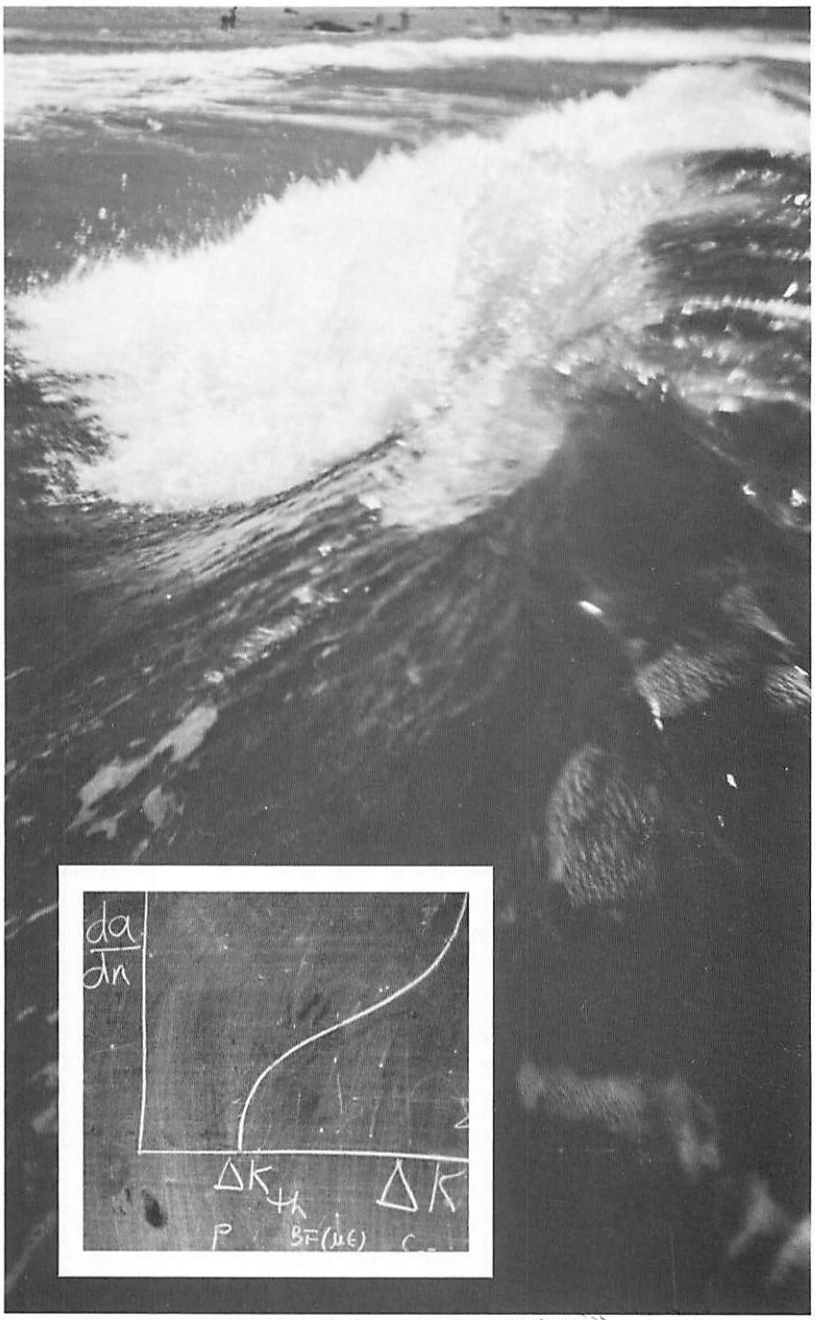
USC Sea Grant

ANNUAL REPORT 1985-86



Introduction

Port of Los Angeles

1985-86 was the University of Southern California's sixteenth year of participation in the National Sea Grant College Program. Funded by the National Oceanic and Atmospheric Administration, this program supports marine research, education and advisory services at universities in 30 coastal and Great Lakes states. As one of the few Sea Grant programs located in a major metropolitan area, the program at USC addresses the problems and opportunities of "The Urban Ocean."

The urban coastline continues to be a magnet for human activity. In greater Los Angeles, for example, the ports of Los Angeles and Long Beach form a complex that is the second largest in the nation. Anticipating growth of Pacific rim trade, both ports plan to expand. Ocean sports are an important pastime and an important industry in southern California. Other marine industries crowd the coast: Todd Shipyards, the Long Beach Naval Shipyard, the Queen Mary, and the Pan Pacific canneries. Several major outfalls conduct urban waste into the ocean. Southern California has long been and probably will continue to be one of the nation's most important locations for recovering offshore oil.

This highly developed region continues to grow in population. A new paper by USC sociologists Margo Koss, Maurice D. Van Arsdol, Jr., and Jael Mongeau, who were funded by USC Sea Grant in 1984-85, documents that in 1970 - 1980, population growth in the "coastal strip" of California's metropolitan coastal counties greatly exceeded that of the inland tracts of these counties. Clearly if this trend continues, the pressures on coastal resources will only increase.

The research supported this year relates in different ways to the concerns of the Los Angeles region and of heavily developed coastal regions of the world. Researchers have investigated:

--the nature of the ocean processes affecting dispersion of sewage effluent from a major coastal outfall;

--local economic predictors that may be useful for assessing demand for new seaport services;

--the contribution of dissolved organic substances in seawater to the early nutrition of oyster larvae, for mariculture;

--comparative growth and chemical composition of kelp taken from different environments along the California coast;

--the frequency and geographic distribution of shallow water diving accidents at the region's beaches;

--the mechanisms governing corrosion fatigue crack growth in marine structural steels; and

--the use of mercuric iodide as an X-ray fluorescence detector material, for locating platinum and cobalt in the seafloor.

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1 "Population Growth and Policies in California's Coastal Region," paper to be delivered and published as part of Coastal Zone '87, Seattle, Wash. May 26-29, 1987.

Cover photo: C.R. Bostick II
Inset: Sally Lawrence

Sea Grant research is primarily applied research. The program at USC, like other Sea Grant programs, is committed to working with representatives of the public and industry to solve marine and coastal problems of regional significance. In return, obtaining local matching funds is a necessary part of Sea Grant programming. In 1985-86, we are pleased to report funds totalling $439,516 from the State of California, the County of Los Angeles, and other sources.

The year's Marine Advisory efforts have reinforced program strengths in seaport management services and marine recreation. A major conference on planned expansions of the ports of Los Angeles and Long Beach, and their relation to Pacific rim trade, is being organized for October 1987.

Sea Grant's endeavors at times extend to the international: in April, 1986, USC Sea Grant hosted an Ocean Policy Round Table, whose participants included a delegation from the State Oceanic Administration, People's Republic of China.

USC has continued to place students in Sea Grant internships; in 1986, Jennifer Starr-Smith, a graduate student in the Master of Marine Affairs Program, was selected for the year-long Washington, D.C.-area internship program. Smith worked with the House Merchant Marine and Fisheries Committee on ocean dumping issues and other marine policy concerns.

In 1986 we completed our first long range plan. The goals and priorities outlined in this document will assist in direction of USC Sea Grant for several years to come. In addition, the closing of 1985-86 and the start of 1986-87 mark a transition for USC Sea Grant from one-year to two-year proposal cycles. This change will streamline many aspects of program administration. It also marks further recognition of improvements in program quality over the past several years.

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Nutritional Implications of Dissolved Organic Material In Seawater for Culturing Oysters *(Crassostrea Gigas)*

Donal T. Manahan, Biological Sciences

The successful aquaculture of mollusks, such as oysters, has been hampered by the lack of information on the dietary requirements of these animals. Information for the early stages of development (embryos and larvae) is especially important because these are the most vulnerable phases of the life cycle.

Understanding the dietary requirements of oyster larvae would provide a solution to one of the most practical biological problems faced by commercial oyster hatcheries. The basic question of the specific nutritional requirements of larvae remains unanswered. The problem addressed in this research is whether the direct uptake of dissolved organic material from seawater makes a substantial contribution to the diet and energy requirements of oyster embryos and larvae.

Dissolved organic carbon is the largest source of organic carbon present in seawater, occurring at approximately ten times the concentration of particulate organic carbon. If dissolved nutrients make a substantial contribution to larval foods, then variations in the organic components of seawater will affect larval growth rates. Indirect support for this idea has come from hatchery operators who often attribute much of the variability in the rates of larval development to variations in "water quality."

Previous attempts to quantify the nutritional role of dissolved organic material have been hampered by the presence of bacteria in experimental systems and a lack of sensitive analytical techniques for measuring organic chemicals in seawater. These limitations were overcome by employing (1) culture techniques to produce bacteria-free oyster larvae and (2) advances in analytical chemistry that now permit the direct measurement of amino acids present in seawater at picogram amounts.

In the previous year (FY84-85), we had obtained quantitative data on the rates of uptake of dissolved amino acids by bacteria-free oyster larvae.

During 1985-86, our goal was to determine the contribution that the uptake of dissolved organic material from seawater made to the metabolic requirements of developing oysters.

The early developmental stages of oysters (egg to larva) have been presumed to be "non-feeding" because they lack a digestive system. The current paradigm is that the adult provides the egg with a sufficiently large amount of organic material (lipid, protein) that decreases over time, providing the energy required for development.

Our previous data had shown that "nonfeeding" oyster larvae can still acquire nutrients from seawater because the larva has the capacity to absorb dissolved organic material across its body surface, independent of the presence or absence of a digestive system. Our hypothesis would predict that a developing larva could still increase in weight even though it lacks a digestive system.

Our data (Fig. 1) show a 100% increase in organic weight as the embryo developed during a five-day period. The inorganic weight of the animal also increased during this time. It is well established that animals obtain inorganic chemicals from seawater for structural purposes (e.g., the incorporation of calcium from seawater into shell). However, the data in Figure 1 are the first to show that oysters can utilize the organic chemistry of seawater for tissue growth.

The increases in organic weight during nonfeeding embryogenesis can be reproduced between different batches of larvae from different adults (Figs. 1 and 2).

The organic weight increases were analyzed biochemically to determine the amount of lipid and protein at each stage of

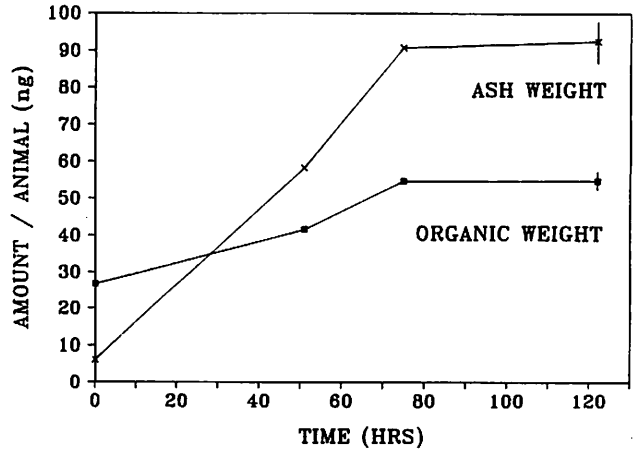

FIGURE 1. Changes in total dry organic weight and ash weight of oyster (Crassostrea gigas) eggs (0 hrs) and larvae (c. 48 hrs) cultured for 5 days at 20 deg C. Larvae were cultured in particle-free seawater (0.2 um-filtered) and the seawater was changed at the times shown by each of the data points. Error bars represent the standard error of the mean; where no errors are shown, the error lies within the graphical represenation of the mean.

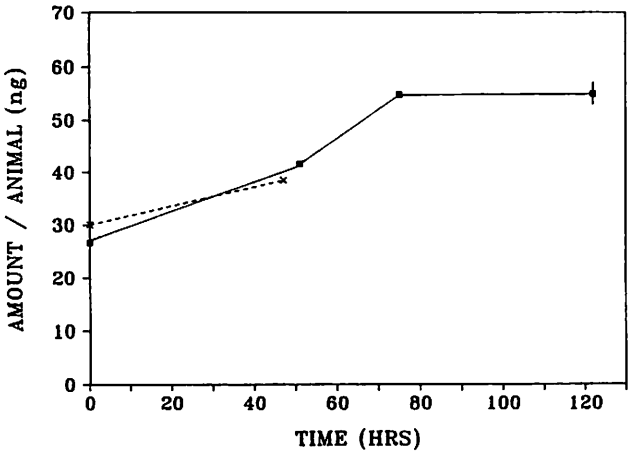

FIGURE 2. Changes in organic weight of two independent batches of oyster eggs and larvae. Solid line represents dry organic weight of one batch of larvae (taken from Fig. 1); dashed line is data from second batch of eggs.

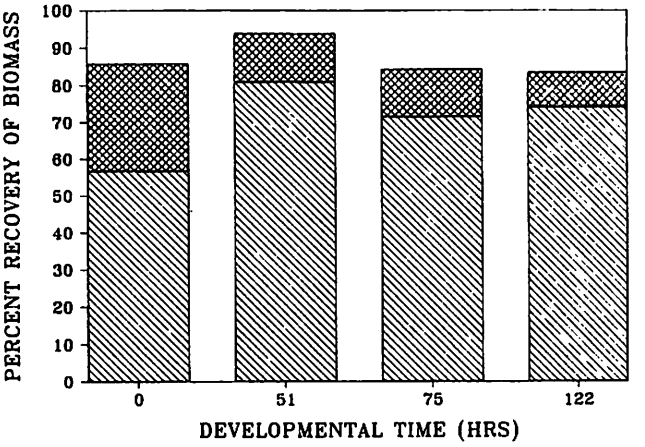

FIGURE 3. Percent recovery of the total dry organic weight determined at each stage of development (Fig. 1) in terms of lipid and protein. The upper part of each histogram (XXX) shows the production of protein/individual; the lower part represents lipid.

development. Eighty to 90 percent of the dry organic weight of individual eggs and larvae was present as lipid and protein (Fig. 3). Total lipid increased from 15 nanogram/egg to ca. 40 nanogram/larva during the 3-4 days post fertilization while protein showed a small net decrease throughout this nonfeeding period (Fig. 4).

We now have (1) predictive data on the rates of uptake of dissolved amino acids from any substrate concentration by oyster larvae and (2) observed changes in oyster biomass during nonfeeding stages of development. We combine these two approaches (Table 1) to calculate the importance of dissolved organic material in the energetics of oyster larvae.

First, we estimate the contribution of dissolved amino acids by comparing their caloric value, at an environmentally realistic concentration (500 nM), to the rate of caloric expenditure of larvae (oxygen consumption). The result: Dissolved amino acids in seawater could contribute 18% of the larva's needs (Table 1). This is a significant input of energy to metabolism considering that it comes from a single fraction representing only 1% of the dissolved organic material in seawater.

Second, the more important contribution of dissolved nutrients to larval growth can now be estimated (Table 1). Oyster embryos and larvae gain in organic weight by 25 ng/individual, equivalent to a doubling in biomass by the third day of development (Fig. 1). Expressed in terms of carbon, a 25 ng gain would be equivalent to 10 ng carbon/larva since organic material is 40% carbon. Larvae can take up 2.6 ng of amino acid carbon from a 500 nM solution during this 3 day period. I have assumed that larvae can also take up other components of the organic material in seawater (e.g., sugars, organic acids, fatty acids etc.) at the same rates. The total dissolved organic carbon pool in seawater is 2000 ug C/l. Therefore, to account for the doubling in organic biomass, a larva could gain 10 ng carbon by utilizing just 4% of the constituents present as dissolved organic carbon in seawater.

These results are consistent with our hypothesis concerning the importance of dissolved organic nutrients as a source of energy for larvae. The data also suggest that the energetics of oyster embryogenesis are more complicated than previously thought, and they may also help to explain how larval growth is arrested during those times of the year when seawater quality is deemed "poor" by commercial growers.

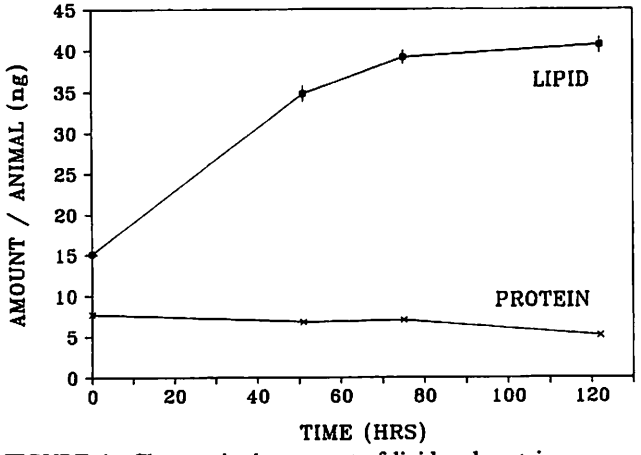

FIGURE 4. Changes in the amount of lipid and protein per individual animal cultured as described in the legend for Figure 1.

The entire West Coast industry for Pacific oysters depends on the production of larvae in hatcheries. Commercial growers need to know the nutritional needs of their animals at every life stage in order to reduce mortality. Our results have illuminated one area relating to the dietary needs of oysters and how these are affected by seawater chemistry.

PROJECT COMMUNICATIONS

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Table 1. The Importance of Dissolved Organic Material for the Development of Oyster Larvae (2-3 day old, 50 ng dry organic wt.)

(1) Maintenance Metabolism

Amino acid uptake from a 500 nM solution	= 36 pg AA/larva-hr
Oxygen consumption of larva	= 198 pl 02/larva-hr
Percent contribution of amino acid uptake to larva's energy needs	= 18% (*)

(2) Growth Requirements

Observed (Fig. 1) 100% increase in organic weight from egg to 3 day-old larva	= 25.0 ng/larva
Equivalent increase in organic carbon (40%)	= 10.0 ng C/larva
Contribution from uptake of amino acid carbon present at 20 ug C/l ([AA] @ 500 nM)	= 2.6 ng C/larva
If 4% (80 ug C/l) of total DOC pool in seawater utilized at same rate as amino acids, contribution would be	= 10.4 ng C/larva

(*): calculation based on the oxycaloric equivalent of 1 pl 02/larva-hr being equal to the complete combustion of 1 pg amino acid/larva-hr.

Unusual abbreviations: AA = amino acid; DOC = dissolved organic carbon.

Physical and Chemical Oceanographic Variability in the Region Near the Los Angeles County White's Point Outfall

Burton H. Jones, Allan Hancock Foundation; Alan Bratkovich, Center for Earth Sciences; and Tommy Dickey, Geological Sciences

The fate of coliform bacteria and dissolved inorganic nitrogen released from submerged ocean sewage outfalls is of major concern to coastal municipalities and sanitation districts. Whether these outfalls affect local beaches and shellfisheries depends to a large extent upon local ocean processes occurring at space and time scales smaller than those often sampled by oceanographers. Lacking adequate understanding of the local oceanography, a waste treatment plant must chlorinate based more upon hindsight (the frequency and proportion of past coliform abundances) than on any predictive capability. One general goal of this study is to develop an understanding of the ways local oceanographic processes affect the fate of coastal waste water discharges. Our results should be useful to design as well as management of ocean sewage discharge systems.

An outfall discharge provides a known source of traceable material that can be mapped. The wastefield's distribution may be used to estimate advection and mixing rates on scales most pertinent to plume evolution. Temporal changes in the waste field distribution provide a way to monitor the response to local physical forcing (wind) and current variables. The result is an enhanced ability to map hydrographic structure in the region.

In the first year of this project, we conducted a field study of the intermediate and far field variability of the outfall plume during winter, when stratification of the water column is generally weak.

Our objectives for this second year were to identify the oceanographic processes which influence current and density structure during the summer stratification regime. The field work was carried out from July through September, 1986. As with the January 1985 field effort, several sampling modes were employed to observe variability at different time and space scales.

Time series observations were obtained with a current meter mooring and with meteorological observations obtained from Point Vicente and other local stations. The current meter mooring was in place from July 1 to October 6, at approximately 2 km upcoast from the Los Angeles County outfalls and at approximately the same isobath (~55 m total water depth) as the outfall diffusers (Figure 1). The mooring had four instruments suspended at 16, 27, 38 and 46m beneath the ocean surface. Temperature and two vector components of current were measured with each instrument. Near-surface currents were mapped using surface drifters on selected days in August and September.

Spatial variability was obtained with satellite sea surface temperature (SST) images and with shipborne sampling. During the July–September period satellite infrared (NOAA-9 AVHRR) SST images were acquired using the Scripps Satellite Facility. These images have been compiled as 35 mm slides and have been archived in digital form on magnetic tape.

The shipborne sampling (August 18 to 20) included hydrography and mapping of the 3-dimensional distributions of temperature, salinity, plant nutrients, beam transmission, chlorophyll, phaeopigment and bacterial abundance. A map was made every 18 hours. During this sampling period the largest tidal amplitudes of the month occurred. A grid was sampled with a set of 5 alongshore tow-yo transects spaced 1 km apart. These transects measured temperature, salinity, and beam transmission and provided more detailed spatial resolution than is possible with a set of discrete vertical profiling stations. Vertical pump profiles of temperature, salinity, nutrients, and chlorophyll were performed on a grid with 2 km intervals between stations (Fig. 1).

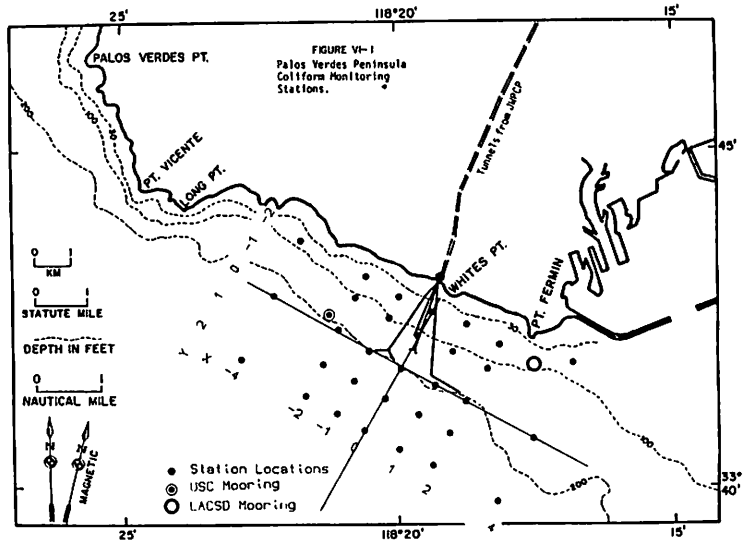

FIGURE 1. Region around the Los Angeles County Sanitation District White's Point outfall.

During August 1986, the water column was strongly stratified. A strong pycnocline was observed between 10 and 20 m depth. The ammonium concentrations, indicative of the effluent plume, were highest at the base of the pycnocline. The surface layer was uniformly depleted of ammonium and other plant nutrients. Meteorological forcing was weak during this period.

These results contrast sharply with those of the 1985 winter field study, from which we made the following observations (as summarized in our paper presented at Third International Symposium on Stratified Flows, February 1987):

In winter 1985, wind and current fluctuations were observed to have relatively small amplitudes. Alongshelf current variability was dominated by near-tidal rather than subinertial components in contrast to other coastal sites in the Southern California Bight. These conditions may have contributed to stronger density stratification and higher than normal near-surface water temperatures.

The winter 1985 hydrography was dominated by two components: the ambient ocean and the outfall effluent field. The perturbation of the ambient hydrographic conditions was much larger for ammonium, phosphate, and bacterial parameters than for temperature and salinity. Other factors which affect the biochemical variables (e.g., growth, death and nutrient uptake) must ultimately be considered. The general distribution of the effluent field was skewed downcoast in the direction of the prevailing currents. In the vicinity of the outfall, stratification appeared to be weakened by the effluent field. Significant spatial variability was associated with the interaction between the effluent and the ambient field. With weak advection (<10 cm s^{-1}) and moderate stratification, the effluent field was confined to a relatively small spatial region.

Three relatively distinct stratification regimes occurred during the course of this winter 1985 study interval. The first was a three day period of greater density stratification and weak current shear. The second was a period of weak wind forcing, weak density stratification, and minimal current shear. In the third period, density stratification reintensified and current shear was enhanced in both horizontal current components.

To our knowledge, this is one of the most comprehensive and integrated process-oriented field studies of an oceanic buoyant plume. Chemical, biological, and optical variables associated with outfall effluent were used effectively to study the dispersion of a buoyant plume in coastal waters. Such data may also be used to supplement and interpret physical observations.

Analysis of both winter 1985 and summer 1986 data sets is continuing and we expect that the results may be useful for modeling the dispersion of buoyant plumes in the coastal environment.

PROJECT COMMUNICATIONS

B.H. Jones, A. Bratkovich, T. Dickey, G. Kleppel, J.A. Steele, R. Iturriaga, and I. Haydock, "Variability of physical, chemical, and biological parameters in the vicinity of an ocean outfall plume," presented at The Third International Symposium on Stratified Flows, California Institute of Technology, February, 1987, and to be published in the symposium proceedings.

Optimizing Mercuric Iodide Detector Systems for Oceanographic Research

William K. Warburton and Andrzej J. Dabrowski, The Institute of Physics, School of Medicine and Manbir Singh, Department of Radiology, School of Medicine

Seabed mineral exploration and heavy metal pollution monitoring would benefit from at-sea, real time mineral analysis, which is not possible at present. It requires a mineral detection instrument which is rugged, portable, relatively inexpensive, low powered, and as sensitive as present day laboratory instruments.

The Institute of Physics has been a leader in the development of the X-ray detector material, mercuric iodide (HgI2), which operates at room temperature, yet possesses resolution approaching that of cryo-cooled Si(Li) detectors. If such detectors are configured into probes with appropriate excitation sources and coupled to analysis programs running on personal computers, then production of the desired analytic instruments should be possible.

In X-ray fluorescence detection, the detector, source and shielding in the probe must be precisely geometrically arranged to obtain optimal performance. This research is aimed toward developing the techniques and understanding needed to design and produce instruments for particular research or exploration. In particular, two specific problems are addressed: the detection of platinum (Pt) in placer deposits and the quantification of Cobalt (Co) levels in manganese nodules and cobalt crusts.

An instrument should be capable of detecting Pt in the 100 ppb to 10 ppm range in the sand and gravel matrix characteristic of placer deposits. Our approach is, first, to stimulate the Pt K emission line by irradiating the low Z matrix with X-rays above the Pt K absorption edge at 78.4 keV and, second, to carefully control the source-sample-detector geometry in order to prevent the weak Pt signal from being swamped by source Compton scattering.

The major restrictions to this approach include: available energies in nuclear sources; energy loss by different orders of Compton scattering; and spectral smearing by the HgI2 detector for high energy X-rays. The latter was computed (Fig. 1) using the method of Singh et al. The spread is due to both hole trapping and Compton scattering in the detector. Its implication for this work is clear: any intense line must be at least 1 keV below the Pt fluorescence or 10 keV above it. At these energies, Compton scattering cross sections exceed elastic cross sections by about 100:1. The previous data then imply that Compton scattering must be kept below the Pt fluorescence. This is reinforced by the fact that multiple Compton scattering also creates a long tail at energies below the Compton edge (the energy loss of the most probable event to reach the detector). This energy can be pushed as far below the Pt fluorescence as possible by working at angles close to back-scattering, the maximum energy loss case. For example, Ba-133 has an 80 keV photon which is backscattered (180o) at 60.9 keV or at 130o at 63.6 keV. Both are more than 1 keV below the Pt fluorescence. Also, to a first approximation, 2nd order Compton scattering loses the same energy as a first order process to the same angle. This is very important, since it implies that only relatively rare third or higher order Compton scattering can create a background to obscure the Pt fluorescence. As a result, our proposed integration model will be inadequate to properly predict the background under the Pt fluorescence. Because precise Monte Carlo modelling is necessary, we are exploring ways to obtain a computer program, "NCSMCXF" (North Carolina State Monte Carlo X-ray Fluorescence), that is optimized for such modelling.

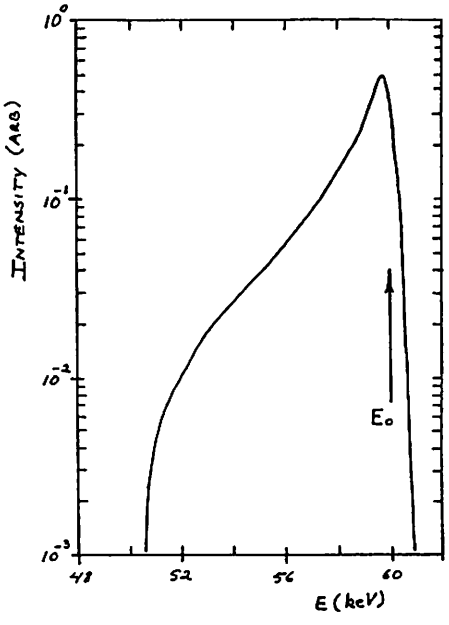

FIGURE 1. Computed response of HgI_2 detector to 60 keV photon assuming typical detector dimensions and charge transport properties. Eo marks the 60 keV input energy.

Co in seabed ores typically appears together with large concentrations of Iron (Fe), whose K-beta peak overlaps and obscures the Co K-alpha peak.

We propose to resolve this problem by exciting the ore matrix with two slightly different X-ray excitation energies, one slightly above the Co K absorption edge, while measuring counts in the Fe K-beta Co K-alpha region. Increased counts would be ascribable to the presence of Co, which is excited only by the higher energy.

We tested this principle at the Stanford Synchrotron Radiation

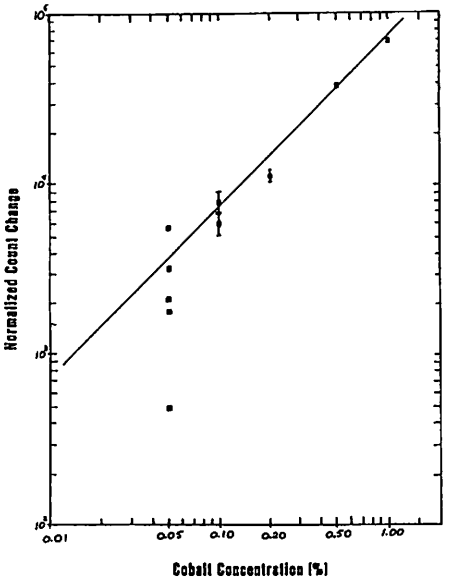

FIGURE 2. Count change in energy window including both Fe K-beta and Co K-alpha fluorescence lines when the energy of the radiation stimulating a sample of the indicated Co concentration is changed from 7660 to 7760 eV. Before subtraction, the two count values are normalized against absorption changes and other fluctuations by dividing by their respective Fe K-alpha intensities.

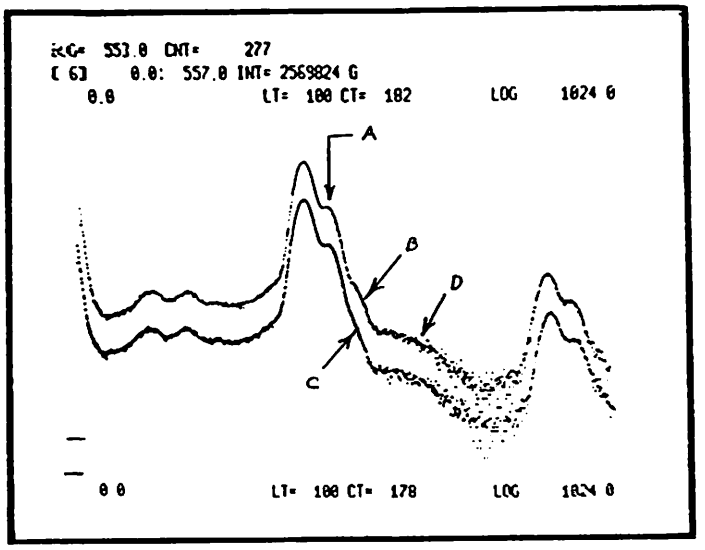

FIGURE 3. Semi-log plots (counts vs energy) of spectra from a sample containing 0.05% Co when stimulated by 7760 ev (upper curve and 7660 ev (lower curve). The difference at A, the Fe K-beta - Co K-alpha overlap, while statistically significant (see Fig. 1) is not apparent to the eye. The Co K-beta peak at B is distinctly visible, compared to C, but is statistically much less accurate. Elastic scatter, at D, is kept very low by the favorable geometry possible at a synchrotron radiation source.

Laboratory. Specimens of Co concentration 1.00, 0.50, 0.20, .10 and .05 percent were exposed to X-rays at 7660 and 7760 eV. Counting times were 10 and 100 seconds. The differential counting rate is clearly linear in concentration (Fig. 2).

However, the technique is relatively inaccurate, especially at lower concentrations. For greater accuracy, the analysis must be carefully corrected for the following: fluctuations in input flux with both time and energy, including differential absorption between source and sample; differences in absorption in the sample with energy and composition; the dependence of fluorescence escape probabilities on the composition; and secondary sources of fluorescent excitation from Compton scattered radiation or fluorescence of other sample constituents. Because sample composition is unknown, these effects can only be approximated.

The problems can be seen in Figure 3; the Fe K-beta overlap with Co K-alpha occurs at A, where no difference is readily apparent. The Co K-beta appearance at 7760 eV (compare B to C) is distinct in this log plot, but does not actually contain enough counts to be very significant over the 100 second counting time. D shows the far lower elastic scatter at the excitation energy. To improve the analysis, we are acquiring a state of the art, nonproprietary, XRF program (NBSGSC), which we can modify for two wavelength case, from Dr. Peter Pella at the National Bureau of Standards.

We have obtained through an NSF grant a Tracor X-ray Spectrace 430 XRF unit with an Rh tube and 50 keV, 2 ma power supply. The tube can be mounted to irradiate either a Cu or Ni secondary target which in turn illuminates the Co containing sample.

Tests of this system have revealed several difficulties. First, our Gaussian pulse shaping laboratory amplifiers are neither optimized for the high counting rates we require nor equipped with pileup rejection. These two factors restrict counting rates to about 20,000 cps, while 100,000 cps is desirable. Second, we need to restrict the amount of source radiation scattered into the detector. Third, we need to improve the resolution of our detector to remove this scatter from the Fe K-beta Co K-alpha channel.

One step is to use a triangular shaping amplifier, another is to choose a higher quality detector and cool it a bit more. Fourth, we need to make our multichannel analysers compatible with personal computers for data transfer, so that the final package will be portable.

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Shallow-Water Diving Accidents at Southern California Beaches

Robert H. Osborne, Geological Sciences; C. Donald Porterfield, College of Business, University of Texas at San Antonio and Carley C. Ward, Biodynamics/Engineering, Inc., Pacific Palisades, CA

Each year, a number of accidents result from running or jogging into the surf zone and diving seaward (plunging dives). Such accidents occur annually during the summer months at many sand beaches in southern California.

There are two principal questions of concern in the present study of surf-related, plunging diving accidents.

1. What are the frequencies and demographic characteristics of such accidents in the Southern California Bight?

2. What are the most effective methods of increasing public awareness of the danger associated with diving seaward in the shallow portion of the surf zone?

Although both of these questions will be addressed in the course of this study, the work performed during 1985-86 mostly concerned the first of these questions. It also laid the foundation for work to be accomplished during 1986-87. Initiation of the data collection was delayed until May 1986 pending the completion of a legal review by the County of Los Angeles; however, five substantive accomplishments have been achieved to date.

1. The establishment of an Advisory Committee of eight members, each of whom is an expert in a specific subject area relating to plunging dive accidents.

2. The selection of Dr. C. Donald Porterfield of the University of Texas at San Antonio to serve as the Associate Investigator in Public Safety/Communications during the second year of this study.

3. Collection of accident and demographic information from Major Incident Reports filed by lifeguards at fourteen state, county and municipal agencies.

4. Development and administration of a questionnaire-based survey of 250 randomly-selected beach users at each of five southern California beaches to provide demographic information and assessments of surf-safety awareness and the effectiveness of present and potential surf-safety advisory systems.

5. A workshop for the Advisory Committee Members, Sea Grant Trainee, and Principal and Associate Investigators was held at the University of Southern California on December 5, 1986, to review the content and organization of a technical report to be completed during spring 1987.

The following conclusions are suggested by the available data:

--The population most at risk from injuries from plunging dives are males between the ages of 16 and 24.

--South- to southwest-facing beaches tend to have higher accident rates. The peak accident time is mid to late summer, when swells generally approach the coastline from the southwest. These swells tend to build the beaches seaward by landward sandbar migration and eventual accretion onto the beachface. The south- to southwest-facing beaches in Orange County tend to have large quantities of sand and are very heavily used during the summer months.

The beaches included in the study that had the highest accident rates are Newport Beach, Huntington Beach, and Venice Beach. Factors that may contribute to these relatively high rates are: (1) beach orientation relative to seasonal oceanographic characteristics; (2) heavy beach use during the summer; (3) sand substrate; and (4) the demographic character of beach user populations.

PROJECT COMMUNICATIONS

The first draft of a technical report by members of the Advisory Committee as well as the Principal and Associate Investigators is near completion, and the final copy of this report is expected to be completed during summer 1987.

Growth and Chemical Composition of Ecotypes of the Giant Kelp, *Macrocystis pyrifera*

James N. Kremer, Biological Sciences; and Richard C. Zimmerman, Hopkins Marine Station, Stanford University

The commercially important giant kelp, *Macrocystis pyrifera*, lives in West Coast habitats ranging from very eutrophic (nutrient-rich) environments in central California to the nearly oligotrophic (nutrient-poor) waters of Santa Catalina and San Clemente Islands. During the 1982-83 El Nino, *M. pyrifera* forests throughout the Southern California Bight were devastated. However, post-El Nino recovery has occurred at different rates in different locations.

This raises the question of whether the differences in kelp recovery are due to genetic or environmental influences. In order to determine whether disparate populations of this species respond differently to the same physical-chemical environment, this study investigated the effects of ambient temperature and nutrient availability on plants from morphologically distinct populations and different environments. The plant responses measured were growth rate and tissue composition.

M. pyrifera juveniles recruit most effectively within a

relatively short distance of the adult that produced the spores. This, combined with different nutrient regimes, may result in local populations specifically adapted to, or more tolerant of, particular environmental conditions.

The study should provide information useful to the kelp harvesting industry and the California Department of Fish and Game, which has attempted to reestablish kelp in certain areas.

The goals for this year were to establish spore cultures of *M. pyrifera* from geographically isolated populations and to compare patterns of growth and chemical composition in these plants when grown in the same environment, both in the laboratory and in the field.

Kelp populations were selected at four locations representing different physical-chemical environments (Fig.1). Monterey Bay, with the most constant temperature and highest nutrients, represents the northern limit of M. pyrifera's distribution. Plants from Refugio State Beach in Santa Barbara County probably experience greater annual temperature variations than plants at Monterey, and less nutrient availability. At Catalina, nutrients are limiting during the summer and early fall, when water temperatures are warm. The waters surrounding Santa Catalina Island are more characteristic of oligotrophic oceanic environments, and nutrient availability in the upper 10 m of the water column is usually low. Bahia Tortugas is at the southern limit of *M. pyrifera's* range. Although plants there experience significant coastal upwelling during spring, they are exposed to very high water temperatures (>25 ^{o}C) and presumably low nutrient availability during summer and fall.

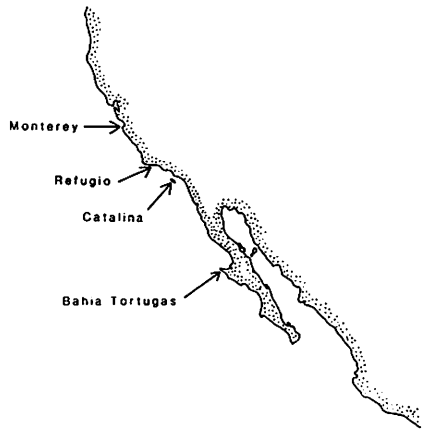


FIGURE 1. Sites of spore collection along the coast of California and Baja California.

Mature sporophylls (spore-bearing blades) were collected by SCUBA divers from ten haphazardly-chosen adult plants at each site. Immediately after collection, blades were wiped clean of epiphytes, rinsed, and placed in chilled (0 ^{o}C) filtered seawater to induce spore release. After 2 h, the spore suspension was collected and diluted to an approximate density of 1,000,000 spores ml^{-1}, and poured over a settling surface made from grooved PVC rings. After 24 hrs, the spore suspension was replaced with culture medium consisting of 0.2 u filtered seawater from Catalina, spiked with NO_3^- and PO_4^{-3} to concentrations of 100 uM and 3 uM, respectively. Cultures were held at constant temperature (12 ^{o}C) under constant illumination (120 uE m^{-2} s^{-1}). Culture medium was changed daily. Germination of viable spores occurred within 24 hrs. Multicellular gametophytes with developing oogonia were visible at 2 weeks and young sporophytes were present at 4 weeks. The PVC rings provide a good surface for cultivating this alga and permit manipulation of individual rings for experimentation and transplanting.

Weight-length data were collected to determine the extent of any gross morphological variation among plants. At each site, 30 to 50 fronds were

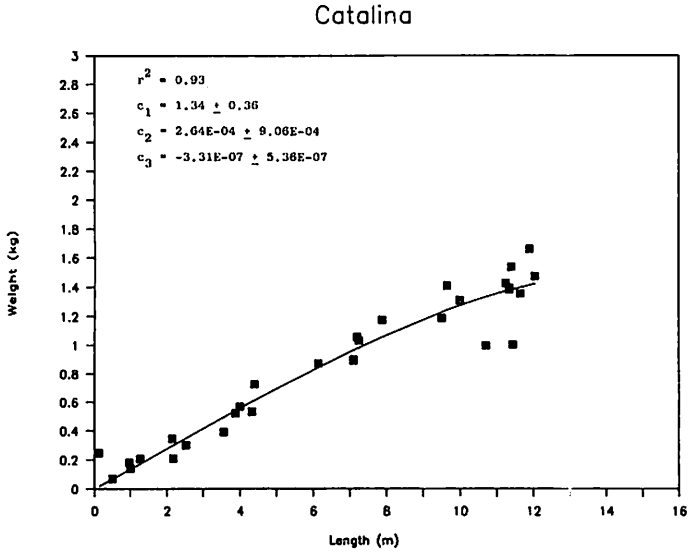


FIGURE 2A. Weight-length data for fronds collected from adult plants at the Catalina site. The curves represent least-squares fits of each data set to a polynomial function. The overall r^2 and values of the regression coefficients (+/-1 SD are indicated on each curve.

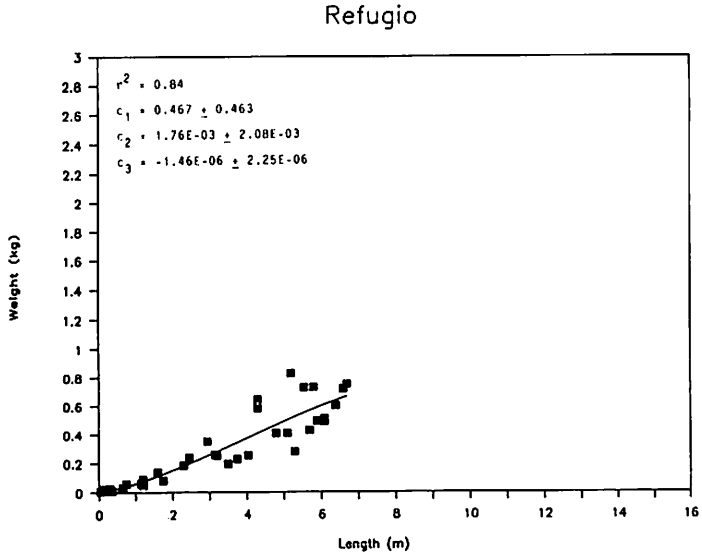


FIGURE 2B. Weight-length data for fronds collected from adult plants at Refugio.

collected, weighed to the nearest gram and measured to the nearest centimeter. Data from all 4 sites were fit to a polynomial function of the form:

$$W = c_1 L + c_2 L^2 + c_3 L^3$$

where "W" is frond weight, "L" is frond length and $c_1..c_3$ are the regression coefficients.

While fronds from Monterey and Bahia Tortugas are virtually indistinguishable based on weight-length relationships, fronds from Catalina and Refugio were significantly shorter, and weighed less for an equivalent length, than those from Bahia Tortugas and Monterey (Fig. 2A, B, C and D.)

Effects of nitrogen availability on growth were examined using 10mm sporophytes (60 to 90 days old) grown from laboratory cultures. Sporophytes from the Catalina culture showed very little evidence of nitrogen limitation, even with no nitrate added to the medium. Tissue nitrogen content also showed little variation across the range of nitrate availability. While sporophytes from the Refugio culture showed a similar flat growth response across the nitrate gradient, there was a stronger gradient in tissue nitrogen content with nitrate availability. In contrast, the Monterey culture showed strong evidence of nitrogen-limited growth and tissue N content. Growth rates of the Bahia Tortugas culture were lower than the other cultures at all nitrate concentrations, and showed no evidence that growth was nitrogen-saturated even at nitrate concentrations of 24 uM, despite the fact that tissue nitrogen levels responded in a manner similar to the other cultures.

Sporophytes from the Catalina, Monterey and Refugio cultures were transplanted to a field site at Santa Catalina Island during May 1986. Culture rings were placed onto clear acrylic rods and anchored at both ends in two

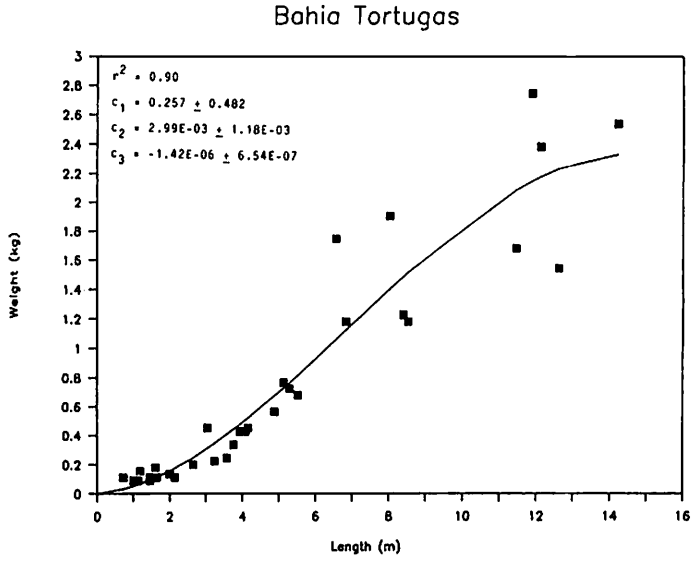


FIGURE 2C. Weight-length data for fronds collected from adult plants at Bahia Tortugas.

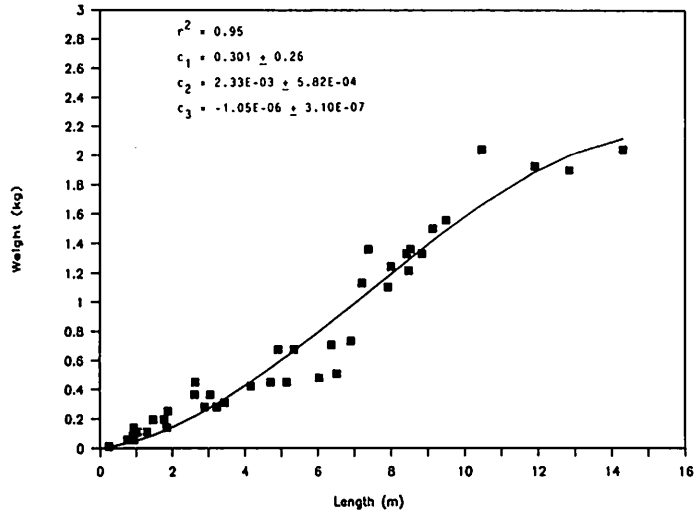


FIGURE 2D. Weight-length data for fronds collected from adult plants at Monterey.

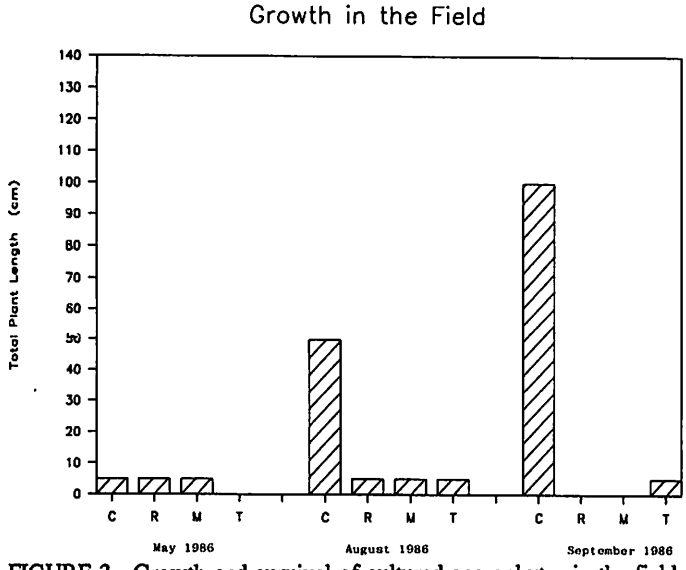


FIGURE 3. Growth and survival of cultured sporophytes in the field at Santa Catalina Island. While plants from the Catalina culture maintained vigorous growth rates, plants from the other cultures showed almost no growth during this period. KEY: C--Catalina R--Refugio M--Monterey T--Bahia Tortugas

sets of arrays containing plants from each culture. By the end of August 1986, the Catalina plants were over 50 cm tall (Fig. 3). In contrast, most of the plants from the other cultures had died. The few that remained were no larger than 50 mm. Sporophytes from the Bahia Tortugas culture were placed in the field at that time. By the end of September, the Catalina plants were over 1 m tall. The few plants from the Refugio and Monterey cultures present in August had disappeared. A few plants from the Bahia Tortugas culture remained, but showed no evidence of growth. By the end of October, the only plants surviving were from the Catalina culture, and they continued to grow vigorously.

Two further experiments will be conducted. First, a reciprocal transplant experiment will be performed in Monterey Bay, where water conditions are eutrophic. Second, another transplanting into the Catalina environment will be made earlier in the season to take advantage of (relatively) more eutrophic waters for starting the very young plants. It is expected that both of these efforts will provide information on moresubtle growth variations among the four cultures.

PROJECT COMMUNICATIONS

Results were presented at the December 1986 AGU/ASLO Winter Meeting in San Francisco, California, with abstract published in EOS, Transactions of the American Geophysical Union, 1986, Vol. 67 (44):984.

Determinants of Seaport Viability in the Local Economy

Willard Price, School of Business and Public Administration, University of the Pacific, Stockton; and Peter Gordon and Kathleen West, Urban and Regional Planning, USC

Since the early 1970's major changes have taken place in maritime shipping technology---changes in cargos, ship design, and cargo handling equipment. These changes, which reflect the economies of larger scale shipping operations, are apparently driving changes in cargo movement patterns, concentrating cargo at fewer larger, "load center" ports. Consequently, changes have also been necessary in both the type and the amount of facilities and services provided at ports. Such new facilities require the long-term commitment of substantial amounts of both public and private resources.

Recently several major seaport development projects have been proposed, evaluated, financed, and constructed---only to sit virtually unused. The Port of Richmond, California, for example, has a new, state-of-the-art facility for handling containerized cargos. It sits vacant and the equipment may be scrapped. Similarly, the Port of Stockton, California, has a new, state-of-the-art coal facility. Like Richmond's container terminal it sits virtually unused. The standard procedure for analyzing and justifying a seaport development project includes engineering cost estimates, an economic impact study (EIS), and market projections for the various potential cargos. These procedures do not include any standard method for evaluating whether or not the potential cargo will, in fact, be attracted to the port in view of the availability of alternative ports. More specifically, they assume that facilities will attract cargo movements and that the cargo movements will cause beneficial growth of local economic activity. If there is any doubt about the development of projected cargo movements (and the examples of Richmond and Stockton supply such doubt), then one or more predictors of demand for seaport services should be identified and incorporated into the standard evaluation procedures. Port and community decision makers need to be able to evaluate proposed port development not only in terms of the costs and revenues but also in light of the probability of realizing the potential revenue benefits.

One source of numerous potential predictors is the local economy. Industrial location theory suggests that larger local economies will attract more than a proportionate share of cargo movements due to scale and agglomeration economies. Consideration of local socioeconomic variables, however, immediately raises a critical question regarding the direction of the flow of causality. Does the seaport activity cause the city to develop (as assumed in the EIS methodology)? Does the economic activity of the city cause the seaport to develop? Do the stimuli work in both directions simultaneously? This is a chicken-and-egg type dilemma whose resolution is beyond the scope of this project, but the potential influence of local socioeconomic variables on seaport activities puts in question the use of current EIS methodology.

The goals of this study were to:

1. Identify available sources of data on local socioeconomic conditions that may influence port activity and demand for port services.

2. Hypothesize possible relationships between the movement of cargo through a port and various social and economic

characteristics of the local community.

3. Hypothesize alternative relationships between the receipt of revenues by the subject ports and the various social and economic characteristics of the local community. Use modern statistical and econometric techniques to test the strength of the hypothesized relationships.

The results of this effort, to date, are:

1. A search of academic literature on seaports identified several previous studies where the local market was considered a significant factor in the decision to route cargos through specific ports. However, of these studies, only one, Kenyon (1970), actually attempted to identify and evaluate statistical indicators. Kenyon compared the relative size of population, value added by manufacturing, and origin of manufactured exports (as percents of the U.S. total) to the market shares of five major seaports. His results showed only weak relationships.

2. Data from the Bureau of the Census special study *Domestic and International Transportation of U.S. Foreign Trade: 1976* was used to calculate the percent of the traffic through domestic seaports that originates in or is destined for the local economy in contrast to the larger hinterland. On a nationwide average 33 percent of imports by value and 38 percent by weight are destined for some activity---production, sales, or consumption--within 50 miles of the port of entry. (Fig. 1).

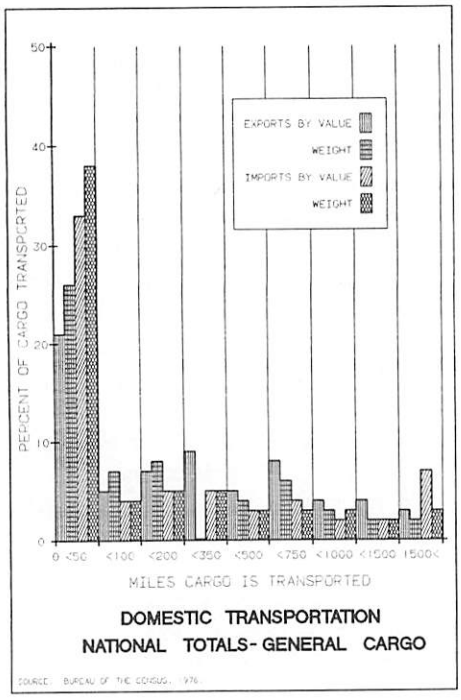


Table 1

Port-Local Economy Combinations

Great Lakes	Atlantic	Pacific
Deluth Superior	Searsport	San Diego
Green Bay	Portland, Me.	Los Angeles
Milwaukee	Portsmouth	San Francisco
Chicago	Boston	Stockton
Detroit	Providence	Sacramento
Toledo	New Haven	Humboldt
Cleveland	Bridgeport	Coos Bay
Erie	New York	Portland
Buffalo	Albany	Astoria
	Philadelphia	Longview
Gulf	Baltimore	Olympia
	Norfolk	Seattle
Pt St Joe	Newport News	Pt Angeles
Tampa	Richmond	Pt Townsend
Panama City	Hopewell	Anacortes
Pensacola	Morehead City	Bellingham
Gulfport	Wilmington	Grays Harbor
Lake Charles	Georgetown	
New Orleans	Charleston	**Off Shore**
Baton Rouge	Savannah	
Beaumont	Brunswich	Ketchikan
Houston	Jacksonville	Anchorage
Corpus Christi	Canaveral	Kodiak
Brownsville	Fort Pierce	Honolulu
	Palm Beach	Nawiliwili
	Miami	

Similarly, 21 percent of exports by value and 26 percent by weight are shipped from within 50 miles of the port of departure. The distance of 50 miles was the value in the available data that most closely corresponds to the average Standard Metropolitan Statistical Area (SMSA), which in turn is used as the best available measure of the "local economy." These findings substantiate the hypothesized differentiation between the local economy and the seaports' larger hinterland.

These findings are being expanded to identify possible variations between the nine customs regions (Boston, New York, Baltimore, Miami, New Orleans, Houston, Los Angeles, San Francisco, and Chicago) which represent potentially different transportation links and different natural and economic resource bases. The possible difference between the domestic transportation of general cargos in contrast to bulk cargos will also be considered.

3. A data set was developed for the 72 port-local economy combinations listed in Table 1, below. This data set is an expansion of the scope originally proposed; it was necessitated by the condensation of the sample set when ports that share the same Standard Consolidated Statistical Area (SCSA) or SMSA were combined to maintain the integrity of the socioeconomic data. The data base contains variables in terms of people, dollars, establishments, and tons of cargo moved (Table 2). It does not contain consistent data on port revenues because of availability problems.

A correlation matrix was calculated for these variables. The highest values resulted from the combinations shown in Table 3. The highest correlation (0.65) is between petroleum cargo and population, with the correlation coefficients for import cargo and total cargo following, at 0.54 and 0.45 respectively. No correlation was apparent between the cargo

Table 2

Variables

Seaport Variables	Socio-Economic Variables
Total cargo tonnage	Population
Change in total tonnage	Change in population
Petroleum tonnage	Per capita income
Non-petroleum tonnage	Number of manufacturers
Import tonnage	Manufacturing employees
Export tonnage	Manufacturing payroll
Bulk cargo tonnage	Manufacturing value added
Port Revenue	Number of wholesalers
	Wholesale sales
	Wholesale employees
	Number of retailers
	Retail sales
	Retail employees

Table 3

Correlation of Variables

Cargo Variable	Economy Variable	Corr. Coeff.
Petroleum cargo	Population	.65
Import cargo	Population	.54
Total cargo	Population	.45

variables and the manufacturing, wholesaling, or retailing variables. The coefficients were all very near zero.

While the statistical relationship between cargo movements and local economic activity is not strongly supported by the results to date, this analysis is ongoing. There is sufficient evidence in the transshipment analysis to suggest that the lack of correlation may be evidenced of deficiencies in the data sets rather than lack of causal relation. It is hoped that publication of our findings will stimulate further discussions and reconsideration of the popular economic impact study methodology.

Corrosion Fatigue of Weldments in Offshore Structures

Judith A. Todd, Materials Science and Mechanical Engineering

Low and medium strength structural steels, when subjected to cyclic stresses in the marine environment, exhibit more rapid nucleation and propagation of corrosion fatigue cracks than comparable steels tested in air. The critical areas in fatigue performance of marine structures (offshore platforms, deep sea pipes, submarine hulls) are welded joints, which must be protected by cathodic polarization. Although sea conditions are relatively quiescent along the California coast and in the Gulf of Mexico (compared to the North Sea), corrosion fatigue problems have still been reported. Such failures typically occur in the welded nodes of offshore structures and corrosion fatigue crack growth may be sufficiently severe to result in the detachment of structural braces.

Few studies exist of corrosion fatigue of weldments in the marine environment, particularly for the low stress frequencies (0.1 - 0.2 Hz) associated with offshore structures. The mechanisms of corrosion fatigue crack nucleation and the roles of metal dissolution at the crack tip, corrosion debris, cathodic hydrogen and weld residual stresses are not well defined for seawater environments. There is a critical need for long term corrosion fatigue crack propagation studies in the slow growth regime (10^{-6} - 10^{-5} mm/cycle), which marks the transition from threshold behavior, below which flaws are non-propagating, to the mid growth regime (10^{-5} - 10^{-3} mm/cycle) where the effects of mean stress, microstructure and environment are no longer dominant. This research provides a fundamental study relating fatigue design parameters to corrosion fatigue mechanisms and crack propagation rates. In the long term, this project seeks to develop an understanding of the mechanisms governing corrosion fatigue cracking in weldments of steel structures in seawater, so that improved, more resistant weldments can be developed. It also seeks to develop conservative design criteria for safety critical applications such as weldments.

To begin to address these questions, in 1985-86 we evaluated three crack growth monitoring techniques and calibrated the CGS Servohydraulic Fatigue Testing System for all load ranges prior to the calibration of the crack monitoring techniques. We also conducted near threshold corrosion fatigue crack growth experiments

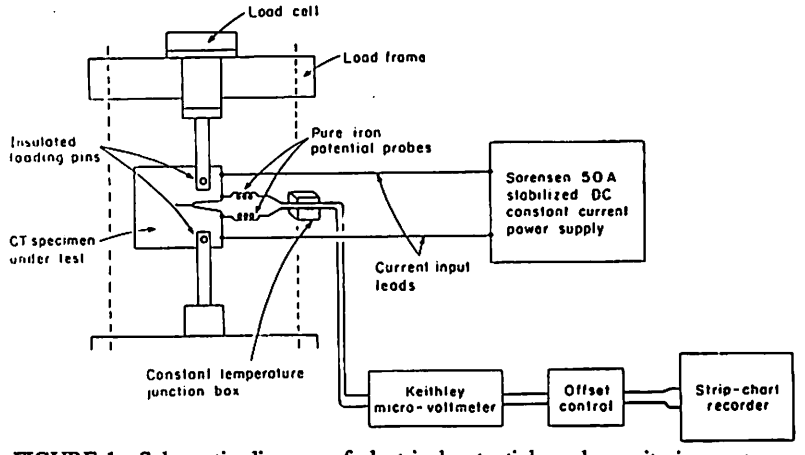


FIGURE 1. Schematic diagram of electrical potential crack monitoring system.

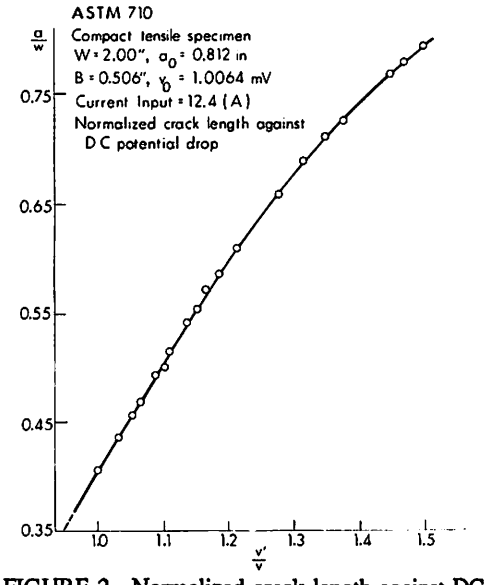


FIGURE 2. Normalized crack length against DC potential drop for ASTM 710 compact tensile specimen.

on both base plate and weld metal samples in air and seawater environments.

(a) Crack Propagation Monitoring Techniques

Three crack monitoring techniques, DC potential drop (DCPD) (Fig. 1), Crack Opening Displacement (COD) and Back Face Strain Monitoring (BFS) were used to compare crack growth measurements in notched compact tension specimens. By changing the load ratio, R, from 0.1 to 0.01, the fracture surface was marked with rings, so that crack lengths could be checked by optical and scanning electron microscopy. Calibration curves for DCPD, (Fig. 2 and 3) COD (Fig. 4) and BFS (Fig. 5) techniques were also obtained by slotting the compact tension specimen a given depth (0.05 inch intervals) and measuring the potential drop, the compliance COD and BFS for each crack length. The best input current for DCPD technique was found to be 12.4 amp since a large input current caused an instability in the measured DC potential drop value accompanied by a noticeable increase in temperature.

The BFS technique was also used to obtain the load-back strain curve. The effect of crack closure and the value of the closure load PCl can be determined from the transition point of the

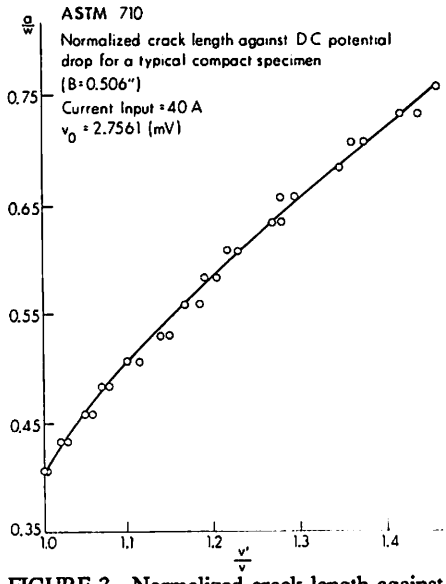


FIGURE 3. Normalized crack length against DC potential drop for a typical compact specimen.

slope of the curve. Thus, the effective stress intensity factor range acting at the tip of the crack, rather than the nominal stress intensity factor range, can be calculated using $(P_{min})_{Cl} = P_{min} + P_{Cl}$ instead of P_{min}. This gives a smaller effective stress intensity factor range than the applied value, requiring a crack closure correction to account for the presence of corrosion or oxidation products.

(b) Fatigue Characteristics of ASTM 710 Steel

1. Frequency Effects

The threshold value of the stress intensity factor range was found to decrease as the test frequency decreased from 20 Hz to 2 Hz (Fig. 6). As the natural frequency of sea waves is in the

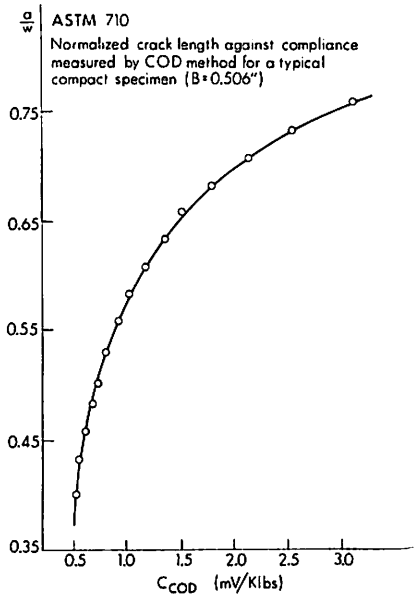


FIGURE 4. Normalized crack length against compliance measured for a typical compact specimen of ASTM 710.

range 0.1-0.2 Hz, a frequency of 2 Hz was chosen for further corrosion fatigue testing in order to obtain data within a reasonable time. (Tests at 2 Hz may take several weeks, making tests at 0.2 Hz unrealistic for a laboratory with limited equipment).

2. Comparison of Base Plate and Weld Metal

At 2 Hz, the weld metal specimen (tested parallel to the direction of welding) exhibited a lower threshold stress intensity factor range than that of the base metal (Fig. 6). This could be

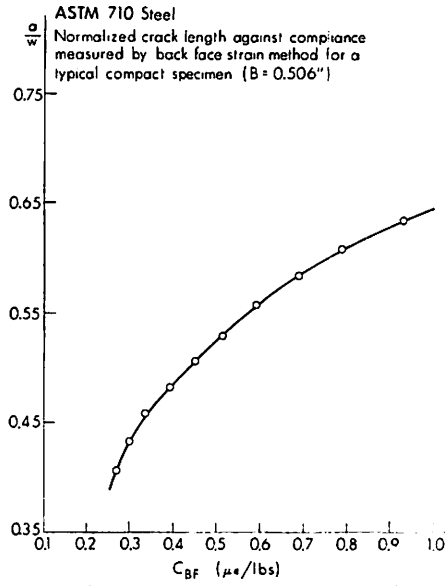


FIGURE 5. Normalized crack length against compliance measured by Back Face Strain method for a typical compact specimen of ASTM 710 Steel.

attributed to the presence of residual welding stresses and the varied microstructures in the weld metal.

3. Effects of Seawater on Corrosion Fatigue

On first examination the base plate specimen tested in seawater exhibits a better resistance to the crack propagation than the sample tested in air (Fig. 7). This can be attributed to the corrosion products piled up in the crack, which results in contact shielding or wedging giving "corrosion debris-induced crack closure." If the nominal stress intensity factor range is modified for the effects of this crack closure, the curve of corrosion fatigue in seawater will be shifted to the left (Fig. 7). Therefore, the effective threshold

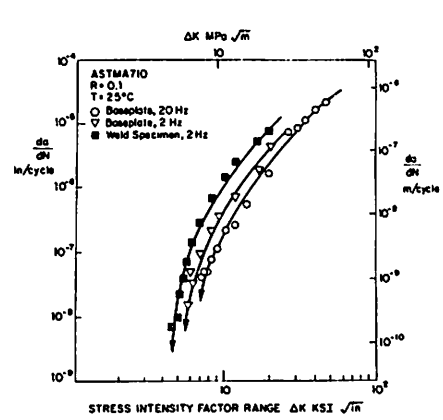


FIGURE 6. Comparison of near-threshold fatigue crack propagation data for ASTM base plate at 20 Hz and 2 Hz with weld metal tested in air at 2 Hz, R = 0.1.

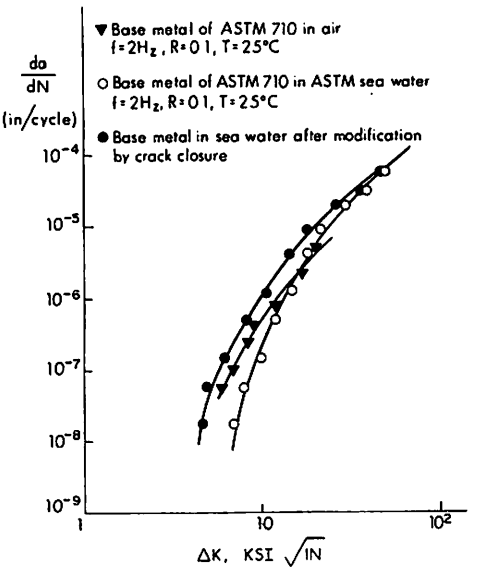


FIGURE 7. Corrosion fatigue of ASTM 710 Steel in sea water environment.

value of the stress intensity factor range is actually lower than that in air. Data collected for the weld metal in seawater indicated that the threshold stress intensity range was similar to that for the base plate, but that, once initiated, the weld metal crack may propagate at a slower rate (Fig. 8). Microstructural studies are in progress to permit better interpretation of these data.

The base plate studies lead to the conclusion that the marine environment, as a corrosion medium, enhances fatigue crack growth and that a means of protection needs to be investigated to avoid this negative effect. The near-threshold corrosion fatigue tests are being continued and followed by tests on cathodically protected steel.

The project was quite successful in attracting matching funds. An electronic console worth $30,000 was provided by the Huck Manufacturing Company and a Materials Test System valued at $268,000 was acquired through support from the National Science Foundation, USC and MTS Systems. A Scanning Auger Microprobe was acquired through support from Department of Energy, USC and PHI Electronics. Renovations of the mechanics laboratory facilities and the electron microscopy center are also being under taken by USC in support of the project.

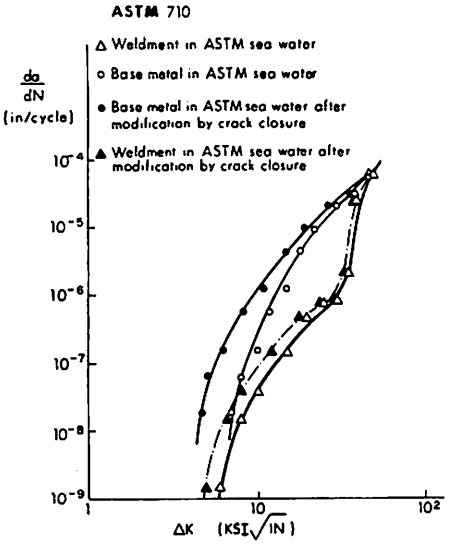


FIGURE 8. Near threshold corrosion fatigue crack propagation data for ASTM A710 base metal and weld metal in ASTM sea water, frequency = 2 Hz, R = 0.1, T = 25°C.

PROJECT COMMUNICATIONS

"Looking Between the Cracks", USC Transcript, December 1985.

"Corrosion Fatigue of ASTM A710" to be presented at International Conference on "Environmental Degradation of Engineering Materials - III" (Invited), Penn. State University, April 13-15, 1987.

Pigments as Marine Food Web Tracers

Project development funds awarded in 1982 enabled USC marine biologist Gary Kleppel (now at Nova University) to investigate new applications of pigment analysis in marine ecology. For many years, the concentration of the photosynthetic pigment chlorophyll has been used as an estimate of phytoplankton standing stocks in the sea. However, phytoplankton contain several "accessory" chlorophylls and carotenoid pigments as well. These pigments are used by the algae to facilitate light capture by the cells and also to protect them from damaging light levels. It was discovered years ago however that different phytoplankton classes frequently possess pigments unique to themselves (e.g. only green algae have chlorophyll b) and so these pigments may serve as taxonomic markers. And because they may occur either unchanged or in a transformed state in organisms that eat phytoplankton, pigments offer the possibility of tracing some of the steps through the food web.

In a chapter to be published in *Indicator Organisms in the Marine Environment* (D. F. Soule and G. S. Kleppel, eds.), now in press, Kleppel reviews the uses of pigment analysis in tracing biological processes in the sea. He attempts to show the value of pigment tracers for making direct quantitative measurements of processes that have heretofore been extremely difficult if not impossible. Researchers have used this approach to investigate the temporal flux and spatial distribution of algal carbon in the sea; ascertain the kinetics of plant carbon transfer through the zooplankton community; and to deduce how much of algal production is grazed by zooplankton and how much settles out to the sediments.

One of the keys to detection and measurement of specific pigments has been the use of High Performance Liquid Chromatography (HPLC).

Kleppel has applied pigment analysis to the detection of selective feeding in copepods and to make the first quantitative measurements of carnivorous feeding by copepods collected at sea.

The biochemistry and metabolism of pigment compounds in the marine food chain may be complex. In the review, Kleppel discusses these aspects of pigment research, and he points out questions that remain to be answered as this area of research is further pursued. His effort has also led to a new USC Sea Grant project to determine how the natural diets of copepods influence their egg production (R/RD-31, 1986-88).

Marine Advisory Services and Education

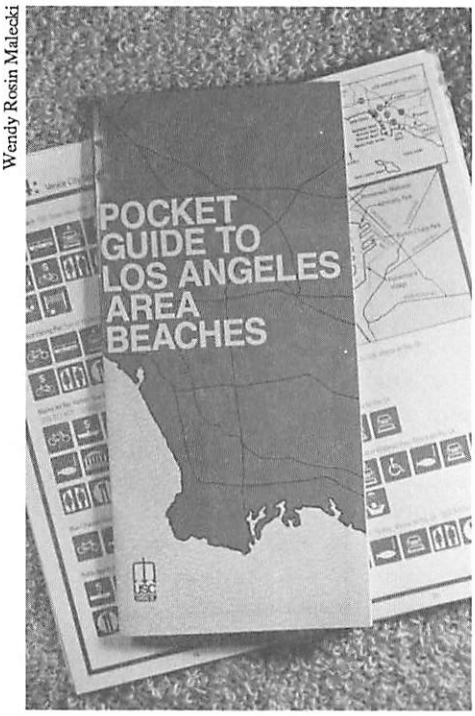
Marine Advisory Services assists in integrating Sea Grant research with the larger community of potential users of the research. The program endeavors to ensure that ocean users have access to the best available information while stimulating others to take advantage of marine resources. Guided by the long range plans drawn up in 1985-86, we have focussed our attention on three major subject areas: marine recreation, port and harbor management, and marine education.

Marine Recreation

Marine recreation has long been one of the principal attractions of Southern California. Boating, swimming, surfing, fishing, diving, and tidepooling are all quite popular; more than 100,000 boats are licensed with the state in Los Angeles County alone, and the National Coalition for Marine Conservation has estimated that the value of marine sportfishing in Southern California is more than $950 million annually. With such great potential for use of the area's marine resources, Marine Advisory Services seeks to ensure that such use is enjoyable and safe.

After two years of research and coordination, the "Pocket Guide to Los Angeles Area Beaches" was published this year. Researched and written by James Fawcett, seaport management specialist, and a group of his students, the guide provides information on the range of services and activities available at all beaches in the county. In an attempt to encourage beach use by groups that do not normally use the beaches, pictorial symbols are used to depict the services and facilities. The glossary of symbols is translated into five languages: English, Spanish, Chinese, Vietnamese, and Korean. Our initial press run of 22,000

Wendy Rosin Malecki



copies is being distributed by us both to reach part of the audience and to interest potential sponsors of a larger printing, for even wider eventual distribution.

We have continued several services pertaining to the weather offshore. Although the marine weather here is typically milder than what can occur elsewhere, difficult weather is frequent and the geography is such that variations from one locale to another can be substantial. Experienced and naive sailors alike need good forecasts and good advice.

For the past two years, Marine Advisory Services has cooperated with the National Weather Service and two volunteer radio operators to establish the area's first Mariner's Reporting Program (MAREP). The operators record weather observations reported by mariners and relay them to the National Weather Service Forecasting Office in Los Angeles, adding to the reports available from buoys and island stations.

The two radio operators, one on Catalina Island and one in Wilmington, near the Port of Los Angeles, cover the southern portion of the San Pedro Channel. Although the program is slow in getting started, our conversations with mariners indicate that they have heard the MAREP operators and some of them have begun to make reports to the operators.

Marine Advisory Services is continuing two additional successful weather information services and is discontinuing a third. A taped marine weather report can be reached by telephone call to the Los Angeles Office of the NWS, 24 hours a day, 365 days a year. We have sponsored this activity for the past 12 years using a commercial quality phone answering machine capable of answering three telephone lines, which we also provide. During 1986, the system answered 75,427 inquiries -- an average of almost 6,300 calls per month.

Second, we have edited and will reprint the booklet, "Weather to Go Boating." The booklet covers weather patterns, boat handling, and visual wind warning signals. As with our last printing, a substantial portion of the cost of this press run will be underwritten by the Marina Foundation, based in Los Angeles County. More than 2000 copies of this publication were distributed last year, many of them for use in boating safety classes run by the Coast Guard Auxiliary.

In fall 1986 we regretfully discontinued our long-running series of marine weather reports on radio station KNX, due in part to the increased costs and scheduling difficulties at the station.

Because of the importance of ocean recreation in the Los Angeles region, marine educational specialist Gilbert Lee has adopted additional responsibilities as marine recreation specialist. With 33 years experience as a lifeguard

with the Los Angeles County Department of Beaches and Harbors, Lee was a welcome addition to an advisory board for a current research project R/CM-34, "Shallow Water Diving Accidents at Southern California Beaches."

Also, his lifeguard experience has led to a proposal to develop policies and educate the public about the conflicts between surfers and swimmers using the same beaches. The Los Angeles County Department of Beaches and Harbors and The City of Huntington Beach have expressed an interest in this proposed effort, which aims to help reduce the unpleasant confrontations and injuries that can occur and to reduce the incidents that distract lifeguards from watching for endangered swimmers.

Marine Education

The effort to better inform Los Angeles area residents about ocean resources is a continuing one. Gilbert Lee, the marine education specialist, has made considerable progress toward the goal of achieving widespread use of the marine education materials developed over past years by USC Sea Grant.

Through Lee's presentations in June 1986 at two city-wide inservice meetings conducted by the Los Angeles Unified School District, over 1,000 teachers were made aware of Sea Grant and its marine education publications. In addition, Lee visited many schools, conversing with principals, curriculum leaders and classroom teachers. As a result of these visits, *Wet and Wild* and other curriculum materials are now well known in Los Angeles and Orange Counties. In California much importance is placed on the relationship of texts and curricula to the State Framework for Education. The six *Wet and Wild* curriculum guides all correlate strongly with the Science Framework Addendum; Lee has correlated the series, page by page. He has found this to be a strong selling point in discussions with teachers and education leaders.

These efforts have generated a gratifying response. Total sales of education publications for 1985-86 were $2,286.00, as contrasted with $1,061 for all USC publications in 1984-85. Most of the sales came from local schools; however, one large order came from a school district in South Africa.

A new association was established with the School of International Relations, as a result of the interest expressed by Dr. Steven Lamy in the K-6 curriculum guides series, *Wet and Wild*, and other education publications. Also, the draft Marine Studies Idea Book for teachers of grades 7-12 is being presented to commercial publishing companies.

Seaports and Shipping

Seaports and shipping are vital pathways for the exchange of imports and exports and are important sources of employment, commercial development and revenues in local areas. Seaport management, now developing as a profession, must address, for example, the redevelopment of older waterfront areas, conflicts between commercial development and public access and maintenance of environmental quality. The problems experienced by California ports are similar to those experienced by other ports across the country, so marine advisory efforts at USC are directed at the investigation and resolution of both local and national problems.

In 1986 we published the proceedings of our 1985 ports conference, held in cooperation with the Louisiana State University Ports and Waterways Institute in Baton Rouge. *Non-Maritime Port Activities: A Research Agenda* has been distributed widely to Sea Grant programs and researchers working in the port management field and has received favorable reviews. Colleagues have used it to guide graduate students to the areas of port research that both industry and academia agree need to be addressed.

This was the third in a series of national meetings arranged and sponsored by USC Sea Grant. Each was focussed on a specific type of port activity (large maritime ports, smaller maritime ports, and non-maritime ports), and each resulted in a published research agenda. The success of these meetings resulted from the traditional Sea Grant approach of bringing together academic researchers and industry professionals to assist one another in improving the operations of the industry.

Locally, we began to plan in 1986 for a conference to be held in fall 1987 on Pacific Rim trade and its influence on infrastructure development in the two major local ports, the Port of Los Angeles and the Port of Long Beach. The aim of the conference is the better integration of the ports' plans with the plans and needs of their clients and of their regulators.

Sea Grant also serves clients by direct consulting. James Fawcett participated with Sea Grant port investigators from California, Oregon, and Washington in performing one of a series of port management audits, for the Port of Crescent City in 1986.

USC Sea Grant efforts on port management reached a larger audience through publications. During 1986, two papers were written by James Fawcett. The first, "Notes on the Political Economy of Public Participation in Ports and Harbors," was delivered at the Second Pacific Congress on Marine Technology in Honolulu in March 1986. The second, "Redefining Local Government Power: The Influence of Informal Powers in Challenging Joint Implementation of a State Coastal Plan," will be published in an upcoming issue of *Policy Studies Review*.

Communications

The communications project provides support for all aspects of USC Sea Grant efforts. In 1985-86, a number of accomplishments highlight the record. The assistance of a freelance science writer enabled improvements in the style of the 1984-85 annual report and production of backlogged publication announcements, resulting in a near tripling of requests for publications, compared with the year before (see Table 1). The editor put considerable effort into the editing of the 1985 port proceedings and the finishing of a large marine education project, the final three volumes of the marine curriculum guides, *Wet and Wild.* The quality of this series, and the efforts of the marine education specialist in acquainting area teachers with the guides, have led to a steady stream of requests. Sales of marine education publications alone for 1985-86 total more than $2000. Also, the mailing list for publications now comprises 3200 names, compared with 2700 names in 1984-85.

USC Sea Grant's profile in southern California was enhanced by the publication of an article about the program in the January 1987 issue of Waterfront magazine. This recreational boating publication has a circulation of 29,000. As a result of the article, we received imquiries from the press and the general public about our research projects and publications.

Karen Charest, the communications specialist for this program, left the program in August 1986 to move to San Diego. She made extensive contributions in her five years, including the designing of a consistent format for publications and organizing the publication distribution system.
Her successor, Sally Lawrence, was a science writer for Washington Sea Grant in 1983-85 and has an M.S. degree in oceanography.

Table 1. Publication Requests Filled, 1985 - 1986
This distribution supplements the initial mandated distribution of our publications.

	Source of Request					
Publication Type	Education	Government	Business/ Industry	General Public	Total	1984-85 Total
Journal Reprints	191	98	76	25	390	56
Technical Reports	84	16	20	1	121	64
Marine Education	341	1	14	2	358	192
Advisory Services:						
Weather to Go Boating	150	2000	2	1	2153	1929
Beach Guide	19	1779	194	1023	3015	N.A.
MAREP flyer	111	0	1	0	112	N.A.
Other	15	15	26	13	69	11
Theses and Dissertations	6	3	2	0	11	5
Other	119	5	11	5	140	40
TOTAL	1036	3917	346	1070	6369	2297

Publications

Reprints

Murphy, Richard C. Factors affecting the distribution of the introduced bivalve, *Mercenaria mercenaria,* in a California lagoon -- the importance of bioturbation. Reprinted from Journal of Marine Research 43:673-692, 1985. USCSG-R-07-85.

Spulber, Daniel F. The multicohort fishery under uncertainty. Reprinted from Marine Resource Economics 1(3):265-282, 1985. USCSG-R-08-85.

Taylor, Gordon T. and C.W. Sullivan. The use of 14 C-labeled bacteria as a tracer of ingestion and metabolism of bacterial biomass by microbial grazers. Reprinted from Journal of Microbiological Methods 3(1984):101-124. USCSG-R-09-85.

Bjur, Dorothy M., Jaqueline B. Rojas and Wesley E. Bjur. Un acercamiento innovador en la preparacion de cientificos y ciudadanos conscientes de la existencia del medio marino. Reprinted from Trabajos Presentados a la Conferencia Internacional Sobre Recursos Marinos del Pacifico (Proceedings of the International Conference on Marine Resources of the Pacific); Patricio M. Arana, (ed.), 1983, Vina del Mar, Chile. USCSG-R-01-86.

Mirman, Leonard J. and Daniel F. Spulber. Fishery regulation with harvest uncertainty. Reprinted from International Economic Review 26(3): 731-746, October 1985. USCSG-R-02-86.

Andrasi, Alexander. Uptake of dissolved Gonyaulax catenella toxins from seawater by *Mytilus edulis* Linne. Reprinted from Toxic Dinoflagellates (Anderson, White and Baden, eds.), pp. 401-406. USCSG-R-03-86.

Ross, Maria R., Alvin Siger and Bernard C. Abbott. The house fly: An acceptable subject for paralytic shellfish toxin bioassay. Reprinted from Toxic Dinoflagellates, Anderson, White & Baden, eds., 1985. pp. 433-438. USCSG-R-04-86.

Yazdandoust, Mohammad H. Cancer crab larvae & goby fish: Vector and victim of paralytic shellfish poisons (PSP). Reprinted from Toxic Dinoflagellates, Anderson, White & Baden, eds., pp. 419-424. USCSG-R-05-86.

Murphy, Richard C. and James N. Kremer. Bivalve contribution to benthic metabolism in a California lagoon. Reprinted from Estuaries 8(4):330-341, copyright 1985 by Estuarine Research Federation, December 1985. USCSG-R-06-86.

Brewer, Gary D. and Gary S. Kleppel. Diel vertical distribution of fish larvae and their prey in nearshore waters of southern California. Reprinted from Marine Ecology Progress Series, Vol. 27:217-226, 1986.

Bakus, Gerald J. A multidisciplinary marine fisheries resource management program for developing countries: with comments on the Indian Ocean. Reprinted from Biology of Benthic Marine Oganisms, Mary-Frances Thompson, Rachakonda Sarojini and Rachakonda Nagabhushanam (eds.), 1986, pp. 425-447. USCSG-R-08-86.

Technical Reports

Fawcett, James A. and Michael Liffman (eds.). Non-Maritime Port Activities: A Research Agenda. Proceedings of a National Conference Cosponsored by University of Southern California Sea Grant Program and the Louisiana Sea Grant College Program, May 16-18, 1985, in Baton Rouge, Louisiana. 40 pp. USCSG-TR-03-85.

Thesis/Dissertation

Steele, John Alexander. Variability in temperature in coastal waters near the Palos Verdes Peninsula between January and May 1985. December 1986 Master's Thesis, Geological Sciences. 104 pp. USCSG-TD-01-1987.

Advisory Services

Charest, Karen and James Fawcett. Pocket Guide to Los Angeles Area Beaches. 27 pp. 1986.
USCSG-AS-01-86.

Marine Education

Wet and Wild: Six bilingual supplementary marine education curriculum guides for teachers, Grades
K-6.
--Unit 4: The Biological Ocean (Hello Down There!). USCSG-ME-04-83.
--Unit 5: The Economic Sea (Riches of the Sea). USCSG-ME-05-83.
--Unit 6: Marine Ecology (You Scratch My Back... I'll Scratch Yours). USCSG-ME-06-83.

Special Reports

USC Sea Grant Annual Report 1984-85. USCSG-SR-01-86.

USC Sea Grant Project Directory 1986-87. USCSG-SR-02-86.

USC Sea Grant Trainee Annual Report 1985-86. USC-SR-03-86.

USC Sea Grant Publications Catalog. USCSG-SR-01-87.

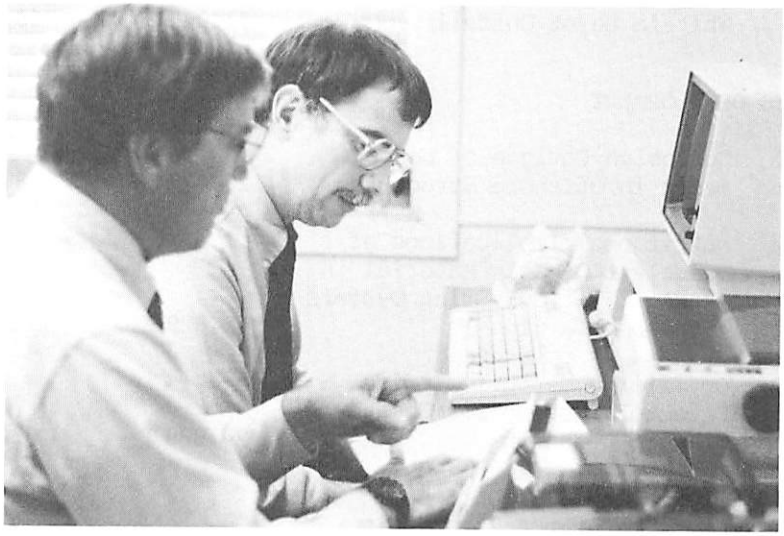
USC Sea Grant Long Range Plan 1986-91. Final draft March 1987. USCSG-SR-02-87.

Program development funds are set aside to provide Sea Grant management the ability to address program needs that arise outside the normal proposal cycle. We may need to be able to respond to an emergency or unanticipated event that requires immediate data collection; to make schedule changes necessitated by outside circumstances; to fund prospective work such as literature searches and experimental design for projects not yet ready for full funding consideration. In addition, symposia or conferences may be funded through this project.

In 1985-86, several items received program development funds. We hosted a delegation from the State Oceanic Administration, People's Republic of China, at our 1986 Site Visit. Their stay included a workshop on "Recent developments in U.S. ocean policy, with an emphasis on the Pacific Basin," which was also attended by outside scholars and state and federal agency representatives.

We also assisted in the announcement of a national "Fishing Vessel Insurance and Safety" workshop sponsored by the Sea Grant College Program network and the National Council of Fishing Vessel Safety and Insurance. In addition, we assisted an investigator developing a copepod reproduction project; sponsored three panel presentations at the Pacific Congress on Marine Technology in Honolulu (March, 1986); upgraded office computer systems, and provided funds for a Sea Grant Intern's interview trip to Washington, D.C., and to a Sea Grant trainee for an advanced summer course at Hopkins Marine Station in Monterey.

Program development funds often are instrumental in sparking new research areas (see article p. 15).



BUDGET SUMMARY and PROJECT STATUS, 1985-1986

		Sea Grant Funds	State/Local Match	Project Status*			
				1984-85	85-86	86-87	87-88
MANAGEMENT, PROGRAM DEVELOPMENT, PUBLICATIONS							
M-1	Administration and Management	143,899	46,987	C	C	C	C
M-2	Program Development	35,010	10,909	C	C	C	C
M-3	Communications and Publications	79,563	19,709	C	C	C	C
ADVISORY SERVICES AND EDUCATION							
AE-1	Advisory Services and Education	203,506	95,340	C	C	C	C
E/M-1	Graduate Student Trainee Program	33,750	7,500	C	C	C	C
COASTAL PLANNING AND MANAGEMENT							
R/CM-34	Shallow-Water Diving Accidents at Southern California Beaches	15,002	34,388	-	I	T	-
R/CM-38	Determinants of Seaport Viability in the Local Economy	15,945	9,779	-	I,T	-	-
R/EQ-40	Physical and Chemical Oceanographic Variability in the Region Near the Los Angeles County White's Point Outfall	51,045	58,587	I	C	T	-
RESOURCE DEVELOPMENT							
R/CE-8	Corrosion Fatigue of Weldments in Offshore Structures	28,077	18,097	C	T	-	-
R/RD-27	Nutritional Implications of Dissolved Organic Material in Seawater for Culturing Oysters (Crassostrea gigas)	35,829	51,638	I	C	T	-
R/RD-29	Optimizing Mercuric Iodide Detector Systems for Oceanographic Research	24,088	62,336	-	I	C	T
R/RD-30	Growth and Composition of Ecotypes of the Giant Kelp, Macrocystis pyrifera	9,286	24,246	-	I	C	T
	TOTAL	675,000	439,516				

* I=Initiated; C=Continuing; T=Terminated

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