and Management of California's Coastal Resources," but this year efforts expanded outside of the University classroom as well.

The first identified project under this heading is the "Sea Grant Intern Program" through which a select number of exceptional graduate students are awarded a stipend to further their degree studies while actively participating in one of the Sea Grant projects. This is truly a unique opportunity: the combination of research and the educational experience which is not simply inwardly directed, but outward to the user-community to which Sea Grant is ultimately responsible.

The second project, "Coastal Zone Environmental Management Institute," was initially created to provide a University-based training program for administrators already actively involved in coastal zone management; affording them an up-to-date, legal and socioeconomic view of the problems that they face daily. Gradually, under the auspices of the School of Public Administration, we hope this will evolve into a training ground for future coastal zone administrators.

Because the work required by the California Coastal Zone Conservation Act of 1972 was new and uncharted, requiring innovations by all participants including both government and individual citizens; an intelligent, open forum—"Participatory Planning Seminar for Coastal Zone Decision-Makers"—for idea exchange was initiated. Moving from the classroom to the community, our principal investigators have begun to bring their expertise to bear on the problems of coastal zone management using a participatory learning situation with political, administrative and citizen participants from Marina del Rey. This group is now a very viable reality, and is an excellent example of the USC Sea Grant Institutional Program's *raison d'etre*: to be of active service—yet maintaining a non-partisan stance—to the concerned public, be they private citizens, developers, environmentalists, or politicians.

Joining us mid-year was our new Coordinator for Marine Education. Under her direction, our modest efforts in the field were continued and expanded into the initiation of a formal, marine curriculum development thrust. There was even more expansion outside of the strict scholastic setting as several seminars involving such interest groups as Harbor Managers and Teachers were convened. These are now being held on a continuing basis. Of course, not to be overlooked are Sea Grant's film series, Underwater Natural History diving classes, Ocean Environmental Workshop and Channel Islands Cruises. All of these are ongoing and open to the public.

COASTAL ZONE ENVIRONMENTAL MANAGEMENT INSTITUTE

Robert Lutz and Ross Clayton
E/CM-3

Since the passage of the California Coastal Zone Conservation Act in 1972, there has been almost an epidemic outbreak of various environmental legislation and regulation as the many levels of State and local government respond to a growing concern about resource management. Simultaneously, rapid changes have been occurring in the social, economic and physical characteristics of coastal areas and these changes have triggered complex legal, political and administrative problems for public agencies and their employees. Private firms and various organizations have been attempting to promote coastline activities while environmental groups concerned with minimizing or planning development have been opposing their efforts.

Determining and pursuing the public interest in this complex, dynamic force field is no easy task. political, legal, administrative, and socio-economic context will require increasingly competent public administrators.
competent public administrators.

The overall purpose of the Coastal Zone Environmental Management Institute, established this fiscal year, has been to provide a University-based training program to develop personnel qualified to work in this increasingly complex milieu. The Institute's long-range focus is on the training of in-service personnel who are already grappling with these problems. Hopefully, it will also, in time, prepare pre-service persons for activities in this field.

Thus far, the Institute's educational philosophy has been an innovative one; one which has matched the variabilities in the changing socio-political landscape with several complimentary *modus operandi:* education, research, training, and advisory services. Each functional category has dealt with three prevading themes: energy resources development, ocean law and policy, and coastal zone management.

Education: The Institute's Director taught two courses this year, both of which were designed to develop a foundation of student expertise for future Institute projects. The first course, Environmental Law and Policy, was housed in the USC Law Center. Twenty-five students enrolled and several were placed in summer positions with various California agencies, i.e., California Public Utilities Commission and California Attorney General's Environmental Unit.

The second course was taught out of the Graduate School of Public Administration and was a small seminar of seven students. One student, now graduated, is pursuing a career in coastal management.

Other educational activities included:

- Faculty sponsor of Jessup International Moot Court Competition.
- Assisted in developing an Environmental Management curriculum for the Center of Public Affairs (still in progress).
- Assisted foreign (German) environmental management specialist by tutoring him with respect to U.S. approaches.
- Lectured frequently for other USC courses, at other universities, and for short courses.
- Elected Vice-Chairman, Association of American Law Schools' Environmental Law Section.

Research: In the realm of research, the Institute participated in many public hearings and wrote several articles to promote the Institute and to provide a better understanding of the policy and legal issues involved in coastal management, energy, and ocean and environmental regulation. Although success in this area is difficult to measure, several indicators suggest a substantial amount of achievement. Requests for subsequent attendance, participation and/or follow-up presentations have been a few gauges; they have been numerous. (A proper listing of delivered papers and articles appear in the general bibliography in the concluding pages of this document.)

The Institute was also active in developing proposals for future funding and for enlargement of the Institute's program to bring in additional support for student assistance. A select number of the proposals read as follows:

- Bureau of Land Management: preliminary discussion and draft regarding onshore impacts from Outer Continental Shelf (OCS) development.
- Federal Energy Administration: preliminary discussions regarding OCS onshore impacts study.
- National Science Foundation: named as Consultant on Geothermal Study Proposal on Policy-making; named as Consultant on Ocean Thermal Gradient study; proposed study of new law of the sea impacts on state governments to be performed jointly with professors of 3 other geographically distributed states.
- Environmental Protection Agency: analysis of EIS requirement for HUD Program.
- Conferred with Dr. Egon Keller of Ecosystem, Inc., Germany, re possible exchange program.
- Proposed international environmental assessment law seminar for multinational corporations.
- Proposal to American Bar Association (ABA) Environmental Controls Committee: conference on "Onshore Impacts for Offshore Oil Development."

To date, only one of these proposals has been funded, while several others are pending. The key point, however, is that the wide range of proposal ideas is indicative of the scope of expertise which the Institute has begun to develop.

Training: The third functional area involved Institute participation in training activities of other areas of the University. While the Institute did participate in these, several new activities may feature the Institute in a co-sponsoring status.

- Participation in Environmental Management Institute.
- Co-sponsorship by Institute and participation by the Director in Environmental Management Seminars.
- Assisted in formative efforts to establish the Management Training Service program of the School of Public Administration.

Advisory Services: The final *modus operandi* of the Institute was Advisory Services and much of its efforts and time were dedicated to this function. The focus of the activities was on providing valuable information to policy- and decision-makers, and providing the public representatives with information and counsel.

- The first of these efforts was a Sea Grant pub-

lication which analyzed the intent of the Coastal Plan Policies affecting development within the coastal zone.

- As a member of both the Concerned Mayor's Committee and the Mayor's Advisory Committee, the Director assisted in the understanding of Outer Continental Shelf development issues and impacts on onshore communities.
- Became an Advisor to the Regional Administrator of the Federal Energy Administration on legal and policy aspects of energy issues.
- Besides delivering innumerable speeches and lectures, the Director also assisted professors in the development of related courses or research projects and advised practicing lawyers, i.e., California Attorney General's Office regarding Environmental Impact Statement issues and the Federal District Court Judge concerning environmental law cases.

The last portion of the Advisory Services thrust manifested itself in conference organizing. The Institute felt that this was a worthwhile area to participate in because the carefully planned conferences would provide a lively forum for experts to discuss essential policy and legal considerations related to coastal management and planning. Thus far, the Institute has involved in the following projects:

- Environmental Management Seminars: the Sea Grant Institute of Coastal Law and Management was a co-sponsor.
- Sea Grant Lawyers' Conference: co-organized annual meeting, May 28, 1975, at the National Coastal Zone Conference.
- "The State Energy Commission and Public Policy": co-sponsoring this with the Federal Energy Administration and the California Energy Commission. It is scheduled for October, 1975.
- ABA Environmental Controls Committee's Section on Corporation, Business and Banking Law Conference on "Onshore Impacts from Offshore Oil Development": chairman.

Establishing an Institute in an area of study which is constantly changing and developing day by day is no small task. In this initial year of the Institute's existence, it was felt that substantial progress was made towards developing its major functional areas: education, research, training, and advisory services.

The 1974-75 fiscal year was the first and only year in which the Institute was the recipient of Sea Grant funding. However, its continuance is assured; not only due to its record of first year activities, but also from financial backing by the School of Public Administration.

PARTICIPATORY PLANNING FOR COASTAL ZONE DECISION-MAKERS

Margarita McCoy
E/CM-4

The State of California has been engaged in a major effort in planning for its coastal zone. Mandated by initiative petition and voted into law in a general election, the California Coastal Zone Conservation Act of 1972 requires the study of "the coastal zone to determine the ecological planning principles and assumptions needed to ensure conservation of coastal zone resources" and the preparation "based upon such study and in full consultation with all affected governmental agencies, private interests and the general public, (of) a comprehensive, coordinated, enforceable plan for the orderly, long-range conservation and management of the natural resources of the coastal zone, to be known as the California Coastal Zone Conservation Plan" (Proposition 20). This plan is to be submitted to the State Legislature in January, 1976.

Anticipating the public demand for improved planning and management of coastal resources, USC Sea Grant began an extensive program of research in socioeconomic issues in coastal planning in 1972. As a part of that program, a series of planning laboratories was conducted for graduate planning students which produced a regional recreation policy plan for the Malibu area in 1972, a coastal plan for Santa Monica in 1973 and applications of the Intensity Element for Los Angeles County in 1974. In addition, the Principal Investigator did extensive research on Marina del Rey and was co-author of *The Development of the Marina*, a 1972 Sea Grant publication. In the summer of 1974, she and a colleague, Dr. Tridib Banerjee, were major authors of the Appearance and Design element adopted by the South Coast Region Coastal Planning Commission in 1974.

The theoretical phase of this effort has now matured into applicability to the important work now being attempted in the preparation of the California Coastal Zone Conservation Plan. Therefore, it was proposed that a coordinated effort be made for local and regional participants in decision-making for the coastal zone.

The format of this initial effort has been based more on participatory planning than on the traditional client-professional relationship. Participatory planning is characterized by learning through an exchange of information leading to a common understanding of problems so that plan solutions of maximum acceptability to all participants can be reached. In an area like California coastal zone planning, where no answers exist for the important questions being asked and no patterns have been established for the democratic process to take place among the political, administrative and citizen participants, this seemed a necessary device to bring about the rapid and effective interchange required for a cooperative institutional response to the demands of the California Coastal Zone Act.

Under the direction of the USC Sea Grant Marine Advisory Program, a group of citizens representing development, finance, homeowners, residents, marine recreation, and other active and pertinent constituency groups in the Marina del Rey subregion were brought together with representatives of city, county and State government, as well as technical advisors from the USC Sea Grant Program. Their reason for meeting was to attempt to implement the newly-established coastal policies which, in part, stated:

> To provide more definitive guidance to affected property owners, local governments, and the general public, and more fully and effectively achieve the policies and objectives of the Coastal Plan, regional plans for specific geographic areas should be prepared in collaboration with local governments, regional agencies, other state agencies and affected citizens.

In its first meetings, the group of participants defined its goal—the creation of a subregion specific plan—formed its components and agreed upon presentation and voting rights, as well as defining tasks, responsibilities and process. It adopted with initial approval the methodology of *The Basic Framework for Preparing Sub-Regional Plans* as presented by Drs. Dickert and Sorenson from the University of California, Berkeley, and it committed itself to a minimum of weekly meetings until the plan is complete. A target date of June 1975 for submission to the South Coast Regional Coastal Commission was agreed upon.

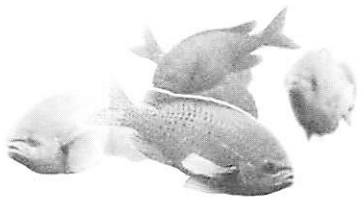
But, in order to achieve the desired goal, the creation of a specific subregional plan for Marina del Rey, the conflicts of goals and values of the participating groups have to be resolved within the plan. Regional and Statewide coastal planning objectives must be considered and then related to and be reflected in the subregional plan. Finally, the subregional plan should be acceptable to and accepted by the local governments incorporating the subregions. Within this process, the trade-offs necessary to make a viable plan for the many constitutencies and governments affected will have to be articulated and resolved.

Details of actions accomplished during this initial year of effort are as follows:

- The subregion to be considered has been defined as two areas—the Specific Plan Area and the larger Recommendation Impact Area which is affected by and affects the plan area. Boundaries for both areas have been agreed upon and base maps are being prepared.
- Participants have constituted themselves into three voting groups for purposes of decision-making and have defined eligibility requirements for membership in each group. The groups directly represent development interests in Group I and growth control interests in Group II. They require residence, employment and/or financial investment within the subject area for membership. These two groups are delegated eight votes each from a maximum of twenty votes. The third group is representative of user interests (e.g., recreational or business) in the area. Eligibility for membership in this group is by approval of Groups I and II. Group III is allotted four votes. Requirements for proxy votes, quorum and necessary majorities for conflict resolution by vote have been set.
- The group has been advised by Mr. Calvin Hamilton, Director of the Los Angeles City Planning Department, who defined many of the legal and political constraints on the effort and offered assistance through provision of existing Los Angeles City Planning Materials, as well as some staff support.
- The USC Sea Grant Marina del Rey offices will supply a meeting room for the weekly meetings and an additional space for ongoing planning work. Technical plan preparation will be under the supervision of the Principal Investigator and planning process coordination and guidance will also be provided by the Principal Investigator as needed.
- A less tangible, but most important accomplishment of the participating group has been its willingness to enter into open discussion of points of conflict and its ability to agree on resolution of these points. This, combined with the dedication shown in fulfilling the volunteer assignments of tasks and attendance at meetings, augers well for the fulfillment of the ambitious objectives the group has defined for itself.

Photo courtesy of Greg Wenger

The objectives of this initial year have been to use the institution of participatory planning processes for administration and implementation of the California Coastal Zone Act. Through this pilot project, the feasibility of recommended coastal policies will be tested. As the process is refined, further progress will be made on the analysis of conflicts and priorities in adopted coastal policies and on evaluation of policy impacts on specific subregions. Involvement and guidance . . . Sea Grant at its best.



SEA GRANT INTERN PROGRAM

Ronald B. Linsky
E/M-1

As with any research grant program, Sea Grant Programs depend upon heavy graduate student involvement, and USC is no exception. Graduate students are, in essence, the backbone of our Program and by initiating a Sea Grant Intern classification during the 1974-75 fiscal year, we hoped to clearly recognize their contribution.

Each year, based on recommendations by faculty advisors, the Intern candidates' records are reviewed by a Sea Grant Intern Selection Committee composed of University faculty and administration. Candidates must be working towards a specific graduate degree and their fields of interest must be adaptable to the USC Sea Grant overall theme of "Planning and Management of California's Coastal Resources," and the Sea Grant mode of research — applicability to real world problems.

Once the selection is made and the stipend awarded, the graduate students are placed under the direction of one of the Sea Grant Principal Investigators within a funded project which directly relates to their area of concentration.

Since the USC Sea Grant Program is interdisciplinary by nature, the Intern Program mirrors its structure with graduate students drawn this first year from the Departments of Engineering, Geology, Law, Biology, and Planning and Urban Studies.

During its first year, the Program was proud to award Sea Grant Intern status to the following graduate students:

Farzad Ahi
M.S. Degree in Engineering
Employed by The Ralph M. Parsons Co. (Engineers & Contractors)
"Wave Energy Permeation of Breakwaters"

James Coyer
Studying for Ph.D. in Zoology
"Inshore Marine Environmental Research"

John Engle
Studying for Ph.D. in Zoology
"The Surf Grass Habitat as a Nursery for Juvenile Spiny Lobsters"

James Gollub
Studying for MPL in Planning and Urban Studies
"Aesthetic Indicators for Land Use Planning: Application to the Coastal Zone"

Carla Johnson
B.S. Degree in Geology
Employed by the Continental Oil Company
"Offshore Sand and Gravel Resources in California"

Soon Tae Kim
Studying for Ph.D. in Engineering
"Wave Energy Permeation of Breakwaters"

Michael Leneman
M.S. Degree in Geology
Employed at California State University, Los Angeles; California State University, Northridge; and Pierce College (Instructor)
"Interdisciplinary Study for a Semi-Protected Hand-Launched Boat Facility"

Don Morrow
J.D. Degree in Law
Employed by Paul Hastings, Janofsky & Walker (Law Firm)
"Marine Advisory Services"

Thomas Nardin
Studying for Ph.D. in Geology
"Oil and Tar Seeps on the Shelf off California"

Thomas O'Neil
Studying for Ph.D. in Organic Geologic Chemistry
"Oil and Tar Seeps on the Shelf off California"

Steve Pavlak
M.S. Degree in Geology
Employed by The Mineral Exploration Company
"Oil and Tar Seeps on the Shelf off California"

Carla Walecka
MPL Degree in Planning and Urban Studies
Employed by Southern California Association of Governments (SCAG)
"Aesthetic Indicators for Land Use Planning: Application to the Coastal Zone"

Motivation *is* a key factor in the educational process; but if it's true that success ultimately depends upon motivation, then our Interns—working closely with researchers in their own fields of interest, tackling problems which present a genuine challenge—have a head start.

MARINE EDUCATION AND TRAINING PROGRAM

Dorothy M. Bjur

Our fledgling marine education and training program began to take form and direction when in mid-year, a Coordinator for its activities was brought on board. Since there was no clearly defined marine education portion of the USC Sea Grant Program, simply a small cluster of rather dissimilar projects, a series of activities was initiated using in-house resources. Experiences and contacts garnered through these were then used to begin shaping a formal, Sea Grant marine education and training program.

First of all, a series of extension programs was conducted during the year, proving beneficial to a wide variety of publics and provoking new interest in the ocean. The Ocean Environmental Workshop brought together professionals, college and high school students, all interested in the current and projected happenings in the field of Oceanography. It was held at the USC campus and combined classroom instruction and field experiences set within a nine/week time frame. Designed to point out the current developments concerning the Outer Continental Shelf on the western coast of the United States, the workshop dealt with such topics as: Law of the Sea, Food from the Sea, The Mystery of the Sliding Plates, Mining the Ocean's Bottom, Man's Place in the Undersea Environment, and Exploring the Oceans with Man's Current and Projected Technology. The Ocean Environmental Workshop was able to disseminate timely information to a wide spectrum of interested publics.

The next marine education venture was a 2½-day Harbor Managers Conference which brought

together University professors and professionals from the fraternity of harbor managers, who shared freely of their time and talents to address the issues expressed by the managers as being timely for their special needs. The program consisted not only of lectures, but roundtable discussions, and gaming and information question/answer periods. Interaction has continued between the harbor organizations and Sea Grant to such an extent that further conferences have been planned in compliance with other articulated needs.

Southern California is a very heavily populated area, yet there are portions which are practically devoid of human life and little known to most Californians. One of these areas, situated off the coast of southern California, is known as the Channel Islands. Sea Grant offered two Channel Island Cruises during the summer months that visited six of the northern islands and provided participants with the opportunity to experience nearly pristine environments. Two days were spent exploring the interior of Santa Catalina, examining its peculiar insular ecology and walking through its unusual geology. While sailing onboard the floating laboratory, specially equipped to sample the oceanic environment, the participants learned-by-doing with the help of trained biologists and geologists.

Another project of marine education and training was the Bi-National Coastal Zone Planning and Management Workshop, held at the University of Baja California in Ensenada, Mexico. For five days, professionals from Mexico and the United States, including biologists, geologists, environmental engineers, planners, industrialists, and representatives of State and federal agencies, met to formulate guidelines for the planning and wise utilization of Baja California. The resulting suggestions were presented by the invited experts to the Mexican Government and the presentations compiled and written into a document.

One of the most enthusiastically received programs has been the Underwater Natural History for the Recreational Diver Class. Participants are flown from San Pedro to the USC Marine Science Center on Catalina Island for the weekend. During those two days, the students are introduced to the fundamentals of the marine natural history around Catalina Island; taken into the water; and

then—with the aid of knowledgeable biologists/divers—are given the chance to explore, study at close range, and participate in actual underwater observational experiments involving the resident marine life. The enthusiasm of the instructors has been contagious, for as a rule, after approximately six hours in a classroom and ten hours underwater, students have expressed a new appreciation for what they have seen.

Towards the end of the fiscal year, the Coordinator took the initial step for the development of a marine education curriculum. Workshops for public school educators and administrators were held both on the USC campus and in the public schools. With lectures and slide presentations, the professionals were shown the "why's" and "how's" of teaching marine education in the classroom. Demonstrations, written materials and field trips further emphasized how easily the oceans can be integrated into music, history, languages, math, or any of the subject matters taught in the school system today . . . without specialized training in biology or marine sciences. Interest was generated and enthusiastic offers made to assist in further development of a broader marine curriculum.

The success achieved in motivating people to "think ocean" was directly related to the activities offered. A program was born during this initial six months, and will continue to grow based on its good works.

Program Information

INSTITUTIONAL PROGRAM SUMMARY
1974-75

		1972-73	1973-74	1974-75
	Program Management			
M-1	Program Administration and Management	C	C	C
	Coastal Zone Management and Planning			
R/CM-3	Interdisciplinary Study for a Semi-Protected, Hand-Launched Boat Facility			N-F
R/CM-4	Aesthetic Indicators for Land Use Planning: Application to the Coastal Zone			N-F
R/CM-5	Appearance and Design Planning in the Coastal Zone			N-F
R/CE-1	Wave Energy Permeation of Breakwaters	N	C	F
	Coastal Resource Development			
R/RD-2	Oil and Tar Seeps on the Shelf off California			N
R/RD-3	Offshore Sand and Gravel Resources in California			N
R/RD-6	The Surf Grass Habitat as a Nursery for Juvenile Spiny Lobsters			N
	Coastal Zone Environmental Quality			
R/CE-4	Storm Water Quality and Land Use Characteristics		N	T
R/H-1	Inshore Marine Environmental Research	C	C	F
R/H-2	The Roles of Microbiological Activity in Harbor Ecosystems	C	C	F
R/H-4	Population Changes in Benthic Communities Following Pollution Abatement	C	C	F
R/H-5	The Effects of Pollution on Fish Populations in Los Angeles-Long Beach Harbors	C	C	F
R/H-6	Aspects of the Biology of the Anchovy, *Engraulis mordax,* in San Pedro Harbor	C	C	F
R/H-7	The City of Avalon Sewer Outfall as an Isolated Case Study	C	C	F
	Marine Advisory Services			
A/S-1	Marine Advisory Services	N	C	C
A/S-2	Information Retrieval and Transfer			N
A/S-3	Coastal Commission Scorecard			N-
A/S-5	Recreational Opportunities in Coastal Development			N
A/S-6	Marine Information and Dissemination Program			N
	Marine Education and Training			
E/CM-3	Coastal Zone Environmental Management Institute			N-T
E/CM-4	Participatory Planning for Coastal Zone Decision-Makers			N
E/M-1	Sea Grant Intern Program			N

C = Continuing
N = New
T = Terminated
F = Completed

ACTIVITY BUDGET SUMMARY
1974-75

		OSG	MATCH
	Program Management		
M-1	Program Administration and Management	$78,215	$32,250
	Coastal Zone Management and Planning		
R/CM-3	Interdisciplinary Study for a Semi-Protected, Hand-Launched Boat Facility	6,213	6,201
R/CM-4	Aesthetic Indicators for Land Use Planning: Application to the Coastal Zone	2,260	-0-
R/CM-5	Appearance and Design Planning in the Coastal Zone	1,200	4,000
R/CE-1	Wave Energy Permeation of Breakwaters	24,338	14,711
	Coastal Resource Development		
R/RD-2	Oil and Tar Seeps on the Shelf off California	29,463	23,118
R/RD-3	Offshore Sand and Gravel Resources in California	31,575	15,229
R/RD-6	The Surf Grass Habitat as a Nursery for Juvenile Spiny Lobsters	1,900	2,957
	Coastal Zone Environmental Quality		
R/CE-4	Storm Water Quality and Land Use Characteristics	16,900	10,890
R/H-1	Inshore Marine Environmental Research	46,762	34,185
R/H-2	The Roles of Microbiological Activity in Harbor Ecosystems	14,220	9,744
R/H-4	Population Changes in Benthic Communities Following Pollution Abatement	12,830	7,060
R/H-5	The Effects of Pollution on Fish Populations in Los Angeles-Long Beach Harbors	2,390	2,625
R/H-6	Aspects of the Biology of the Anchovy, *Engraulis mordax,* in San Pedro Harbor	2,428	3,450
R/H-7	The City of Avalon Sewer Outfall as an Isolated Case Study	8,750	7,611
	Marine Advisory Services		
A/S-1	Marine Advisory Services	34,306	7,796
A/S-2	Information Retrieval and Transfer	26,550	995
A/S-3	Coastal Commission Scorecard	2,866	1,858
A/S-5	Recreational Opportunities in Coastal Development	15,290	-0-
A/S-6	Marine Information and Dissemination Program	26,450	86,294
	Marine Education and Training		
E/CM-3	Coastal Zone Environmental Management Institute	37,200	2,125
E/CM-4	Participatory Planning for Coastal Zone Decision-Makers	16,740	2,121
E/M-1	Sea Grant Intern Program	46,654	13,600

USC SEA GRANT ADVISORY PANEL 1974-75

Victor Adorian, Director
Department of Small Crafts Harbors
County of Los Angeles

Willard Bascom, Director
Southern California Coastal Water Research Project

Capt. Jack Boller, Director
Marine Board
National Academy of Engineering

Dr. Richard A. Geyer, Chairman
Department of Oceanography
Texas A & M University

Col. Ted Gillenwaters
Oceanic Research Institute

Dr. Arie Haagen-Smit

George Hatchett, President
Hydro-Products

Robert D. Kleist

Robert Krueger, Esq.
Nossaman, Walters, Scott, Krueger & Riordan

Howard R. Talkington, Head
Ocean Technology Department
Naval Undersea Center

Capt. T. K. Treadwell
Department of Oceanography
Texas A & M University

Cmdr. Don Walsh
Deputy Director, Navy Lab
Department of the Navy

O. D. Waters, Jr., Rear Adm. USN (Ret.)
Head, Department of Oceanography
Florida Institute of Technology

Elmer Wheaton

SOURCES OF MATCH FUNDING 1974-75

- Battelle/Columbus Laboratories
- California State Department of Fish and Game
- California State Lands Commission
- California State Resources Agency
- California State University, Long Beach
- City of Avalon, Santa Catalina Island
- CONOCO
- Dames and Moore
- Datatronics Systems Corporation
- EXXON
- KNX Radio
- Long Beach Harbor Department
- Los Angeles County Sanitation District
- Los Angeles County Small Craft Harbor Commission
- Los Angeles Flood Control District
- Los Angeles Harbor Department
- Occidental College
- Pacific Lighting Services Company and Subsidieries: Southern California Gas Company and Pacific Alaska LNG Company
- Society of Sigma Xi
- StarKist Foods, Inc.
- Tetra Tech, Inc.
- Todd Shipyards Corporation
- Tuna Research Foundation
- United States Army Corps of Engineers
- U.S. Borax

USC SEA GRANT INTERACTIONS 1974-75

INSTITUTIONS OF HIGHER LEARNING

- California State University, Long Beach
- Immaculate Heart College
- Occidental College
- University of California
- University of Hawaii
- University of Michigan

LOCAL, STATE AND FEDERAL AGENCIES

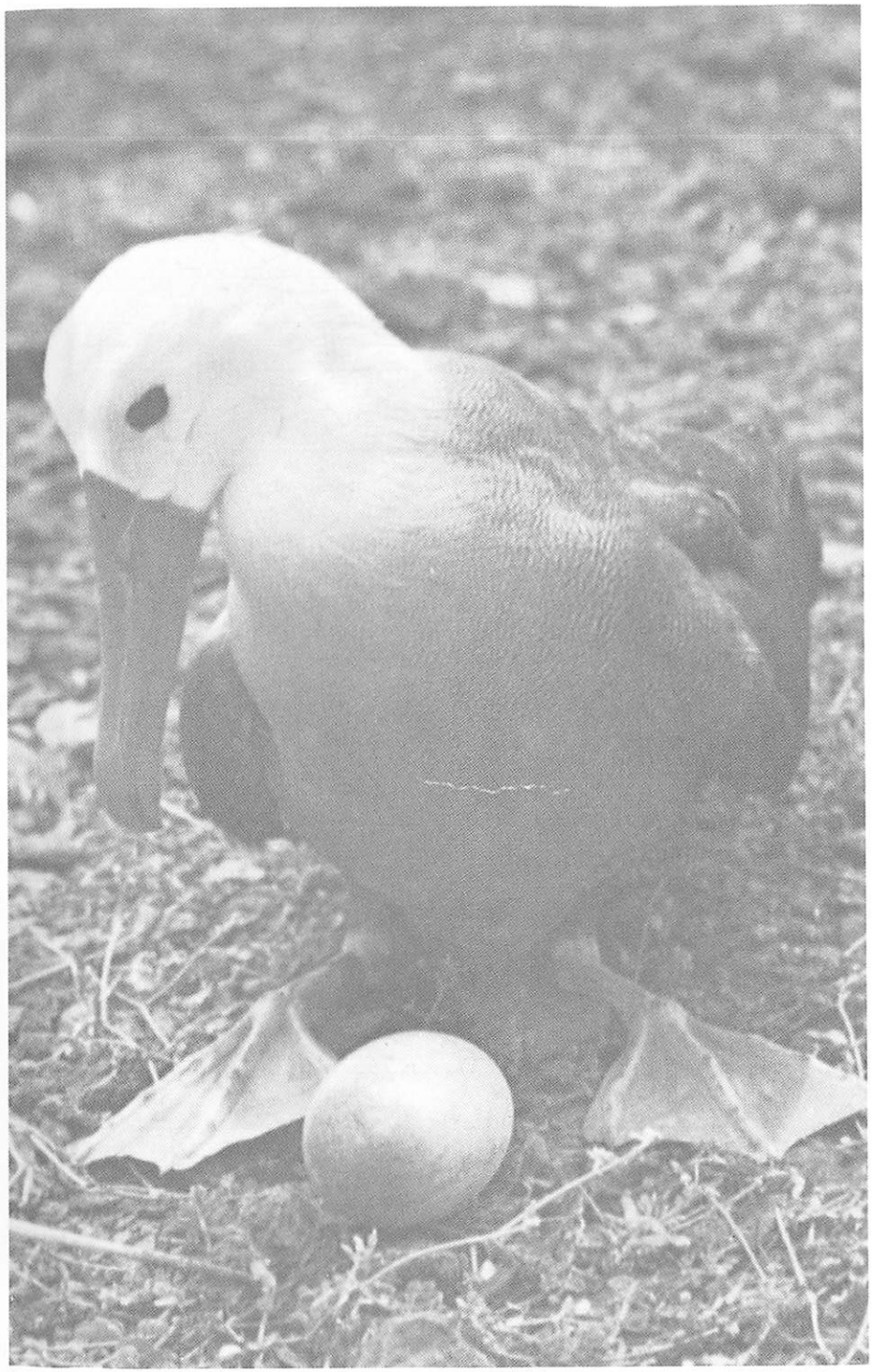
- California Coastal Zone Conservation Commission (State and Region V)
- California Marine Advisory Program (CMAP)
- California State Assembly Select Committee on Coastal Zone Resources
- California State Department of Fish and Game
- California State Department of Navigation and Ocean Development (DNOD)
- California State Lands Commission, Division of Mines and Geology
- California State Resources Agency
- City of Avalon, Santa Catalina Island
- Long Beach Harbor Department
- Los Angeles County Sanitation District
- Los Angeles County Small Craft Harbor Commission
- Los Angeles Flood Control District
- Los Angeles Harbor Department
- National Marine Advisory Service (NMAS)
- Pacific Sea Grant Advisory Program (PASGAP)
- United States Army Corps of Engineers

INDUSTRY

- AFL-CIO
- Battelle/Columbus Laboratories
- CONOCO
- Dames and Moore
- Datatronics Systems Corporation
- Environmental Feasibility Studies, Inc.
- Environmental Planning and Management, Inc.
- EXXON
- KNX Radio
- Los Angeles Chamber of Commerce
- Marine Technology Society
- Pacific Lighting Services Company and Subsidiaries: Southern California Gas Company Pacific Alaska LNG Company
- Santa Catalina Island Company
- StarKist Foods, Inc.
- Tetra Tech, Inc.
- Todd Shipyards Corporation
- Tuna Research Foundation
- Ultra Systems, Inc.
- U.S. Borax

OTHER

- Sierra Club
- Society of Sigma Xi



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Henyey, Thomas and Ta-liang Ten. "Oil and Tar Seep Studies on the Shelves off Southern California, I: Initial Progress," Tech. Rpt. #74-4 (University of Southern California, Department of Geological Sciences, Geophysical Laboratory, February 1, 1975).

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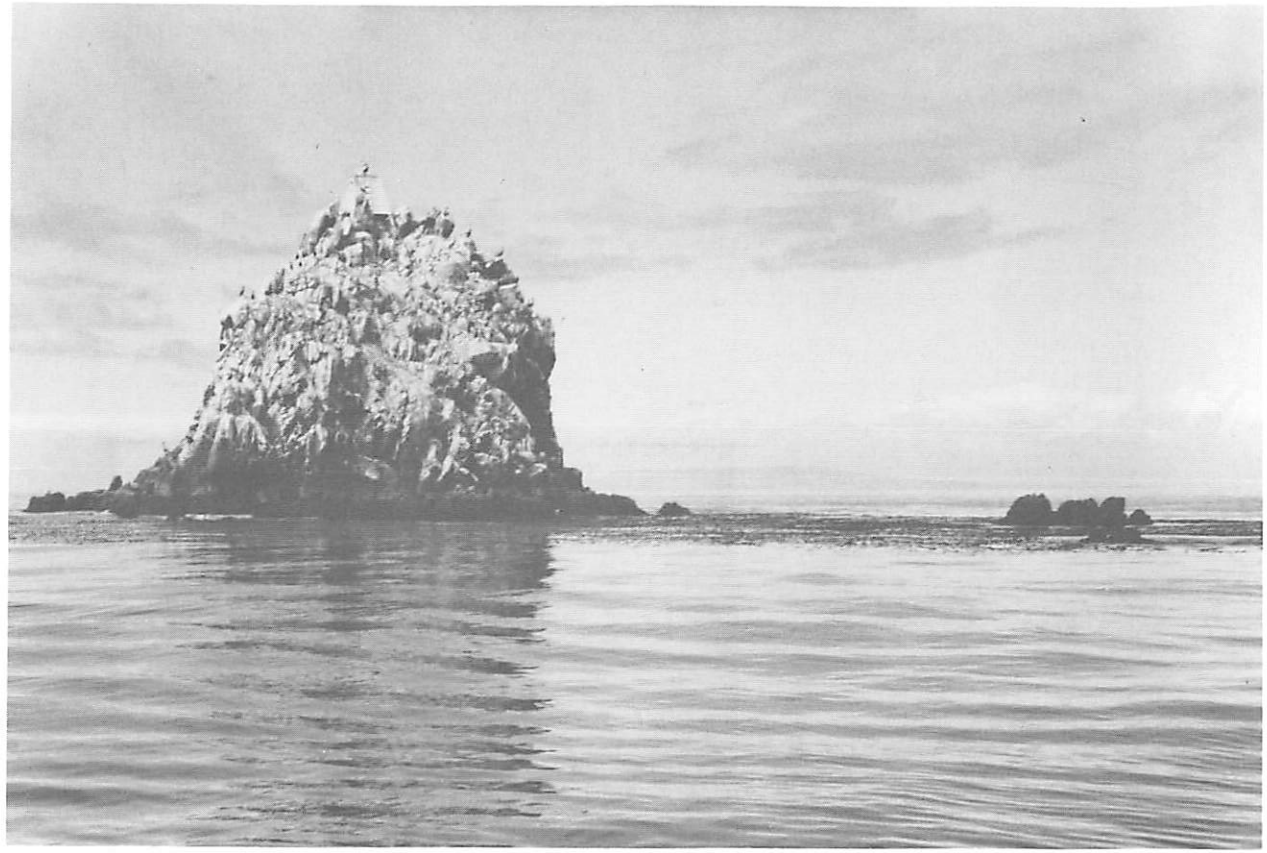
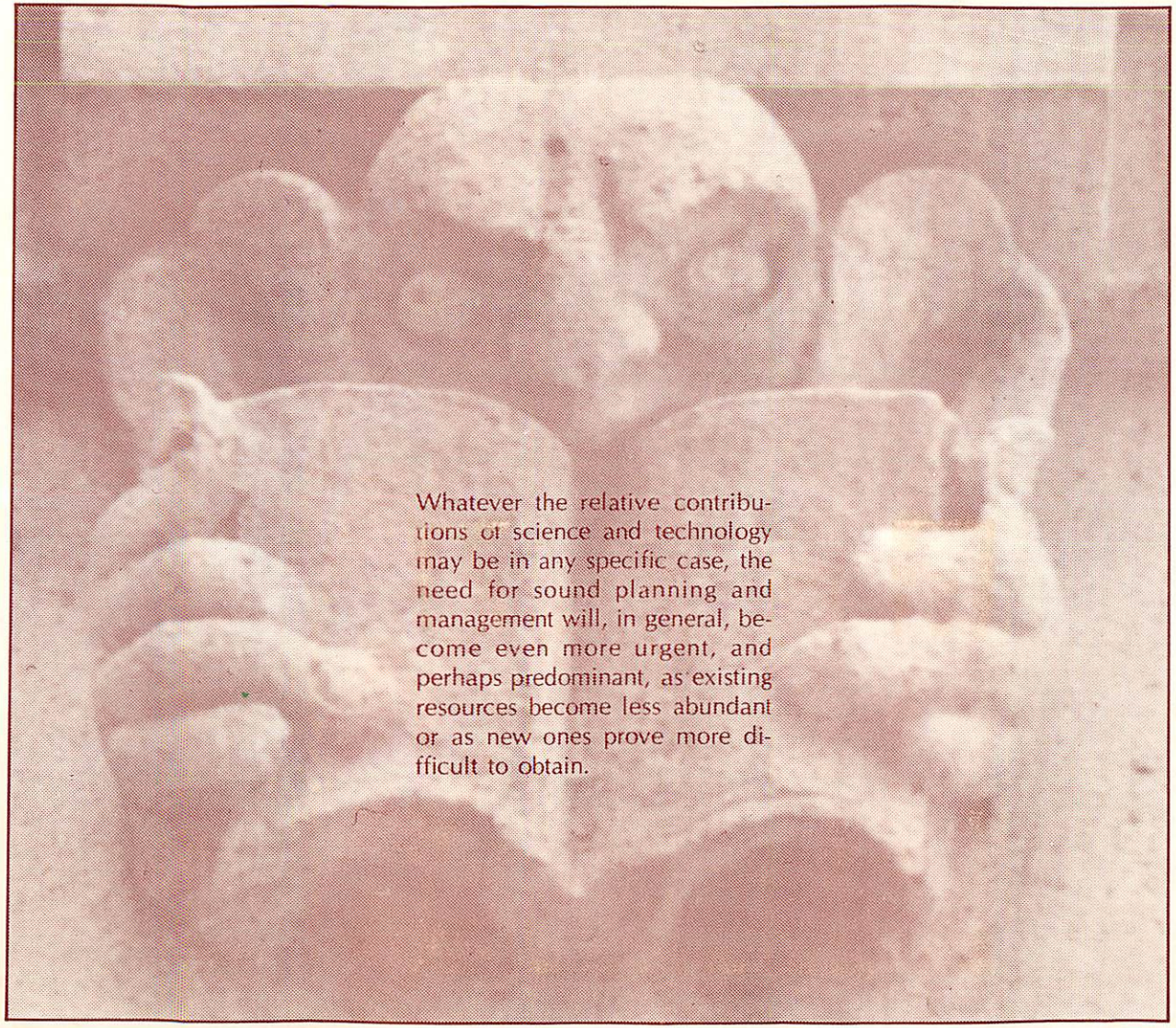


Designed and Edited by Shirley Hudgins



Whatever the relative contributions of science and technology may be in any specific case, the need for sound planning and management will, in general, become even more urgent, and perhaps predominant, as existing resources become less abundant or as new ones prove more difficult to obtain.