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The University at Work in the Ocean

A QUADRENNIAL
REPORT ON THE
ACTIVITIES OF THE
UNIVERSITY OF HAWAII
SEA GRANT
COLLEGE PROGRAM

Years 08-11 (1976-79)

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Text by
Rose T. Pfund

DIRECTOR'S REPORT

DEVELOPMENT OF THE UNIVERSITY OF HAWAII SEA GRANT COLLEGE PROGRAM — AN OVERVIEW

The University of Hawaii received one of the nation's first "Sea Grants" in 1968. A major commitment to the development of a Sea Grant College was made in 1970 with the establishment of the Sea Grant Director's Office and the appointment of Dr. Jack R. Davidson. The University announced a second major commitment to development of excellence in marine programs in 1970 through the establishment of the Office of Marine Programs with Dr. John P. Craven as dean. The quality of the programs established following these actions was reflected in the designation of the University of Hawaii as the fourth Sea Grant College in October 1972.

The early Sea Grant programs (1970-75) emphasized development of a strong applied research program focused on Hawaii's marine challenges and opportunities. The 1969 *Hawaii and the Sea* (updated in 1974) provided a framework for marine program development. Early areas of interest and emphasis included plant and animal aquaculture, engineering of stable ocean platforms, human physiology under hyperbaric conditions, and quality of marine environments.

The University of Hawaii Sea Grant College Program also took an early lead among the Sea Grant Colleges and institutions in the development of innovative marine education programs. These included the undergraduate Marine Option Program, the Makahiki Kai (Festival of

the Sea) with emphasis on grades 4-6, marine graduate course development, and initiation of a major high school marine science curriculum development program.

The Marine Advisory Program was developed more slowly. The philosophy was to expand this program in size and function as the needs were clearly established and resources became available to assure a quality program. The early advisory program featured a small statewide staff servicing identifiable state marine public education needs through publications and workshops, as well as seminars featuring local and visiting marine experts. The first phase of a proposed statewide network of county agents was implemented in 1974.

In 1975 Ronald Linsky became the acting Director. The next two years saw a major effort to complete the Marine Advisory Program's county field agent network and to supply necessary support services. This effort, in the face of level funding and steadily increasing inflation throughout the period, resulted in a substantial reduction in funding for research (Figure 1).

State marine planning efforts accelerated during this period with the emergence of a draft state aquaculture plan and the initiation of state marine education and fisheries planning efforts.

In 1977, Jack R. Davidson returned as Sea Grant Director. The major emphasis of program management for the next biennium can be summarized as increases in the efficiency and effectiveness of program administration, improvement in the quality and focus of research, and definition and planning for an appropriate future role for the University of Hawaii Sea Grant College Program in the US territories of the subtropical Pacific. The results included institution of more rigorous peer reviews of

all proposals and programs; emphasis on the quality of science in all research undertakings; development of the large Northwestern Hawaiian Islands Fisheries Investigations; reconstitution of the Hawaiian Prawn Aquaculture program, development of the plan to extend the marine advisory network to include Guam, the Commonwealth of the Northern Mariana Islands, and American Samoa; and completion of ongoing marine education programs and dissemination of results.

The efforts were facilitated by a general increase in program funding (Figure 2). Although these increases did not match the rate of inflation, they did permit maintenance of a level of programs which, coupled with improvements in focus and quality, resulted in a higher level of overall productivity.

THE SEA GRANT QUADRENNIAL 1976-79 PROGRAMS

The UH Sea Grant quadrennial 1976-79 program consisted of a tripartite of education, research, and advisory programs as proscribed for a Sea Grant College. The quadrennial research programs consisted of 43 programs and projects under four general topic areas:

1. Marine resources development
2. Socioeconomic and legal studies
3. Marine technology research and development
4. Marine environmental research

A total of 38 separate programs and projects were undertaken at a cost of \$2,814,081.

The 18 resource development projects included the emergence of two major multidisciplinary programs:

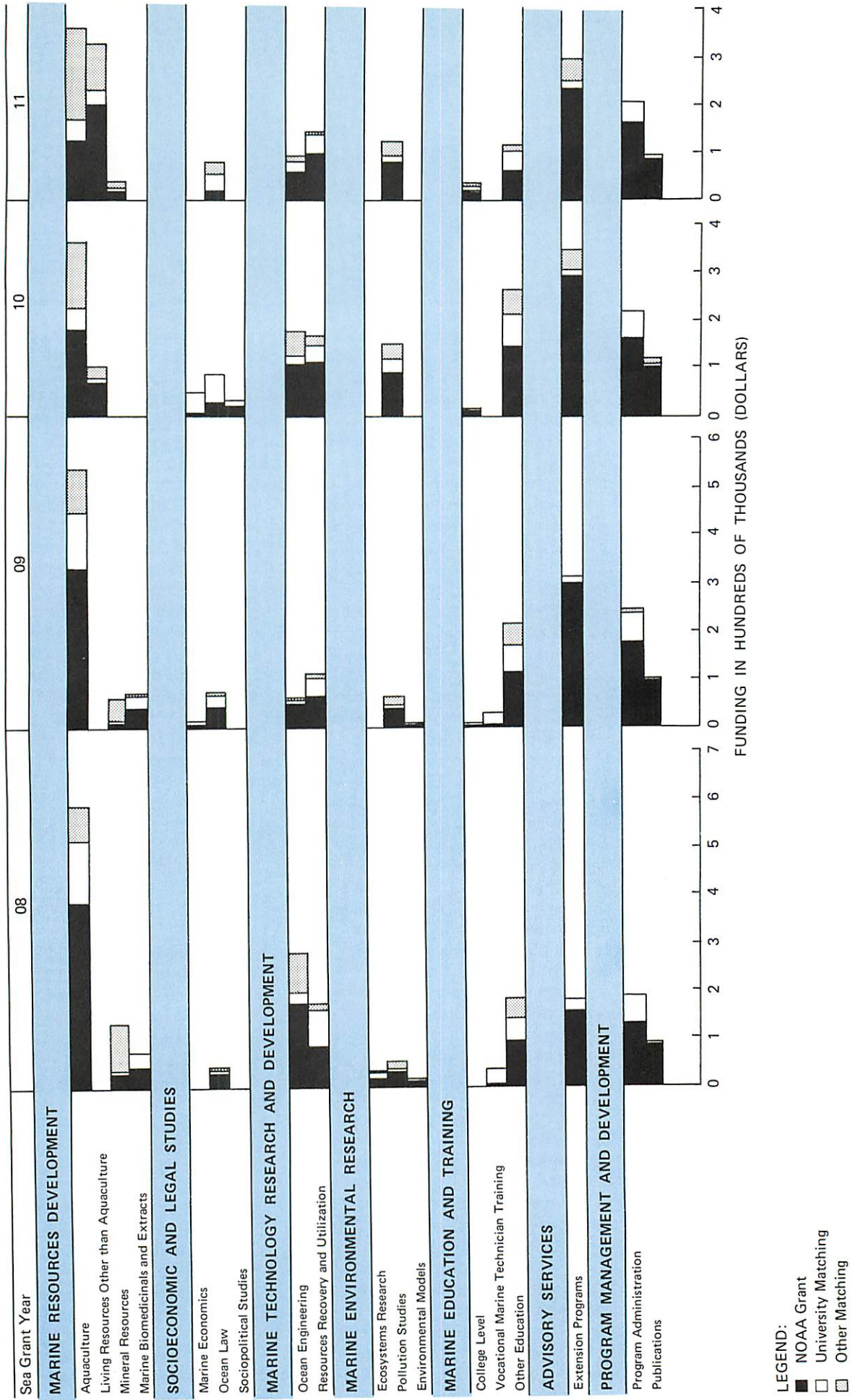
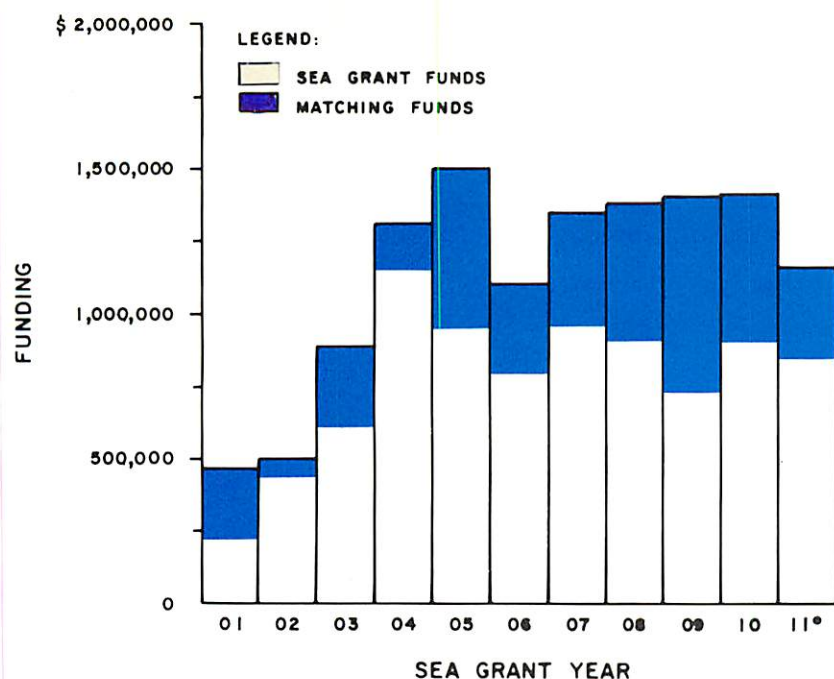


Figure 1. Funding level and sources for SG Years 08-11



* 9-MONTH BUDGET (CHANGE IN FISCAL YEAR)

Figure 2. A comparison of Sea Grant and matching funds: SG Years 01-11

the Hawaiian Prawn Aquaculture program with six subprojects ranging from basic production parameters to economic analyses; and the North-western Hawaiian Islands Fisheries Investigations. The latter consists of seven projects designed to complement the federal-state tripartite goals for development and management of the area resources. Other research areas included projects on baitfish, ciguatera poisoning, and deep ocean manganese nodules.

Twelve marine education projects and programs ranging from elementary to postgraduate studies were undertaken. The Marine Advisory Program in completing its statewide network placed field agents and support staff in each of the counties of the state. County advisory committees were formed and the appropriate county programs developed. The period also saw development of a framework to extend these programs to other Pacific island communities. The projects and programs of the quadrennium are listed in Table 1.

TABLE 1. STATUS OF SEA GRANT PROJECTS AND PROGRAMS: YEARS 08-11

Project Title	Principal Investigator(s)	Year Funded				
		08	09	10	11	
		1975	1976	1977	1978	1979
MARINE RESOURCES DEVELOPMENT						
Tropical Animal Aquaculture*	J.E. Bardach	→				
Nutritional Requirements of <i>Macrobrachium rosenbergii</i>	G.A. Ahearn					
Genetics of <i>Macrobrachium rosenbergii</i>	S.R. Malecha					
Prawn Production and Management Systems Analysis†	J.K. Wang					
Moi	R.C. May					
Culture of Baitfish	W.J. Baldwin					
Hawaiian Prawn Aquaculture*						
Pond Productivity Determinants	E.A. Laws					
Post-Harvest Handling and Processing	W.K. Nip, J. Moy					
Behavioral Biology	J.B. Peebles					
Genetic Improvement	S.R. Malecha					
Economic Analysis and Information Systems	J.J. Polovina, R.E. Peterson, K.K. Seo					
Aquaculture Engineering and Systems Analysis†	J.K. Wang					
Engineering Advisory Services†	J.K. Wang					
Tropical Marine Agronomy	M.S. Doty	→				
MMDC-HIMB Cooperative Aquaculture Project	R.C. May					
Ciguatoxin: A Possible New Bioassay; Its Mechanism of Action; Its Biological Origin	A.H. Banner, P.J. Scheuer	→				
The Structure of Palytoxin	P.J. Scheuer					
Ecology and Resource Potential of Bottom Fisheries in the Leeward Hawaiian Islands	R.W. Grigg					
Novel Approaches to Uses of Land Plants in the Sea	B.Z. Siegel, S.M. Siegel					
Manganese Resources	J.E. Andrews					
Hydrometallurgical Separation of Metals from Ferromanganese Nodules and Large-Scale Uses of Residual Oxides	H. Zeitlin					→

*The research program begun under "Tropical Animal Aquaculture" as preliminary feasibility studies became focused under the "Hawaiian Prawn Aquaculture" program.

†The hardware developed under the "Aquaculture Engineering and Systems Analysis" project during the first and second years was field tested by prawn farmers during the third year. The associate investigator provided advisory-extension service.

TABLE 1. STATUS OF SEA GRANT PROJECTS AND PROGRAMS: YEARS 08-11 (continued)

Project Title	Principal Investigator(s)	Year Funded				
		08	09	10	11	
		1975	1976	1977	1978	1979
Northwestern Hawaiian Islands Fisheries Investigations						
Primary and Secondary Plankton Productivity and Potential Fishery Yields in the Hawaiian Archipelago	J. Hirota					→
Reef and Precious Coral Resources: Comparative Ecology Within the Hawaiian Archipelago	R.W. Grigg					→
Population Biology of Spiny Lobsters Throughout the Hawaiian Archipelago	J.S. Stimson, C. MacDonald					→
An Analysis of Some Aspects of the Fishery Biology of Snapper and Grouper Populations in the Hawaiian Archipelago	P. Helfrich					→
Genetic Aspects of Population Structure of Spiny Lobsters and Snappers in the Northwestern Hawaiian Islands	J.B. Shaklee					→
Economics of Fisheries Development for the Hawaiian Archipelago	J.R. Davidson					→
Survey and Assessment of Green Sea Turtle Resources of the Northwestern Hawaiian Islands	G.H. Balazs					→
SOCIOECONOMIC AND LEGAL STUDIES						
A Legal and Institutional Response to Oil and Deep Sea Mineral Exploitation in the Pacific Basin	J.P. Craven, J. Gresser, V.C. Bloede					
Environmental Aspects of Deep Sea Mining and Processing	J. Gresser					
Multinational Corporations and Ocean Resource Development: Economic and Institutional Aspects	C. Gopalakrishnan					
Law of the Sea Institute	J.P. Craven					→
MARINE TECHNOLOGY RESEARCH AND DEVELOPMENT						
Human Performance in the Sea	E.L. Beckman, R.M. Smith, J.T. O'Brien	→				
Seaward Advancement of Industrial Societies	J.P. Craven	→				
Pipeline Survival Under Ocean Wave Attack	R.A. Grace	→				
Wave Attenuation and Wave-Induced Setup on Shallow Reefs	T.T. Lee					
High Visibility Undersea Observation Structure	R.H. Knapp					
Exogenous Gas Bubble Disease: Its Detection, Prevention, and Treatment	E.L. Beckman, D.E. Yount					→
Inert Gas Elimination During Decompression	Y.C. Lin					
OTEC Heat Exchanger Biofouling Experiment	P. Yuen, J. Jones					
The Effect of Terrain Roughness on Tsunami Run-up and Inundation	C.L. Bretschneider					
Manned Submersible Reconnaissance of Proposed Ocean Thermal Energy Conversion Pipeline Route, Ke-Ahole Point, Hawaii	E.K. Noda					
A Slanted Look At Ocean Wave Forces on Pipes	R.A. Grace					→
MARINE ENVIRONMENTAL RESEARCH						
Reef Fish Populations of Hawaii and Their Exploitation	L.R. Taylor, Jr.	→				
Extreme Wave Conditions for Selected Hawaiian Areas	C.L. Bretschneider	→				
Pathogenic Enteric Viruses in Hawaiian Ocean Environment: Viability and Die-off	P.C. Loh, L.S. Lau					
Pathogenic Human Enteric Viruses in Hawaiian Ocean Waters: Role and Effects of Antiviral Agent(s)	P.C. Loh, L. S. Lau					→
Microbiological Indicator for Ascertaining Fecal Contamination of Marine Recreational Waters	R.S. Fujioka					→
Marine Mollusks as Indicator Organisms In Benthic Communities	E.A. Kay					→
MARINE EDUCATION AND TRAINING						
Marine Option Program	J.J. McMahon	→				→
Blue-Water Marine Lab	J.P. Craven	→				
Curriculum Design for Secondary Schools—Grades 10-12	F.M. Pottenger III	→				
Marine Studies for Elementary Children of Hawaii	E.L. Demanche					
Makahiki Kai—Festival of the Sea	R.T. Pfund					
Teacher Training Program for Marine Technology in Pacific Basin Area	K.K. Kamimura	→				
Marshallese-FAST Project: Training and Assessment	E.L. Demanche					
Development of New Course "Ocean Economics of Hawaii and the Pacific Basin"	D. Heenan, K.K. Seo					
Development of Three New Courses in Aquaculture	S.R. Malecha					
Field and Instructional Support for an Undergraduate Aquaculture Curriculum	S. Goto					
Ho'i Ana Ike Kai—Return to the Sea	R.T. Pfund					→
Development of a New Course in Underwater Technology	E.K. Noda					→

The research and education functions merge in the training of graduate students, who while participating in and contributing to the research progress earn baccalaureate, masters, and doctoral degrees. The educational process continues in the research associate relationship where post-doctorate and other postgraduates join with faculty in research endeavors on a more nearly peer basis.

During the quadrennium, 199 undergraduate students and 88 graduate students were involved in one or more of the projects funded under Sea Grant (see Table 2). While the number of undergraduate students who were supported by Sea Grant is less than 0.5 percent of the annual graduating class, the annual average of 27 graduate students who were supported through research projects is nearly 6 percent of the students who received advanced degrees.

Table 2 summarizes the degrees earned by students who participated on Sea Grant programs and projects. On the average the 199 undergraduates would not be as heavily involved with a Sea Grant project or program as are graduate students. Graduate student funding, work commitments, and degree of involvement in a project are much higher. As shown in Table 3, 20 of the students who earned degrees in the quadrennium are employed by private firms and 13 are employed in academic or public institutions.

The UH Sea Grant College Program's early and innovative marine education efforts at all appropriate levels, not only facilitated local education program development, but projected participating personnel into a regional and national marine education advisory role. The contribution of the Hawaii program is difficult to document but the number of requests for materials, advice, and personnel participation in state, regional, and national forums has been substantial.

Program development requires advanced planning, review, and defense of the institutional program. The quadrennium saw the evolution of the National Sea Grant from an annual to a biennial proposal process. This increased the emphasis on effective advance planning in an effort to diminish the need for the costly annual site review. To facilitate advanced planning and to meet short-range opportunities and needs, the Director manages a small amount of funds for planning, proposal development, and rapid response grants. These projects are shown in Table 4. Although the sought-for results are often grounds for a more comprehensive research proposal, a number of publications and reports arose from these projects (see publications section).

The "rapid response" projects take two forms. The first capitalizes on an opportunity to facilitate the completion of a high quality marine effort appropriate to the Sea Grant role, e.g., when a scientist has developed a concept to a certain point with his own initiative or other funding and requires only limited funding for completion. The project duration is usually less than one year and the program is usually at a critical stage where delay would result in loss of personnel or continuity in observations. The second type of project addresses a vital need for information for decision-making, usually for a state agency or marine industry. In some instances, a limited amount of extra funds is required to complete a Sea Grant program where the approved budgets were not adequate to meet an unusual cost, an expected delay, etc.

A summary of publications produced during the quadrennium is given below:

Type of Publication	Fiscal Year			
	08	09	10	11
Technical Reports	3	5	2	
Advisory Reports	2	2	2	
Miscellaneous Reports	3	4	5	4
Journal Contributions	16	11	6	15
Cooperative Reports	2	3	2	2
Miscellaneous Brochures	3	2	1	
Technical Papers				3
Seminar Papers			1	
Working Papers	6	6	8	2
Miscellaneous Contributions		1	2	
Conference Papers	3	3	1	3
Advisory Brochures	3	7	8	4
Newsletters				
Sea Grant	12	12	9	12
Coastal Zone News				12

The first decade of Sea Grant program involvement in Hawaii has been responsible for a major increase in marine awareness in the state. The program has initiated research efforts which have resulted in development of much new knowledge to facilitate policy formulation and decisions. The program has been a significant factor in the development of the state's scientific talent and expertise in marine fields. The next decade will see increasingly sophisticated applications of science to support state and national goals for the Hawaiian Archipelago and surrounding oceans. It will also witness major contributions of the Sea Grant program to the solution of problems and meeting needs in marine education, research, and advisory services in the greater Pacific region.

Jack R. Davidson

TABLE 2. NUMBER OF STUDENTS INVOLVED IN SEA GRANT PROJECTS: YEARS 08-11

Discipline	Degree Earned/to be Earned											SG Year			
	BA	BBA	BEd	BFA	BS	MA	MBA	MS	MURP	PhD	Unknown	08	09	10	11
												UG	G	UG	G
Agricultural Economics					1/1			/1					1	1	1
Agricultural Engineering								/1					1		
Animal Science								2/1				1			
Art	2/1			1/1							6	5	4	4	2
Asian Studies	/1												1	1	
Biochemistry										/1					1
Biology					1/6						1		2	1	2
Biology/Anthropology					/1									1	4
Botanical Science					1/			1/		1/		1	3	2	1
Business		1/5					1/					1	3	4	1
Business/Accounting											1		1		2
Chemistry					1/			1/1		1/5				3	2
Civil Engineering					2/							2		1	5
Communications	/5					1/							3	1	1
Computer Science	1/				/1			1/						1	2
Education			/1			/1							1	1	1
Education Communication/ Technology											1		1	1	1
Ethnology	/1												1		
Fisheries										/1					1
Food and Nutritional Sciences					1/										1
Food Science								/3						2	2
General Agriculture					/3							2	1	1	1
Genetics					2/			/2				1		2	1
Geology and Geophysics					1/			/1						1	1
Ichthyology								/1					1		
Journalism	2/												1	2	1
Liberal Studies											2			2	
Math											1	1			
Mechanical Agriculture Production					1/								1	1	
Mechanical Engineering					/3			1/				1	1	2	1
Medical Technology					/1										1
Microbiology								1/1		/1				2	1
Nursing					/1						1		1	1	
Nutritional Science					/1							1	1		
Ocean Engineering					/1			5/5		2/		1	9	5	1
Oceanography										/3	1	3	2		1
Physical Education	/1												1		
Physics					1/					1/		1		1	1
Physiology										/3					3
Political Science	/1									/1			1		
Psychology													1		
Public Health								/1							1
Secretarial Science											2	2			
Sociology											1		1		
Special Education	1/											1			
Speech	/1												1	1	1
Tropical Medicine										/1					1
Urban Planning									/2						2
Zoology	4/				1/3					/3			4	3	1
Unknown												30	1	26	3
TOTAL:	10/11	1/5	/1	1/1	13/22	1/1	1/	12/18	/2	5/19	17	47	19	72	25

TABLE 3. EMPLOYMENT STATUS OF STUDENTS INVOLVED IN SEA GRANT PROJECTS: YEARS 08-11

Discipline	Degree Earned/to be Earned 08-11									Employer 08-11				
	BA	BBA	BEd	BFA	BS	MA	MLS	MS	PhD	Academic Institution	Private Firm	Public Service	Unknown	Graduate Student
Agricultural Engineering								1/				1		
Animal Science					1/						1			
Anthropology	1/										1			
Art				1/							1			
Biology					3/						2	1		
Botanical Science									1/		1			
Chemistry								1/			1			
Civil Engineering					2/						2			
Communications	/1											1		
Computer Science								1/			1			
Ecology								1/		1				
Education			1/			1/				1		1		
Electrical Engineering					1/						1			
Food and Nutritional Sciences					1/							1		
Journalism	2/										1		1	
Library Science							1/					1		
Marketing		1/										1		
Mechanical Agriculture Production					1/						1			
Ocean Engineering								5/1	1/	2	2	1		2
Oceanography								1/			1			
Physiology								3/						3
Zoology	5/									1	4			
TOTAL:	8/1	1/	1/	1/	9/	1/	1/	13/1	2/	5	20	8	1	5

TABLE 4. PROGRAM MANAGEMENT INITIATIVES: SEA GRANT YEARS 08-11

Project	Grantee	Funding Level
YEAR 08		
Preliminary Study Design of An Economic Evaluation of Aquaculture	K.K. Seo, R.E. Peterson	\$ 2,490
Determination of the Optimum Marketing Strategy for the Hawaiian Prawn	E.W.J. Faison	734
Marine Studies Lecture Series	S.A. Reed	500
Marine Education—Preplanning Conference for Hawaiian Educators	M. Muraoka	2,053
Overview and Long-Range Plans for Ocean Engineering Academic & Research Activities at the UH	C.L. Bretschneider	5,000
Population Survey of Humpback Whale Wintering in the Hawaiian Islands	T. Smith, E. Shallenberger	1,638
Investigation into a Journal of Marine Education Concept	R.B. Linsky	5,000
Survey of Hawaiian Divers for Dysbaric Osteonecrosis	E.L. Beckman	2,000
Development of a Computer Program for Calculating Decompression Tables	E.L. Beckman	2,500
Institute for Marine Educators (also Year 09)	B. Klemm, R. Campbell	1,400
Study of Tuna Chemical Attractants (also Year 07 \$3,000)	J.E. Bardach	1,841
YEAR 09		
Novel Approaches to Uses of Land Plants in the Sea	B.Z. Siegel, S.M. Siegel	8,138
Marine Social Studies Materials Production	F.M. Pottenger III	2,001
Marine Programs and Aquaculture Seminars	R.B. Linsky	1,038
Practical Guide for Coastal Protection	F. Gerritsen	2,500
Price and Demand Study of Fresh Table Fishes in Hawaii	Y.C. Shang	897
Advisory Services to Algae Farmers	G. Prawse	3,000
Shark Fishery Research and Development Program	J.J. Harris	3,500

TABLE 4. PROGRAM MANAGEMENT INITIATIVES: SEA GRANT YEARS 08-11 (continued)

Project	Grantee	Funding Level
DUMAND Site Survey	J. Andrews, R. Harvey	\$ 5,680
Institute for Marine Educators (also Year 08)	B. Klemm, F.M. Pottenger III	1,630
Statewide Marine Science Planning Conference of Secondary Teachers and Administrators	J.J. McMahon, M. Muraoka	970
Richardson Ocean Center Development	J.L. Ball, Jr.	5,000
Separation of Some Metals from Ferromanganese Nodules and Large Scale Uses of Some Residual Oxides	H. Zeitlin, Q. Fernando	3,000
Hawaii Aquaculture Planning Program Support	R.B. Linsky, R. Shleser	25,000
Training and Education in Diving Medicine	E.L. Beckman	1,500
Computer Services for Dissemination of Improved Air Decompression Schedules Data	E.L. Beckman	1,500
YEAR 10		
Burnt Tuna Problem in the Hawaiian Fisheries	E.K. Noda, T.T. Lee	4,500
Marine Life Population Survey Off Papohaku Beach, Molokai	J.J. McMahon, J. Shaklee	1,784
Ho'i Ana Ike Kai—Return to the Sea	R.T. Pfund	3,264
Development of an Air Stabilized Ocean Platform Concept	L.H. Seidl	3,500
Behavioral Biology of the <i>Macrobrachium rosenbergii</i>	J.B. Peebles, S.R. Malecha	8,883
Sea Grant Intern for Institutional Economics of Extended Jurisdiction in the Western Pacific	H. Yamauchi	4,106
Tropical Marine Aquarium Fish Health Program	R. Nakamura, L.R. Taylor	4,822
Industry Field Testing of Prawn Harvesting Systems	J.K. Wang, M. Williamson	3,000
Diet Study of the Blueline Snapper (also Year 11)	J.D. Parrish	3,041
Coastal Flora of Hawaii (also Year 11)	R.S. Tabata, B.Y. Kimura, K.M. Nagata	1,450
Ocean Transportation in Hawaii	J. Morgan	4,018
Sea Grant Intern in Ocean Engineering	F. Gerritsen	6,647
Compendium of Sand Mining Data in Hawaii	S.J. Dollar	3,923
Logistics Guide of the Northwestern Hawaiian Islands	S.J. Dollar	3,701
YEAR 11		
Marine Corrosion Instruction and Research Program (with Consultant Frank La Que)	J. Larsen-Basse	6,000
Tuesday Night Aquatic Animal Disease Group	R. Nakamura	3,000
Bioerosion of Coral in Hawaii	J. Bailey-Brock	6,121
Diet Study of the Blueline Snapper (also Year 10)	J.D. Parrish	2,093
Growth and Repopulation Studies of <i>Gracilaria</i> in Guam	R.T. Tsuda, S.G. Nelson	2,902
Northwestern Hawaiian Islands Fisheries Investigations—Top-Level Carnivores	L.R. Taylor	7,027
<i>Eucheuma</i> Farming in Ponape	M.S. Doty	23,000
Preliminary Investigation in Physics of Bubble Dissolution in Gelatin	E.L. Beckman	7,256
Development and Testing of Fish (<i>Seriola dumerilii</i>) for Ciguatoxin	Y. Hokama	3,404
Development of a Teaching Unit in Deep-Sea Biology	S. Maynard, R. Young	3,104
Investigation of Coral Sclerochronology	R.W. Grigg	1,900
Saturation and Equilibrium Exposures in Diving and Thermodynamic Theory of Monolayer Permeation	D.E. Yount, T.D. Kunkle	10,190
Coastal Flora of Hawaii (also Year 10)	R.S. Tabata, B.Y. Kimura, K.M. Nagata	300
International Freshwater Prawn Farming Training Session (also Year 12)	T. Fujimura, J. Corbin	660
Development of Sea Grant Hawaii Multimedia Presentation	R.T. Pfund	3,200
Study of Transportation Costs of Solid Wastes	N. Poapongsakorn, T. Chomaitong	1,790
Literature Search of Evaluation Research	R.T. Pfund, S.K. Holt	2,190
Ecosystems Model for the Northwestern Hawaiian Islands	T. Laevastu	620
International Geophysical Data Transfer Project Planning in Tonga and New Zealand	F.J. Campbell	1,846
Sand Mining Site Survey	F.M. Casciano	1,042
Marine Education Project in Palau	E.H. Chave, C.S. McCord	2,044

INTRODUCTION

*the
transitional period
between emergence
of a program
and maturity*

A quadrennial assessment of program progress, particularly when it spans the transitional period between emergence of a program and maturity, provides an opportune time to show trends and directions. The report of the University of Hawaii Sea Grant College Program (UHSGCP) for Years 08-11 is presented as an evaluation of activities rather than as a description as is usually provided in annual reports.

The nine program areas which will be examined were selected on the basis of the amount of funding allotted for the activities over Years 08-11. The cutoff amount for each program area was arbitrarily set at \$.25 million. The measures applied to the analysis of the program evaluation are:

1. Achievement of goals
2. Institutionalization or perpetuation of the activity beyond the availability of Sea Grant funds
3. Impact on target group(s)

The program areas are in some cases composites of more than one discrete subprogram or project. Hence, the three criteria are applicable only in a general way to the overall programs. Where substantial resources were expended on a subprogram or discrete projects, a more detailed examination is made.

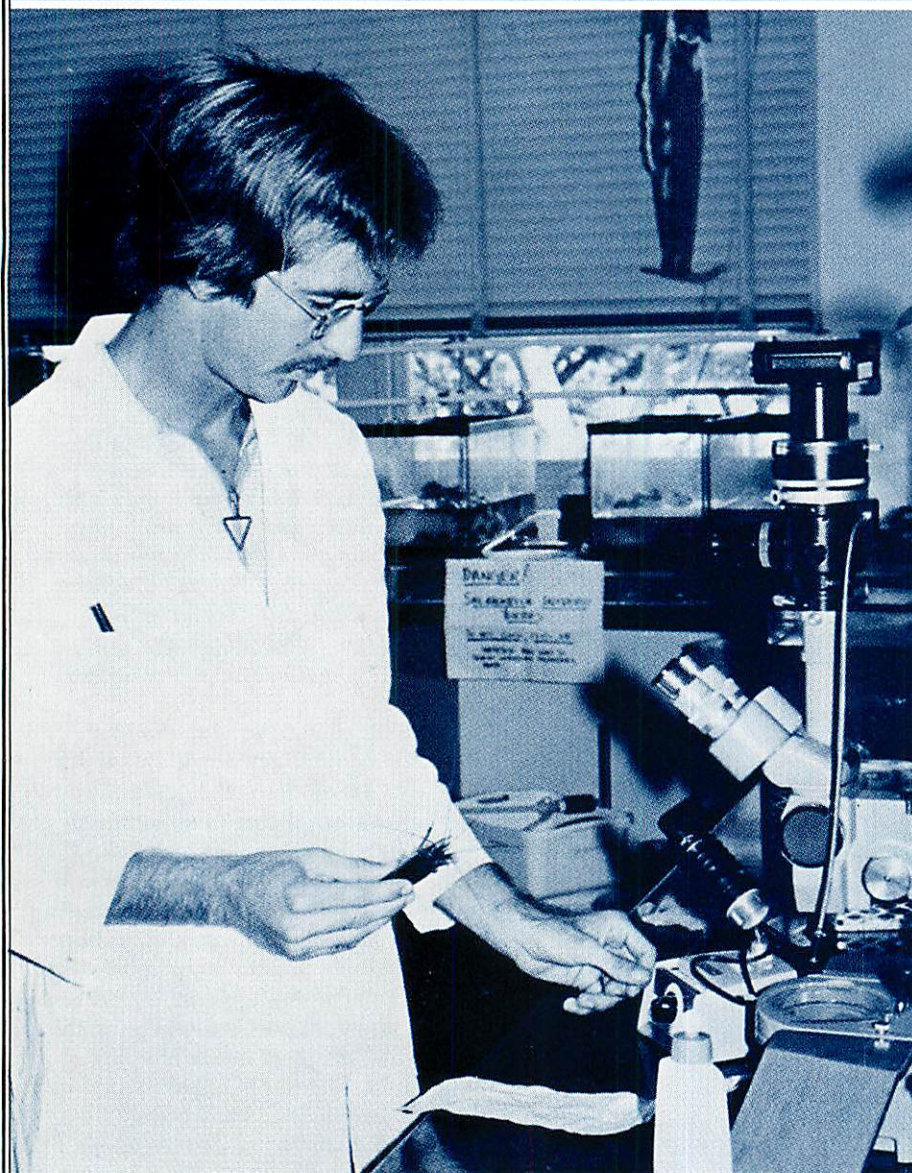
The culmination of the first decade of activities of the University of Hawaii Sea Grant College Program is included in the quadrennium covered by this report. The major experimenting both in programming and in the scheme of managing the Sea Grant tripart activities—research, education, and advisory services—occurred during the formative years. Hence, by the end of the first decade of its existence, the UHSGCP achieved the early stages of maturity. The fourth university to be designated a Sea Grant college, in 1972, the University of Hawaii is a unique component of the national

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program. It is the only island-based program among its sister sea grant college institutions.

Over the past decade, the expenditure of Sea Grant resources, both funding and personnel, has focused in nine specific categories: aquaculture, ocean engineering, resource recovery, pollution, living resources, mineral extraction, ocean law, lower education, and marine advisory services.

The quadrennium has been a period of steadily evolving cooperation between academia and the state of Hawaii in the development of marine programs. The Sea Grant concept and the University of Hawaii Sea Grant have been directly or indirectly responsible for much of the development of state aquaculture, fisheries, and marine education programs. The expanding coordination occurs because of the accessibility of university researchers to state agencies and a continuing informal dialogue with state lawmakers. In addition, the Sea Grant College Program Advisory Council, which advises the director, is composed of state, county, and federal agency representatives and the business community. The council members play a major role in setting research directions, and, hence, provide direction to the overall research program carried on by the University of Hawaii Sea Grant College Program.



R E S E A R C H



MARINE RESOURCES DEVELOPMENT

The largest single area of funding concentration with more than \$2.9 million allotted over the quadrennium is the research and development of living and non-living marine resources.

The activities under this program category include:

Aquaculture	\$1.9 million
Other living resources	\$.46 million
Non-living resources	\$.37 million

The seeming disparity in the total amount and the sum of the sub-programs is due to rounding of the figures.

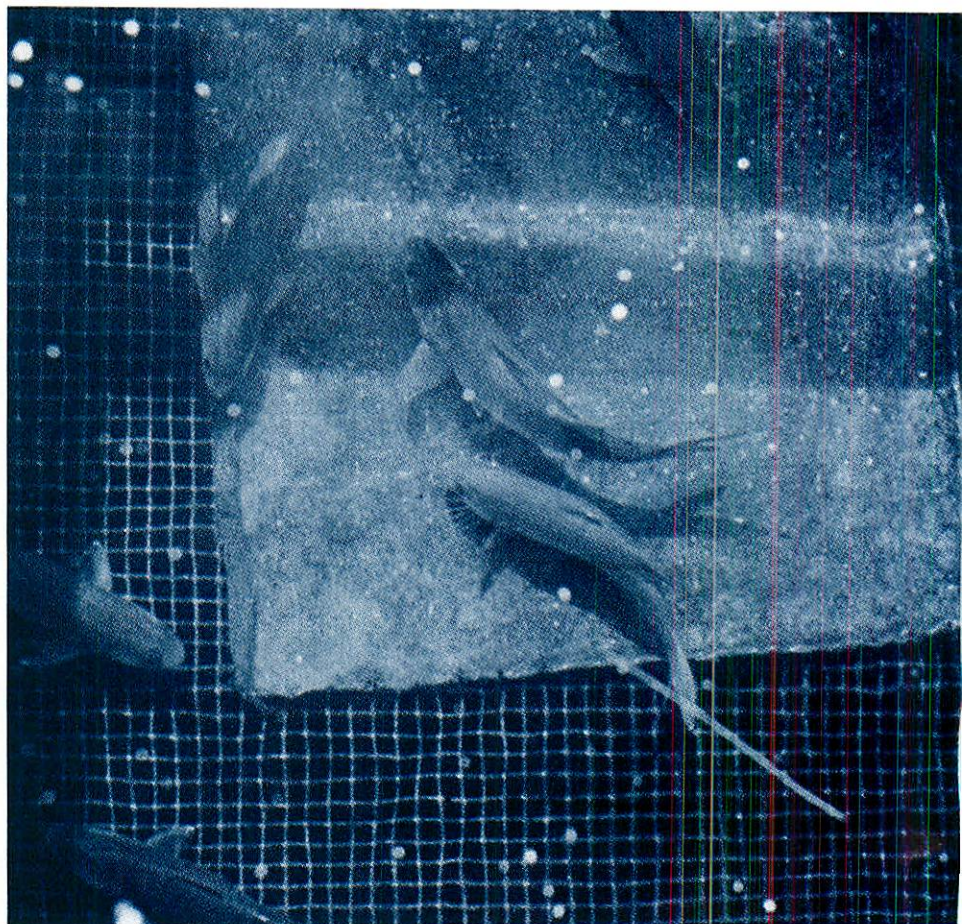
AQUACULTURE

No single area of research at the University of Hawaii more clearly illustrates the far-sighted vision of academicians than in the role they played in the development of aquaculture. Long before aquaculture became a popular buzz word, Sea Grant-funded researchers began the tedious and exacting task of screening and studying species which had traditional significance to local residents and, hence, commercial value. Although the focus of these efforts was on very localized species, researchers were well aware that the ecosystems, culture, and traditions of Hawaii reflect those of island communities throughout much of the Pacific. Therefore, the potential market for the knowledge developed concerning these species is much larger than that found in Hawaii.

In addition, the search to distinguish candidates for aquaculture in these early studies reflects the concern of the citizens of the state who noted the diminishing populations of reef and offshore fish stocks. As the numbers of recreational and commercial fishermen increased and fishing methods became more efficient, the wildstocks have not been able to maintain their communities at earlier levels when most nearshore fisheries were harvested for subsistence consumption.

Ultimately, abundance of wildstocks is governed by the geologic morphology of the Hawaiian Islands. The steep volcanic structure lacks the broad continental shelves of the U.S. mainland or other continental land masses. Although the world famous Hawaiian waters win high marks for

clarity, such clarity is indicative of low plankton productivity. The limited reef habitats and reef flats, therefore, constitute the available fishing grounds in the Hawaiian Islands. As these resources are impinged on by human activity or as fishing pressures mount, wildstocks will diminish.



MOI IN FEEDING PEN
AT HAWAII INSTITUTE OF
MARINE BIOLOGY

Overview of the Program

The University of Hawaii aquaculture research program, which began in 1968 (Sea Grant Year 01), followed the natural division of plant and animal sciences. Researchers in the Department of Botany studied seaweeds and biologists at the Hawaii Institute of Marine Biology (HIMB) worked on animal species. The studies on animal aquaculture focused on two phases: species evaluation and economic enhancement of *Macrobrachium rosenbergii*. A cooperative program between HIMB and the Micronesian Mariculture Development Center in Palau, continued into Year 08. Seaweed culture studies were carried on in the Philippines from Year 01.

Animal Aquaculture

The early aquaculture programs consisted of a series of screening and culture experiments for both finfish and crustacea. Economic criterion weighed most heavily in the assessment of the 19 species studied during the first eight-year period from 1968 to 1976 (Table 5). In some cases, the costs of closing the biological cycle were prohibitory. Uneconomic dietary requirements, or lack of markets, precluded consideration of certain species as viable aquaculture animals. This phase of work contributed greatly to knowledge concerning the species studied. However, each was eliminated as a candidate for commercial aquaculture in Hawaii.

CULTURING TANK
AT ANUENUE FISHERIES
RESEARCH CENTER

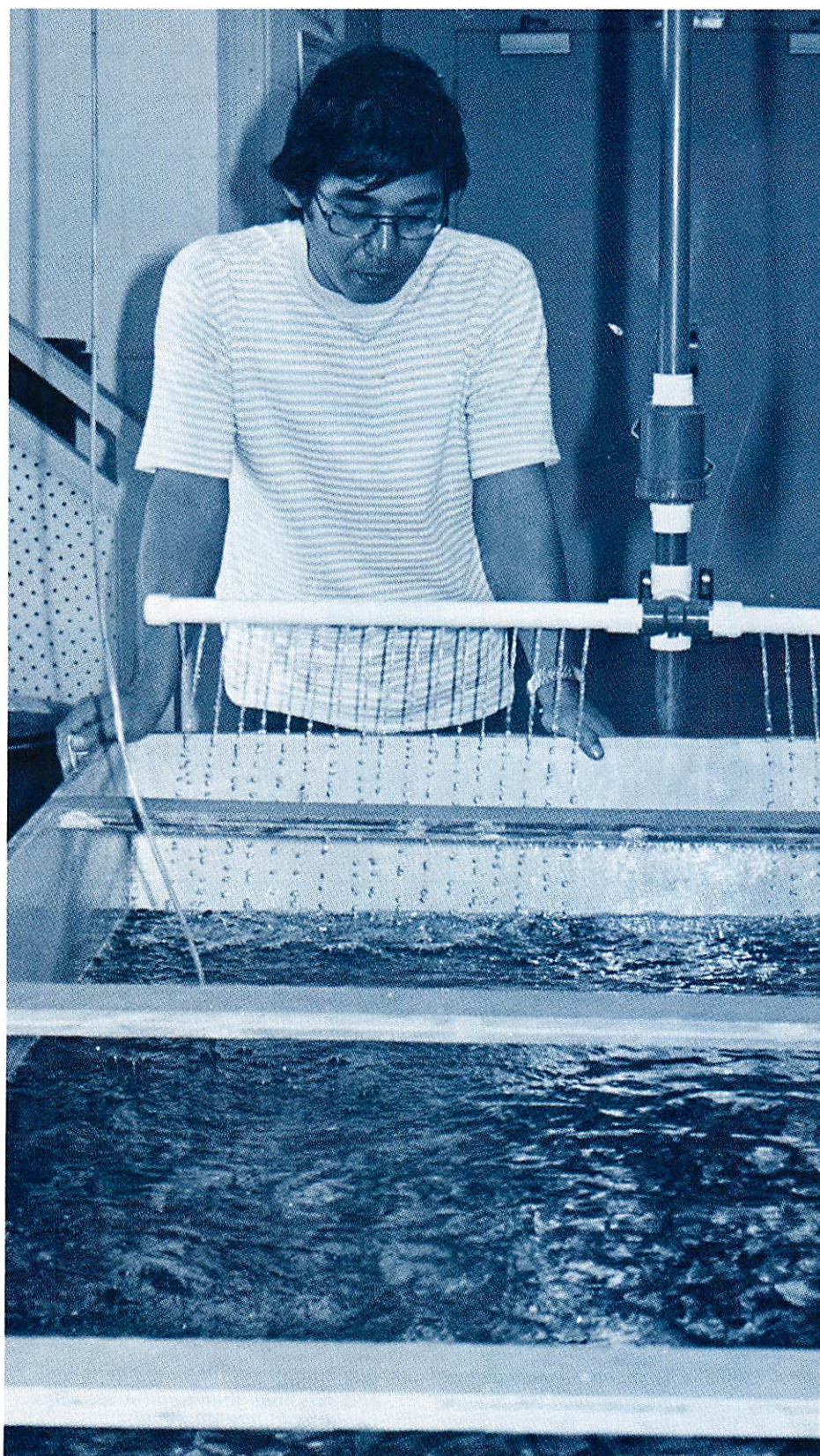


TABLE 5. HIMB/SEA GRANT RESEARCH BY SPECIES, YEAR, FUNDING, AND SOURCE

	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	
Species:									
Omaka									
Yellow Ulua									
Moi									
Mahimahi									
Kumu									
Rabbit Fish									
Baitfish									
Japanese Yellowtail									
Opihi									
Octopus (Day and Mexican)									
Penaeid Shrimp									
Malaysian Prawn									
Brine Shrimp									
Samoa Crab									
White Crab									
Japanese Clam									
American Oyster									
Green Sea Turtle									
									Total
Funding (dollars):									
Federal (Other)	--	--	--	--	--	--	--	--	--
NOAA Sea Grant	42,900	53,600	119,500	124,700	272,900	209,700	210,000	268,100	1,301,400
State	22,500	72,400	136,000	117,600	163,900	99,700	126,100	134,400	872,600
Private	--	--	--	--	--	--	10,000	3,600	13,600
TOTAL	65,400	126,000	255,500	242,300	436,800	309,400	346,100	406,100	2,187,600

Indicates work was in progress during a particular year.

Source: Corbin, John S. 1976. *Aquaculture in Hawaii: 1976*. Department of Planning and Economic Development, State of Hawaii. p. 36 (cited as Table III in the report).

The Anuenue Fisheries Research Center (AFRC) of the Hawaii Department of Land and Natural Resources began cultivation studies of *Macrobrachium rosenbergii* in 1965 and their program was well underway when University of Hawaii researchers funded by Sea Grant entered the animal research arena in 1968. During this early stage, university researchers limited their study of *Macrobrachium* to nutritional requirements, particularly the amino intake of the prawns.

The second phase, with focus on *Macrobrachium*, began in Year 09. The research site shifted from the HIMB laboratory at Coconut Island to the Sand Island laboratory of AFRC. The university researchers joined state personnel to closely coordinate their efforts. AFRC personnel answered immediately problems of pond management, propagation, water quality, etc., and the university researchers dug into areas which were more basic and required long-term study. Sea Grant and state funds were used to develop a study program which

included the analysis of prawn behavior, establishment of genetic broodstock of prawns obtained from several areas in Malaysia and Southeast Asia, basic productivity of ponds, and nutritional requirements of the prawns at various stages of growth. Development of hardware—pond aerator, harvester, and feeder—was also done and basic plans turned over to a commercial firm for further refinement.

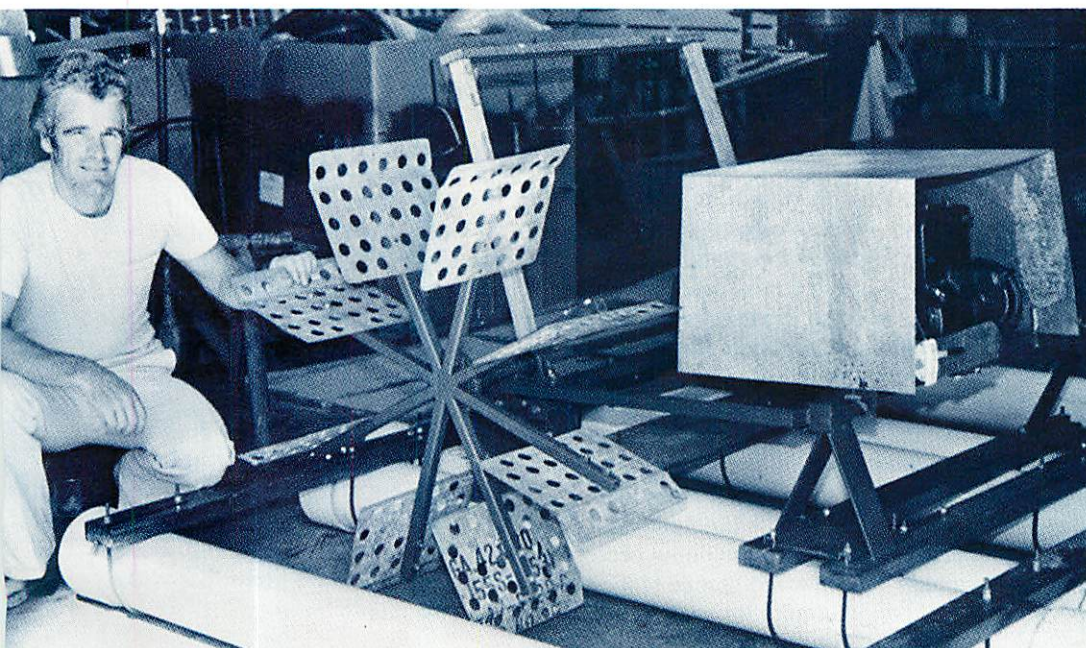
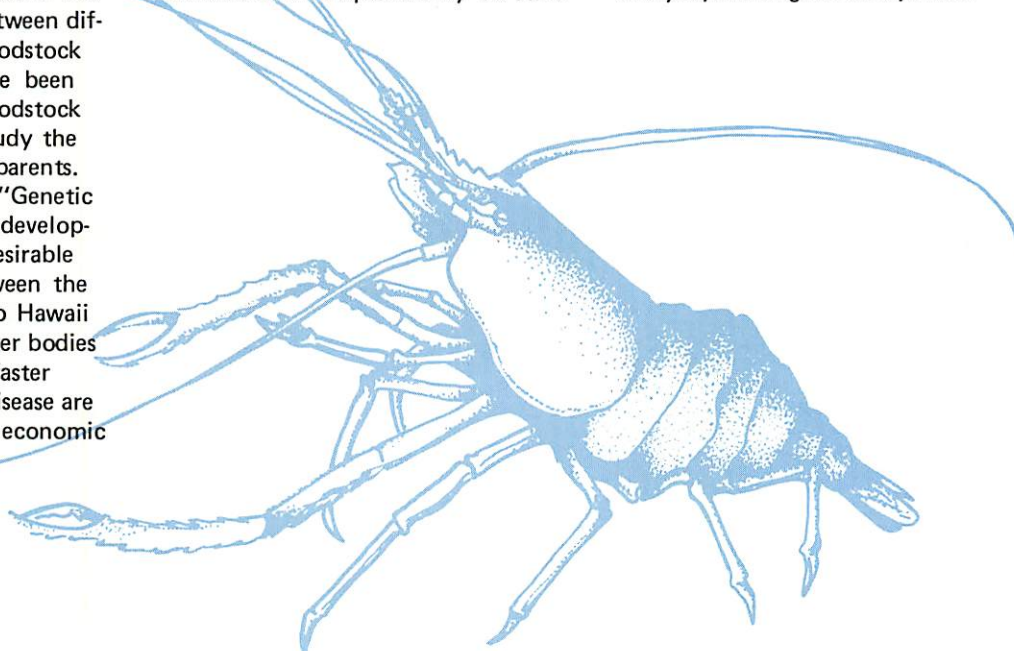
Macrobrachium rosenbergii

The Sea Grant-supported research on *Macrobrachium* has had measurable success, especially in the development of new genotypes from indigenous species obtained from several Southeast Asian countries. At the end of two years, Sea Grant Years 10-11, researchers obtained 64 successful live hatches of which 13 were between different stocks. Parental broodstock and hybrid broodstock have been established. The hybrid broodstock will enable researchers to study the genetic dominance of the parents.

The overall goal of the "Genetic Improvement" project is the development of an economically desirable animal through crosses between the various specimens brought to Hawaii for testing. Such traits as larger bodies in relation to head size, faster maturity, and resistance to disease are among those which will have economic payoff.

On an ongoing basis, the information which is being generated by Sea Grant researchers is stored in a computer data bank. Prawn farmers and other individuals, state, local, and federal agencies, and foreign countries are provided information upon request. The data bank is operated by the state

fisheries research center in cooperation with Sea Grant. Information provided by Sea Grant researchers include data on pond productivity determinants, postharvest handling and processing techniques, behavior and biology, genetic improvement, economic analysis, and engineered systems.



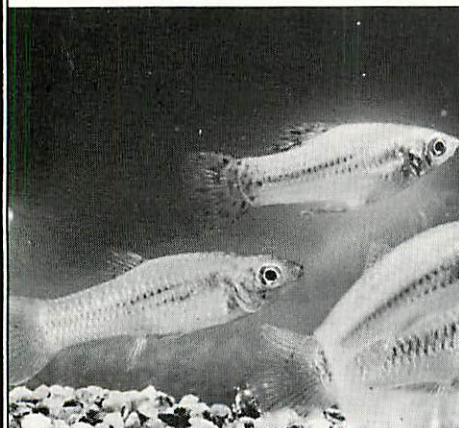
**ADULT
MACROBRACHIUM
ROSENBERGII**

**FULL-SIZED
PADDLE-WHEEL-TYPE
AERATOR FOR USE
IN HAWAIIAN
PRAWN PONDS**



**HARVESTING SKIPJACK USING
POLE-AND-LINE METHOD**

ADULT TOPMINNOW



Baitfish Culture

Because the inadequate and undependable supply of baitfish limits the capability of Hawaiian fishermen to harvest skipjack, the culturing of alternative baitfish is an important aspect of aquaculture in Hawaii. Attempts to introduce other baits over the previous decade have met with little success. Species considered included tilapia, threadfin shad, and California anchovy. The culture of hardy topminnows as baitfish was begun in Year 08. Local fishermen have traditionally preferred the short-lived and over-fished Hawaiian anchovy, nehu (*Stolephorus purpureus*). The topminnow program recognized that acceptance of a viable bait would require sea trials as well as a successful culture program. State and

county agencies bore the brunt of the financial burden for culture and sea trials. Sea Grant's contribution largely revolved around scientific assistance. Culture and sea trials were conducted in American Samoa during the summer of 1978 and in Maui in 1979. The results in Samoa appeared to be satisfactory, and hence, there is some interest in Samoa in culturing topminnows. While the culture program succeeded on Maui, sea trials gave marginal results with nehu still a more successful baitfish than cultured topminnow.

The four-year study of topminnows and the unimpressive sea trials have shifted attention to the Mexican topminnow.

Tropical Marine Agronomy

The long-term research and development program to study the feasibility of seaweed aquaculture, begun in Year 01, is unique in its holistic approach. Researchers have investigated the available sites in Hawaii, using such criteria as coastal areas which are not suitable for farming and sites which were used for aquaculture by ancient Hawaiians. The ecology and physiology of native algae, *Hypnea* spp., *Gracilaria* spp., *Dictyopteris* spp., and others, were studied and pilot production of these species were successfully accomplished. Aging and destruction of farm units by turbulence were noted as problems.

The program was expanded in Year 02 to encompass the development of family farming in the Philippines to test small-scale production of *Eucheuma* spp., which produced carrageenans, a commercially valuable substance used in the manufacture of a multitude of goods ranging from tires to lipstick to time-release cold capsules. Other field studies were conducted in the Trust Territory of the Pacific Islands and the Indian Ocean. At the same time, assay methodologies were developed to test the extracts of various species. The third area of study was the batch production of phytoplankton species which were considered to have some potential as food in the pond culture of marine organisms.

THALLUS OF
EUCHEUMA STRIATUM
WEIGHING OVER
5 KILOGRAMS



A COMMON
FORM OF
EUCHEUMA
SPINOSUM



By Sea Grant Year 07, over 100 tons of cultured *Eucheuma* were exported from the Philippines and Indonesia. Assays of the farmed crop indicated that it was of higher quality than the wild crop and the sale price of the former was double that of the latter. With the increase in production, processing methodology has been studied to extend storage time without deterioration. "Washing" processes developed by researchers doubled the value of the seaweed. It was also found that drying caused 84 to 87 percent weight loss so that one ton dry weight was equivalent to 7 or 8 tons wet weight. Optimum water content to maintain high quality of the seaweed was also explored.

With the successful production of *Eucheuma* in the Philippines, where monthly export exceeds 1,000 tons to processors, and the development of farm management procedures, Sea Grant assistance to this area was largely phased out. Interest in field studies shifted to the western Pacific in Year 08 when Sea Grant funded the development of small-scale farming of seaweeds in Ponape, the Trust Territory. Initial problems included the small test patch being decimated by grazing fish. The new, larger planting in Year 11 has more successfully withstood grazing.

Seaweed cultivation can be an important source of cash income for Pacific island trust territory peoples. Since the production, harvesting, and drying processes for *Eucheuma* are similar to that for copra, the simple organizational structure needed to sustain a family-based industry in Ponape is already present. The long-term commitment of the Ponape people to the development of an industry remains to be seen. With the surrounding sea as their only exploitable resource, other independent Pacific island nations have expressed interest in the culturing of seaweed. Since the criterion of an existing infrastructure is vital to the establishment of a new technology, the cultivation of seaweed is several levels above even that of animal aquaculture in terms of feasibility in most of these islands.

A coldwater strain of *Eucheuma* was successfully cultured in Kaneohe Bay, Hawaii on a pilot scale. Although several attempts have been made to establish commercial seaweed farms in Hawaii, institutional and environmental constraints have thus far thwarted such attempts. While these restrictions make the economic payoff questionable for Hawaii, the development of seaweed farming in the Philippines and Indonesia has indirectly supported American processors. Researchers

estimate that more than double the value of the total Sea Grant expenditure for seaweed research (\$.75 million) is imported annually from the areas where farming was developed under the UH Sea Grant College Program. The estimated current export of dried seaweed is 15,000 tons per year as compared with the sporadic supply which was foraged from the ever-decreasing wildstock about 10 years ago. The establishment of an industry in the Trust Territory will hopefully provide American industry with a still more stable supply source. The frequent political upheavals in the hinterlands of the Philippines have often interfered with the delivery of the seaweed.

Eleven publications were produced and nine Ph.D. and two master's degree students were involved in various aspects of this program. A graduate-level course, Botany 651, "Marine Agronomics," was also developed by the principal investigator and others.

NORTHWESTERN HAWAIIAN ISLANDS FISHERIES INVESTIGATIONS

This major research program was initiated in Year 11 to facilitate the development and management of NWHI resources. The initial program included eight studies ranging from assessment of top and bottom fisheries to the study of the primary and secondary productivity in the offshore waters of the Hawaiian Archipelago. The Sea Grant-funded effort complements a tripartite (tri-agency) effort of the state of Hawaii, the U.S. Fish and Wildlife Service, and the National Marine Fisheries Service to monitor and make stock assessments.

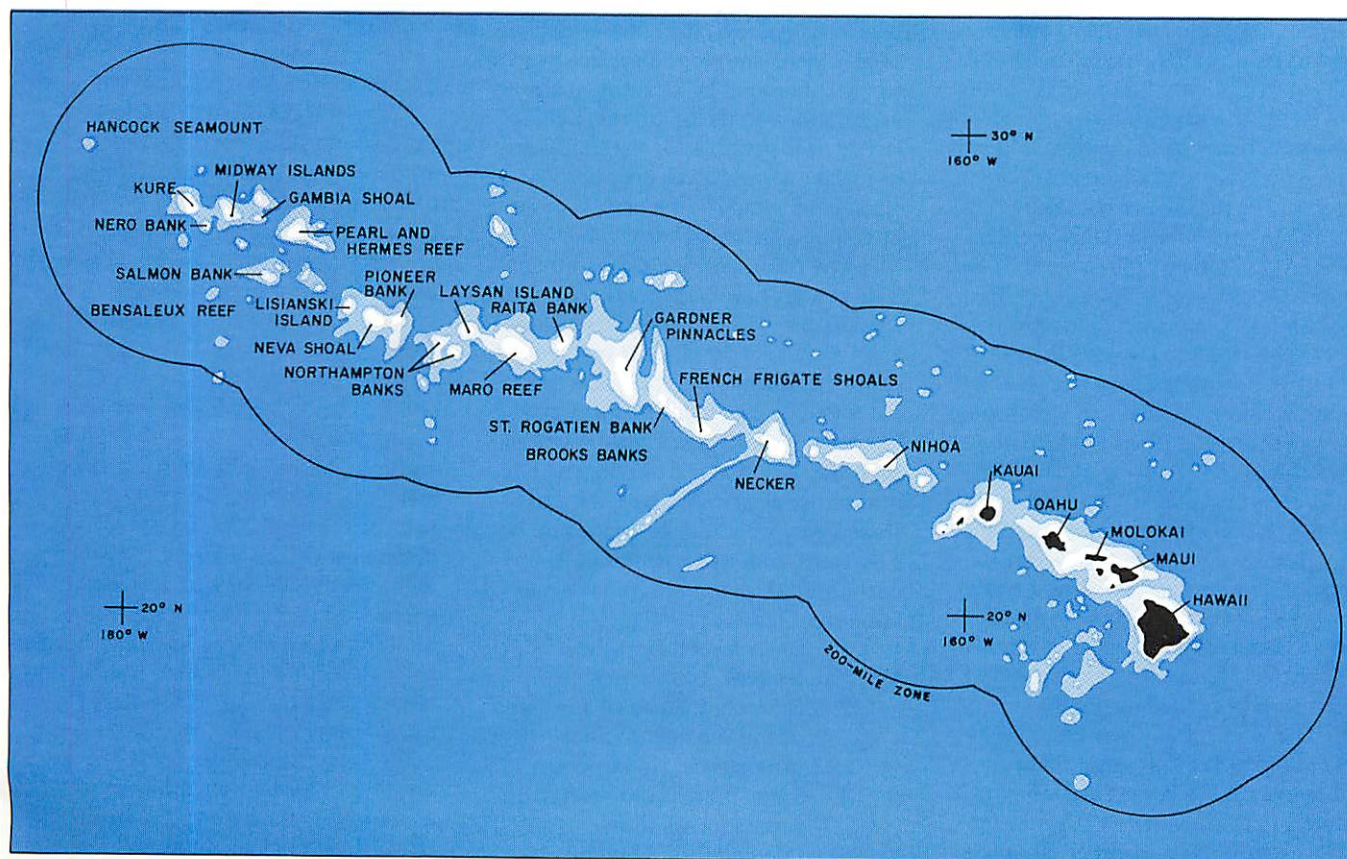
The NWHIFI program is specifically designed to provide information to fill gaps in the research conducted under the tripartite study. The several

activities which were begun in Year 11 will continue beyond the Years 08-11 quadrennium. Other activities will be added as resources become available.

Preliminary information has been regularly provided by Sea Grant researchers to the Western Pacific Regional Fishery Management Council and has been incorporated into fisheries management plans. An ecological model (DYNUMES) is being developed by NMFS to provide decisionmakers with a management tool to assess the impact of the absence or overabundance of a major species on the ecosystem. The Sea Grant studies are providing much of the new data needed for the DYNUMES model.

It is too early to judge the total impact of this activity on the economic and institutional structures of the state and the federal agencies. However, the importance of the preliminary data is already evident in their ready utilization by state fisheries planners, the Western Pacific Regional Fishery Management Council, and the National Marine Fisheries Service.

HAWAIIAN ARCHIPELAGO



SOCIOECONOMIC AND LEGAL STUDIES

The proliferation of man-made structures and systems which have been developed to support an advanced technological society will continue to tax land-sited resources at ever-increasing rates. In addition, the unstable political conditions of the world, especially in less developed countries which have the large deposits of scarce metals needed to support industrial societies, have enhanced the unreliability of these vital supply sources.

These conditions, as well as others, have given ample reasons for explorations of the non-living resources of the oceans and the development of engineered systems to harvest or harness these resources. Further, current technology and the high costs of energy production have made ocean mining less expensive and environmentally more attractive than its land-based counterpart. As ocean-based activities accelerate, however, issues of capital costs, jurisdictional boundaries, ownership of resources, and environmental impacts will arise and increase in direct proportion to the level of development, especially of the deep seabed resources.

While the international conferences on the Law of the Sea have been convened to resolve questions of boundaries, ownership, and governance of international waters, as yet no definitive negotiated text has emerged from the three conferences which were convened under the auspices of the United Nations. As long as an internationally acceptable convention is lacking not much progress toward the establishment of an industry can be expected beyond experimental trials. The requirement of large capital outlay demands the existence of an internationally acceptable regime of ownership of seabed resources.

The void left by the absence of international laws is being filled by unilateral and bilateral agreements between governments on the management of fisheries and other resources

which may well set precedence. The impact of these agreements on institutions, national legal frameworks, and the environment has been studied under Sea Grant funding. These and other studies indicate that even with a Law of the Sea treaty, the number of unresolved problems will grow almost on a daily basis, particularly those related to ocean energy.

The roles of multinational corporations (MNC) vis-a-vis less developed coastal countries (LDCC) were studied as they related to options for interaction. Obviously, one would be that of adversaries. However, if this stance is assumed by the LDCC or the MNC, nothing is to be gained by either, according to the Sea Grant study. Instead, a synergistic relationship is called for. While it would appear that the LDCC would be at a disadvantage in bargaining, the competitiveness of the MNC among themselves need to be considered as a factor in the negotiations in favor of the LDCC. Hence, it is possible for the LDCC to negotiate a resource development agreement which is favorable to its interest by judicious bargaining.

The results of Sea Grant-funded legal studies have been focused in the Law of the Sea Institute (LSI) since Sea Grant Year 10 when it was moved from the University of Rhode Island to its Pacific domicile. With the shift in siting has also come a shift in the programmatic focus from domestic to international arenas. Over the past three years, conferences sponsored by LSI have addressed issues at the cutting edge of international ocean-related problems:

1. Deep seabed workshop (Hawaii, USA)
2. Neglected issues of the Law of the Sea negotiations (The Hague, Netherlands)
3. State practices in zones of special jurisdiction (Mexico City, Mexico)

Future conferences and workshops are projected for Europe and Asia. Two hardcover books have been published as the proceedings of the first two conferences (1 and 2 above).

Each conference has been attended by international scholars and thinkers who comprise the brain trust in all aspects of international law and, hence, in a non-political forum, the basic issues and positions underlying Law of the Sea negotiations are played out. The significant impact of these conferences is the opportunities scholars have of interacting and thinking through ideas which will in all likelihood be incorporated into the negotiating documents of their countries. The long-term value of this tandem non-binding, non-political forum for discussion cannot fully be ascertained at present, but immediate and direct benefits are already evident in the wide use of the proceedings of the conferences by many governments.

The shift in programmatic emphasis from domestic to international was in the fullness of time and the location of LSI in Hawaii. Funding and other support from foreign governments and private industry have been measures of the usefulness and perceived need for LSI in national and international spheres. The goals of LSI, to bring together participants from both East and West to discuss timely and pressing issues on marine law and policies and to publish the proceedings of the meetings, have had impact beyond the halls of academe. The thoughts of the distinguished scholars who participated in the workshops and conferences have been channeled through the published proceedings to universities, official negotiating teams, and other bodies of state. The academic forum for considering basic questions and developing alternative solutions to existing or potential problems will encourage continuing dialogue between nations in the global arena.

MARINE TECHNOLOGY RESEARCH AND DEVELOPMENT

HUMAN PERFORMANCE IN THE SEA

The influence of studies begun in 1968 and conducted by the University of Hawaii Sea Grant researchers on the physical effects of the hyperbaric environment on human beings has extended beyond the bounds of Hawaii and the United States. Four Japan-Hawaii cooperative dry saturation dives have been held, the last in cooperation with the State University of New York at Buffalo and the Japanese Marine Science and Technology Center (JAMSTEC) in late summer 1979 in Japan. Two of the earlier dive studies were conducted in Hawaii.

In addition, researchers have published two monographs and numerous journal articles, conference papers, and reports. Based on new data, a revised decompression schedule was published for commercial diving. Currently, work is proceeding on the development of computer programs to calculate decompression profiles for human beings.

From the initial broad-based program, studies have focused on two areas during Sea Grant Years 08-11. The physical formation of gas bubbles, which cause the dreaded exogenous gas bubble disease, is being studied by a team of medical doctors and a physicist. The gelatin model devised by a University of Hawaii Sea Grant researcher in 1974 is being refined and subjected to pressures which are greater than the initial compression or crushing pressure to study the formation of gas bubbles.

The second area of focus is the physiological aspect of the effect of the hyperbaric environment on human beings. Surrogate experiments are being conducted with rats and dogs, the former in awake condition to test qualitative methodologies for measuring oxygen intake as a function of "work" condition. In another aspect of this study, large rats were implanted with a Doppler probe to test the feasibility of using this methodology to detect bubbles *in vivo*. Each saturation pressure level was maintained for one hour then the chamber in which the rat was kept was rapidly decompressed to a reduced pressure. The animal was observed and the Doppler flowmeter monitored. This routine was repeated until the threshold for bubble formation was detected.

Most recently, "work" conditions have been simulated successfully using 2,4-dinitrophenol. It was found that the drug induces the activation of a reflex loop in respiratory control as indicated by rise in respiratory rate, tidal volume, and minute ventilation. Heart rate increased simply as a function of body temperature.

The high incidence of bone necrosis found among Hawaiian divers has been the price paid for not adhering to diving tables. Because this form of diving disease is not readily apparent to the diver, it is all the more devastating. Sea Grant researchers discovered that nearly all Hawaiian commercial divers suffer from this disease. This knowledge triggered a series of workshops, conducted in cooperation with the Sea Grant College Marine Advisory Program, to inform divers of the disease and the dangers of not adhering to the safety margins within the diving tables.

While more than 20 scholarly papers produced by researchers is the hallmark of the academic quality of these studies on human performance in the sea, the statewide extension-advisory activities of the researchers have furthered the outreach to both divers and physicians to understand and recognize the symptoms of the "bends."

Researchers have also been involved in the establishment of decompression chambers in neighbor island counties in cooperation with the UH Sea Grant College Marine Advisory Program, the Office of the Marine Affairs Coordinator, and local physicians.

ENGINEERING SYSTEMS AND STRUCTURES

The impact of engineering studies, especially if hardware is developed, is rather easy to measure. The results of such research as the wave force as it travels over shallow reefs, or the inundation brought on by tsunamis, or wave force on submerged pipes, or the ocean thermal energy conversion (OTEC) exchanger biofouling, or underwater reconnaissance studies, however, provide very basic information to larger programs or to scientists or professional users. Hence, these efforts cannot directly be evaluated for their use by or impact on society-at-large. Their benefits accrue indirectly in the reduction of costs of engineered systems and structures by eliminating overcompensation of the safety factor which is wasteful or by developing trouble-free equipment.

The study of floating platforms to support such activities as energy generation or a self-contained living-working structure—a floating city—may have provided the basic design and engineering methodology for the development of the large oil rigs used in the North Sea. The initial thrust of the University of Hawaii study coincides with the concept-design stage of the rigs. A series of seminars sponsored by Sea Grant and the University of Hawaii Department of Ocean Engineering brought together major researchers of floating structures to Hawaii.

Direct credit for the basic design of the Japanese-built *Aquapolis* has been given to University of Hawaii Sea Grant researchers. The *Aquapolis* was one of the many lavish components of the Japanese *Expo '75*. The structure, while of prototype scale, was the concrete and steel reality of the engineering feasibility studies done by Sea Grant researchers. It seemed in the early 1970s that the United States appeared to be moving toward greater awareness of the potential of ocean engineering. This proved to be a

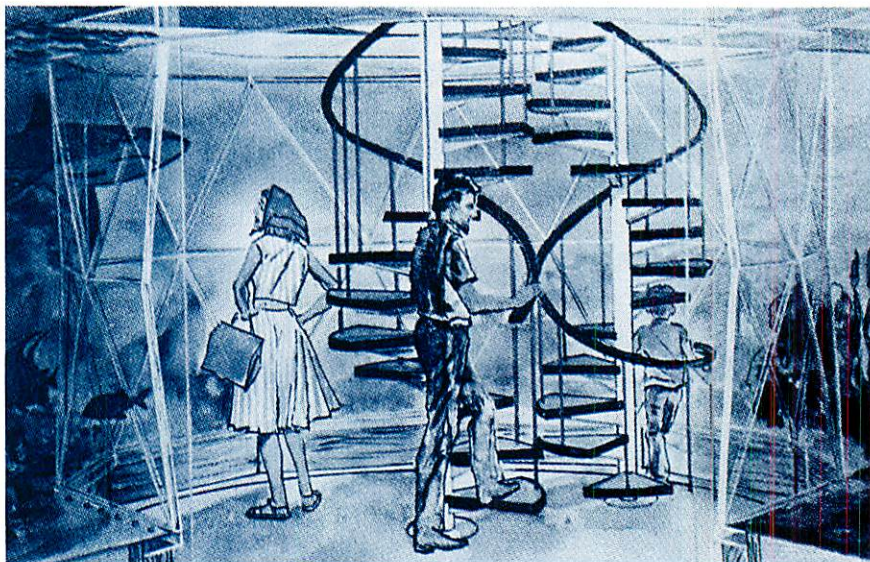
short-lived dream as federal and other funding cutbacks, triggered by recession, precluded the actual building of stable floating structures in the United States.

The absence of existing public or private infrastructures, which utilize floating platforms, makes the immediate use of the findings of this research effort unlikely. However, as coastal lands continue to rise in value, the emplacement of industries at offshore sites will increase.

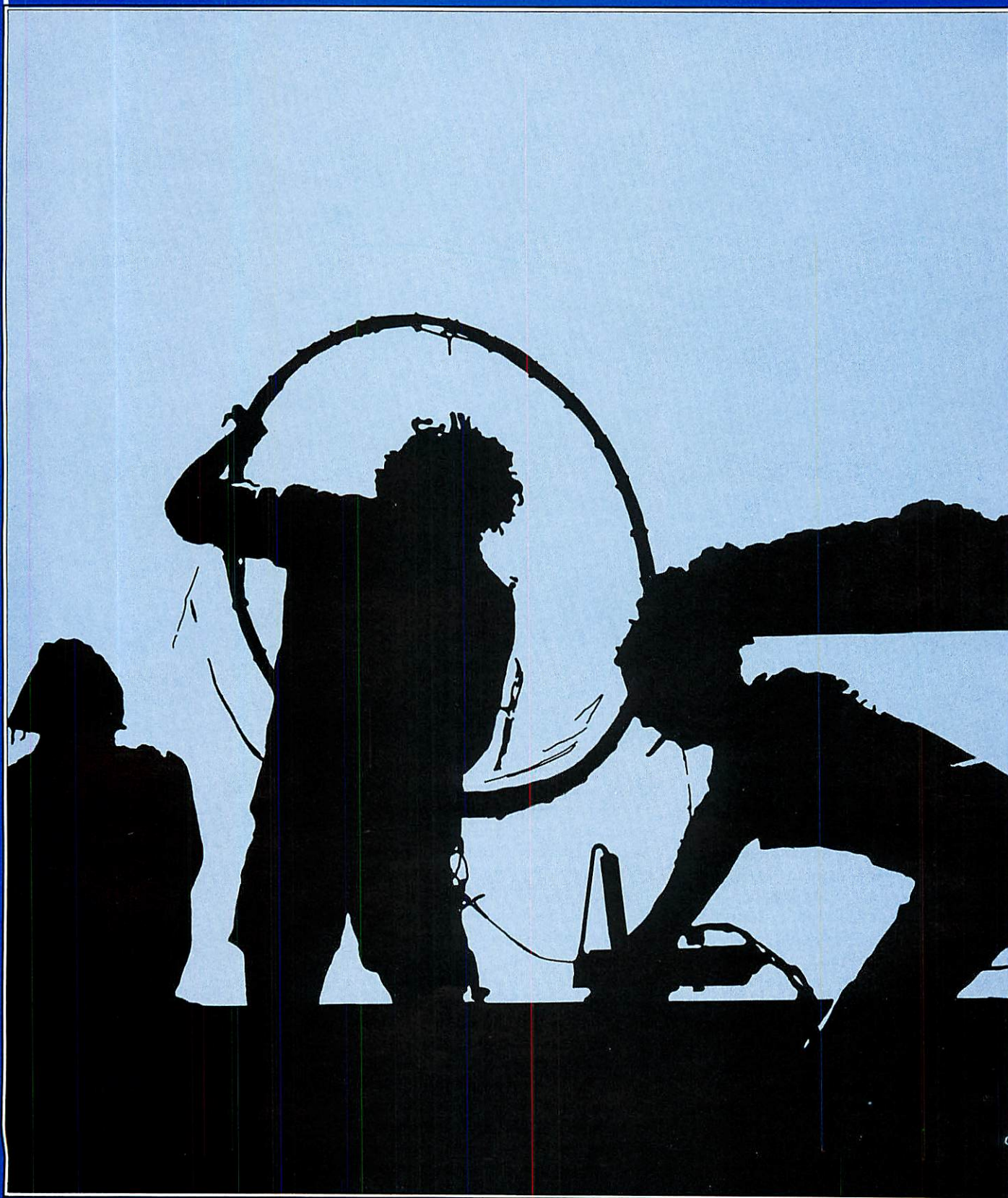
One of the most innovative engineered structures developed with Sea Grant funds is a polyhedral cylinder which has been proposed as an aquarium for the County of Hawaii. The design and development stages were begun prior to Year 08 and continue beyond the four years covered by this report. The polyhedral structure is constructed of 47 clear triangular acrylic panels, which were bonded and baked, using a methodology that was devised by the researcher. Its unique pre-buckled configuration has the advantage of providing flat viewing surfaces without the optical distortion created by the curved surface of the perfect cylinder.

With the establishment of the aquarium on Hawaii, proposed for late 1980, the county will have a one of a kind in the aquaria world. It will enhance the county's school programs in marine education and provide the residents and tourists with a unique recreational facility. The aquarium is proposed as a joint project of the county, state, and Sea Grant College Marine Advisory Program.

INTERNAL VIEW OF
PROTOTYPE UNDERWATER
POLYHEDRAL CYLINDRICAL
STRUCTURE



EDUCATION





Of the \$1.06 million expended for educational programs during Years 08-11, \$.85 million was expended for projects targeted for lower education and the balance for higher education.

At the undergraduate level, the ongoing Marine Option Program has been upheld nationally for its innovative outreach in providing hands-on experiences to students through employment in governmental agencies and private industry involved in ocean-related activities. Sea Grant also provided seed monies to develop graduate and undergraduate courses in aquaculture and a graduate course in ocean engineering during Years 08-11.

The UH Sea Grant College Program was largely responsible for the advancement of Sea Grant into lower education. The Blue-Water Marine Laboratory (BML), a hands-on on-the-water program for high school students; Makahiki Kai (Festival of the Sea), a five-year traveling marine exhibit; marine science curriculum for secondary schools, a semester-long course; teacher in-service workshops in Hawaii and in the Marshall Islands; the annual secondary student symposium on marine affairs; and Ho'i Ana Ike Kai (Return to the Sea), a culture-based curriculum to motivate rural coastal native Hawaiian students in high school and an enrichment program for elementary students, are projects which have made an impact on the children of Hawaii.

MAKAHIKI KAI EXHIBITS ATTRACT ELEMENTARY SCHOOL STUDENTS

UNDERGRADUATE EDUCATIONAL PROGRAMS

The Marine Option Program (MOP) has been widely acclaimed for effectively providing undergraduates, no matter what their major area of study, with a marine orientation and practical experience.

A satellite program has taken root at Windward Community College to

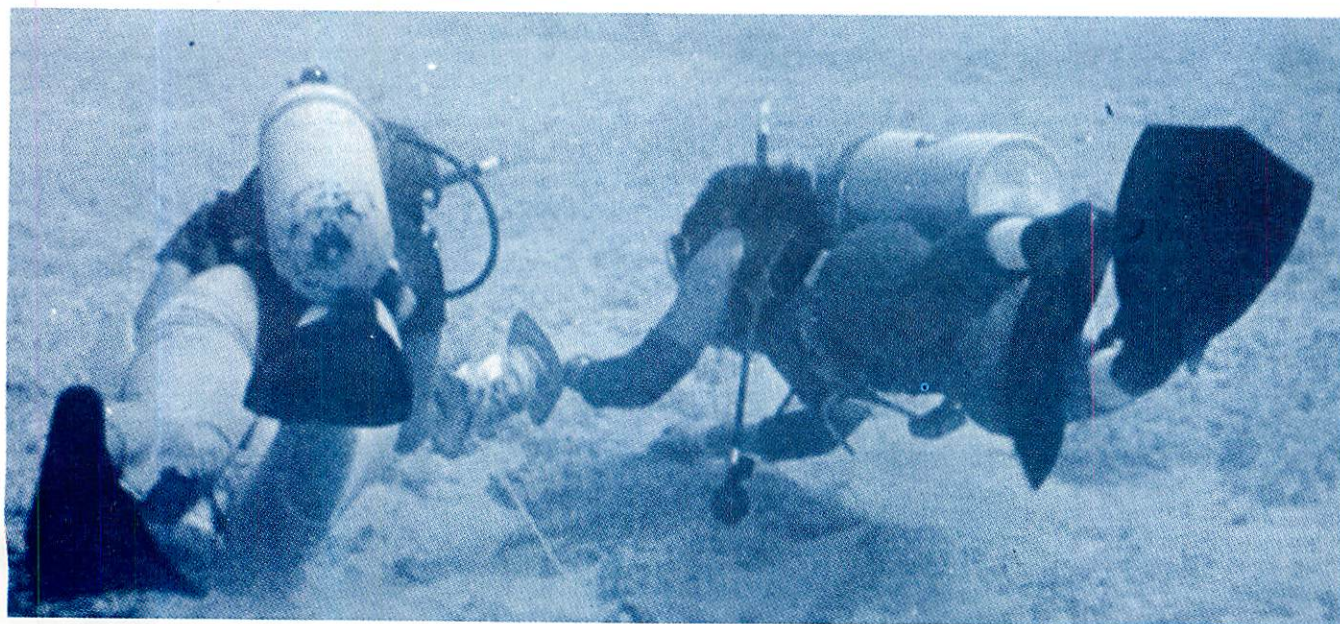
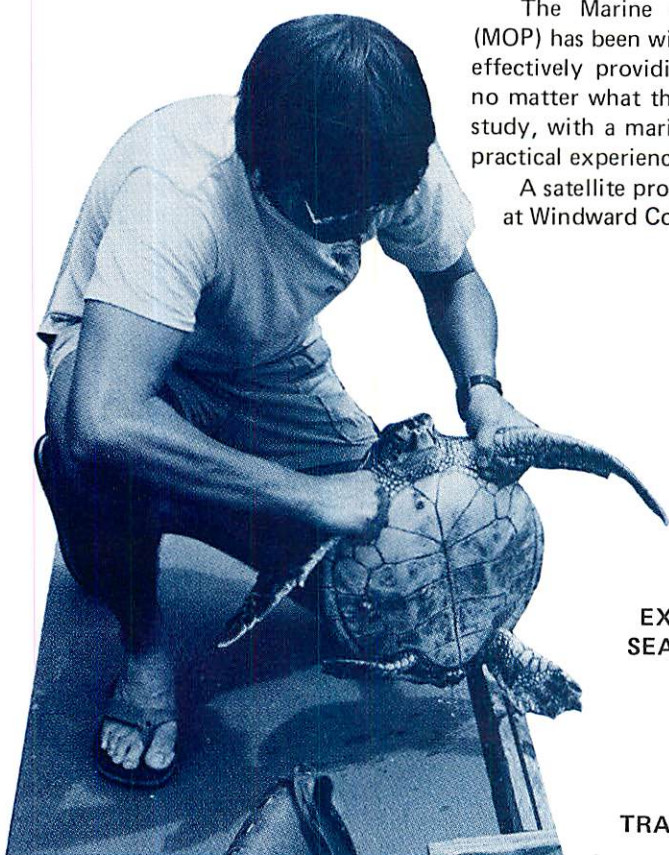
extend the student outreach from the Manoa campus. Attempts to establish the program on the various community college campuses and the four-year campus in Hilo, Hawaii have been unsuccessful to date.

MOP students have opportunities to participate in field work with faculty members or personnel of state and federal agencies. MOP students have successfully obtained funding from the National Science Foundation to conduct summer projects under the Student-Originated Studies program. This program is supervised by university faculty and have given undergraduate students field experience, such as underwater surveying, and the more significant data are contained in working papers published by the Sea Grant College Program.

"Graduates" of MOP have been hired by the aquaculture industry and federal, state, and county agencies. During the quadrennium, 405 students participated in the program activities and 103 students completed the required coursework and skills acquisition.

**MOP STUDENT
EXAMINING GREEN
SEA TURTLE (LEFT)**

**OTHER MOP
STUDENTS
CONDUCTING
UNDERWATER
TRANSECTS (BELOW)**



LOWER EDUCATION PROGRAMS

The theme of the Ho'i Ana Ike Kai project at the elementary level is "Polynesian Voyaging." The unit which has been developed was incorporated into the pilot school's fourth grade Hawaiiana curriculum. It features a simulated day-long "voyage" to Tahiti. The children sun-dry fish, potatoes, and fruit as part of the pre-voyage preparation. The program includes elementary-level studies on celestial navigation, physical oceanography, and marine biology. Students learn to weave coconut fronds to create utensils and shelter used during the "voyage." A follow-up fifth grade curriculum is also being developed. The curriculum materials, which have been developed by the teachers, will be evaluated after the second-year pilot tests and printed for general

distribution. The high school curriculum on "Polynesian Voyaging" and "Fishing in Hawaii" will be edited by a curriculum team during the summer and published for general distribution.

Dissemination of the unit and student evaluation are projected for the final year to test the attitudinal impact of the program and to validate the norms utilized to measure attitudinal changes of native children.

In terms of greatest total impact, perhaps Makahiki Kai, "Festival of the Sea," which reached not only students and teachers, but also the general public, is most wide ranging. Over a five-year period, Makahiki Kai exhibits were displayed in shopping centers, the Honolulu and Hawaii County exhibition halls, state and county fairs, schools, in various marine

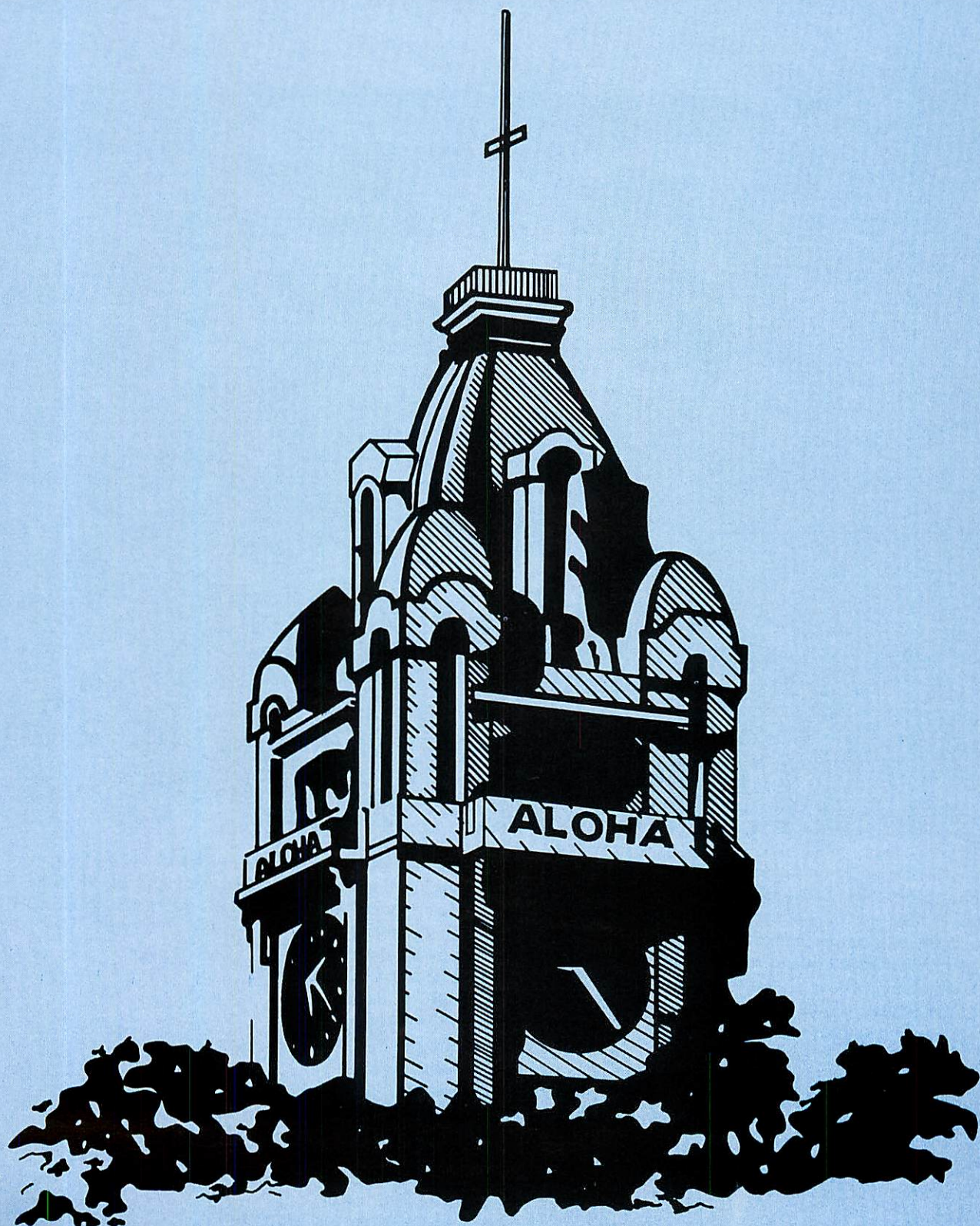
fairs, and in the Lyman Museum in Hilo, Hawaii. A rough estimate of total number of contact is .25 million individuals. To aid teachers in preparing students to fully benefit from Makahiki Kai, student workbooks and teacher guides were prepared. They have been widely distributed in Hawaii, the mainland, and the Trust Territory. Parts of the 1977 edition have been modified by the Palauans and included in their high school marine science curriculum.

The marine science curriculum for secondary students attracted national attention and established Hawaii as a leader in marine education. Workshops were conducted in Massachusetts and Hawaii by curriculum developers from the UH College of Education.



WAIANAE
HIGH SCHOOL
STUDENTS
PREPARE
TO SAIL THE
MO'OLELE

A D V I S O R Y S E R V I C E S





Nearly \$1.5 million was expended during the Years 08-11 quadrennium for marine advisory activities which expanded its outreach program in Year 08 to the neighbor island counties by establishing offices at four sites: Lihue, Kauai; Kahului, Maui; Kona, Hawaii; and Hilo, Hawaii.

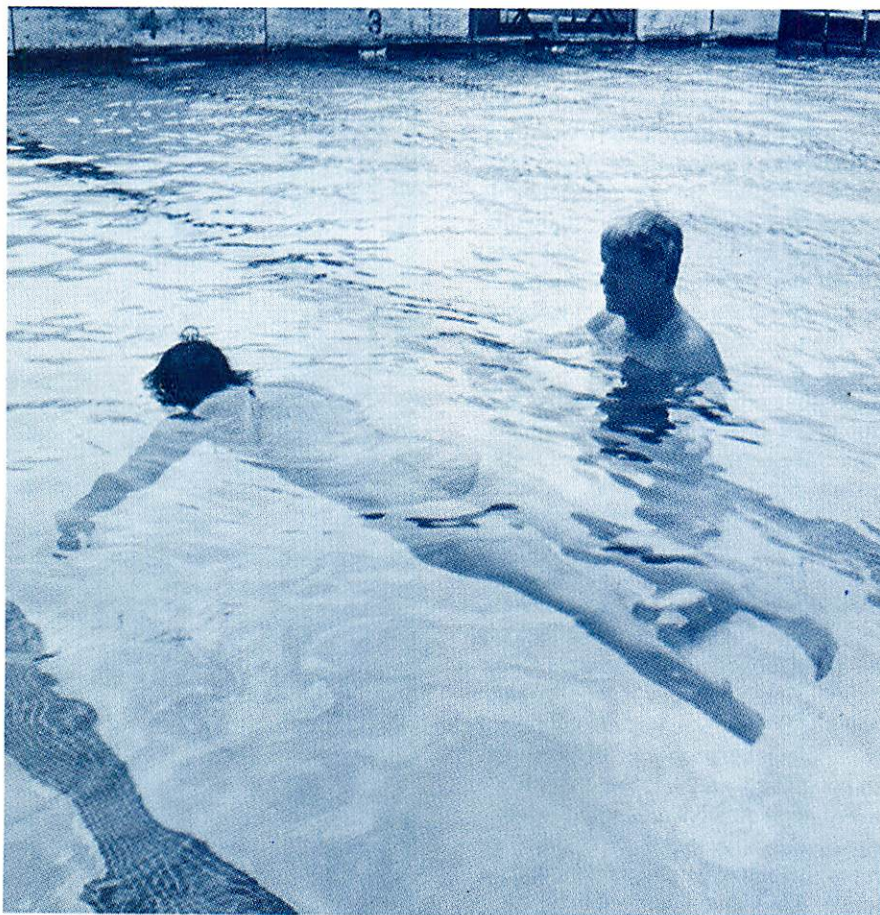
The program was expanded to Guam in Year 11 with the appointment of an agent attached to the University of Guam. Further expansion in the western Pacific is currently being studied for the siting of an agent in Western Samoa and the Northern Marianas.

During the quadrennium, site-specific programs were developed to meet local needs. The interest in prawn aquaculture on the island of Hawaii was met largely by the Hilo agent who provided information and advice on the feasibility of farming prawns on proposed sites. The agent produced a popular prawn cookbook. The large number of small boats along the lee coast of the island produces a demand for small-boat maintenance and small-scale fishing information. The Kona agent produced a nationally recognized series of pamphlets on small-boat maintenance and repair, fiberglassing, etc., which have become classics in their field.

**MAP AGENT (CENTER)
CONDUCTING BODYSURFING
CLINIC AT SANDY BEACH,
OAHU**

The desire of the County of Maui to develop its commercial fishing fleet was supported by the Maui agent through his involvement in the baitfish culturing program. Topminnows were cultivated for sea trials in summer 1978. The researcher who developed the technology with Sea Grant funding served as a consultant.

The County of Kauai apparently is equally balanced in its desire to develop and preserve its resources. Much of the Kauai agent's activity has been in the promotion of conservation of the natural resources through educational programs in local public schools and through lectures and workshops for the residents. He has, in addition, met the needs of the relatively large portion of the resident population, who are either small-scale commercial fishermen or weekend recreational fishermen, through workshops on postharvest handling and fishing technology (ika-shibi).



PRACTICING DROWNPROOFING
AT WORKSHOP FOR
SCHOOL TEACHERS AND
AQUATIC DIRECTORS

MAP AGENT INFORMING
YOUNGSTER THAT IN
HAWAII IT IS ILLEGAL
FOR ANY PERSON
BELOW THE AGE OF 14
TO FISH WITH A
SPEAR GUN UNLESS
ACCOMPANIED BY
AN ADULT

The large urban Honolulu marine clientele has been reached only to a limited extent through workshops and seminars. Sustained contact is achieved through the two newsletters: the *Hawai'i Coastal Zone News* and the MAP insert in the *Sea Grant Newsletter*. Slideshows, on such subjects as water safety and coastal flora, have been developed to promote public education. They are available for loan to any community group or school.

Other products of MAP efforts are numerous brochures and pamphlets which are given without charge to the general public upon request.

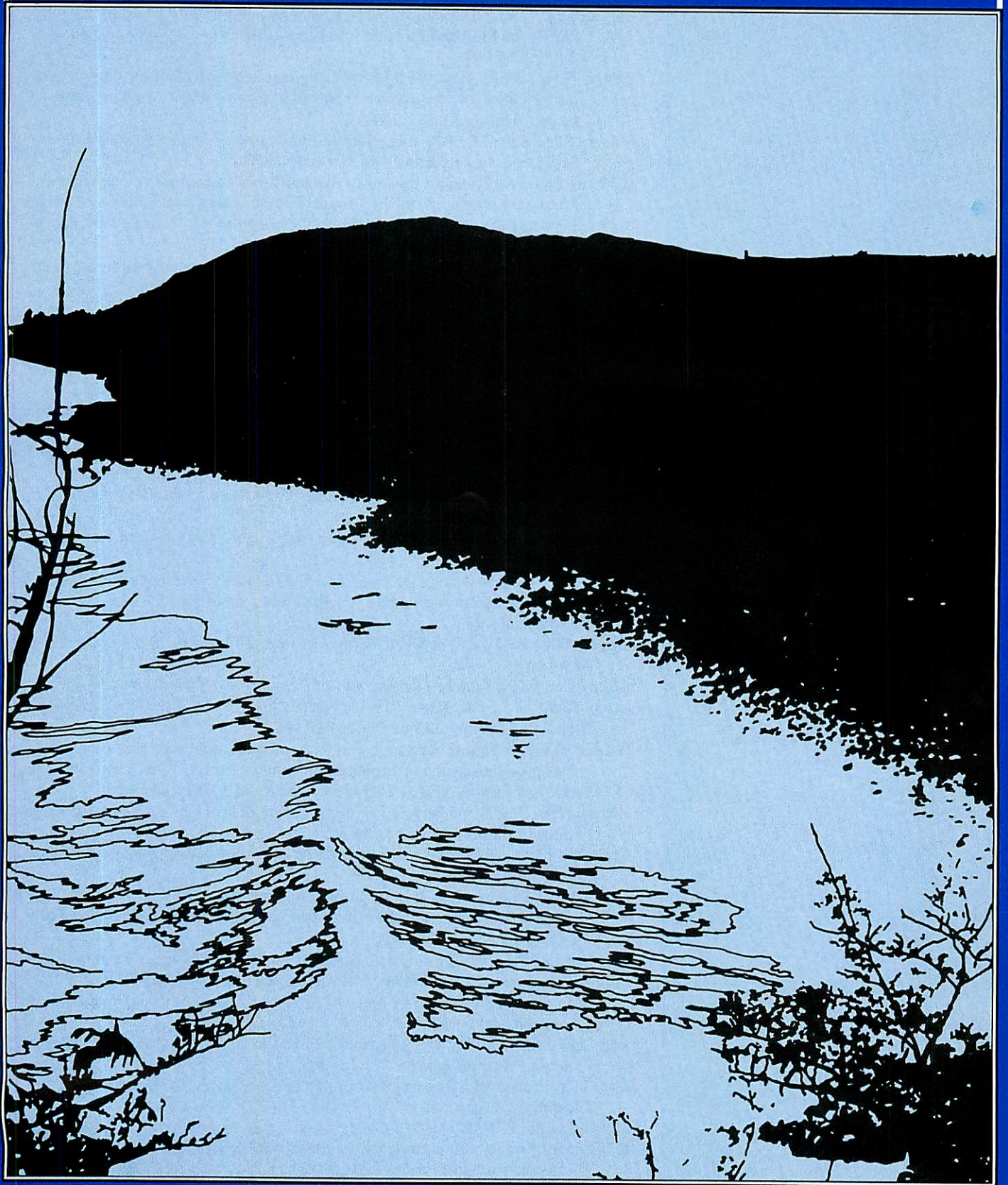
MAP information dissemination activity has been centralized in a marine resource center staffed by two part-time information specialists during Year 11. This center is located on the University's Manoa campus.

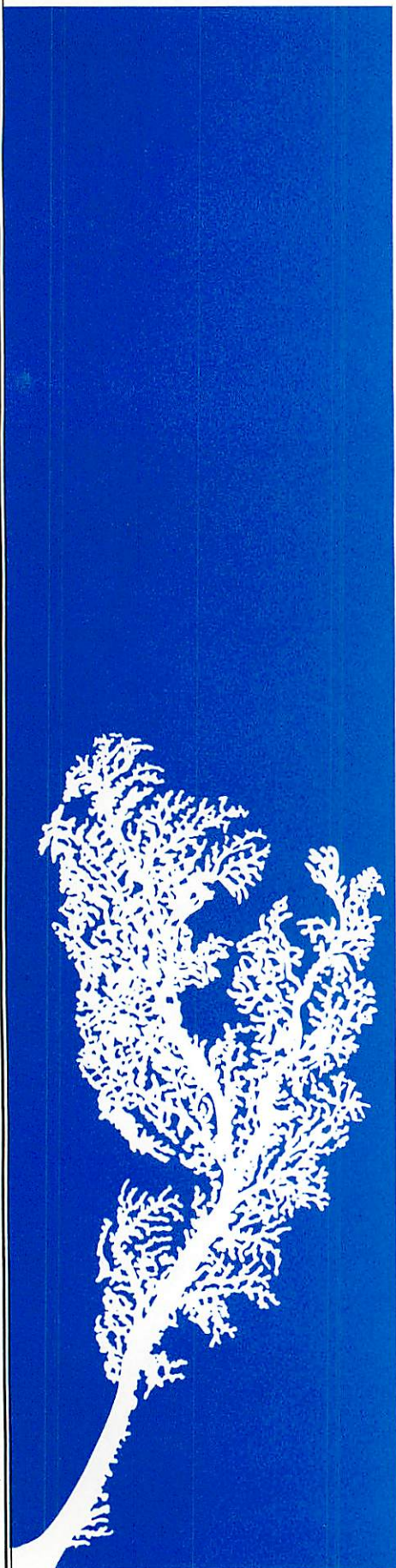
During Years 08-11, the Marine Advisory Program has attempted to emplace personnel in the counties to meet local needs. What is lacking is the place for advisory activities in the plan for marine resource development of the county governments which have the responsibility for setting such directions. The County of Maui is perhaps the only exception in the close-working relationship of the agent with the county government on the baitfish project. Areas of closer cooperation are currently being studied to enable MAP agents to mesh their activities with county priorities.



MAP AGENT IN ACTION
AT LIMU PRESSING
DEMONSTRATION

PUBLICATIONS





- Ahern, G. A. "Co-transport of glycine and sodium across the mucosal border of the midgut epithelium in the marine shrimp, *Penaeus marginatus*." *Journal of Physiology* 258:499-520.
- Ahern, G.A., L.A. Maginniss, Y.K. Song, and A. Tornquist. *Intestinal Water Ion Transport in Freshwater Malacostracan Prawns (Crustacea)*.
- Balazs, G.H. "A hawksbill turtle in Kaneohe Bay, Oahu." *Journal of the Hawaii Audubon Society* 38(11):128-129.
- Balazs, G.H. "Terrestrial critical habitat for sea turtles under United States jurisdiction in the Pacific region." *Journal of the Hawaii Audubon Society* 39(4):37-41.
- Balazs, G.H., and E. Ross. "Effect of protein source and level on growth and performance of the captive freshwater prawn, *Macrobrachium rosenbergii*." *Aquaculture* 7:299-313.
- Balazs, G.H., and G.C. Whittow. *Revised Bibliography of the Hawaiian Monk Seal Monachus schauinslandi Matschie 1905*.
- Baldwin, W.J. "A review on the use of live baitfishes to capture skipjack tuna, *Katsuwonus pelamis*, in the tropical Pacific Ocean with emphasis on their behavior, survival, and availability." *Collection of Tuna Baitfish Papers*. NOAA Technical Report, NMFS Circular 408.
- Berger, J.A., and L.R. Berger. "Studies to develop a colorimetric elisa test to assay ciguatoxin in fish tissue." *Rev. Int. Oceanogr. Med.* Tomes LIII-LIV: 23-32.
- Brock, J.A., R.M. Nakamura, A.Y. Miyahara, and E.M.L. Chang. "Tuberculosis in Pacific green sea turtles, *Chelonia mydas*." *Transactions of the American Fisheries Society* 105(4):564-566.
- Burzminski, M.J., Q. Fernando, and H. Zeitlin. "Extraction of copper and nickel from deep sea ferromanganese nodules." *Analytical Chemistry* 50:1177-1180.
- Coleman, D.E. *Phototactic Responses of Larval Macrobrachium rosenbergii (De Man)*.
- Comitini, Salvatore. *An Economic Analysis of the State of the Hawaiian Skipjack Tuna Fishery*.
- Dollar, Steven J. *Guide to Research Logistics in the Northwestern Hawaiian Islands*.
- Frank, D.J., M.A. Meylan, J.D. Craig, and G.P. Glasby. *Ferromanganese Deposits of the Hawaiian Archipelago*. Hawaii Institute of Geophysics, University of Hawaii, Honolulu.
- Gibson, Richard T., and Jaw-Kai Wang. *An Alternative Prawn Production Systems Design in Hawaii*.
- Grigg, Richard W. *Fishery Management of Precious and Stony Corals in Hawaii*.
- Grigg, R.W., and F.M. Bayer. "Present knowledge of the order Gorgonacea in Hawaii." *Pacific Science* 30(2):167-175.
- Herrick, S.F., Jr. "Some economic and technological aspects related to commercial production of the topminnow *Poecilia vittata*." *Collection of Tuna Baitfish Papers*. NOAA Technical Report, NMFS Circular 408.
- Huang, W.Y., J.K. Wang, and T. Fujimura. "A model for estimating prawn populations in ponds." *Aquaculture* 8:57-70.
- Iwai, Thomas Y. *A Preliminary Investigation of Oxygen Consumption of Macrobrachium rosenbergii*.
- Lee, J. H., J. Gilje, and H. Zeitlin. "Low temperature interaction of sulfur dioxide with Pacific ferromanganese nodules." *Environmental Science and Technology* 12(13):1428-1431.
- Lee, J.H., J. Gilje, H. Zeitlin, S.J. Kirchner, and Q. Fernando. "Sulfation of Ferromanganese Nodules: A Route to the Selective Separation of Some Economically Valuable Metals." *Chemical Marketing and Economics Preprints* :425-447.
- Leis, J.M., and J.M. Miller. "Offshore distributional patterns of Hawaiian fish larvae." *Marine Biology* 36:359-367.
- Magruder, William H. "The life history of the red alga *Ahnfeltia concinna* (Rhodophyta, Gigartinales)." *Phycologia* 16(2):197-203.
- McVey, James P. *MMDC-HIMB Cooperative Aquaculture Program: Final Report*.
- Miller, J.M. "Nearshore abundance of tuna (Pisces: Scombridae) larvae in the Hawaiian Islands." *Bulletin of Marine Science* 29(1):19-26.

SOCIOECONOMIC AND LEGAL STUDIES

MARINE ENVIRONMENTAL RESEARCH

- Oona, H., S.J. Kirchner, P.L. Kreson, Q. Fernando, and H. Zeitlin. "Thin carbon foils for the elimination of charging effects in proton induced x-ray emission spectrometry." *Analytical Chemistry* 51(2):302-303.
- Peebles, J.B. "A rapid technique for molt staging in live *Macrobrachium rosenbergii*." *Aquaculture* 12:173-180.
- Peebles, J.B. "The roles of prior residence and relative size in competition for shelter by the Malaysian prawn, *Macrobrachium rosenbergii*." *Fishery Bulletin* 76(4):905-911.
- Peterson, R.E., and K.K. Seo. "Thermal aquaculture." In *1977/8th World Mariculture Society Proceedings*.
- Ralston, S. "Age determination of a tropical reef butterflyfish utilizing daily growth rings of otoliths." *Fishery Bulletin* 74(4):990-994.
- Rao, Teegavarapu R. *Enhancement of Natural Populations of Moi (Polydactylus sexfilis) in Hawaii through the Release of Hatchery-Reared Juveniles: A Feasibility Study of Sea Ranching*.
- Santelices, B. "Taxonomic and nomenclatural notes on some gelidiales (Rhodophyta)." *Phycologia* 15(2):165-173.
- Santerre, M.T., and R.C. May. "Some effects of temperature and salinity on laboratory-reared eggs and larvae of *Polydactylus sexfilis* (Pisces: Polynemidae)." *Aquaculture* 10:341-351.
- Santos, G.A., and M.S. Doty. "IR studies on carrageenan of *Ahnfeltia concinna*, a marine red alga." *Journal of Pharmaceutical Sciences* 64(10):1704-1706.
- Scheuer, P.J. "Marine toxins." *Accounts of Chemical Research* 10(33):33-39.
- Siegel, S.M., and B.Z. Siegel. *Novel Approaches to the Use of Land Plants in the Sea*.
- Smith, A.C., and F.K. Hartley. "Keloid in the grey reef shark, *Carcharhinus amblyrhynchos*." *Pacific Science* 30(2):109-112.
- Stevens, H.C., M. Calvan, K. Lee, B.Z. Siegel, and S.M. Siegel. "Peroxidase activity as a screening parameter for salt stress in Brassica species." *Phytochemistry* 17:1521-1522.
- Struhsaker, Jeanette Whipple, Wayne J. Baldwin, and Garth I. Murphy. *Environmental Factors Affecting Stress and Mortality of the Hawaiian Anchovy in Captivity*.
- Wang, J.K., and J.S. Kuwabara. "Engineering analysis of prawn larvae culture." *Transactions of the ASAE* 19(6):1197-1200.
- Wang, J.K., and M.R. Williamson. "Automated prawn larvae/juvenile separation." In *Oceans '76 Proceedings*.
- Ward, Linda A. *Common Hawaiian Polychaete Larvae*.
- Zeitlin, H., S.J. Kirchner, J. Dyke, A.C. Stiff, and Q. Fernando. *Recovery of Metals from Deep Sea Ferromanganese Nodules*.

- Schmitt, Robert, Linda Luke, Edwina Yee, Robert Strand, and Carter Kearns. *The Hawaiian Archipelago: Defining the Boundaries of the State*.
- Wheaton, Elmer P. *National Attitudes, Goals, and Policies Regarding the Oceans*.

- Bathen, Karl H. *Circulation Atlas for Oahu, Hawaii*.
- Hall, Donald. *Use of Agricultural Chemicals and Factors Contributing to Their Transport to Estuaries in Hawaii*.
- Helfrich, Philip. *An Assessment of the Expected Impact of a Dredging Project for Pala Lagoon, American Samoa*.
- Kay, E. Alison, L. Stephen Lau, Edward D. Stroup, Stephen J. Dollar, David P. Fellows, and Reginald H.F. Young. *Hydrologic and Ecologic Inventories of the Coastal Waters of West Hawaii*.
- Kimmerer, William J., and Woodrow W. Durbin, Jr. *The Potential for Additional Marine Conservation Districts on Oahu and Hawaii*.
- Lau, L. Stephen, Philip C. Loh, and Roger S. Fujioka. *Pathogenic Enteric Viruses in the Hawaiian Ocean Environment Viability and Die-Off (Annual Progress Report No. 1)*.
- Maragos, James E., et al. *Environmental Surveys Before, During, and After Off-shore Marine Sand Mining Operations at Keauhou Bay, Hawaii*.
- McCain, John C., and James M. Peck, Jr. *The Toxicity of Selected Chemicals Used in Power Generating Stations to Hawaiian Fishes*.
- McCain, John C., James M. Peck, Jr., and Stephen L. Coles. *The Marine Biological Impact of the Honolulu Generating Station*.



- Beckman, Edward L. *Recommendations for Improved Air Decompression Schedules for Commercial Diving*.
- Bennett, P.B., ed. *Studies on Human Performance in the Sea: Vol. 2*.
- Black, Kerry P. *User's Guide to Programs Written for J.K.K. Look Laboratory Wave Transformation Project*.
- Bretschneider, C.L., and E.E. Tamaye. "Hurricane wind and wave forecasting techniques." In *Proceedings of the Fifteenth Coastal Engineering Conference, July 11-17, 1976, Honolulu, Hawaii*. Volume 1, Chapter 013.
- Bretschneider, C.L., and P.G. Wybro. "Tsunami inundation prediction." In *Proceedings of the Fifteenth Coastal Engineering Conference, July 11-17, 1976, Honolulu, Hawaii*. Volume 1, Chapter 060.
- Casciano, Frederick M. *Submarine Sand Recovery System: Keauhou Bay Field Test*.
- Collier, Jeanne M., Stephen B. Ribakoff, and Guy N. Rothwell. *Hawaii's Floating City Development Program: Transportation Aspects of Offshore Complexes*.
- Dressendorfer, R.H., J.F. Morlock, D.G. Baker, and S.K. Hong. "Effects of head-out water immersion on cardiorespiratory responses to maximal cycling exercise." *Undersea Biomedical Research* 3(3):177-187.
- Dressendorfer, R.H., R.M. Smith, D.G. Baker, and S.K. Hong. "Cold tolerance of long-distance runners and swimmers in Hawaii." *Int. J. Biometeor.* 21(1):51-63.
- Gerritsen, Franciscus. *Beach and Surf Parameters in Hawaii*.
- Grace, R.A. "Near-bottom water motion under ocean waves." In *Proceedings of the Fifteenth Coastal Engineering Conference, July 11-17 1976, Honolulu, Hawaii*. Volume II, Chapter 139.
- Grace, Robert A. *Pipeline Survival Under Ocean Wave Attack*.
- Grace, R.A. "Surface wave heights from pressure records." *Coastal Engineering* 2:55-67.
- Grace, R.A., and S.A. Nicinski. "Wave force coefficients from pipeline research in the ocean." Paper Number OTC 2676 presented at the Eight Annual Offshore Technology Conference, Houston, Texas, May 3-6, 1976.
- Hanna, J.M., R.H. Strauss, B. Itagaki, W.J. Kwon, R. Stanyon, J. Bindon, and S.K. Hong. "Marijuana smoking and cold tolerance in man." *Aviation, Space, and Environmental Medicine* 47(6):634-639.
- Hanna, J.M., and R.M. Smith. "Responses of Hawaiian-born Japanese and Caucasians to a standardized cold exposure." *Human Biology* 47(4):427-440.
- Hart, J.L. "Salicylate hypothermia in rats exposed to hyperbaric air and helium." *Journal of Applied Physiology* 39(4):575-579.
- Harvey, Robert R., James E. Andrews, and J. Ronald Zaneveld. *Preliminary Dumand Site Evaluations: Maui Basin and Keahole Point Basin*.
- Hochachka, P.W., and R.H. Dressendorfer. "Succinate accumulation in man during exercise." *Applied Physiology* 35:235-242.
- Hong, S.K., ed. *International Symposium on Man in the Sea, 13-15 July, 1975, Honolulu, Hawaii*.
- Hong, Suk Ki, and Terence O. Moore, eds. *Studies on Human Performance in the Sea: Volume 1*.
- Knapp, R.H. "Pseudo-cylindrical shells: a new concept for undersea structures." *Journal of Engineering for Industry* 99(2):485-492.
- Knapp, R.H., and C. Dumlao. "Experimental investigations of prebuckled cylinders under external pressure." *Journal of Engineering for Industry* 101(2):178-184.
- Kunkle, Thomas D., and David E. Yount. *Gas Nucleation in Gelatin*.
- Lin, Y.C., and L.H. Chen, and D.G. Baker. "Factors affecting the physical performance of the rat in hyperbaric environments." *Journal of Applied Physiology* 46(5):984-991.
- Lin, Y.C., T.O. Moore, J.J. McNamara, and S.K. Hong. "Oxygen consumption and conservation during apnea in the anesthetized dog." *Respiration Physiology* 24:313-324.
- Lipp, David. *Design Criteria and Considerations for a Hawaiian Stable Semi-Submerged Fishing Vessel (SSFV)*.
- Paganelli, C.V., R.H. Strauss, and D.E. Yount. "Bubble formation within decompressed hen's eggs." *Aviation, Space, and Environmental Medicine* 48(1):48-49.

- Seidl, Ludwig H., Frans Gerritsen, Pieter G. Wybro, and Steven Nicinski. *Preliminary Feasibility Study: A Marine Transit System as a Supplement to a Land-Based Rapid Transit System.*
- Smith, R.M., and S.K. Hong. "Heart rate response to breath holding at 18.6 ATA." *Respiration Physiology* 30:69-79.
- Wade, C.E., E.M. Hayashi, T.M. Cashman, and E.L. Beckman. "Incidence of dysbaric osteonecrosis in Hawaii's diving fishermen." *Undersea Biomedical Research* 5(2):137-147.
- Watt, D.G., and Y.C. Lin. "Doppler detection of thresholds for decompression induced venous gas emboli in the awake rat." *Aviation, Space, and Environmental Medicine* 50(1):44-50.
- Wilson, Douglas C. *High Hydrostatic Pressure Curing of Fresh Mortar: Its Application to Concrete Curing.*
- Yount, D.E. "Application of a bubble formation model to decompression sickness in rats and humans." *Aviation, Space, and Environmental Medicine* 5(1):44-50.
- Yount, D.E., and R.H. Strauss. "Bubble formation in gelatin: a model for decompression sickness." *Journal of Applied Physics* 47(11):5081-5089.
- Yount, D.E., and T.D. Kunkle. "Gas nucleation in the vicinity of solid hydrophobic sphere." *Journal of Applied Physics* 46(10):4484-4486.
- Yount, D.E., T.D. Kunkle, J.S. D'Arrigo, F.W. Ingle, C.M. Yeung, and E.L. Beckman. "Stabilization of gas cavitation nuclei by surface-active compounds." *Aviation, Space, and Environmental Medicine* 48(3):185-191.

MARINE EDUCATION AND TRAINING

- Blue-Water Marine Laboratory Staff. *The Blue-Water Marine Laboratory.* Curriculum Research and Development Group, University of Hawaii. *Reef and Shore.*
- McMahon, John J. *University of Hawaii Marine Option Program Annual Report 1976-77.*

ADVISORY SERVICES

- Arrigoni, Ed. *A Nature Walk to Ka'ena, Oahu.*
- Clark, Athline M. *Dangerous Marine Organisms of Hawaii.*
- Doughtie, Maureen G., and Raymond S. Tabata. *Marine Bills '78: A Digest of Marine-Related Laws Enacted by the 1978 State Legislature.*
- Fujimoto, Amy S., Compiler. *Hawaii's Ocean Resources: A Bibliography.*
- Harris, Jeremy. *Ancient Hawai'i in Harmony with the Sea.*
- Harris, Jeremy. *Hawai'i in Harmony with the Sea: He'e and 'Ōlepe—Octopuses and Shellfish.*
- Harris, Jeremy. *Hawai'i in Harmony with the Sea: Illegal Fishing Techniques in Hawai'i.*
- Harris, Jeremy. *Hawai'i in Harmony with the Sea: Ula and Papa'i—Lobster and Crab.*
- Hau, Skippy. *Marine Audiovisual Catalog: 16mm Films and Slideshows.*
- Hendricks, Peter L. *Basic Outboard Motor Maintenance.*
- Hendricks, Peter L. *Fiberglass Boat Repair.*
- Hendricks, Peter L., Coordinator. *Papers and Comments on Tropical Reef Fish.*
- Hendricks, Peter L. *Small Motorboats for Hawaiian Waters.*
- Holt, Susan K., Compiler. *Recordkeeping Book for Hawaii Commercial Fishermen.*
- Holt, Susan K., and Peter L. Hendricks. *Guidelines for Preparing Chilled Seawater Brine.*
- McCrerey, Linda. *Bodysurfing Safety.*
- McCrerey, Linda. *Sunburn and Skin Care.*
- Miller, Sharman. *Directory of Marine Resources in Maui County.*
- Tabata, Raymond S. *EIS Handbook: A Guide to Hawaii's Requirements and Process.*
- Tabata, Ray. *Kaena Point, Oahu.*
- Tachibana, Alvin, ed. *Ono Hawaiian Shark Recipes.*
- Takata, Howard A., ed. *Hawaii Prawn Recipes.*
- Takemoto, Roy, Raymond Tabata, and Maureen Doughtie. *Hawaii Fishing Laws and Regulations for Salt Water Sports Fishing.*
- Takenaka, Brooks. *Efficient Fish Processing and Storing.*

PROGRAM MANAGEMENT AND DEVELOPMENT

University of Hawaii Sea Grant Marine Advisory Program. *Five Year Development Plan*.

University of Hawaii Sea Grant Marine Advisory Program. *Marine Advisory Program*.

University of Hawaii Sea Grant Marine Advisory Program. *Year 09 Activity Plan*.

Matsuzaki, Carrie. *Makahiki Kai Festival of the Sea '77: Teachers' Guide*.

Pfund, Rose T. *Activities in: Research, Education for the Fiscal Year 1977-1978*.

Pfund, Rose T., ed. *Bibliography of Marine Affairs*.

Pfund, Rose T. *Hawaii's Commercial Aku Fishing Industry*.

Pfund, Rose T. *Hawaii's Commercial Aku Fishing Industry: Makahiki Kai at the Hotel King Kamehameha, Kona, Hawaii*.

Pfund, Rose T. *Makahiki Kai '76 Teacher's Guide*.

Pfund, Rose T. *Makahiki Kai '76 Teacher's Guide Sheet: Neighbor Island Edition*.

Pfund, Rose T. *Part 1. The University at Work in the Ocean: Program Overview 1973-75. A Biennial Report of the Activities of the University of Hawaii Sea Grant College Program*.

Pfund, Rose T. *Part 2. The University at Work in the Ocean: Program Highlights 1973-75. A Biennial Report of the Activities of the University of Hawaii Sea Grant College Program*.

Pfund, Rose T., Coordinator. *Proceedings of the First Annual Student Symposium on Marine Affairs*.

Pfund, Rose T., Coordinator. *Proceedings of the Second Annual Student Symposium on Marine Affairs*.

Pfund, Rose T., Coordinator. *Proceedings of the Third Annual Student Symposium on Marine Affairs*.

Pfund, Rose T., and Wendy F. Nakano. *Makahiki Kai '76 Student Workbook*.

Pfund, Rose T., and Wendy F. Nakano. *Makahiki Kai Festival of the Sea '77 Student Workbook*.

Pfund, Rose T., Jane Torikai, and Wendy F. Nakano. *Makahiki Kai Festival of the Sea '78 Student Workbook*.

Torikai, Jane. *Makahiki Kai Festival of the Sea '78: Teachers' Guide*.

University of Hawaii Sea Grant College Program. *Bibliography: Volume 1*.

University of Hawaii Sea Grant College Program. *Papers Presented at the Beach and Surf Parameters Workshop: November 7, 1975*.

University of Hawaii Sea Grant College Program. *Publication List 1976*.

University of Hawaii Sea Grant College Program. *Sharks and Man...A Perspective*.
Waikiki Aquarium. *Docent Handbook*.

