Proposal for a Graduate Program in Coastal and Marine Resources

By

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Executive Summary

This is a proposal to establish a graduate academic program in Coastal and Marine Resources. The coastal areas of the U.S. are among the most developed and certainly the fastest growing areas in the country. Coastal counties are growing three times faster than other U.S. counties, adding more than 3,600 people per day to their populations. The challenge of the 21st century will be to achieve a balance between use and protection of coastal and marine resources[1]. Within that context, the primary focus of the Coastal and Marine Resources graduate program will be responsible management of living coastal and marine resources.

Under UH Executive Policy E5.201 (Approval of New Academic Programs and Review of Provisional Academic Programs[2]), this proposal presents a new graduate degree program named Coastal and Marine Resources Graduate Program with tracks in tropical fisheries, tropical aquaculture, coastal and marine policy, and sustainable coastal and marine resources. The Authorization to Plan for UH-Manoa was approved on Sept. 10th, 2003, by UHM Chancellor Peter Englert (Appendix A); and for Hilo by UH-Hilo Chancellor, Dr. Rose Tseng. This proposal is the result of an extended planning process and builds upon the 1995 Tropical Fisheries and Aquaculture (TFA) proposal that was not approved because of financial constraints.

The most important of the program's goals is the education of a cadre of highly trained, post-baccalaureate professionals, with a broad knowledge of relevant biological and social sciences, whose expertise is specifically directed toward practice and research in the management of coastal and marine resources, including tropical fisheries, the cultivation of tropical aquatic species and policy governing the management of these activities. These human resources are a critical necessity if the State of Hawaii and other Pacific Basin governments are to manage and utilize their coastal and aquatic resources in a sustainable manner. Using the unique biological resources and physical environment of Hawaii and the Pacific, students will be exposed to theory, recent technical advances in the field, and hands-on experience in field and laboratory techniques. The interdisciplinary aspects of the program will be achieved through the participation of faculty across a broad range of disciplines at both UH-Manoa and UH-Hilo

campuses, using a full array of distance education technologies in compliance with current policy. Coursework, internships and research opportunities offered by program-affiliated faculty in federal and state agencies, private firms and nonprofits, and partner universities will provide additional depth to the program.

Researchers focused on myriad aspects of coastal and marine resources and those seeking to implement the results of their studies must possess both depth and breadth of knowledge and skills across many interconnected disciplines. At the master's level, students will be required to complete a set of core courses and one of four sets of focus courses depending on their chosen academic track emphasizing tropical fisheries, tropical aquaculture, coastal and marine policy, or sustainable coastal and marine resources. The M.S. degree will require coursework and a thesis and the M.A. (Coastal and Marine Policy and Sustainable Coastal and Marine Resources tracks only) degree will require coursework plus an appropriate internship. The Ph.D. will be offered in the same four tracks, with remedial coursework concentrations (if necessary) approved by the student's advisory committee. UH-Manoa will offer the masters and doctoral degrees, however, only the masters degrees will be offered through UH-Hilo. The program was originally meant to be a joint program, but because no system-wide degree is possible, approval for the program is being sought separately by both UH-Manoa and UH-Hilo. UH-Hilo will offer the MS and MA in Tropical Aquaculture. Essentially the programs at UH-Hilo and UH-Manoa will be identical, with the same requirements at both campuses and students free to choose coursework and complete residency requirements at either campus. Once the programs are approved, an MOU between the campuses will formalize the details of the joint program. Ideally, this cooperation between campuses will promote the free and open exchange of ideas among our faculties, facilitate individualized and need-based educational programs for our students, and provide seamless transition from masters to Ph.D.-level studies.

COASTAL AND MARINE RESOURCES GRADUATE PROGRAM

1.0 Introduction

It has been estimated that 75% of marine fish stocks or species groups are either overexploited, fully exploited, significantly depleted or recovering from depletion[3]. Similar concerns were reflected in the conclusions and recommendations of the recent United Nations Summit on Sustainable Development[4]. This gathering resulted in long list of resolutions aimed at recognizing the importance and interconnectedness of ocean and coastal resources and devoted six sections to specific initiatives to manage, maintain and restore them. Many agencies predict that future increases in available seafood will come from aquaculture, not wild catch. Just to maintain current per capita consumption levels, aquaculture production must double over the next 25 years. Most of that new production is and will continue to occur in the tropics – more specifically, the Asia-Pacific region. Over the past decade, aquaculture was the fastest growing sector of national agriculture, and is currently valued at $1 billion annually[5], Hawaii product sales accounting for about $25 million of this figure[6]. The U.S. is, after Japan, the world's largest importer of seafood so the market potential is enormous. This has resulted in an annual trade deficit of $7 billon for edible seafood, which is the thirst largest contributor to the U.S. trade deficit, after petroleum and automobiles. Given that most of the seafood consumed in the U.S. is farmed, the industry has tremendous growth potential at the national level. Hawaii has a small aquaculture industry when compared to the nation's largest producing states, but it is disproportionately large, diverse and progressive relative to the state's land area and population, and Hawaii currently is a leader in open-ocean cage mariculture. With a growth rate of more than 13% from 2001 to 2002, aquaculture was the State's fastest growing local agriculture sector and has demonstrated a potential for further expansion and diversification mirroring national and global trends[6]. Hawaii also has had a long-standing tradition in the development and export of technology and has facilitated the bringing together of ideas and people to provide the education and training necessary to characterize and manage coastal and marine resources. Companies in Hawaii rely on research and technology to increase their production, generate new products for

market, and remain globally competitive. In essence, our aim is to establish Hawaii as a technology and education center for coastal and marine resource research, production and management.

Hawaii has become a major center for fisheries activities in the Pacific. Honolulu consistently ranks among the top ten U.S. ports by landed value of catch. Two other Western Pacific ports, Pago Pago (American Samoa) and Agana (Guam), also occur on this list. Hawaii is the administrative center for the management of U.S. fisheries in the Western Pacific. The Western Pacific Regional Fishery Management Council, headquartered in Honolulu, has the responsibility for setting fishery management policy in a region that comprises 48% of the total U.S. exclusive economic zone. In recognition of this importance, the NOAA Fisheries (formerly National Marine Fisheries Service) has created a new administrative region in the Western Pacific with headquarters in Honolulu. The leadership of the NMFS Honolulu Laboratory strongly supports this proposed program and has made a commitment to allow some of the lab's scientific staff to participate in the program by co-teaching certain courses. Such an arrangement spares the need to recruit new faculty immediately and underscores the present existence, support and proximity of many experts in the fields emphasized by the proposed program.

In 1992, when highly migratory species (tuna, marlin and related species) were included in the Magnusson-Stevens Act, Congress established the Pelagic Fisheries Research Program (PFRP) at the University of Hawaii to augment research capacity in the Western Pacific[7]. Concentration on pelagic fisheries – the single most important fishery in Hawaii and the Pacific Islands – gives UH a unique advantage. The only comparable specialization is the "halieutique" specialization offered by l'Ecole Nationale Superieure Agronomique de Rennes (ENSAR), France. UH has world-class faculty and staff currently engaged in this research. The PFRP has become a world leader in multi-disciplinary research on pelagic fisheries systems. The PFRP steering committee strongly supports the CMR Program initiative and has provided funds for the initial hire of a program coordinator.

Both the fisheries and aquaculture industries need trained workers, streams of new ideas, and trained leadership. Ideally, this program will forge tighter links between the aquaculture and fisheries industries in Hawaii and researchers at the University, making a measurable contribution to the viability, growth and profitability of these industries and to Hawaii's economy. In summary, the Coastal and Marine Resources Program is proposed in response to the importance of fisheries and aquaculture to the nation and to the state of Hawaii, the growing NOAA presence and focus on sustainable exploitation of fisheries, the current "critical mass" of expertise in Hawaii, the 2003 Pew report on the Oceans[8] and the 2004 U.S. Commission on Ocean Policy draft report[9].

2.0 Program Vision, Mission, and Objectives

2.1 Program Vision

The vision for the Coastal and Marine Resources (CMR) Program is one of cutting-edge, multi-disciplinary education and research with strengths in the areas of sustainable tropical fisheries, tropical aquaculture, and coastal and marine policy. Faculty at UH-Manoa and UH-Hilo are currently engaged in research relating to this vision. By means of this proposal, the School of Ocean and Earth Science and Technology (SOEST) seeks to establish a complimentary educational program, in collaboration with the College of Tropical Agriculture and Human Resources (CTAHR), the College of Social Sciences, and the School of Law at the University of Hawaii at Manoa and with the College of Agriculture, Forestry, and Natural Resource Management (CAFNRM) at the UH-Hilo.

2.2 Program Mission

The mission of the CMR program is to provide graduate-level education in sustainable tropical fisheries, tropical aquaculture and coastal and marine policy, consistent with the mission of the University of Hawaii, the economic development goals of the State of Hawaii and the needs of the region. The targeted student pool will include individuals with undergraduate degrees in aquaculture, fisheries biology, zoology, oceanography, environmental science, botany and other

related fields. This diversity in student preparation poses some challenges in optimal curriculum design, but will be a strength of the program by providing a vibrant and diverse set of perspectives to be brought to issues at hand. Rather than find some common denominator in terms of science or technological content, we have built curricula around a core concept of sustainable utilization of coastal and marine resources, policy analysis, statistics and experimental design, resource economics, and oceanography.

2.3 Program Objectives

The CMR program is designed to provide a flexible framework within which students tailor a degree program to their particular research interests and career goals. The program will provide advanced professional training in Hawaii, meeting State and national needs for mid-level managers in both the private and public sectors. Additionally, the Ph.D. programs will prepare future college-level instructors and researchers for entry into a rapidly expanding field. It is hoped that the CMR program also will expand the scope and scale of university faculty research, accelerating ecosystem-level research and management understanding. The availability of Ph.D. students is an asset for any advanced research project. The program also will act as an important bridge between University researchers, industry, and government via the CMR program advisory council.

Student Educational Outcomes:

A core knowledge base is expected of all graduates of the program. Students are expected to demonstrate basic competence in the following areas:

- Aquatic and marine ecosystems emphasizing living marine resources
- Population monitoring and assessment
- Multi-disciplinary understanding of the complexity of aquatic systems, including the human element
- Familiarity with recently published research and methodological techniques in chosen field, including public policy

We expect Masters-level graduates of the CMR program will have the following skills:

- A broad base of knowledge in the academic field of study that will allow effective communication with colleagues at a professional level;
- Competence at quantitative analysis and interpretation of fisheries and aquaculture data
- An ability to read and critically evaluate relevant scientific and policy literature;
- An appreciation for the interdisciplinary applications of their chosen fields of study and the skills to take advantage of employment opportunities;
- Sufficient flexibility in their training so that they can adapt to the changing opportunities presented to them in their careers;
- An ability to communicate effectively both orally and in writing;
- An ability to work in a team environment;
- Superior computing skills across a broad range of platforms and software;
- Apply computer models to analyze data and predict outcomes;
- Be able to describe and explain the basic components of Earth systems;
- Acquire a mastery of knowledge relevant to their subfield;
- Be able to collect original data using field or archival techniques
- A knowledge of appropriate techniques and field methods for measuring and recording biological and environmental phenomena;
- Use of specialized, modern instrumentation standard in the chosen field;
- Familiarity across the many traditional disciplines that intersect with the description, monitoring and management of coastal and marine resources with consideration for associated human needs (research methodology, data analysis and interpretation, management strategy, policy implementation, sociological and economic considerations, etc.)

Additionally, at the Ph.D. level, graduates will be expected to

- Be productive researchers conducting original research and developing new technologies in fisheries and aquaculture practice and policy;
- Have the experience to publish in refereed journals.

More detailed knowledge specific to their study focus area will be required of all graduates (see section 4.1 for detailed listing of core and focus courses).

3.0 Program Appropriateness

3.1 Relationship to University and Campus Mission, Plans and Needs

The University of Hawaii at Manoa Strategic Plan 2002-2010: Defining our Destiny – Continuing our Commitment[10] emphasizes Manoa's core commitments to research, educational effectiveness, social justice, place, economic development, culture, society and the arts, and technology. Within that framework, the CMR program will undertake research that benefits and involves the local community, expand applied research and scholarship, and initiate new learning centers that respond to societal needs such as public policy, environmental sustainability, and other interdisciplinary areas of inquiry. With respect to economic development, the CMR program addresses several key strategic imperatives:

- Educate a highly skilled, flexible, world-class labor force
- Enhance human capital and knowledge infrastructure, technology, and the integration of Hawaii into the global economy
- Expand the funded research enterprise
- Strengthen public and private partnerships
- Promote environmentally and culturally sensitive economic development in services, high technology, diversified agriculture, tourism and emerging sectors

The 1997-2007 UH-Hilo Strategic Plan emphasizes the concept that "Hawai'i's incomparable natural and cultural environment serves as a learning laboratory, the setting for many teaching, research, and service activities." This was reiterated in the UH-Hilo 2001-2002 Strategic Plan Review Process[11]. An M.S. in Tropical Fisheries and Aquaculture was identified as a strategic initiative for UH-Hilo. This proposal will be submitted by Kevin Hopkins, University of

Hawaii-Hilo; formal collaboration on the program will be via Memorandum of Understanding with UH-Hilo.

BOR criteria for the establishment of graduate programs require relevance to the professional, economic, social, occupational, and general educational needs of Hawaii. The CMR program will provide graduate education and training needed by professionals to respond more effectively and responsibly to the emerging challenges and associated opportunities of sustainable coastal and marine resource exploitation and environmental stewardship in the 21st Century. The scope and focus of the program will emphasize technologies and issues of relevance to Hawaii and the Pacific Rim community – notably the sustainable development and use of coastal and marine resources.

3.2 Relationship to State, National and International Needs

Fisheries are a source of employment for more than 200 million people worldwide, who depend directly or indirectly on ocean fishing for their livelihoods. Fish is the primary source of protein for 950 million people worldwide and is a substantial dietary component for many more[12]. While the depletion of the nation's coastal fishery resources was noted as long ago as the mid-1800s, the notion of managing the wild stocks of marine fisheries at that time went no farther than studying the biology of popular game fish and the establishment of laboratories by the federal and state governments. The management of popular recreational freshwater fisheries in streams, rivers, and reservoirs included augmentation by cultured stock. Hence, fish culture was an integral part of the early management of freshwater fisheries in the United States.

The first comprehensive federal statute for the management of marine fisheries did not occur until 1976 with the enactment of the Magnuson-Stevens Fisheries Management and Conservation Act[13]. However, to date, the management of the nation's coastal fisheries has been ineffective, if stock depletion is used as an index. There are inherent difficulties in establishing the sustainable yield of wild fish stocks because of the fluid nature of the habitat and the

migratory behavior of fishes. Added to these problems is the influence of the behavior of fishermen, who are the highest order of predators, in establishing appropriate levels of catch to maintain the viability of the commercial and recreational fisheries. The average dockside landings of commercial fisheries have averaged 4.3 million metric tons valued at $3.4 billion over the last 5 years, supporting employment for 250,000 harvesters and processors. U.S. recreational fisheries provide a source of recreation and food to approximately 17 million Americans, who expend $20 billion a year on recreational angling. There are also significant non-market economic benefits associated with the existence of healthy fish stocks[14]. At the present time, approximately 37,000 fisheries and wildlife managers are employed worldwide with a 6-10% growth in demand annually. A substantial portion of these managers is approaching retirement age, a major concern for the management agencies as there is a dearth of students studying fishery management[15].

As recently as the 1980s, the notion of culturing commercial species caused fishermen to be fearful of the potential competition for market niches by cultured species. The current commercial development of aquaculture has not curtailed the long-standing tradition of fish culturing to enhance wild stocks as a government-sponsored activity. What began as the incidental raising of freshwater species, has become an important multi-billion dollar economic endeavor in the United States (estimated value of US $1.98 billion in 2000) and the world (estimated value of US $56.5 billion in 2000) including aquatic plants. Employment in the field of aquaculture currently exceeds 180,000 and is now the fastest growing agricultural sector both in terms of employment and production, both nationally and globally[16].

However, the capture and cultivation of food fish is a risky and complex endeavor. The World Fish Center (formerly known and International Center for Living Aquatic Resources Management, ICLARM) noted that among the emerging issues are "tension over such issues as trade, local and international market competition, demand for fisheries access by foreign fleets, illegal cross-border fishing… public alarm over genetic technologies and intellectual property rights as well as global climate change, have added to the already complex issues"[17]. More

recently, at a February 2002 meeting in Pohnpei organized under a mariculture sustainability project funded by the US Department of Agriculture's Initiative for Future Agriculture and Food Systems program, an integrated aquaculture education system culminating in a graduate program was identified as a key need for the industry. A needs assessment conducted by the same project in Hawaii in mid-2002 also identified graduate studies, conveniently offered at the major aquaculture centers (e.g., Natural Energy Laboratory of Hawaii Authority and Oceanic Institute), as a key need.

Hawaii is ideally situated in geography and expertise to generate the knowledge and technology to provide the products, training, and education necessary to support fisheries management and aquaculture development in tropical and subtropical environments. The state's mid-Pacific location gives it a special competitive advantage both through easy access to and maintenance of both temperate and tropical species. Hawaii's cultural underpinnings span not only those of the U.S. mainland, but also of Asia and other Pacific islands and are rooted in the ocean and its resources. Moreover, Hawaii has a long tradition of aquaculture and currently has one of the highest concentrations of aquaculturists in the world.

Resource sustainability is a goal that is regularly articulated by the community and government in Hawaii because of far-reaching economic and social implications. The graduates and research conducted as part of the CMR program are expected to contribute significantly to meeting this challenge.

The Exclusive Economic Zone (EEZ) of the State of Hawaii is the second largest in the U.S. Vast marine resources within that EEZ hold great promise and profound benefit to the people of Hawaii. The curricula and research activities of the CMR program respond to this opportunity and, recognizing the unique and outstanding resources available locally, will leverage the expertise that has been cultivated in oceanography and marine biotechnology at UH and in the private sector in Hawaii in recent years.

The CMR program will provide graduate education in subject areas that are recognized technology challenges or commercial opportunities in Hawaii, and for which there are no comparable programs at UH to meet the educational demand. The graduate and research products of the program will constitute an important contribution toward satisfying the growing expectation that UH must serve as a major engine for economic development in Hawaii.

Despite Hawaii's aquaculture heritage, there are no UH graduate programs directed toward the use and management of fisheries and aquaculture and relevant policy issues. We propose to correct this shortcoming by combining teaching, research, and service functions across the UH system into an integrated graduate program offered throughout the state and eventually, the Pacific. This will be accomplished by the collaborative effort of biologists, oceanographers, agricultural and resource economists, biosystems engineers, and social scientists within the University of Hawaii and related organizations that will constitute the interdisciplinary faculty of the CMR Program.

4.0 Program Organization

The collaborative CMR program will be offered by both UH-Hilo and UH-Manoa. Master's degrees in tropical aquaculture (and possibly fisheries) will be offered by UH-Hilo, while both Master's and the Ph.D. will be available at UH-Manoa. M.S. ("Plan A") students will complete coursework and a research-based thesis, under the supervision of a primary faculty advisor. M.A. ("Plan B") students will complete coursework and an internship or research project with an approved partner organization (affiliated faculty). Under both plans, students will have a graduate committee of at least three faculty members, who serve as advisors in determining appropriate curricula to meet each student's career objectives, and who will aid research design or in finding internship opportunities. This committee should be chosen after the student's first semester and must meet at least once a semester to assess progress toward the degree.

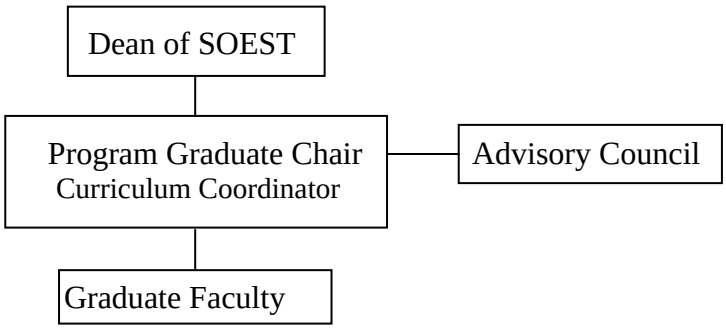
Ph.D. students will complete remedial coursework, if necessary, and a dissertation under the direction of their advisor, as directed by their graduate committees. The graduate committees

for the Ph.D. will consist of five members who represent a range of disciplines related to fisheries and aquaculture and must include both the biological and social sciences.

A multi-disciplinary graduate faculty composed of faculty from UH-Manoa, UH-Hilo, and affiliated graduate faculty from partner organizations will staff the program. Potential faculty in fisheries, aquaculture and policy (Table 1) were identified through a faculty surveys conducted in 2001 and 2003 (Appendix B) and subsequent contacts. Based on the expertise of those individuals who indicated a preliminary interest in teaching in the program, most aquaculture subjects have adequate coverage, although a few deficiencies are still evident: particularly in fish feeds and feeding and processing of aquaculture products. Tropical fisheries, on the other hand, will require additional effort to provide an adequate faculty base. This will be addressed initially by facilitating the participation of scientists at NOAA Fisheries and other local sources, to teach as affiliate faculty.

Day-to-day administration of the UH-Manoa program will be at SOEST's Hawaii Institute of Marine Biology, under the direction of a faculty program coordinator; while the administrative office for the UH-Hilo program will be at College of Agriculture, Forestry, and Natural Resource Management's Pacific Aquaculture and Coastal Resources Center (PACRC). These administrative offices will serve as the points of contact for potential students, current students, alumni, and faculty across the system. Overall coordination will be through the Graduate School.

We propose the following structure for the CMR program:



The program will have a graduate chair appointed by the Dean of SOEST. We have obtained funding to hire a program coordinator through the Joint Institutes for Marine and Atmospheric Research (JIMAR) Pelagic Fisheries program. This person will be responsible for the day-to-day academic administrative functions of the program as well as some student services. Clerical functions and student services will be absorbed by existing staff until the program is permanently established; at that time, additional funds may be required to hire full-time clerical and/or student services staff.

The Advisory Council will consist of the CMR graduate chair, a representative from the Department of Business, Economic Development and Tourism (DBEDT) Energy Division; a representative from Department of Land and Natural Resources Division of Aquatic Resources; a representative from National Marine Fisheries Service, a representative from the Hawaii Department of Agriculture, the Director of the UH Sea Grant program; representatives of deans who provide resources for the program; and representatives of partner institutions. This body will be advisory to the graduate chair; its purpose is to keep the curricula current in theory, technology, and field applications. The chair of the Advisory Council will have a two-year rotation among the members. The program graduate chair will represent the interests of the Graduate Faculty.

Table 1. Faculty Interested in Teaching Courses in the CMR Graduate Program (from 01& 03 surveys)

Name	Organization	Location	Areas of specialization
Harry Ako	CTAHR	Manoa	Biochemistry and nutrition
Adam Asquith	Sea Grant	Kauai	Ahupua'a restoration
Marlin Atkinson	HIMB	Manoa	Marine chemistry, remote sensing; reef ecology
Jim Beets	UHH	Hilo	Coral reef fish communities
Peter Boucher	CAFNRM	Hilo	Aquaculture engineering
Richard Brock	Sea Grant	Manoa	Fisheries Biology
Julie Brock	Zoology	Manoa	Invertebrate zoology
Eric DeCarlo	SOEST	Manoa	Watershed and coastal biogeochemistry
Charles Fletcher	SOEST	Manoa	Coastal processes and coastal erosion
Alan Friedlander	OI, NOS	Oahu	MPAs, Reef assessment/monitoring
Gordon Grau	Sea Grant	Manoa	Environmental physiology of fish
Michael Hamnett	Social Sciences	Manoa	Coastal zone management; fisheries economics
Maria Haws	PACRC, Sea Grant	Hilo	Mollusks and coastal resource management
Kevin Hopkins	PACRC	Hilo	General aquaculture and finfish; fisheries biology
Bob Howerton	Sea Grant	Maui	General aquaculture and water quality
Casey Jarman	Law	Manoa	Environmental law, ocean law
Denise Konan	Economics	Manoa	Microeconomics, computational economics
Edward Laws	SOEST	Manoa	Aquatic pollution
Cheng-Sheng Lee	OI	Oahu	Aquaculture, reproduction, hatchery management
JoAnn Leong	HIMB	Kaneohe	Marine biotechnology & fish disease
PingSun Leung	CTAHR	Manoa	Aquaculture economics and modeling
Dan Lindstrom	SOEST/HIMB	Manoa	Molecular applications & Phylogeography
Kem Lowry	Urban Planning	Manoa	Coastal management
Lorenz Magaard	SOEST	Manoa	Ocean and climate policy
Fred Mackenzie	SOEST	Manoa	Watershed and coastal biogeochemistry
Spencer Malecha	HNFAS, CTAHR	Manoa	Aquaculture
Bruce Matthews	CAFNRM	Hilo	Water quality
Karla McDermid	UHH/CAS	Hilo	Algae
Margaret McManus	SOEST	Manoa	Physical oceanography; marine plankton

Jim Parrish	HCFU	Manoa	Fisheries biology
Michael Parsons	Marine Science	Hilo	Culture of microalgae
Sam Pooley	NOAA Fisheries	Honolulu	Fisheries economics
James Roumasset	Economics	Manoa	Environmental & agricultural economics
Tom Schroeder	SOEST	Manoa	Climate, tropical weather
Craig Severance	UHH/CAS	Hilo	Fishing communities and fishery mgmt.
John Sibert	PFRP	Manoa	Population dynamics, fisheries, modeling
Brian Szuster	Geography	Manoa	Coastal and Marine Resources
Jim Szyper	Sea Grant	Hilo	General aquaculture, microalgae and finfish
Howard Takata	PACRC	Hilo	General aquaculture and extension methods
Clyde Tamaru	Sea Grant	Manoa	Aquaculture, reproduction, hatchery management
Andy Taylor	Zoology	Manoa	Biostatistics
Sharon Ziegler-Chong	PACRC, Sea Grant	Hilo	General aquaculture and extension methods

4.1 Curriculum

The course requirements for the CMR degrees were developed after reviewing existing fisheries, aquaculture, policy and related curricula at other institutions (Appendix C) and recent articles on the requirements for aquaculture and fisheries education[18]. We also considered the draft masters curriculum in aquaculture endorsed at the Summer 2002 meeting of aquaculture experts and producers sponsored by the USDA-funded project entitled "Bridging gaps to ensure long-term viability of small tropical mariculture ventures in Hawaii and the US-affiliated Islands" along with the results of a survey given to the participants of the most recent PFRP Principal Investigators Workshop held at the University of Hawaii in December 2003 (Appendix D).

A substantial number of existing courses at UH-Manoa and UH-Hilo can be organized into appropriate curricula. Some will be modified as the program evolves to more closely address the mission and expressed needs of students. This may increase the applied aspects of some courses, and increase the "tropical" emphasis of others. Some new courses need to be developed. Cross-listing will be done where appropriate. The proposed curricula are designed to be flexible to accommodate the individual needs of students. As appropriate, students will be encouraged to take other related courses to enrich the scope of their studies. The most relevant courses currently offered at UHM and UHH are listed in Appendices E and F, respectively. A list of required and desired new courses is provided in Appendix G.

Composition of the curricula as outlined below is predicated on the inter- and multi-disciplinary nature of both fisheries and aquaculture. Students require an understanding of organismal and population biology of the species they are to work with. In addition, it is necessary to understand the components and processes of the habitat of the organisms—whether it be the open ocean or an earthen pond. It may be desirable for some students to be able to deal with the food processing sector of the enterprise. It is also helpful to be familiar with the management and economics of the enterprise—whether it is a public natural resource or a business/industry. Each student and his or her committee will tailor a curriculum from these constituent fields to meet the student's needs.

Degrees to be offered:

MA, MS, PhD in Coastal and Marine Resources

Focus Areas:
- **Tropical Fisheries**
- **Tropical Aquaculture**
- **Coastal and Marine Policy**
- **Sustainable Coastal and Marine Resources**

Masters Degree Course Requirements (32 credits):

Core Curriculum (See below)	11 credits
Focus Courses (See below)	9-12 credits (depending on focus area)
Research or Internship (OEST 700/699/6xx)	6 credits
Electives (As approved by thesis committee) (See below and Table 2 for details)	3-6 credits (depending on focus area)

Core Curriculum (11 credits):

Earth System Science (OCN 638) †**or** Biological Oceanography (OCN 621)	3 credits
Environmental Resource Economics (ECON 638) †**or** Economics of Marine Resources (AREC 694)	3 credits
Biometry (ZOOL 631) †**or** Other approved graduate level biostatistics course	3 credits
Ocean Policy Seminar (OEST 735)	1 credit
CMR Sustainability Seminar (OEST 7xx)	1 credit

(See Appendices E, F, and G for course descriptions)

†Will be chosen on the basis of background of student and academic focus.

Required Focus Courses (see Appendices E, F, and G for course descriptions):

Tropical Fisheries

- Fisheries Science (ZOOL 466) 3 credits
- Marine Ecology (ZOOL 620) 3 credits
- Population Biology (ZOOL 652/BOT 652) 3 credits
- Topics in Fish and Fisheries Biology (ZOOL 716) 1 credit
- 5 Credits of elective courses approved by committee* 5 credits

Tropical Aquaculture

- Aquaculture Production (OCN 450/ANSC 450) 3 credits
- Aquaculture Systems (BE 604) 3 credits
- Advanced Animal Nutrition (ANSC 642) 3 credits
- Genetics and Animal Breeding (ANSC 445) 3 credits
- 3 Credits of elective courses approved by committee* 3 credits

Coastal and Marine Policy

- Environmental Law (LAW 582) 3 credits
- Domestic Ocean and Coastal Law (LAW 592) 3 credits
- Population Biology (ZOOL 652/BOT 652) 3 credits
- International Ocean Law (LAW 593) 2 credits
- 4 Credits of elective courses approved by committee* 4 credits

Sustainable Coastal and Marine Resources

- Population Biology (ZOOL 652/BOT 652) 3 credits
- Conservation Biology (ZOOL 690) 3 credits
- Environmental Law (LAW 582) 3 credits
- 6 Credits of elective courses approved by committee* 6 credits

Electives:

*****Electives can be chosen from the many appropriate courses offered by the University listed in the Catalog and any under development (Appendix E, F & G).

PhD Course Requirements (30 credits):

The PhD candidate must demonstrate the ability to do original experimental research and to produce an acceptable dissertation. A comprehensive examination, written and oral, is required, and the dissertation must be successfully defended before the faculty. Students are responsible for the material covered in the core curriculum and for the focus courses in their areas of specialization. Deficiencies in coursework must be remedied before advancing to candidacy (see section 4.1.2 below for details).

Table 2. CMR Curricular Requirements by Focus Area in Matrix Form

				Focus Area Requirements			
Course Subject	**UHM Code(s)**	**UHH Code**	**Credits**	**Fisheries**	**Aquaculture**	**Policy**	**Sustainability**
Biometry	ZOOL 631	Biol 380	3	**C**	**C**	**C**	**C**
Environmental Resource Economics **Or** Economics of Marine Resource	ECON 638 or AREC 694		3	**C**	**C**	**C**	**C**
Earth Systems Science and Global Change **Or** Biological Oceanography	OCN 638 or OCN 621		3	**C**	**C**	**C**	**C**
Fisheries Science	ZOOL 466	Aqua 466	3	**X**			
Marine Ecology	ZOOL 620		3	**X**			
Population Biology	ZOOL 652	Biol 475	3	**X**		**X**	**X**
Conservation Biology	ZOOL 690		3				**X**
Environmental Law	LAW 582		3			**X**	**X**
Domestic Ocean and Coastal Law	LAW 592		3			**X**	
International Ocean Law	LAW 593		2			**X**	
Aquaculture Production	ANSC 450	Aqua 450	3*		**X**		
Advanced Animal Nutrition	ANSC 642		3		**X**		
Genetics and Animal Breeding	ANSC 445		3		**X**		
Aquaculture Systems	BE 604	AgEn 400	3*		**X**		
Topics in Fish and Fisheries Biology	ZOOL 716		1	**X**			
Ocean Policy Seminar	OEST 735		1	**C**	**C**	**C**	**C**
CMR Sustainability Seminar	OEST 7xx		1	**C**	**C**	**C**	**C**
Thesis/Directed Research/Internship	OEST 700/699/800		6	**X**	**X**	**X**	**X**
Elective(s) as approved by Thesis Committee				5	3	4	6
Total Credits (minimum required for degree, *not including lab credits)				32	32	32	32

C indicates a core course required of all students. **X** indicates a required course for that particular Focus Area. If a student has already completed any of these courses prior to admission, their graduate committees will determine if it adequately meets the requirement and assign an alternate course in order to meet credit requirement (i.e., no double counting is allowed and total credit hours required will still stand).

4.1.1 M.A. and M.S. Degree Requirements

The CMR program at the Masters level has the following requirements:

- Pre-program
- Masters General Exam
- Core, focus area and elective courses
- MS thesis or approved MA independent project.

The pre-program, which includes a general education component, one year of college-level mathematics and one-and one-half years of basic science topics provides students with a broad educational background and covers technical and non-technical issues commonly encountered by aquaculture and fisheries professionals. Students with comprehensive undergraduate degrees in aquaculture, fisheries biology, zoology, oceanography, environmental science, botany or other allied disciplines should satisfy the pre-program requirements without need of further preparative coursework.

The MS degree can be earned under the Plan A (thesis) option; the MA degree can be earned under the Plan B (independent project) option. The program requires a minimum of 32 academic credits in all specializations. At least 24 credits must be earned in advanced courses numbered 600 or above. Up to two credits of directed reading and six transferred credits can be counted towards the Master's requirements as approved by graduate advisor and committee. Students who satisfy the pre-program requirements are required to take the General Examination during the first semester of their full-time enrollment to test their knowledge in mathematics, science, and their preparation for graduate-level coursework. Passing the exam advances the student to Master's candidacy.

The core courses provide the students with a broad understanding of the monitoring, assessment, and reporting tools applicable to aquaculture and fisheries. The focus-area courses prepare students for specialization in tropical fisheries, tropical aquaculture, coastal and marine policy, or sustainable coastal and marine resources. All students are required to attend seminars that cover policy issues related to coastal and marine resources and case studies in the area of sustainable

coastal and marine resources. The core and focus-area courses and seminar requirements amount to 26 - 29 academic credits (depending on focus area selected) and the remaining elective credits are to be chosen to form a coherent plan of study.

Both the MS and MA require a detailed proposal outlining the subject area, objectives, methodology, sources of data, and anticipated results of their chosen thesis/project subject that must be approved by a committee of at least three faculty members with appropriate specialties. This thesis/project provides students with an opportunity to explore and contribute to the knowledge base of their coastal and marine resources focus area. The work results in a thesis or a report that demonstrates both mastery of the subject matter and a high level of communication skills on par with professional publications in their chosen filed. The student must present and defend the work at a final examination, which provides the faculty a final opportunity to test the student's understanding and ability to integrate his or her work at the Masters level.

The Plan A (M.S.) degree is intended to prepare students for research, academic, and top-level management careers. The Plan B (M.A.) degree is intended to prepare students for mid-level roles in industry, civil service and management.

The minimum residency time for the Masters degree at the University of Hawaii at Manoa is two semesters full-time.

4.1.2 Ph.D. Degree Requirements

Students pursuing the Ph.D. degree are required to achieve a broad understanding of the principal areas of coastal and marine resources, as well as a thorough understanding of a specific focus area. Students must, at a minimum, possess the knowledge covered by the core and required courses of the Master's degree in Coastal and Marine Resources.

All intended candidates for the Ph.D. degree must take a written qualifying examination before or during the third semester of full-time enrollment. In addition to covering the basic undergraduate fundamentals, the 6-hour exam tests the students' understanding of the

coursework at the Master's level. Students receiving an average of 75% or above pass the exam, and below that, will be judged on a case-by-case basis by the faculty.

After passing the qualifying examination and being advanced to candidacy, the students must take a comprehensive examination, which tests their ability to carry out original research and their preparation for the selected dissertation topic. The examination has a five-day (Monday through Friday) written component and an oral component in the following week. The written component is equivalent to a take-home exam. Students have access to books, computers, and software, but must not discuss the questions with anyone other than the exam committee members. The oral exam provides the students with an opportunity to address issues that may arise from the written part and to defend the novelty of the proposed research.

The dissertation topic must be approved by a committee consisting of a minimum of five graduate faculty members. The student is encouraged to publish the research work in refereed journals in order to obtain feedback from the research community and to develop a publication track record prior to graduation. The student must present and defend the dissertation at a final examination.

The minimum residency requirement for the Ph.D. at the University of Hawaii at Manoa is three semesters full-time.

Students failing any one of the general, qualifying, comprehensive, and final examinations twice will be dropped from the program. Students who do not complete all requirements within seven years after admission, will be dropped from the program. Reinstatement for a limited period of time is possible only through petition by the department chair to the graduate division.

Ph.D. students must have completed the CMR Master's degree or a course by course equivalent degree (as documented by the student and approved by a graduate advisor and committee) prior to entry into the program. If previous academic record is deemed to be lacking in this regard, a committee will determine which UH courses must be taken within the first two years after acceptance into the program in order to obtain an equivalency. All other necessary coursework

will be designed by the student in collaboration and with approval of the graduate advisor and committee. The research project culminating in the dissertation is the most important part of the PhD degree program. The dissertation is to be an original contribution based on independent research, carried out under the guidance of the adviser and dissertation committee. The completed dissertation is defended at a public final examination, conducted by the dissertation committee and including a public research seminar by the candidate.

4.1.3 Comparison to Other Programs

Tables 3 and 4 list some notable domestic and foreign institutions that currently offer graduate programs in areas similar to those being proposed in this document.

A sampling of the degree requirements for these programs (Appendix C) shows that the CMR program requirements are appropriate for a marine resources program with a tropical focus. Analyses of these and other programs were conducted to identify those areas of strength that will be adopted by the UH CMR program, while tailoring it to accommodate the specific objectives, resources, and circumstances under which it will operate. These factors include: the role of the program with respect to benefits to Hawaii and the Pacific Rim region; participating faculty and their current and projected research interests, specializations and expertise; available facilities at UH; and the anticipated student pool.

Table 3. Selected US Graduate Programs in Aquaculture and Closely-Related Subjects

Institution	Masters	Doctorates	City & State/Prov
Auburn University	Aquaculture; Fisheries & Allied Aquaculture	Fisheries & Allied Aquaculture	Auburn, Alabama
Clemson University	Aquaculture, Fisheries & Wildlife	Fisheries & Wildlife Science	Clemson, South Carolina
Duke University	Environmental Economics & Policy, Marine Science and Policy	Environmental Economics & Policy, Marine Science and Policy	Durham, North Carolina
Humboldt State University	Natural Resources (Fisheries)		Arcata, California
Kentucky State University	Aquaculture		Frankfort, Kentucky
Louisiana State University	Biological & Agricultural Engineering; Fisheries	Wildlife & Fisheries Science	Baton Rouge, Louisiana
Mississippi State University	Wildlife Ecology (Aquaculture)		Starkville, Mississippi
Oregon State University	Bioresource Engineering; Agriculture (Aquaculture); Fisheries Science	Bioresource Engineering; Fisheries Science	Corvallis, Oregon
South Dakota State University	Wilflife & Fisheries Science	Biological Sciences	Brookings, South Dakota
Texas A&M	Wildlife & Fisheries	Wildlife & Fisheries	College Station, Texas
Texas A&M, Corpus Cristi	Mariculture	Mariculture	Corpus Cristi, Texas
Texas A&M, Galveston	Marine Resource Management		Galveston, Texas
University of Arizona	Wildlife & Fisheries Science	Wildlife & Fisheries Science	Tucson, Arizona
University of Arkansas/Pine Bluff	Aquaculture/Fisheries		Pine Bluff, Arkansas
University of California at Davis	Biological Systems Engineering; Animal Science	Biological Systems Engineering; Animal Science	Davis, California
University of Delaware	Marine Policy	Marine Policy	Newark & Lewes, Delaware
University of Florida	Fisheries & Aquatic Sciences	Fisheries & Aquatic Sciences	Gainesville, Florida
University of Maine	Marine Policy		Orono, Maine
University of Maryland, College Park	Fisheries Science	Fisheries Science	College Park, Maryland
University of Rhode Island	Aquaculture, Marine Affairs	Environmental Science (Aquaculture or Aquaculture Pathology), Marine Affairs	Kingston, Rhode Island
University of Washington	Aquatic & Fisheries Sciences, Marine Affairs	Aquatic & Fisheries Sciences	Seattle, Washington
Virginia Tech	Fisheries and Wildlife Science	Fisheries and Wildlife Science	Blacksburg, Virginia
William & Mary/Virginia Institute of Marine Science	Wildlife and Fisheries Science	Fisheries Science	Gloucester Pt., Virginia

Table 4. Selected Foreign Graduate Programs in Aquaculture, Fisheries and Closely-Related Subjects conducted in English

Institution	Country	Masters	Doctorates
Australian Maritime College	Australia	Marine Policy, Fisheries	Marine Policy, Fisheries
Deakin University	Australia	Aquaculture	
Hokkaido University	Japan	Marine Environment Resources	Marine Environment Resources
James Cook University	Australia	Tropical Marine Ecology and Fisheries Biology, Aquaculture	Marine Biology, Aquaculture
Northern Territory University	Australia	Biological Sciences (Aquaculture)	Biological Sciences (Aquaculture)
University of Queensland	Australia	Aquaculture	
University of Tasmania	Australia	Applied Science in Aquaculture	
Memorial University	Canada	Aquaculture	
Nova Scotia Agricultural College & Dalhousie University	Canada	Animal Science (specialization in Aquaculture)	
Wageningen University	Netherlands	Aquaculture	Aquaculture
Central Luzon State University	Philippines	Inland Fisheries (Aquaculture)	
University of the Philippines in the Visayas	Philippines	Aquaculture	Fisheries (Aquaculture)
Rhodes University	South Africa	Aquaculture	Aquaculture
University of the North	South Africa	Aquaculture	Aquaculture
Asian Institute of Technology	Thailand	Aquaculture Technology; Aquatic Resources Management	Aquaculture Technology; Aquatic Resources Management
University of Stirling	United Kingdom	Aquaculture; Aquatic Pathology; Aquatic Veterinary Studies	PhD Research

4.2 Admissions Policies

Students are admitted for graduate study on the basis of their scholastic records. Degree candidates for the Masters program usually have a bachelor's degree in a biological discipline that provides adequate background in mathematics, chemistry, physics, and biology. Students may be required to take coursework to satisfy the pre-program requirements as outlined in section 4.1. Students seeking admission to the Ph.D. program should have an M.S. in fisheries, aquaculture, marine policy, or equivalent qualification. However, exceptionally qualified students with an appropriate B.S. degree, who do not have a master's degree, may petition to be admitted to the Ph.D. program directly.

Students submit their applications to the University of Hawaii Graduate Division, which will perform initial screening to ensure satisfaction of University admission requirements. The CMR Program Coordinator then evaluates the applicants and determines their admissibility to the program in consultation with the Graduate Faculty Committee. The Program Coordinator also provides consultation to applicants and matches applicants to appropriate research assistantships and internships. Official scores in the GRE General Test are required for all Ph.D. applicants. Entering non-native English speaking students are required to have taken the TOEFL examination. Depending on TOEFL scores, these students may be evaluated individually at the University of Hawaii English Language Institute and assigned English as a Second Language (ESL) courses if necessary. Detailed requirements for admission and application deadlines are published in the General and Graduate Information Catalog.

For the Ph.D. program, the only admission requirements will be a Master's degree from an accredited institution, TOEFL scores (for some students), and consent of the admissions committee which determines that the student should be able to complete the program.

4.3 Advising and Counseling

Upon admission, the Program Coordinator will meet with each incoming student at a preliminary conference to discuss the program requirements and determine any pre-program deficiencies.

The program allows up to six transfer credits of courses taken elsewhere. These courses must be equivalent to the core or option-area courses of the program and approved by instructors upon evaluation of syllabi, course notes, assignments, and exam questions. The program coordinator will then recommend to the Associate Dean of the Graduate Division to approve the transfer credits. The student identifies an area of study or track from one of the four option areas, and selects an academic advisor from the participating graduate faculty. The program coordinator serves as the advisor to students until they satisfy the pre-program requirements and select academic advisors from their areas of study. Academic advisors review the coursework of the students and progress toward degree annually. All information is recorded on the student progress form, which provides data for subsequent program assessments. The program coordinator is tasked with monitoring the students for at least three years after graduation and maintaining an alumni database.

4.4 Student Financial Support

Graduate students will be supported through a variety of means, primarily faculty research grants and internships paid by the sponsoring institutions.

5.0 Program Enrollment

5.1 Target Groups

Academic programs must evolve to meet the needs of industry and society. The CMR program will provide education and training that will prepare its graduates to respond to current technical challenges with special emphasis placed on those technologies and issues of importance to the State of Hawaii and the Pacific Rim. We anticipate that the progressive and cross-disciplinary scope and focus of the program will attract students from diverse backgrounds. To a certain extent, the portfolio of research projects of participating faculty will initially determine the pool of applicants, as these projects serve to define the UH program and distinguish it from its competitors at other universities.

University of Hawaii faculty and their current research programs have enjoyed tremendous success in engaging a broad international mix of visiting scholars and post-doctoral fellows from

Europe, the Americas, and Asia, and this appeal should carry over to the new program. A modest number of applicants are expected to come from within the UH system; a larger percentage will be from U.S. mainland and other universities. The movement of students from UH undergraduate programs to the new CMR graduate program will serve as a mechanism to retain exceptional students who would otherwise pursue employment or enroll in graduate programs outside of Hawaii. The CMR program is unique from other UH graduate programs and will not compete directly with other UH departments for students.

We recognize that graduate programs with inherent focus on the application of knowledge and technology stand to benefit significantly from a student body that includes individuals with practical experience. Therefore, every effort will be made to market the program to attract returning students from industry. Many of the prospective student inquiries we have already received concerning this proposed program have come from this pool.

5.2 Projected Enrollment

Based on the number of inquiries about graduate degrees received recently from students interested in the CMR tracks, we anticipate a minimum of 5-10 students for the first few years, increasing to a maximum of 30 within five years.

We expect the program to maintain a graduate student population between 25-30 graduate students after the initial ramp-up period. This range of values was based on the set of assumptions illustrated in Table 5, although ultimately, the enrollment in science and engineering programs often depends on the number of graduate assistantships supported by faculty.

Table 5. Summary of assumptions used to project CMR program enrollment

CMR Program Student Enrollment Profile	# Students Enrolling per Year	Years to Degree Completion
M.S. entering with B.S.	6	2
Ph.D. entering with B.S.	1	5
Ph.D. entering with M.S. from other university	1	4
Ph.D. entering with M.S. from CMR at UH	2	3

Carrying these enrollment rates until steady-state within five years yields a projected enrollment of 27 students. A range of 25-30 students arises from changes to the above assumptions.

5.3 Evidence of Student Interest

On average, about 5-10 inquiries per year about the availability of specialized instruction in aquaculture and/or fisheries science and ocean policy are fielded by the Oceanography Department at UH Manoa. In the last year word has gotten out about the possibility of the proposed program and we have already been contacted by dozens of interested and qualified prospective students. The UH-Hilo Pacific Aquaculture and Coastal Resources Center receives more than 10 inquiries per year.

5.4 Assessment of Demand for CMR Program Graduates

The objective of the CMR program is to prepare qualified graduate students for professional careers in sustainable fisheries management or aquaculture, and marine policy. The graduates have a variety of career possibilities:

- Academic careers in research and teaching
- Government or private foundation positions as researchers, policy specialists
- Private sector positions as managers and operators of aquaculture and fisheries operations
- Consulting

All of these sectors are represented to some extent in the Hawaii economy.

Although the relative funding for science is not what it was in the 1970's, many excellent positions are and will be available in both government and industry. Well trained and proficient marine, estuarine and environmental scientists with a number of grants and publications will continue to be in demand, and as such should have a significant edge in competing for employment.

The opportunities that exist for a well-trained individual are in every branch of fisheries and aquaculture. Many students are excited about pursuing those areas with the most potential for assisting society and protecting the marine environment. Most career opportunities in fisheries science are in the government and academic sectors, although in recent years private businesses, research firms and aquaculture businesses offer increasingly diverse career choices.

Coastal development has risen sharply in recent years and governments are trying to minimize environmental impacts resulting from this growth. Human populations and the associated problems continue to increase in areas where the land meets the sea. For this reason, planning and coastal zone management positions may be an increasing source of future employment. More jobs are becoming available in the private sector as well. Concern for the environment is growing and there is an increasing demand for environmental impact studies. Environmental consulting firms are filling this need and creating jobs.

Ecotourism may also offer opportunities for future employment. Nature-based tourism firms are searching for qualified interpreters to teach the public about the natural and marine environments. Teaching positions are occasionally available at colleges and universities, but these are scarce and competitive.

Positions will be available, but job seekers must be prepared to interview many times and may need to be willing to relocate. Certain parts of the country may have more marine opportunities available than other parts. While the number of positions may be increasing in certain areas of marine science, one must remember that there are a lot of eager, talented international job seekers as well.

6.0 Program Resource Needs Present and Future

Faculty of the Oceanography Department, Hawaii Institute of Marine Biology, and Joint Institute for Marine and Atmospheric Research (JIMAR) at UH-Manoa and the Pacific Aquaculture and Coastal Resources Center at UH-Hilo constitute the core group supporting the CMR program. Faculty members from departments within other schools and employees of the NOAA Fisheries

(adjacent to the Manoa Campus) also have expressed a desire to participate in the program. Table 2 provides a summary of the individual faculty members and their current research interests, and professional affiliations. The curriculum vitae of each faculty member are attached as Appendix H. We do not anticipate that faculty commitments to the CMR program will conflict with or have a negative impact on current research and teaching commitments. The limited number of new courses developed for this program will be initially taught by visiting and affiliate faculty, and funded using external funds. We expect that participating faculty members' individual research programs will benefit from the academic training received by graduate students enrolled in the program and working as research assistants.

Physical resource requirements for the CMR program include: access to classrooms and laboratory space to support instruction and access to laboratory space, library, and computer resources to conduct graduate student research. We estimate that two to four courses will be offered specifically for the CMR program per semester and this demand for classroom space can be accommodated, especially since there generally is greater flexibility in scheduling graduate-level courses compared to undergraduate classes. Laboratory exercises in support of classroom activities will be carried out in existing lab space under the control of the course instructor; no additional laboratory facilities are required. Office space for graduate students also will be provided from existing allocations. Present computer resources within HIMB, SOEST, and Information Technology Services support research conducted by graduate students supervised by HIMB and other SOEST faculty. We anticipate that this will be sufficient to meet the demands of the proposed program. The use of resources to support the CMR program will not create negative impacts on existing programs.

Most of the students enrolled in the CMR program will be supported by graduate assistantships funded by research grants. While research is an important part of graduate education, we recognize the importance of teaching experience in providing future faculty with a more complete view of academia.

For the first five years, the program will be funded to the maximum extent possible via external grants and contracts. After the required fifth-year review, we will request permanent status for

the program. Along with the request for permanent status, we will submit a request for two tenure-track positions plus start-up funds, a faculty specialist program coordinator, and office manager, and two graduate teaching assistants. Estimated costs associated with these hires are:

Faculty [2 @ $100,000 + $75,000 start-up]	$350,000
Program Coordinator	$ 80,000
APT	$ 40,000
Graduate Teaching Assistant [2 @ $30,000]	$ 60,000
Total:	$530,000

Some of the additional faculty expertise requirements for the program may be met as the Department of Oceanography and Hawaii Institute of Marine Biology continue to fill vacant positions. In that case, of course, we will not seek additional hires; the above figure represents an upper bound on estimated costs. We will continue to seek external funding for this project in support of research, honoraria for guest lecturers, travel for students to attend national meetings in their respective fields for purpose of presenting research results, and internships.

7.0 Program Efficiency

Indicators of program efficiency include students per faculty, average class size, and anticipated cost per student. These indicators are projected for the CMR program and are tabulated below with similar data for a sampling of other applied science programs, namely, Civil Engineering (CE), Ocean and Resources Engineering (ORE), and Molecular Biosciences and Bioengineering (MBBE). The number of graduate students in the MBBE program is an aggregate of students in the Molecular Biosciences and Bioengineering (M.S. and Ph.D.) and Bioengineering (M.S.) graduate programs. Average class size is also an aggregate of the two graduate programs.

The number of graduate students per Faculty FTE ranges from 2.7 to 4.8. We have assigned a nominal 10 Faculty FTE to the CMR program, although all faculty participating as instructors and advisors to graduate students are housed in existing departments. Graduate class sizes for SOEST vary depending on whether the course is required or elective. Average class size is also

skewed by required one-credit graduate seminars with large enrollment, sometimes >25. Based on the projected number of graduate students, the number of courses in the CMR core curriculum, and estimates of course interest from students not enrolled in the CMR program, the anticipated class size for CMR is estimated to be 6.

Data on cost per student semester hour are also included in Table 6 for the 2000-02 academic years. This cost is the ratio of expenditures for staff and faculty salaries, benefits and program supplies to number of courses offered, enrollment and course credits. Unfortunately, this data is available only at the college level. Based on the data we have, it looks like the CMR program will be as efficient as similar programs at UH.

Table 6. Comparison of efficiency indicators for CMR and UH applied science programs.

	# G-Funded Faculty FTE[1]	# Graduate Students[2]	Graduate Students per G-Funded FTE	Cost per Student Semester Hour[3]	Average Class Size[4]
COE				$1,262	
CE	17.5	67	3.8		9
SOEST				$1,357	
ORE	5.0	24	4.8		6
CMR	~10.0	27	2.7		6
CTAHR				$1,124	
MBBE	17.4	49	2.8		16

[1]Source: Office of Human Resources, University of Hawaii. Data for Fall, 2002.
[2]Source: MAPS Reports, Headcount Enrollment of Credit Students by Major and Level, University of Hawaii at Manoa. Data for Fall 2002.
[3]Source: UH Manoa Expenditure Reports. Data for 2000-01 academic year.
[4]Source: MAPS Reports, Course Registration Report, University of Hawaii at Manoa. Data for Fall 2002.

8.0 Program Assessment Plan

Assessment of student learning is both a key indicator of program success and an important agent for change. In addition to a straightforward assessment of the skills listed in section 2.4 by faculty advisors, any assessment must include input from a variety of constituencies and "stakeholders." These include the students themselves, alumni, and faculty; the university community, including the college that houses the program; and employers and potential employers of program graduates. Evaluation of student learning outcomes and the overall effectiveness of the CMR program will include:

1. pre- and post-testing of student knowledge in capstone courses
2. feedback from current students
3. feedback from external constituencies
4. teaching evaluations
5. periodic curriculum review
6. focus group interviews with students at various levels of the major
7. videotapes of student skills, such as oral presentations
8. follow-up with students who leave the program
9. analysis of performance in licensure and qualifying exams
10. exit interviews with graduates
11. comparison of student writing samples at entrance/exit
12. tracking of graduates career paths

Focus group interviews with students will be conducted by an independent, professional facilitator. The focus group will target program strengths and weaknesses and seek to identify ways in which to correct perceived weaknesses. Results of the focus group sessions will be presented to the graduate faculty by the facilitator.

A database of contact information for program alumni will be maintained by the program coordinator and the importance of keeping this data base current will be stressed during the exit interview. Using this database, period surveys of educational outcomes will be conducted to determine whether the program has adequately prepared the students to perform well in their chosen career. A description of each alumnus' employment situation will provide insight into career path choices made by program graduates.

Evaluation of student learning by employers will be sought using similar survey instruments. Employer feedback will include information on the expectations of the employer, the degree to which expectations have been fulfilled by the program graduate, and suggestions about how the program can be improved. Additional input will be sought via the advisory board, which will meet periodically to review and critique the program.

The Graduate Division reviews all graduate programs every five years. Review teams routinely include student learning outcomes information in their reports, and this information also will assist the graduate faculty in improving the program.

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Appendix A. Authorization to Plan

AUTHORIZATION TO PLAN AN ACADEMIC PROGRAM AT University of Hawaii at MANOA

1. Locus (School): School of Ocean and Earth Science and Technology

2. Convener of Planning Committee: Dr. Patricia Cooper, Interim Associate Dean, School of Ocean and Earth Science and Technology

3. Program Category: New, Multidisciplinary, Inter-institutional

4. Program Name: Coastal and Marine Resources

5. Level of Program or Major: Graduate

6. Degree or Certificate Proposed:

M.S., Ph.D.	Tropical Aquaculture
M.S., Ph.D.	Tropical Fisheries
M.A., Ph.D.	Marine Policy
M.A., M.S., Ph.D.	Sustainable Coastal & Marine Resources

7. Proposed Planning Period: March 2003 to February 2004
(If significant work has not been done during a one-year period, approval may be withdrawn)

8. Proposed Date of Implementation: Fall Semester, 2005

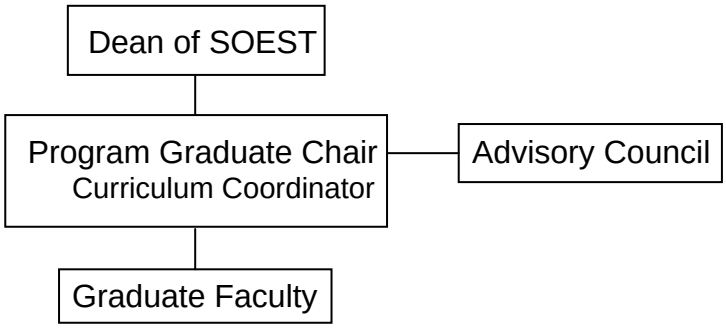
9. Program Description (Objectives and Relationship to Mission):
This proposal calls for the establishment of a joint UH-Hilo/UH-Manoa, modern, broad-based graduate academic program in Coastal and Marine Resources (CMR), with the objectives of training students in advanced tropical aquaculture, tropical fisheries, sustainable aquatic resources, and ocean policy, thus, serving an important sector of Hawaii's future diversified economy and establishing the University of Hawaii as a full partner in the State of Hawaii's growing fisheries and aquaculture industry. The CMR program will be flexible, emphasizing curriculum paths in Tropical Aquaculture (M.A., M.S., Ph.D.), Tropical Fisheries (M.S., Ph.D.), Sustainable Coastal Resources (M.S., Ph.D), and Coastal and Marine Policy (M.A., Ph.D).

The program is fundamentally multidisciplinary, in that it draws upon a broad intellectual base embracing the natural sciences, oceanography and the social sciences. Although based in SOEST for administrative purposes, the program will be inter-institutional in that UH-Hilo and UH-Manoa will partner to deliver coursework that transcends traditional academic boundaries. The program will be international,

hopefully, Pacific-wide, with partnerships and/or joint degree offerings in the Western United States and Canada, Mexico and Central America, New Zealand and other Pacific Island Nations and U.S. Territories, Japan, Korea, Southeast Asia and Australia.

The program will have a significant distance education component. Degree candidates will be able to complete required coursework on-line as appropriate. Field experience or internship will be required; international partnerships will permit students to obtain experience that is both scientifically and culturally relevant.

We propose the following structure for the CMR program:



The program will have a graduate chair appointed by the Dean of SOEST. We have obtained funding to hire a program coordinator through the Joint Institutes for Oceanographic and Atmospheric Research (JIMAR) Pelagic Fisheries program. This person will be responsible for the day-to-day academic administrative functions of the program as well as some student services. Clerical functions and student services will be absorbed by existing staff until the program is fully established; at that time, additional funds may be required to hire full-time clerical and/or student services staff.

The Advisory Council will consist of the CMR graduate chair, a representative from the Department of Business, Economic Development and Tourism (DBEDT) Energy Division; a representative from Department of Land and Natural Resources Division of Aquatic Resources; a representative from National Marine Fisheries Service, the Director of the UH Sea Grant program; representatives of deans who provide resources for the program; representatives of partner institutions. This body will be advisory to the graduate chair; its purpose is to keep the program current in theory, technology, and field applications. The chair of the Advisory Council will have a two-year rotation among the members. The program graduate chair will represent the interests of the Graduate Faculty.

10. Program Justification (Needs and Rationale):

Currently, there is no graduate training program at the University of Hawaii that encompasses aquaculture, fisheries, and coastal and marine policy. The Department of Oceanography offers a certificate program in Marine Policy, which

forms the basis for the Coastal and Marine Policy focus of this proposed CMR program. However, over the past ten years, the importance of climate change and variability requires that the scope of this program be broadened to include atmospheric as well as ocean. The American Meteorological Society considers the merging of ocean and atmospheric policy a high priority. Formal training in fisheries and aquaculture is available at the graduate level only as a matter of personal choice in one's research focus.

The CMR program is intended to form a foundation for the expansion of aquaculture and for the full and proper management of fisheries resources in the State of Hawaii. Diversification of Hawaii's economic base could benefit from improving its competitiveness in the world market for exported cultured seafood and cultured tropical flora and fauna.

On a regional scale, the aquaculture and fisheries industries rely increasingly on applied research and technology to remain competitive. The proposed program could also build the State's already significant strength in aquaculture consulting, a profession in which advanced degrees are highly desirable. The proposed program could become the center for education and training for Hawaii, the Pacific Basin, and Asia. UH has in place many of the basic requirements for establishing world leadership in tropical fisheries and aquaculture research and education, such as nationally and internationally recognized scientists, laboratories, equipment, and an ocean-going capability.

Over the years, UH has established cooperative relationships with major universities in Asia and the Pacific. These liaisons will channel the development of mutually beneficial formal and informal student and faculty exchanges. We believe that with no additional personnel and funding, the University can be in a position to become a major center of research and teaching of tropical fisheries and aquaculture for Hawaii, the Pacific and Asia by pooling resources with our partner institutions. The proposed program will enable in-state students to obtain graduate training in fisheries and aquaculture in Hawaii instead of going to the mainland and working with temperate instead of tropical species. The proposed program could also attract Pacific Basin students who now go to mainland or foreign institutions.

As research directed toward increasing the food supply ascends in importance, there will be greater opportunities for employment in academia and in public and private research. Professional consulting in aquaculture already is a rapidly growing activity that requires advanced degrees. Similarly, there will be a continuing need for highly qualified fisheries professional to characterize and manage the complex and often conflicting demands and constraints that determine the optimum sustainable level of harvesting of diminishing seafood stocks. These fields play an important role in Hawaii's present and future economy (see attached article from Hawaii Business magazine). Industry and government needs scientists to solve problems in the development of sustainable coastal and marine resources.

Partnerships with institutions in the Pacific Basin serve two purposes. First, it offers Pacific Island nations the opportunity to educate promising young men and women and mid-career administrators in the management and culturing of tropical coastal and marine resources with direct application to their own fisheries and aquaculture industries and policy development. Second, the program meets the joint commitment of the State of Hawaii and its University to support the developing nations of the Pacific region and Asia.

11. Activities to be Undertaken During the Planning Phase:

- Expand planning committee to include representatives of major stakeholders' groups
- Formalize the program's administrative structure;
- Develop timetable for implementation
- Document future needs and challenges
- Establish a Program Graduate Chair and hire a Program Coordinator, and define their roles and responsibilities;
- Create an academic-government-industrial advisory board;
- Survey stakeholders (students from targeted programs at Hawaii and mainland universities, professional societies, potential employers, State and federal research laboratories and agencies) to determine their needs;
- Define degree completion requirements;
- Finalize agreements for broadcast of distance education components;
- Finalize listing of faculty interested in affiliation with the program;
- Finalize MOUs with partner institutions and agencies
- Identify existing courses that can be used and those that need to be developed;
- Define admission requirements;
- Identify marketing requirements including budgets;
- Identify program needs with respect to administrative support;
- Identify extramural fund sources to support operational needs during probation period.
- Prepare catalogue listing

12. Description of Resources Required and Status or Sources:

Faculty: Faculty from several institutes and academic departments at both University of Hawaii at Manoa and University of Hawaii at Hilo have stated a desire to develop and participate in the program. Our goal is a fully integrated UHM-UHH program. Strong collaboration/partnering exists at the faculty and administrative levels between the University of Hawaii and the University of Guam, Tokyo University, Hokkaido University, Victoria University of Wellington, and the National Marine Fisheries Service. In preparation for submittal of the full proposal for this program, we will formalize cooperative agreements with these and other universities. Our goal is formal faculty/student exchange agreements and/or joint degree programs with international academic institutions.

Library Resources (including an evaluation of current resources and an estimate of the cost of additional resources required): The libraries currently maintained by SOEST and the University of Hawaii (Hamilton) are more than adequate to support the graduate program. Hamilton Library offers all major search engines for research publications as well as a fully serviced and well subsidized interlibrary loan program for all books and research papers that are not held within the UH system.

Physical Resources (space, equipment, etc.): SOEST resources already support 160 graduate students. We anticipate an initial enrollment of 5, gradually increasing to 40 over a period of 5 years. Although current space and physical resources at both UHM and UHH probably will be sufficient to accommodate the program during the initial ramp-up phase, we anticipate that additional space requirements will be identified during the planning phase.

Additional Resources Required (staff, graduate assistantships, etc.): Our intention is to support the program (staff, graduate assistantships, etc.) by aggressively pursuing external funding. The development of a systemwide graduate program at the University of Hawaii that involves partnerships with a variety of universities, agencies and corporations around the Pacific Rim and Basin presents a wealth of opportunities to pursue funding from the National Science Foundation in the following areas:

National Ecological Observatory Network (NEON): a system of environmental research facilities and state of the art instrumentation for studying the environment. Each node in NEON will be a regional observatory, comprised of a core site and associated sites that are linked via cyberinfrastructure. These observatories will be geographically distributed based on the US Forest Service defined ecoregions of the US. Observatories will be selected through an open merit review process. UH can logically be expected to participate in NEON by serving as a tropical site. It is anticipated that other nodes in the tropical ecoregion will include Puerto Rico and Costa Rica at the very least.

Environmental Research and Education: several directorates are represented within this consolidated section of NSF. Examples of funding opportunities that fall within this section include:

- Biocomplexity in the Environment, which has a number of competitions at any given time. Current competitions include but are not limited to
  - Coupled Biogeochemical Cycles 01/28/2003
  - Dynamics of Coupled Natural and Human Systems 11/19/2002
  - Materials Use: Science, Engineering, and Society 03/04/2003
  - Genome-Enabled Environmental Sciences and Engineering 12/17/2002
  - Instrumentation Development for Environmental Activities 11/19/200

- Centers for Research Excellence in Science and Technology (CREST) NSF 02-280: The CREST Program makes substantial resources available to upgrade the capabilities of the most research-productive minority-serving institutions. It develops outstanding research centers through the integration of education and research.
- Coastal Long Term Ecological Research (cLTER): The general mission of the cLTER Network is to understand ecological phenomena which occur over long temporal and broad spatial scales and provide information necessary for the identification and solution of environmental problems. (Hawaii provides a microcosm of temporal venues by virtue of our islands' moving over the hot spot, right?)

This degree offering would also position UH to successfully compete for funding from programs such as the Ecological Rates of Change, Ecological Diversity, and Water and Energy: Atmospheric, Vegetative, & Earth Interactions programs.

There are many other funding programs and agencies that UH could successfully tap as a result of the international and Pacific-wide nature of the collaborations suggested in the authorization to plan. This will enable UH and her partner institutions to compete for funding on a wider scale than ever before.

Estimate of Additional Position Counts and Budget Implementation for First Five Years of the Program: **No additional position counts will be requested for the first five years of the program.**

13. Does the Current or Proposed Budget Include funds or a Request for Funds for the Proposed Program? Please Provide Details:
No funds are requested for the program.

14. Given a "Flat Budget" Situation, How Will the Proposed Program be Funded?
The program's administrative needs will be met by hiring a coordinator using funds obtained from JIMAR. To minimize cost and duplication of effort, the proposed curriculum will build upon existing courses and university resources, and upon coursework under development by existing faculty specifically for this program.

15. Impact on Current Courses or Programs: The program is expected to have a positive impact on programs at UHH and UHM because the degree programs will attract students who otherwise would not have selected UH; the program will be directly supportive of graduate educational goals as identified by the Strategic Plan. The home unit of each instructor that contributes to the program will receive the returned tuition as incentive to participation.

16. If the Program is Multidisciplinary, Provide Evidence of Commitment for Support From the Colleges, Departments, Programs, and/or Individuals Expected to Participate:

Table 1 presents a list of faculty from institutes/departments who will develop new courses, cross-list their existing courses, and otherwise directly participate in the education of graduate students participating in the program. Also included are initial results of contacts with Pacific Basin institutions re: this proposed program.

17. Authorization to Plan Approvals

Department Chair(s)/Program Director(s):

Department Chair(s)/Program Director(s):

Chris Measures (Oceanography)	Signature	Date 4/15/03
Tom Schroeder (Meteorology/JIMAR)	Signature	Date see table 1
Charles Kinoshita (Mol. Biosc. & Bioeng.)	Signature	Date 4/16/03
Print Name	Signature	Date

College/School Dean(s):

C. Barry Raleigh (SOEST)	Signature Dean's Circ 8/14/03	Date 4/15/03
Jo-ann Leong (HIMB)	Signature	Date see table 1
Rick Rocheleau (HNEI)	Signature	Date see table 1
Andrew Hashimoto (CTAHR)	Signature per attached recommendation	Date 4/28/03
Lawrence Foster (LAW)	Signature	Date 4/11/03

Graduate Division Dean:
Comments and Recommendations:

Peter Carroll — Signature — 8/29/03
Print Name — Signature — Date

Appropriate Vice Chancellor:
Comments and Recommendations:

Karl Kim — Signature — 9/5/03
Karl Kim (VCAA) — Signature — Date

Chancellor: ✓ Approve ___ Disapprove ___ Defer
Comments and Recommendations:

Peter Englert — Signature — 9/9/03
Peter Englert — Signature — Date

Department Chair(s)/Program Director(s):

		3 July 03
Kevin Hopkins (Pacific Aquaculture & Coastal Resources)	Signature	Date
		7/10/03
Don Hemmes (Natural Science Division)	Signature	Date
		7/7/03
Marcia Sakai (School of Business)	Signature	Date

College/School/Dean (s):

Michael Collier (CAFNRM)	Signature	Date
		7/8/03
Stephen Hora (CAS)	Signature	Date

Graduate Division
Comments and Recommendations:

		7/7/03
Jim Juvik	Signature	Date

Appropriate Vice Chancellor:
Comments and Recommendations:

		7/14/03
Christopher Lu (VCAA)	Signature	Date

Chancellor: ✓ Approve ___ Disapprove ___ Defer
Comments and Recommendations:

		7/15/03
Rose Tseng	Signature	Date

Table 1		
Jo-Ann Leong	HIMB	
John Sibert	JIMAR-PFRP	
Gordon Grau	Sea Grant	
Patricia Cooper	SOEST	
Ed Laws	Oceanography	
James Szyper	Sea Grant	
Robert Howerton	Sea Grant	
Clyde Tamaru	Sea Grant	
Fred Mackenzie	Oceanography	
PingSun Leung	CTAHR	See attached
Kim Holland	HIMB	Decline as written – please see attached
Eric DeCarlo	Oceanography	

Table 1, continued		
Casey Jarman	Law	Casey Jarman
Rick Rocheleau	HNEI	
Tom Schroeder	Meteorology	
Francisco Arreguin-Sanchez	CICIMAR-IPN Baja Calif. Sur Mexico	See attached.
Nathan Evans	U. of the S. Pacific Fiji	See attached.
Kohei Ueda	Kagoshima U. Japan	See attached.
Marcia Haws	PACRC/UH-Hilo	
Lorenz Magaard	IPRC; Internat. Ctr. for Climate and Society	Lorenz Magaard

Appendix B. Faculty/Stakeholder questionnaires to determine interest in program.

The following questionnaire was sent Via Email in December 2003 to 70 UH faculty and staff members as well as 90 other non-University stakeholders with possible interest in a Fisheries, Aquaculture, Marine Policy and Sustainability graduate program. Tallies of responses are shown in parentheses on the questionnaire.

Dear Colleague,

Attached you will find a copy of the recently approved Authorization to Plan for a U.H. graduate degree program entitled Coastal and Marine Resources (CMR). The CMR program will be flexible, emphasizing curriculum paths in Tropical Fisheries, Tropical Aquaculture, Marine Policy, and Sustainable Coastal and Marine Resources. The objectives of the program are to provide training to students in advanced aquaculture, fisheries, marine policy and coastal resources technology, thus serving an important sector of Hawaii's future diversified economy and establishing Hawaii as a center for Pacific Rim marine resource management.

As you may have some expertise and interest in this area, we are asking you to take a few moments and to assist us in the planning process by answering a few questions below. We plan on completing a preliminary version of the full program proposal soon and will then be scheduling several stakeholder meetings to which you will be encouraged to attend and give input.

Please reply to any applicable questions below by interspersing your answers and comments throughout the text below. Also, feel free to contact me directly if you have any questions.

Thanks in advance for taking the time to complete this.

Dan

Daniel P. Lindstrom, Ph.D.
Coordinator
Coastal and Marine Resources Program

Do you think UH should have graduate degree programs in:

Tropical Aquaculture	yes (23)	no (3)
Tropical Fisheries	yes (22)	no (0)
Sustainable Coastal Resources	yes (20)	no (4)
Coastal and Maine Policy	yes (24)	no (0)

What degrees should be offered (MS, MA, PhD)?	MS (21), MA (15), PhD (22)	
Are you willing to serve:		
As thesis/dissertation advisor to students in the programs?	yes (19)	no (5)
On the thesis/dissertation committees of students in the programs?	yes (23)	no (3)
On the technical advisory board?	yes (21)	no (4)
On the curriculum coordinating committee?	yes (17)	no (8)
You may have been contacted because of a course you currently offer.		
Would you be willing to develop new courses in your area of expertise?	yes (20)	no (4)
You may have been contacted because of a course you currently offer.		
Would you be willing to put your coursework on-line?	yes (9)	no (2)

Please provide the contact information for person(s) you think may be interested in participating:

The following questionnaire was sent Via Email in September 2000 to UH faculty with possible interest in a Fisheries and Aquaculture graduate program. A summary of responses are shown in table 7.

Dear People,

Ed Laws and I have been trying to resurrect the process to establish a graduate program in aquaculture and tropical fisheries. We feel that such a program has great potential, but will need to utilize the aquaculture and tropical fisheries resources throughout the UH system. As you have (or have had) an interest in aquaculture and/or tropical fisheries, we are asking you to take a few minutes to assist us in the planning process.

1. Do you think UH should have a graduate program in aquaculture?

2. Do you think UH should have a graduate program in tropical fisheries?

3. If yes, what degree(s) should be offered? Examples: M.S., M.A., Ph.D.

4. Are you willing to teach in such a graduate program(s)?

5. If yes, are you willing to teach via distance education?

6. What courses do you teach or would want to teach for such a program(s). Please indicate their current frequency of offering and typical number of students.

7. Are you willing to serve on graduate committees for such a program(s)?

8. Please review the list of potential faculty below, edit your interests and provide names of other persons who you think should be included in this planning effort. (Please note that this e-mail is the first notice about the current effort so none of the persons listed have yet committed to teach in the program(s).

Dr. Harry Ako - CTAHR, nutrition
Mr. Peter Boucher - UHH, aquaculture engineering
Dr. Richard Brock – UH Sea Grant Extension, tropical fisheries
Dr. Thomas Clarke – HIMB, fish ecology
Dr. Marta DeMaintenon - UHH, mollusc biology and culture
Dr. Arlo W. Fast - HIMB, crustacean aquaculture and water quality
Dr. Gordon Grau - UH Sea Grant extension, endocrinology of fishes
Dr. David Greenfield – UHM Zoology, ichthyology
Dr. Paul Haberstroh - UHH, water quality
Dr. Leon Hallacher - UHH, biology of fishes
Dr. Maria Haws - UHH and UH Sea Grant, mollusc culture, BMPs, coastal zone mgt.
Dr. Kim Holland – HIMB, fish ecology
Dr. Kevin Hopkins - UHH, general aquaculture and fisheries management
Dr. Robert Howerton - UH Sea Grant extension, general aquaculture & water quality

Dr. Edward A. Laws - SOEST, water quality and environmental impacts
Dr. Cheng-Sheng Lee - CTSA, fish reproduction
Dr. Jo-Ann Leong – HIMB, virology
Dr. Ping S. Leung - CTAHR, aquaculture economics
Dr. Spencer R Malecha - CTAHR, crustacean aquaculture
Dr. Bruce Mathews - UHH, water quality and environmental impacts
Dr. Karla McDermid - UHH, seaweed culture
Dr. Michael Parsons - UHH, algal culture
Dr. Craig Severance - UHH, cultural anthropology and fisheries management
Dr. YC Shang - CTAHR, aquaculture economics
Dr. John Stimson – UHM Zoology, population ecology
Dr. James Szyper - UH Sea Grant extension, algal & general aquaculture
Dr. Clyde Tamaru - UH Sea Grant extension, fish reproduction & general aquaculture
Dr. Jaw Kai Wang - CTAHR, aquaculture engineering
Ms. Sharon Ziegler-Chong - UH Sea Grant extension, general aquaculture & training

Thanks for your assistance.

Best regards,
Kevin Hopkins
Interim Director
Pacific Aquaculture & Coastal Resources Center
University of Hawaii at Hilo
200 West Kawili Street
Hilo, Hawaii 96720
Telephone (808) 933-0706

Table 7. Graduate Program Survey Results as of (9/18/2001)

Name	Aquaculture Program?	Fisheries Program?	Type of Degrees	Willing to Teach	Distance Ed?	Courses to be taught Name	Frequency & # students	Graduate Committee?
Peter Boucher	Y	Y	MS & PhD	Y	not sure	aqua eng, water quality, facility design	Aqua Eng 1/yr 5-10 students	not sure
Kevin Hopkins	Y	Y	MA & MS,intially	Y	Y	aqua 262, 350, 351, 425, 475; agen 400	all courses are offered 1/yr.	Y
Kim Holland	Y	Y	all + diploma & short course	Y	Y	tagging & electronec devices in fisheries research; fish movement patterns and fisheries mgmt.	na	Y
Leon Hallacher	N	Y	MS or MA	N	na	na	na	M
PingSun Leung	Y	Y	MS & PhD	Y	M	aquaculture econ and modeling		Y
Arlo Fast	*	*	*	N	N	none	none	Y
Edward Laws	Y	Y	MS & PhD	Y	Y	ocn 320 - aquatic pollution		Y
Gordon Grau	*Y	*Y	MS & PhD	Y	Y	Graduate seminar in enviromental physiology of fishes		Y
Harry Ako	Y	Y	MS & PhD	Y	Y	Biochemistry	1/yr to about 100 students	Y
Clyde Tamaru	Y	Y	MS & PhD	Y	Y	fish repro, controlled maturation & spawning, larval culture, live feed production		Y

Name	Aquaculture Program?	Fisheries Program?	Type of Degrees	Willing to Teach	Distance Ed?	Courses to be taught Name	Frequency & # students	Graduate Committee?
David Greenfield	na	na	na	na	na	na	na	na
Jim Szyper	Y	*M	MS/?	Y	*M	I'm flexible to the program		Y
Craig Severance	*Y	*Y	applied MS w/enviro and research PhD.	*Y	*M	Looking to develop a UG course in fishing communities and fishery mgmt.		Y
John Stimson	Y	N	MS & PhD	N	na	na	na	Y
Cheng-Sheng Lee	Y	Y	MS & PhD	*Y	*Y	Reproduction, Early life history of fish, Live food biology and culture, aquaculture mgmt, and general aqua.		Y
JoAnn Leong	Y	Y	MS & PhD	Y	Y	Marine Biotechnology & Fish Disease	na	Y
Maria Haws*	Y	Y	MS & PhD	Y	Y	Mollusk culture, coastal resource management		
Howard Takata*	Y	Y	MS & PhD	Y	Y	General aquaculture, extension		
Sharon Ziegler-Chong*	Y	Y	MS & PhD	Y	Y	General aquaculture, extension		
Bob Howerton*	Y	Y	MS & PhD	Y	Y	General aquaculture, water quality		
* Based on oral interview								

Appendix C. Program Requirements of other Institutions Similar to CMR Degree

The follow are examples of the requirements of several domestic graduate programs with a similar focus to areas of the proposed CMR Program.

University of Washington:

School of Aquatic & Fishery Sciences (http://www.fish.washington.edu/)

Degree Programs

The School of Aquatic & Fishery Sciences offers two graduate degrees, the Master of Science and Doctor of Philosophy, each requiring the preparation of a thesis or dissertation, respectively. Students entering without a Master's Degree are assumed to be working for that degree. The completion of a Master's Degree is normally required before application can be made to enter the Doctoral Degree program. In exceptional cases, however, the student, after completing at least a year in the Master's program, may petition the School of Aquatic & Fishery Sciences to bypass the Master's Degree and complete the Doctoral Degree program. The procedures and requirements necessary to accomplish this are outlined in the section on the Doctoral Degree program.

School of Aquatic & Fishery Sciences Core Courses: The following core courses required of all PhD and MS students and must be taken as part of the doctoral program if they or their equivalents have not been taken during the MS program before admission to doctoral studies.

- QSCI 482, Statistical Inference in Applied Research, 5 credits
- FISH 510-514, Current Topics series (offered credit/no credit only), 2 credits each, students are required to complete at least two of these courses (each course must be a different number, such as 510 and 512) during their graduate program.
- FISH 521, Research Proposal Writing, 4 credits.
- FISH 522, Hot Topics in Aquatic & Fishery Sciences (offered credit/no credit only), 2 credits.
- FISH 800, Doctoral Dissertation (offered credit/no credit only), 27 credits minimum; a maximum of 10 dissertation credits may be taken in any one academic quarter; the 27 credits must be taken over at least three-quarters.

Additional course requirements include at least 12 credits of coursework at the 400-500 level in addition to the Required Core Courses listed above. At least nine of the additional 12 credits must be numerically graded and at least four must be in 500-level courses. The student in consultation

with his or her Supervisory Committee chooses the specific courses. If any of the above core required courses are waived, students should plan to make up those missed credits under additional course requirements.

Degree requirements for the Ph.D. are set in part by the Graduate School and in part by the School of Aquatic & Fishery Sciences. The Graduate School sets University-wide requirements for minimum scholarship (a GPA of 3.0 or higher), residence at the University of Washington (see above), certain numbers of required credits and continuous enrollment; the School of Aquatic & Fishery Sciences sets the required curriculum and has added some credit requirements to the University minimums. The course curriculum is designed to provide breadth and, at the same time, depth in the disciplines related to the dissertation research. The number of credits required to do this varies, depending on the area of specialization involved and the previous preparation of the student, but all students getting a PhD from the University of Washington need to accumulate a total of 90 credits at the graduate level.

School of Marine Affairs (http://www.sma.washington.edu/index.html)

Degree Program

The Master of Marine Affairs (M.M.A.) degree is granted by the School of Marine Affairs, an academic and research unit of the College of Ocean and Fishery Sciences. The M.M.A. degree program is a two-year graduate course of studies requiring the completion of 59 quarter credits. Designed to familiarize students with a diversity of conceptual and methodological approaches and substantive areas in Marine Affairs, the required credits are distributed among the following topics:

The Core Curriculum (26 credits minimum)

- *Introduction to Marine Affairs*
- *Integrated Marine Affairs Practice*
- *Policy Processes*
- *Marine Law*
- *Marine Science*
- *Economics*
- *Policy analysis*
- *Quantitative Skills*
- *Qualitative Skills*

Electives (23 credits minimum)

The Thesis and Thesis Presentation (10 credits minimum)

Career Skills (non credit requirement)

William and Mary/Virginia Institute of Marine Science:

Fisheries Science (http://www.fisheries.vims.edu/)

Students interested in graduate study in Fisheries Science should have a solid under-graduate background in biology including: physiology, biochemistry, comparative morphology or developmental biology, genetics, ecology and related topics, and evolutionary biology. College physics, chemistry (through organic) and math through calculus are required. Courses in statistics, marine biology and fishery biology may be helpful but are not prerequisites.

In addition to the core courses required of all SMS graduate students, Fisheries students are required to take Marine Fisheries Science (MS 528) and an additional quantitative course such as Experimental and Quantitative Ecology (MS 667), Mul-tivariate Analysis and Time Series (MS 625); Applied Regression and Forecasting (MS 672); or Stock Assessment Methods (MS 670). Among the courses offered by the Fisheries faculty are Fisheries Climatology (MS 665), Ichthyology (MS 666), Diseases of Marine Organisms (MS 566), Malacology (MS 668), Marine Fisheries Science (MS 528), Culture and Physiology of Marine Organisms (MS 571), Early Life History of Marine Fishes (MS 657), Fisheries Population Dynamics (MS 671) and Marine Molecular Genetics (MS 673).

University of Maryland – College Park:

Marine Estuarine Environmental Science Graduate Program, Fisheries Science (http://www.mees.umd.edu/areas_fishsci.htm)

The multidisciplinary nature of fisheries science requires broad training in areas that may include ecology, oceanography, aquaculture, economics, mathematics, seafood technology, pathology and diseases, and management science. Students select a curriculum, with assistance from their Research Advisory committees, to best achieve their academic and professional goals.

The program in fisheries offers both M.S. and Ph.D. degrees. Graduates at either level may expect to find challenging career opportunities.

Course work and research undertaken by MEES students emphasize three fields of study:

<u>Fisheries Ecology</u>
Basic studies in fish and invertebrate population biology, food webs, recruitment and life history processes, predator-prey and competitive interactions, diseases, and effects of habitat conditions.

<u>Fisheries Management</u>
Basic and applied studies on the effects of exploitation, pollution and habitat change on fish and invertebrate populations. Assessment of resources and their potential yields. Development of models and information useful for management of living aquatic resources. Students with outstanding credentials in economics, mathematics, or operations research may request Fisheries AOS co-chairs to waive certain pre-requisites.

<u>Fisheries Aquaculture</u>

Research on the culture of aquatic organisms and the development of aquaculture systems. A broad disciplinary area that includes ecology, physiology, chemistry, genetics, seafood technology, diseases and pathology, engineering, economics and management under its auspices.

Prerequisites include the Bachelor's degree in the natural sciences or other field with a strong quantitative emphasis, including
1. Two semesters of Calculus
2. Two semesters of Introductory Chemistry
3. Two semesters of Organic Chemistry, Biochemistry, or Physics
4. Two semesters of Introductory Biology (or high placement test, high GRE Biology scores)
5. Advanced Biology courses, such as Ecology and Ichthyology, are recommended

Five core courses are offered and at least three must be successfully completed by all students entering the Fisheries Science AOS. The requirements may be waived if equivalent course work has been obtained elsewhere, or if the student and his or her Research Advisory committee successfully petition the AOS Committee.

1. Fisheries Science and Management - covers the basic principles of aquatic productivity, fish/invertebrate population biology, harvest and conservation of resources, assessing yield potentials, and fishery management practices.

2. Fisheries Ecology - covers the biological processes that affect productivity, abundances, and distributions of fish and invertebrate resources. Includes life history theory, predator-prey relationships, bioenergetics, trophic ecology, and zoogeography.

3. Aquaculture - covers the theory and practices of modern aquaculture of fishes and invertebrates. Includes coverage on water quality, production systems, extensive and intensive approaches, culture genetics, fish diseases, and management.

4. Quantitative Fisheries Science - covers factors affecting the stability and resilience of exploited marine and estuarine populations. Basic ecological models and applied fisheries models are presented in theoretical and practical frameworks. It is recommended that either Fisheries Science and Management or Fisheries Ecology are taken prior to this course.

5. Graduate Level Course in Oceanography (physical, chemical or biological) or Stream Ecology - covers major and minor elements, composition of seawater, seawater ionic structure and interactions, nutrient distributions, biogeochemical cycles, and the biology of marine organisms. Students will obtain most of their academic course work from a broad array of relevant courses presently available throughout the University System of Maryland. Each student and his or her Research Advisory Committee will design a course of study to be approved by the Fisheries AOS. Curricular requirements are purposefully flexible, yet rigorous, to accommodate the diverse needs of students in fisheries science. In addition, the following core courses are required:

6. A 400 or 600 level course from one of the other MEES AOSs (from an approved list, which can include items 2, 4, and 5)

7. One course or seminar in Environmental Management (item 1 or 4 satisfies this requirement; any such 3-4-credit course can satisfy item 6)

8. A course in Statistics/Biostatistics (600 level for the Ph.D., 400 level for the M.S.)

9. Courses in Experimental Design and Analysis and in Scientific Writing are strongly recommended

10. One graduate level seminar for each year in residence (on average)

University of Delaware:

Graduate College of Marine Studies: Marine Policy

(http://www.ocean.udel.edu/graduate/marpol/marpol.html)

The Marine Policy Program examines the economic, legal, political, and social aspects of the world ocean, the seabed, and the coastal zone. Students and faculty in the program analyze public issues regarding the law of the sea, ports and shipping, marine minerals, ocean and coastal zone management, fisheries, naval affairs, marine biotechnology, and the global environment, frequently making recommendations for policy at the regional, national, and international level.

The master of marine policy, a two-year professional degree created at the University of Delaware, prepares students for careers in research, management, and administration in marine-oriented government agencies, private associations, and business firms. For a few highly qualified students who already hold an advanced degree in marine policy or a related subject and who generally have some experience in policy research or management, the Ph.D. in marine (policy) studies is available.

DOCTOR OF PHILOSOPHY DEGREE REQUIREMENTS
(Ph.D. in Marine Studies with Concentration in Marine Policy)

Course Requirements

Meet **equivalency requirements**, that is, have taken and passed with a grade of B or better, graduate courses equivalent to the required courses in the M.M.P. program other than College distribution course and seminar series (See Section 5, Admissions, in Graduate Policy Statement.

Twelve credit hours in a disciplinary concentration. Courses that are required for M.M.P. may not be counted. The concentration program must be approved by the advisor.

Three credit hours in Research and Methodology.

Three credit hours in Marine Policy Seminar. This does not apply to students who fulfilled requirement during M.M.P.; however, M.M.P. students may take seminar three more times during Ph.D.

One course outside of her/his home program (minimum of 3 credits). This may include one of the specially designed introductory courses or a more advanced course. Students may not test out of these courses. This does not apply to students who fulfilled requirement during M.M.P.

Introductory courses outside of this program include:
MAST 601 Introduction to Oceanography (3)
MAST 627 Marine Biology (3)

Minimum of 21 graduate credits (not to include research/dissertation credits).

Dissertation: 9 credits

Additional graduate-level course work as determined by advisory committee.

Other Requirements:

Advisory **committee selection** and **dissertation proposal** (to be completed by the end of the student's third semester). Committee approves proposal.

Ph.D. qualifying examination

Defense of dissertation.

MASTER OF MARINE POLICY REQUIREMENTS
(Master of Marine Policy)

Course Requirements

Minimum of **33 graduate course credits** (not to include thesis/ research credits)

Core courses:

MAST 670 U.S. Ocean & Coastal Policy

MAST 873 Marine Policy Seminar(1) is required to be taken three times.

Twenty-one graduate credits in marine policy and related courses which must include **MAST 675**, **MAST 676**, and **MAST 677**.

MAST 817 Research Design and Methods (3) or **MAST 672** (3) Applied Policy Analysis

One course outside of her/his home program (minimum of 3 credits). This may include one of the specially designed introductory courses or a more advanced course. Students may not test out of these courses.

Introductory courses outside of this program include:
MAST 601 Introduction to Oceanography (3)
MAST 627 Marine Biology (3)

Thesis credits, a minimum of six (6) credits of **MAST 869**, (will not count toward minimum of 33 course credits).

Other Requirements	**Additional graduate-level course work** as determined by advisory committee. Advisory **committee selection** and **thesis proposal** (to be completed by the end of the student's second semester). Committee approves proposal. **Defense** of thesis.

Appendix D. Suggested Curricula.

The following list resulted from a questionnaire distributed to members of the Pelagic Fisheries Research Program Principal Investigators Workshop held in December, 2003 at The University of Hawaii at Manoa. The investigators were asked to list what they thought were the top three academic courses absolutely necessary for someone with a graduate degree in fisheries.

PFRP-PI, GRADUATE FISHERIES CURRICULUM SURVEY 12/03

Course Title	Number of respondents out of 16 Who indicated this a one of their top 3
Oceanography (Physical, Biological)	6
Marine Ecology	5
Marine Resource/Fisheries Economics	5
Statistics/Experimental Design	5
Marine Policy	4
Social/Cultural Aspects of Fisheries	3
Population Dynamics	2
Aquaculture	1
Bartending	1
Commercial Recreational and Subsistence Fisheries of the World	1
Ecological Modeling & Statistics	1
Environmental Studies	1
Fisheries History (Case Histories, Philosophy, Culture)	1
Fisheries Management Issues	1
Genetics and Evolution	1
Ichthyology	1
International Fisheries	1
Internship	1
Life History	1
Ocean Law	1
Physiology	1
Stock Assessment Methods	1
Marine System Dynamics	1

The following is a draft of a masters degree curriculum in aquaculture endorsed at the Summer 2002 meeting of aquaculture experts and producers sponsored by the USDA-funded project entitled "Bridging gaps to ensure long-term viability of small tropical mariculture ventures in Hawaii and the US-affiliated Islands.

General Description (DRAFT)

MA and MS – Masters in Tropical Aquaculture Production

Entry Requirements

BA or BS from accredited undergraduate institution and consent of admissions committee (which determines that the student should be able to complete the program).

Total Number of Hours 36 semester hours

Required Courses

6 hrs- practicum - 600 hours (at least 300 hrs in production situation)
or
6 hrs. Research and Thesis

3 hrs – Culture of Finfish
3 hrs – Culture of Algae and Seaweeds
3 hrs – Culture of Invertebrates
3 hrs – Health Management in Aquaculture
3 hrs – Nutrition and Feeding in Aquaculture
3 hrs – Water Quality/Aquatic Productivity
3 hrs – Economics of Fisheries and Aquaculture
3 hrs – Selective Breeding of Aquatic Organisms
3 hrs – Aquacultural Engineering
3 hrs – Fisheries Biology

Suggested Alternatives or Electives (for persons who have credit for above-listed courses as undergraduates)

3 hrs - Advanced Aquacultural Engineering
3 hrs - Legal and Social Aspects of Aquaculture
3 hrs - Marketing Aquatic Products
3 hrs - Processing Aquatic Products
3 hrs – Fish Diseases and Parasites

Appendix E: Existing UHM Course Descriptions Relevant to CMR

Agricultural and Resource Economics (AREC)

AREC 610 Biosystems Modeling (3) Introduction to system thinking, procedures for developing system models, characteristics of important agricultural system modes, computer approach to evaluation and optimization of system models. A–F only. Pre: MATH 242 or consent. (Cross-listed as BE 638)

AREC 624 Research Methodology (3) Philosophical setting for scientific inquiry, scientific method and its antecedents, application in agricultural economics research. Original research project required. Pre: 634 and ECON 608, or consent.

AREC 626 Econometrics I (3) Review of probability, estimation, small sample and asymptotic properties. Bivariate and multiple regression and matrix algebra formulation. Regression diagnostics. Introduction to heteroskedastidity, autocorrelation, simultaneity, dichotomous variables, advanced topics. Pre: NREM 310 or ECON 321, and MATH 241; or consent. (Cross-listed as ECON 628)

AREC 634 Econometrics II (3) Specification, statistical estimation, inference, and forecasting of economic models. Includes advanced topics for single-equation models, pooled models, qualitative dependent variables, simultaneous systems, distributed lags, and time series. Pre: 626, ECON 628 or consent. (Cross-listed as ECON 629)

AREC 694 Economics of Marine Resources (3)

Animal Sciences (ANSC)

ANSC 360 Topics in Aquaculture Science (3) Survey of specific areas in aquaculture including biological, physical, economic aspects of intensive/extensive crustacean, fish, mollusc, aquatic plant culture; terrestrial system integration. Pre: 200 and 201, or BIOL 171; or consent. **DB**

ANSC 445 Genetics and Animal Breeding (3) Review and application of genetic principles to livestock, poultry, companion, aquatic, and laboratory research animals. Current practices and future developments. Pre: BIOL 222, ZOOL 101, or equivalent; or consent. Recommended: biochemistry and genetics or equivalent. **DB**

ANSC 450 Aquaculture Production (3) Theory and practice of aquaculture: reproduction, yield trials, management, economics and business case studies of fish, crustaceans, and molluscs. Field classes held at commercial farm and hatchery. Repeatable. Pre: 200 (or concurrent) and 201 (or concurrent), or BIOL 172 (or concurrent). (Cross-listed as OCN 450) **DB**

ANSC 460 Biology and Culture of Shrimp and Prawns (2) Aspects of the biology and culture of the freshwater prawn Macrobrachium rosenbergii and marine shrimp Penaeus (sp) species. Scientific research results and case studies presented and analyzed. Pre: BIOL 222, ZOOL 101, or equivalent; or consent.

ANSC 603 Experimental Design (4) (3 Lec, 1 3-hr Lab) Design of experiments and variance analyses in biological and agricultural research. Pre: NREM 310 or ZOOL 631. Recommended: ZOOL 632. (Cross-listed as TPSS 603)

ANSC 642 Advanced Animal Nutrition (3) An advanced course in the nutrition of mono-gastric, ruminant, avian, and aquatic species. Topics include digestive system structures, utilization of nutrients, energy metabolism, and experimental techniques used in the study of animal nutrition. Pre: introductory biochemistry or animal nutrition; or consent.

Anthropology (ANTH)

ANTH 415 Ecological Anthropology (3) Relationship of humans with natural environment; role of culture in ecological systems. Pre: 200 or consent. **DS**

ANTH 427 Food, Health, and Society (3) How human groups identify, collect, create, and transform foods; how they shape those into dietary behaviors, and the influence of those behaviors on health. Pre: 150 (or concurrent) or 200 (or concurrent), or consent. **DS**

ANTH 430 Human Adaptation to the Sea (3) How people from prehistoric to modern times have sailed, fished, or otherwise exploited and enjoyed the sea; how the sea has molded human life. Pre: upper division standing or consent. **DS**

ANTH 480 (Alpha) Anthropological Applications (3) Anthropological theory, method, and data applied to problems in specialized fields. For students in professional fields who lack anthropological background; (B) development; (C) health; (D) education. (480D cross-listed as EDEF 480) **DS**

ANTH 481 Applied Anthropology (3) Methods and results in application of anthropological concepts to the practical problems of agricultural, commercial, and industrial development. Pre: 200 or consent. **DS**

BioEngineering (BE)

BE 401 Modeling and Simulation of Dynamic Systems (3) Introduction to analytic solution of differential equations. Modeling and computer simulation of dynamic systems encountered in bioengineering with design applications. A-F only. Pre: BIOL 171, CHEM 171, EE 160, MATH 243, and PHYS 170; or consent.

BE 431 Environmental Biotechnology (3) Environmental impact and control; the micro-organism and its nutrition and growth conditions; microbial growth and substrate removal kinetics; bioreactors; biological treatment systems; biodegradation of xenobiotic organic chemicals; case studies. A-F only. Pre: consent. Spring only. **DP**

BE 437 Biosystems Unit Operations (2) Pumps and fans; size reduction; cleaning and sorting; materials handling; processing of fruits, nuts, vegetables, animals, and other bio-products. Pre: PHYS 151. **DP**

BE 440 Bioremediation: Principles and Practices (3) (2 Lec, 1 3-hr Lab) Soil environment, fate and transport of contaminants; microbial ecology, metabolism, and energy production; biodegradation of selected compounds. In situ treatment, solid-phase bioremediation, slurry-phase bioremediation, and vapor-phase biological treatment. Open to nonmajors. Repeatable once. Pre: 360, CHEM 161, MATH 241 and 206, PHYS 170, or consent. **DP**

BE 460 Bioreactor Design and Analysis (3) Application of mass/energy balances and reaction kinetics for the design and analysis of bioreactors for microbial, plant, and animal cell cultures. Pre: CHEM 161, PHYS 170, and MATH 241; or consent. **DP**

BE 604 Aquaculture Systems (3) Study and review of fundamental principles and mechanisms critical to understanding and operating aquaculture systems. Engineering, business, and operating analyses. Pre: CEE 320, CHEM 151, and MATH 241.

BE 606 Instrumentation and Measurement (3) Measurement concepts and operating principles applied to the selection and use of instruments important to scientists and engineers dealing with biological systems, including automatic data acquisition and processing. Pre: CHEM 151, MATH 241, and ME 311; or consent.

BE 610 Advanced Food Processing Technology (3) Principles and applications of new methods of food preservation. Repeatable. Pre: FSHN 401 and FSHN 403, or equivalent; or consent. (Cross-listed as FSHN 610)

BE 622 Experimental Methods in Cause-Effect Modeling (3) Factorial designs and fractional factorial designs for screening variable and response optimization. Response surface methodology. Experimental designs appropriate to building and testing multi-variable behavior relationships. Sequential experimental designs.

BE 634 Biological Treatment (3) Fundamentals of applied microbiology and biochemical reactor engineering, quantitative description of microbial growth, operational theory and design basis of aerobic, anoxic and anaerobic treatment processes. Applications for water, wastewater, air, solid wastes, and soil. (Cross-listed as CEE 634)
BE 635 Irrigation System Design (3) Hydraulics of surface irrigation, volume balance analysis and irrigation efficiency, optimal length of run and irrigation scheduling; sprinkler irrigation system design, distribution, and uniformity; drip irrigation system design and related problems. Pre: 435 or consent.

BE 638 Biosystems Modeling (3) Introduction to system thinking, procedures for developing system models, characteristics of important agricultural system models, computer approach to evaluation and optimization of system models. Pre: MATH 242.

BE 648 Biosystems Simulation (3) Discrete and continuous simulation models and their application in design and management of engineering and biological systems.

Botany (BOT)

BOT 455 Analysis of Biological Data (3) Application of computers to analysis of biological data; preparation and storage, report production, database analysis procedures, univariate and bivariate statistical analyses. Pre: BIOL 172 or consent.

BOT 480 Algal Diversity and Evolution (4) (3 Lec, 1 3-hr Lab) Principles of algal diversity, structure, and evolution. Identification of common Hawaiian algae. Pre: one of 101, BIOL 172, MICR 351, ZOOL 101, or consent. **DB**

BOT 482 Adaptations of Plants to Marine Environment (3) Morphological, physiological, cellular, and molecular examples of adaptation to marine environments by marine macroalgae, phytoplankton, and sea grasses. Pre: 480. (Alt. years) **DB**

BOT 482L Adaptations of Plants to Marine Environment Lab (1) (1 3-hr Lab) Laboratory exercises emphasizing current research tools and opportunities in algal/sea grass physiological ecology. Repeatable once. Pre: 482 (or concurrent); or consent. **DY**

BOT 652 Population Biology (3) Theory and applications of population biology; behavior of population models, as revealed by analytical methods and computer simulation; application to population problems such as endangered species; discussion of classical and current literature in population biology. Pre: an upper-level ecology course and MATH 215 or MATH 241; or consent. (Cross-listed as ZOOL 652)

BOT 680 Marine Macrophytes Seminar (2) Discussion of current literature in physiological ecology, cellular and molecular adaptations to environmental factors by marine plants. Repeatable four times. Pre: 480.

BOT 690 Conservation Biology (3) Theories and concepts of ecology, evolution, and genetics for conservation of biological diversity. Topics will include restoration ecology, management planning, laws and policies, biological invasions. Pre: 453 or ZOOL 439, 462 or ZOOL 480. (Cross-listed as ZOOL 690)

Cell and Molecular Biology (CMB)

CMB 650 Population Genetics (3) Mathematical, observational, experimental results on effects of mutation, selection, and systems of mating on distribution of genes. Analysis of non-experimental populations. Pre: 601 or consent.

Civil Engineering (CEE)

CEE 630 Water Resources Systems Planning and Management (3) Planning and management of multiobjective water resources systems to achieve a sustainable development. Using EIA/EIS for project alternatives evaluation to attend optimal balance in economic development and environmental quality enhancement. A-F only. Pre: students with a B.S. degree or senior standing in civil and environmental engineering; or consent.

CEE 634 Biological Treatment (3) Fundamentals of applied microbiology and biochemical reactor engineering, quantitative description of microbial growth, operational theory and design basis of aerobic, anoxic and anaerobic treatment processes. Applications for water, wastewater, air, solid wastes, and soil. A-F only. Pre: consent. Fall only. (Cross-listed as BE 634)

CEE 635 Environmental Chemistry (3) Basic concepts of chemistry as related to the environment, with more emphasis on water. Topics include chemical kinetics, equilibrium, acid-base, precipitation and dissolution redox reactions, sorption, organic chemicals in the environment. Pre: consent.

CEE 636 Water Quality Biology (3) Fundamental microbiology involved in environmental engineering processes and research with special emphasis on mixed culture systems, biochemistry, and microbiological aspects of water supply protection and wastewater treatment. Pre: consent.

CEE 641 Marine Disposal of Wastewaters (3) Types of wastes, their treatment and disposal; water quality standards; oceanographic variables and related data collection; diffusion and dispersion of effluent; ocean outfall design; ecological problems with pollutants; engineering problems with outfalls. Pre: consent. (Alt. years)

CEE 644 Water Quality Modeling (3) Mathematical formulation of pollutant transport and mixing in the water environment. Kinetics formulation and parameter identification, model calibration and verification. Design projects. Pre: 422 and 431, or consent.

Economics (ECON)

ECON 458 Project Evaluation and Resource Management (3) Principles of project evaluation and policy analysis. Shadow pricing, economic cost of taxes and tariffs; public policy for exhaustible, renewable, and environmental resources. Pre: 301. (Cross-listed as NREM 458) **DS**

ECON 604 Microeconomics and Policy Analysis (3) Theory of the consumer, firm, and market. Role of governments and analysis of public policy. Applications to both industrialized and developing countries. Pre: 301 and one of AREC 210, MATH 203, or MATH 241; or consent.

ECON 637 Resource Economics (3) Analysis of problems of development and management of natural resources with emphasis on resources in agriculture and role in economic development. Pre: 608, AREC 634, and NREM 432; or consent. (Cross-listed as NREM 637)

ECON 638 Environmental Resource Economics (3) Principles of policy design and evaluation for environmental resources management, forestry and watershed conservation, and sustainable economic development. Pre: 604 or 606; or consent.

Geography (GEOG)

GEOG 435 Political Geography of Oceans (3) The oceans' evolution and relation to problems of economic development, resources, seapower, shipping, trade. Pre: 335 or consent. **DS**

GEOG 455 Resource Management (3) (2 Lec, 1 3-hr Lab) Hands-on development of analytical models for application to problems of water resource, coastal fisheries, agroforestry, and/or land management. Focus on problems facing Hawai‘i and the Pacific. Pre: 101, 445 or AREC 410 (or equivalent), and SOCS 225 (or equivalent); or consent. May be taken concurrently with 445 or AREC 410. **DS**

GEOG 488 Geographic Information Systems (3) Design, implementation, and use. Database construction and documentation. Techniques for spatial data manipulation and display. Evaluation of existing systems. Student research projects. Pre: 375. **DS**

GEOG 628 (Alpha) Resource Systems (3) Resource development and use in a time perspective. Ecological and socioeconomic impacts, concepts, definitions, and methodology. (B) renewable; (C) nonrenewable. Pre: consent.

GEOG 637 Environment and Development (3) Theories and practice of development; how changing development paradigms shape different ideas concerning the environment and the management of natural resources; emerging debates in development and environment in post-modern era. (Cross-listed as PLAN 637)

GEOG 639 Planning for Rural Development (3) Rural development theories and policies. Planning and spatial aspect of Asian and Pacific development: integrated development, agropolitan development and rural industrialization. Pre: PLAN 630 or consent. (Cross-listed as PLAN 639)

GEOG 693 Technology and Natural Risks Methods of Analysis (3) Survey of tools for evaluating risks to human health from technological and natural hazards. Historical and international context of methods. Pre: consent.

GEOG 752 Research Seminar: Resource Management (3)

GEOG 765 Research Seminar: Coastal and Marine Geography (3)

Law (LAW)

LAW 503 Wildlife and Natural Resources Law (V) Seminar covering federal and Hawai‘i laws that govern the management of wildlife resources, with a particular focus on wildlife conflicts arising in Hawai‘i.

LAW 512 Environmental Compliance and Regulated Industries (V) In depth study of the federal and state environmental laws that impact modern businesses and industries, and exploration of the compliance issues that arise under the statutes, regulations and case law.

LAW 527 Topics in Environmental Law (V) An entry-level course focusing on current topics and developments in environmental law.

LAW 528 International Environmental Law (3) Study of the international regulation of activities and processes used to prevent environmental degradation and to preserve resources of environmental value. Pre: 585 (or concurrent).

LAW 529 Environmental Litigation Seminar (2) Seminar on the techniques, law, and strategy involved in federal and state court environmental litigation.

LAW 549 Admiralty Law (3) Introduction to U.S. maritime law and admiralty jurisdiction emphasizing development of rules of maritime law and rights of seamen and maritime workers.

LAW 582 Environmental Law (3) Basic policy questions and problems concerning environment. Examination of federal and Hawaiian statutes. Focus on environmental problems of Hawai‘i.

LAW 585 International Law (3) Evolving process of formulating rules to govern nations and peoples of the world in their attempts to solve problems recognized as requiring global solutions.

LAW 588 Legal Aspects of Water Resources and Control (2) Legal aspects of water and water rights with focus on Hawai‘i.

LAW 592 Domestic Ocean and Coastal Law (3) Examination of the history of United States and Hawai‘i sea-use law; comprehensive coverage of modern issues concerning the use of the sea including special Hawaiian problems.

LAW 593 International Ocean Law (2) Examination of the history of international sea- use law, including comprehensive coverage of modern problems and issues concerning the use of the sea among nations. Repeatable once.

Mathematics (MATH)

MATH 471 Probability (3) Probability spaces, random variables, distributions, expectations, moment-generating and characteristic functions, limit theorems. Continuous probability emphasized. Pre: 244 or 253 (or concurrent), and 371; or consent.

MATH 472 Statistical Inference (3) Sampling and parameter estimation, tests of hypotheses, correlation, regression, analysis of variance, sequential analysis, rank order statistics. Pre: 471 or consent.

Molecular Biosciences and Biosystems Engineering (MBBE)

MBBE 401 Molecular Biotechnology (3) General principles, applications, and recent advances of the rapidly growing science of biotechnology. Topics include impact of biotechnology on medicine, animal sciences, environment, agriculture, forensics, and economic and socio-ethical issues. Pre: BIOL 275 or consent. (Cross-listed as BIOL 401) **DB**

MBBE 412 Environmental Biochemistry (3) Biochemical and chemical principles of occurrence, distribution, biotic and abiotic conversion, fate, and impact of synthetic and natural molecules in the environment. Important pollutants will be used as case studies to illustrate the principles. A-F only. Pre: CHEM 152 or CHEM 272 and CHEM 162 or 171; or consent. Spring only. (Cross-listed as PEPS 412) **DB**

MBBE 607 Advanced Food Science I (3) Advanced topics in chemical and physical characteristics of foods as well as their role in human nutrition. Repeatable one time. A-F only. Pre: graduate student status with undergraduate courses in organic chemistry, microbiology, additional biological science, physics, and biochemistry. Basic knowledge of food science is expected; or consent. Fall only. (Cross-listed as FSHN 607 and TPSS 607)

MBBE 608 Advanced Food Science II (3) Advances in sensory quality and evaluation, deterioration of foods and food safety, as well as food processing technology. Repeatable one time. A-F only. Pre: graduate student status with undergraduate courses in organic chemistry, microbiology, additional biological sciences, physics, and biochemistry. Basic knowledge of food science is expected; or consent. Spring only. (Cross-listed as FSHN 608 and TPSS 608)

MBBE 609 Advanced Food Safety (3) Real and perceived food hazards, their ethical issues and implications, advanced emerging topics in food safety, and controls, including laws and regulations of food safety issues and public perception of food safety will be discussed. Repeatable one time. A-F only. Pre: graduate student status with undergraduate courses in biochemistry, microbiology, food processing, physics and organic chemistry. Basic food science knowledge is required; or consent. Spring only. (Cross-listed as FSHN 609 and TPSS 609)

Natural Resources and Environmental Management (NREM)

NREM 432 Natural Resource Economics (3) Introduction to the economic theory of optimal management of natural resources and the environment. Property rights, externalities and welfare economics, non-renewable and renewable resource management and regulation, pollution control in theory and practice. Pre: ECON 301 or consent. **DS**

NREM 458 Project Evaluation and Resource Management (3) Fundamentals of benefit-cost analysis with extensions to environmental impacts and projects; case studies. Pre: ECON 301 or consent. (Cross-listed as ECON 458) **DS**

NREM 637 Resource Economics (3) Analysis of problems of development and management of natural resources with emphasis on resources in agriculture and role in economic development. Pre: 432, AREC 634, and ECON 608; or consent. (Cross-listed as ECON 637)

NREM 670 Agrarian Systems Analysis (3) Comparative analysis of philosophy and process of interdisciplinary and participatory approaches to sustainable development and rural resource management including farming systems research and extension (FSRandE), agroecosystem analysis (AEA), participatory action research (PAR), and rapid rural appraisal (RRA). Repeatable. Pre: consent. (Cross-listed as TPSS 670)

NREM 671 International Agricultural Systems (2) Analysis of trends and strategies in international agricultural research and development. International agricultural research centers (IARC), Food and Agriculture Organization (FAO), university networks and consortia, and private voluntary organizations (PVOs). Pre: graduate standing or advanced undergraduate standing, and consent.

NREM 691 Advanced Topics in Natural Resources and Environmental Management (V) Study and discussion of significant topics and problems at an advanced level. Offered by visiting or existing faculty as a special course. Repeatable. Pre: graduate standing or consent.

Ocean and Earth Science and Technology (OEST)

OEST 735 Ocean Policy Seminar (2) Interdisciplinary approach to problems relating to humans and their interactions with the world's oceans and coasts. Theme changes each semester. Repeatable.

Ocean and Resources Engineering (ORE)

ORE 620 Marine Bioprocess Engineering (3) Mass and energy balances in marine bioproducts processing, primary and secondary metabolism products of marine organisms, biokinetics, stoichiometry and energetics in cell growth, metabolism engineering and yield improvement, properties and markets of marine bioproducts. A-F only. Pre: consent.

ORE 621 Bioreactor Design (3) Application of hydrodynamics, thermodynamics, gas exchange rates, physics of light, and microbial kinetics to the design of bioreactors. Emphasis placed on marine bioproducts and integration with product separation and processing systems. A-F only. Pre: consent. Co-requisite: 620.

ORE 641 Environmental Fluid Dynamics (3) Fluid dynamics for coastal and estuarine environments. Turbulent mixing processes in homogeneous and stratified fluids. Buoyancy driven flows, internal hydraulics, topographic effects and estuarine circulation. Spill and pollutant dispersal. Pre: 603 or consent.

ORE 642 Marine Environmental Remediation (3) Thermodynamics, chemistry and measurements of marine pollutants, biodegradation and biotransformation of pollutants, symbiosis and mass transfer in biofilms, bioremediation of oil spills, hazardous sediments, algae control, regulations on marine environment. Pre: consent.

ORE 661 Coastal and Harbor Engineering (3) Planning and design of seawalls, groins, jetties, breakwaters, and layout of ports. Design requirements for harbor entrances and channels. Littoral drift and sedimentation problems. Navigation and mooring requirements. Pre: 607 or consent.

ORE 664 Nearshore Processes and Sediment Transport (3) Sediment transport by waves and currents in coastal areas and its effect on morphological processes. Effect of man-made structures on littoral drift and shoreline. Pre: 607 or consent.

ORE 677 OTEC Systems (3) Ocean thermal energy conversion (OTEC) systems, thermodynamics, alternative processes, co-products, and environmental context. Pre: ME 311 or equivalent.

Oceanography (OCN)

OCN 331 Living Resources of the Sea (3) Marine fisheries, aquaculture, and law of the sea. Principles of management of renewable resources. Political and scientific constraints and limitations. Pre: 201. **DB**

OCN 450 Aquaculture Production (3) Theory and practice of aquaculture: reproduction, yield trials, management, economics, and business case studies of fish, crustaceans, and molluscs. Field classes held at commercial farm and hatchery. Repeatable. Pre: ANSC 200 (or concurrent) and ANSC 201 (or concurrent) or BIOL 172 (or concurrent). (Cross-listed as ANSC 450) **DB**

OCN 621 Biological Oceanography (3) Factors governing productivity, population dynamics, distribution of organisms in major ecosystems of the ocean, emphasis on ecology of pelagic zone. Pre: 620 or consent.

OCN 626 Marine Microplankton Ecology (4) (3 Lec, 1 3-hr Lab) Distribution, abundance, and ecology of marine microplankton, including bacteria, algae, and protozoans, with an emphasis on metabolic rates and processes. Pre: consent. Spring only.

OCN 627 Ecology of Pelagic Marine Animals (4) (3 Lec, 1 3-hr Lab) Ecology of pelagic animals including feeding, energetics, predation, and anti-predation tactics. Life-history strategies, vertical flux of materials, population dynamics, fisheries. Pre: consent. Spring only.

OCN 628 Benthic Biological Oceanography (4) (3 Lec, 1 3-hr Lab) Processes controlling the structure and function of benthic communities, including organism-sediment-flow interactions, sediment geochemistry, feeding strategies, recruitment, succession, and population interactions. Pre: consent. Spring only.

OCN 633 Chemical Oceanography Lab Methods (2) (1 Lec, 1 2-hr Lab) Lab and field analytical techniques. Pre: consent.

OCN 638 Earth System Science and Global Change (3) Global view of the planet and how it functions as an integrated unit. Biogeochemical processes, dynamics, and cycles, and analysis of natural and human-induced environmental change. Chemical history of ocean-atmosphere-sediment system and co-evolution of the biota. Repeatable once. Pre: BS in environmentally related science or one year of chemistry, physics, and calculus. (Cross-listed as GG 638)

OCN 645 Marine Organic Geochemistry (3) Processes responsible for cycling of organic material in marine waters and sediments. Pre: 622, 623, and CHEM 272; or consent.

OCN 650 Math Techniques for Oceanographers (5) (3 Lec, 2 3-hr Lab) Introduction to numerical methods, data analysis, error propagation, box models, linear and nonlinear least squares, perturbation theory, numerical integration. Pre: MATH 244.

OCN 653 Methods in Microbiology Oceanography (3) (1 8-hr Lab) Modern methods for sampling microbial populations from the sea and for quantifying biomass and in siturates of metabolism. Integrated field projects, theme varies. Pre: 621 or 623, and 626; or consent.

OCN 664 Oceanographic Instrumentation and Technology (3) Measurement techniques in physical oceanography, including pressure, temperature, salinity, oxygen, optical sensors, current meters, navigation systems, ocean acoustics, and mooring structures. Includes a laboratory research project. Pre: 620 or consent.

Plant and Environmental Protection Sciences (PEPS)

PEPS 412 Environmental Biochemistry (3) Biochemical and chemical principles of occurrence, distribution, biotic and abiotic conversion, fate,
and impact of synthetic and natural molecules in the environment. Important pollutants will be used as case studies to illustrate the principles. A-F only. Pre: CHEM 152 or CHEM 272 and CHEM 162 or 171; or consent. Spring only. (Cross-listed as MBBE 412)

PEPS 422 Biocontrol of Invasive Species (3) Biological control of arthropods, weeds, plant pathogens, and vertebrates. Pre: 350, BIOL 171, or consent. Fall only. **DB**

PEPS 451 Environmental Law (3) Policies, regulations, acts, and laws that govern our interaction with the environment are explored. Analysis of the legal system's impact on the movement of invasive pests, control of agricultural and urban pests, agribusiness and property rights, endangered species protection and private land ownership rights, water resource management, and pollution effects. Pre: 350 or 363 or 405; or consent. Spring only.

Public Administration (PUBA)

PUBA 601 Policy and Organizational Processes (7) Organized in a series of integrated modules, the course addresses issues people in public service are likely to face. Modules include frameworks for understanding and improving organizations, administrative law and issues of discretion, budget processes, research and analysis relevant to public work, public service ethics, and concern for future generations. A-F only. Pre: 600. Spring only.

PUBA 662 Applied Policy Analysis (3) Explores significant contemporary policy issues relating to public administration practice. Develops analytic techniques and models of public policy-making processes, and looks at how social forces and political and economic pressures influence policy orientations. Pre: graduate standing and consent.

PUBA 663 Law, Economics, and Public Administration (3) Course uses economic thinking to explore U.S. law and the legal system with special application to public institutions. Topics include: underlying rationale of law; elements of property, contract, and tort law; evolution of administrative law, and economic efficiency of the common law system. Course explores economic forces that help shape the law, the effects of legal rules on economic behavior, and the implied role of public institutions. A-F only. Pre: graduate standing or consent. Fall only.

Public Health Sciences and Epidemiology (PH)

PH 655 Biostatistics I (3) Introduction to statistical methods for public health sciences. Probability, experimental design, t tests and analysis of variance, 2X2 contingency tables, linear regression, introduction to life tables. Pre: MATH 203 or MATH 205 or equivalent course in calculus, and graduate standing; or consent.

PH 656 Biostatistics II (3) Poisson distribution, Fisher’s exact test, contrasts in ANOVA, two way ANOVA, multiple linear regression and analysis of covariance, path analysis, logistic regression, method of maximum likelihood, likelihood ratio tests. Pre: 655, completion of one semester of calculus; or consent.

Zoology (ZOOL)

ZOOL 410 Corals and Coral Reefs (3) A course in the biogeography, evolution, ecology, and physiology of corals and coral reefs, and the application of this information to the management of coral reefs. Emphasis will be placed on processes such as dispersal, the evolution and operation of mutualisms, calcification, reproduction, and the maintenance of diversity. Pre: BIOL 265. Spring only.

ZOOL 465 General Ichthyology (3) Biology of fishes; reproduction, physiological processes, functional anatomy, behavior, ecology, distribution, and systematics. Pre: BIOL 265. Co-requisite: 465L. DB

ZOOL 465L General Ichthyology Lab (1) (2 2-hr Lab) Overview of the major orders and families of fishes of the world; introduction to local Hawaiian fishes; coverage of basic fish anatomy; introduction to field and laboratory techniques in fish research. Pre: BIOL 265. Co-requisite: 465. DY

ZOOL 466 Fisheries Science (3) General characteristics of fisheries; harvesting methods; principles and techniques to derive data and analyze fished populations. Field trips. Pre: some background in fish biology and aquatic ecology or consent. DB

ZOOL 467 Ecology of Fishes (3) Reproduction, early life history, age and growth, feeding, niche specificity, competitive interactions, communities, and evolutionary mechanisms. Pre: 465 or consent. DB

ZOOL 470 Limnology (2) Biology, physics, chemistry of lakes, streams, estuaries. Pre: BIOL 172 or consent. Co-requisite: 470L. DB

ZOOL 470L Limnology Lab (1) (1 3-hr Lab) Experimental and descriptive field projects on the biology, chemistry, hydrology, and physics of lakes, streams, and estuaries. Pre: BIOL 172 or consent. Co-requisite: 470. (Alt. years) DY

ZOOL 619 Seminar on Science Teaching (1) Effective teaching methods, organization of courses, lectures, laboratory exercises; development and evaluation of examinations; computers and audio-visual aids. Open to graduate students in various science disciplines. Repeatable one time. (Cross-listed as NSCI 619)

ZOOL 620 Marine Ecology (3) (2 Lec, 1 3-hr Lab) Principles of ecology of marine biota and environment. Pre: graduate standing in zoology, oceanography, or botany; or consent.

ZOOL 621 Evolutionary Ecology (4) (3 Lec, 1 Discussion) Interaction of evolutionary process with ecological principles. How do ecological interactions evolve? What ecological conditions affect evolutionary pathways? What is the nature and ecology of adaptation? What are the units of natural selection? Pre: 480 or consent. (Alt. years)

ZOOL 623 Quantitative Field Ecology (3) (1 Lec, 1 2-hr Lab, 1 Discussion) Formal quantitative approach in identifying, designing, performing, analyzing, and interpreting ecological field problems. Pre: 439, 439L, and 631; or consent. (Alt. years)

ZOOL 631 Biometry (4) (3 Lec, 1 2-hr Discussion) Basic statistical methods: design of studies; data exploration; probability; distributions; parametric and nonparametric one-sample, two-sample, multi-sample, regression, and correlation analyses; frequency tables. Pre: MATH 241 or consent.

ZOOL 632 Advanced Biometry (4) (3 Lec, 1 2-hr Discussion) Multivariate statistical methods: multiple regression and correlation; multiway anova; general linear models; repeated measures and multivariate anova; loglinear analysis and logistic regression. Pre: 631 and MATH 241, or consent.

ZOOL 652 Population Biology (3) Theory and applications of population biology; behavior of population models, as revealed by analytical methods and computer simulation; application to population problems such as endangered species; discussion of classical and current literature in population biology. Pre: an upper-level ecology course and MATH 215 or MATH 241; or consent. (Cross-listed as BOT 652)

ZOOL 666 Systematic Ichthyology (3) Review of the higher classification of the fishes of the world. Pre: 465.

ZOOL 690 Conservation Biology (3) Theories and concepts of ecology, evolution and genetics for conservation of biological diversity. Topics will include restoration ecology, management planning, laws and policies, biological invasions. Pre: 439 or BOT 453; 480 or BOT 462; and CMB 451. (Cross-listed as BOT 690)

ZOOL 710 Topics in Biometry (V) Selected advanced topics in experimental design or data analysis for biologists. Repeatable. Pre: 631 and 632, or consent.

ZOOL 716 Topics in Fish and Fisheries Biology (V) Lecture-discussion of various aspects.

ZOOL 750 Topics in Conservation Biology (V) Advanced topics in conservation and environmental biology. Repeatable three times. A–F only. Pre: consent. (Cross-listed as BOT 750)

Appendix F: Existing UHH Course Descriptions Relevant to CMR

AgEn 400 Aquaculture Engineering (3 lec., 1 lab) (4) (Y) Principles of site selection, design and construction of aquaculture systems. Pre: Aqua 262. (Same as Mare 400)

Ag En 435 Irrigation Principles and Practices (2 lec., 1 lab) (3) (Y) Comprehensive study of basic irrigation principles and practices. Basic hydraulics, water supply, conveyance, and measurement. Plant-soil-water relationship, evapotranspiration. and scheduling. Planning and design of irrigation systems. Pumps: types, selection and operation. Pre: College Algebra or consent of instructor.

AnSc 445 Animal Breeding and Genetics (2 lec, 1 lab) (3) (Y) Principles of Mendelian, population and quantitative genetics. Applications to improvement of livestock through selection methods and mating systems. Pre: AnSc 141 Math 121 or equivalent course is recommended.

Aqua 425 Water Quality & Aquatic Productivity (3 lec) (Y) Study of water quality, aquatic productivity, and the causes and consequences of water pollution, particularly in aquaculture and coastal ecosystems. Pre: Chem 124 or consent

Aqua 425L Water Quality & Aquatic Productivity Laboratory (1 lab) (Y) Hands-on education in the monitoring and management of water quality & algal populations in ponds & other aquatic systems. Pre: Aqua 425 or concurrent enrollment in Aqua 425 or consent

Aqua 450 Aquaculture Production Techniques (3 lec) (Y) Theory and practice of aquaculture techniques: identification, reproduction, hatchery and nursery operations, growout, health management, harvest and marketing, Pre: Aqua 262 or aquatic ecology or consent of instructor

Aqua 450L Aquaculture Production Techniques Laboratory (1 lab) (Y) Hands-on experience in hatchery, nursery and grow-out of algae, molluscs, crustaceans, and fish. Includes field trips. Pre: Aqua 450 or concurrent enrollment in Aqua 450 or consent

Aqua 466 Fisheries Science (3lec) (Y) General characteristics of fisheries; harvesting methods; principles and techniques to derive data and analyze fished populations. Pre: some background in fish biology and aquatic ecology or consent

Biol 381 Conservation Biology (3) (Y) Principles of conservation biology and their application to the maintenance and enhancement of biodiversity. Philosophical basis for conservation, scientific theories and research methods used by conservation biologists, and case studies of scientific and socio-political interactions in conservation problems. Prerequisites: Biol 270 and Biol 281 or consent of the instructor.

Biol 475 Fish Population Dynamics (2 lec., 1 lab) (3) (Y) (Aquaculture 475, College of Agriculture, may be taken for biology credit as Biol 475.)

Biol 484 Biology of Fishes (3) (AY) The biology of marine and freshwater fishes. Topics covered include: general anatomy, locomotion, respiration, osmoregulation, sensory systems, reproduction, electrosensitive and electrogenic fishes, coloration and bioluminescence in fishes, migratory patterns, trophic ecology, territorial behavior, and phylogenic interrelationships. Pre: Biol/Mare 171 of Biol 150 of their equivalent, or consent of the instructor. (Same as Mare 484)

Biol 484 L Biology of Fishes Laboratory (1 3-hr. lab) (1) (IO) Anatomy of jawless, cartilaginous and bony fishes. Review of common local reef fishes. Optional laboratory and field trips for Biology of Fishes. (Same as Mare 484L)

Econ 380 Natural Resource and Environmental Economics (3) (AY) An analytical framework for examining the relationships among environmental quality, natural resource use, and economic and political systems; analysis of circumstances that give rise to environmental problems, resource use conflicts, and possible policy solutions to these problems and conflicts. The course will emphasize issues pertaining to Hawai‘i. Pre: Econ 130.

Geog 326 Natural Resources (3)* (AY) Philosophy and history of the conservation movement in the United States. Ecological considerations in the management of renewable and nonrenewable resources. Current conservation issues in Hawai‘i. Pre: Geog 101 or consent of instructor.

Mare 475 Fish Population Dynamics (2 lec., 1 lab) (3) (Y) (Aquaculture 475, College of Agriculture, may be taken for marine science credit as Mare 475.)

NRes 320 Aquatic Pollution and Environmental Quality (2 lec., 1 lab) (3) (Y) Causes, consequences, and corrective measures for pollution of freshwater and marine systems by agricultural, industrial, urban, and recreational activities. Pollutant transport, soil erosion control, and treatment and utilization of bio-wastes. Sccientific, legal, and socio-economic aspects of human activities on the quality of coastal environments will be considered. Pre: Chem 124 or consent of instructor.

NRes 425 Marine Biogeochemistry (3) (Y) Marine biogeochemistry examines the chemical processes occurring in marine and estuarine waters, their impact on near shore and oceanic environments, and their connection to climatic stability. Topics include: origin of elements; differentiation of elements in Earth; formation of oceans; properties of water; seawater salinity; chlorinity; alkalinity; major and minor elements; dissolved gases in seawater; macro and micronutrients; dissolved and particulate organic matter; geochemistry of marine sediments; radiometric dating and stable isotope tracers of water mass mixing and residence time. Marine biogeochemistry is inherently interdisciplinary, involving aspects of biology, earth science, and physics as well as chemistry.

Appendix G: New Courses for CMR Degrees

Required New Classes (all 600 level or above)

- CMR Thesis Research (OEST 700) V hrs
- CMR Internship (OEST 699) V hrs
- CMR Sustainability Seminar (OEST 7xx) 1 hr

Case studies addressing contemporary topics and issues in sustainability, with emphasis on fisheries and ecosystems management; impacts of resource exploitation of water and energy; effects of pollution on marine and coastal resources, communities, and human health in Hawaii and the Pacific Basin.

- CMR Dissertation Research (OEST 800) V hrs

Additional Desired New Classes (all 600 level or above)

- Legal, Social and Cultural Aspects of Coastal and Marine Resources 3 hrs
- Health Management in Aquaculture 3 hrs
- Selective Breeding of Aquatic Organisms 3 hrs
- Aquaculture Feeds 3 hrs
- Fish Population Dynamics 3 hrs
- Culture of Finfish 3 hrs
- Culture of Algae and Seaweeds 3 hrs
- Culture of Aquatic Invertebrates 3 hrs
- Nutrition of Aquatic Organisms 3 hrs
- Advanced Aquaculture System Design 3 hrs
- Diseases of Aquatic Organisms 3 hrs
- Parasites of Aquatic Organisms 3 hrs
- Fishing Gear Design and Operation 3 hrs
- Fish Processing Technology 3 hrs
- Marketing of Aquatic Products 3 hrs
- Acoustic Surveying of Fish Populations 3 hrs

Appendix H: Faculty CVs

Curriculum vitae

Name: Harry Ako. Phone 808-956-2012, FAX 808-956-3542, e-mail hako@hawaii.edu

Training:

- Post-doctoral, 1973-1975, biochemistry, Univ. of Washington
- Ph.D., 1973, biochemistry, Washington State Univ.
- A.B., 1967, biochemistry, Univ. of California at Berkeley.

Professional experience (all at University of Hawaii):

- 2003-present. Chair (interim), Department of Molecular Biosciences and
- 2001-2 Bioengineering
- 2001-present Coordinator (chair), Plant and Environmental Biotechnology interdisciplinary undergraduate major program
- 1999-2001 Member, U.S. EPA. technical subgroup, ornamental fish,
- 1998-2000 Chair of chairs founding the emerging Department of Molecular

Biosciences and Biosystems Engineering

2000 Professor
1997-1998 Chair, Department of Environmental Biochemistry

- 2000-present Chair, Technical Committee, Center for Tropical and Subtropical
- 1994-1999 Aquaculture (annual election)
- 1982 Associate Professor, tenured; Dept. of Environmental Biochemistry
- 1976-1982 Assistant Professor, Department of Agricultural Biochemistry

Honors:

- 1988, Teaching award, 1988, National Association of Colleges and Teachers of Agriculture

Teaching:

- Biochemistry lecture and laboratory courses at least once a year.
- An active directed research program primarily for undergraduate students. Since last promotion approximately 30 students (mentorees) have gone on to the doctorate.

Grants. Totalling over $1.6 M in the following areas.

- Coqui frog control
- Marine ornamental and food fishes
- Freshwater ornamental and food fishes
- Fish flesh deterioration, tuna burning
- Kukui and Macadamia Nut Oils

Publications.

Refereed publications: Over 40 refereed publications in recirculating aquaculture, marine ornamentals, freshwater ornamentals (feeds and color enhancement), larval rearing of marine

finfish, stress resistance in marine finfish and DHA, fatty acid biochemistry (cosmetic oils and effects of fatty acids on human health) and including a biochemistry textbook.

Outreach publications. Nearly 40.

International presentations: Over 40 international research presentations, many of which were invited. These are primarily in the area of aquaculture though some have been received relating to teaching.

Ad hoc reviewer for papers and grants.

Marlin J. Atkinson

Department of Oceanography
University of Hawai'i at Manoa
1000 Pope Road
Honolulu, HI 96822
and
Hawaii Institute of Marine Biology
PO Box 1346
Kaneohe, HI 96744

EDUCATION

Ph.D. 1981 - Oceanography, University of Hawaii
M.S. 1976 - Aquatic Biology, University of Michigan
B.G.S. 1974 - Biology and Mathematics, University of Michigan

CURRENT GRANTS

- 1998-2001 Hyperspectral remote sensing of coral reefs in a tropical estuary. NASA & University of Hawaii: $225,998
- 1998-2001 CISnet: Linkages between a tropical watershed and reef ecosystem (co-Investigator with R. Kinzie). NOAA: $595,390
- 1999-2000 Computer modeling of Biosphere 2 coral reef biome. Biosphere 2: $25,000
- 1999-2001 Relative effects of seawater carbonate chemistry and nutrients on coral reef calcification. NOAA Sea Grant: $101,988, UH match: $15,865, Biosphere 2 match: $95,679
- 1999-2001 Impacts of endocrine disruptors on reproduction of coral from the Hawaii costal environment (co-PI with S. Atkinson) NOAA Sea Grant: $88,022, UH match: $55,008
- 1999-2004 Cottonwoods and Corals: Investigating CO_2 impacts on ecosystem processes using experimental approaches. Co-PI with W. Broecker, J. Berry, K. Griffin, Packard Foundation: $1,000,000

TEACHING ACTIVITIES
OCN 623 - Chemical Oceanography
OCN 643 - Biogeochemistry of Coral Reef
OCN 699, 700 - Directed and Thesis Research

MOST RECENT PUBLICATIONS

Baird, M.; M.J. Atkinson. 1997. Measurement and prediction of mass transfer to coral reefs. *Limnology and Oceanography*. 42(8):1685-1693.

Larned, S.; M.J. Atkinson. 1997. Effects of water velocity on ammonium and phosphate uptake and nutrient-limited growth in the macroalga, *Dictyosphaeria cavernosa*. *Marine Ecology Progress Series* 157:295-302.

Atkinson, M.J.; C. Bingman. 1997. Elemental composition of commercial seasalts. *Journal of Aquariculture and Aquatic Sciences* 8:39-43.

Crow, G.L.; M.J. Atkinson; B. Ron; S. Atkinson; A.D.K. Skillman; G.T.F. Wong. 1998. Relationships of water chemistry to serum thyroid hormones in captive sharks with goitres. *Aquatic Geochemistry* 4:469-480.

Atkinson, M.J.; H. Barnett; H. Anderson; C. Langdon; S.J. Carpenter; T. McConnaughey; E. Hochberg; M. Smith; B. Marino. 1998. The Biosphere 2 Coral Reef Biome. *Ecological Engineering* 13:147-171.

Tarrant, A.M.; S. Atkinson; M.J. Atkinson. 1998. Estrone and estradiol-17b concentration in tissue of the scleractinian coral, *Montipora verrucose*. *Comparative Biochemistry and Physiology* A 122:85-89.

Langdon, C.; T. Takahashi; F. Marubini; M.J. Atkinson; C. Sweeney; H. Aceves; H. Barnett; D. Chipman; J. Goggard. 1999. Effect of calcium carbonate saturation state on calcification rate of experimental coral reef. In Press *Global Geochemical Cycles.*

Atkinson, M.J. 1999. Topographical relief as a proxy for friction factors of reefs: estimates of nutrient uptake into coral reefs benthos. Proceeding of the *Hawaii Coral Reef Monitoring Workshop,* Honolulu, June 9-11.

Marubini, F.; M.J. Atkinson. 1999. Effects of lowered pH and elevated nitrate on coral calcification. In Press *Marine Ecology Progress Series* 188:117-121.

Hochberg, E.J.; M.J. Atkinson. 1999. Spectral discrimination of coral reef benthic types. In Press *Coral Reefs.*

PETER J. BOUCHER, P.E.
1537 Kalote Place, Hilo, Hawaii 96720

Experience:

Division Chief, Wastewater

1994–Present County of Hawaii, DEM Hilo, Hawaii

- Responsible for the operation and maintenance of the County's wastewater collection, treatment and disposal facilities; management of programs for the planning, design and construction of new facilities; and the collection of user and other fees.

Resident Engineer

1990–1994 R.M. Towill Corp. Kailua-Kona,

Hawaii

- Owner's on-site representative for construction of numerous public works projects including wastewater treatment plants and pump stations; airport administration facilities, mass grading, and other improvements.

Project Manager

1987–1990 Pan-Pacific Construction Honolulu, Hawaii

- Managed construction of several wastewater treatment plant upgrades and various other projects totaling over $40M for a large general contractor.

Project Engineer

1986–1987 Aquatic Farms, Inc. Honolulu, Hawaii

- Engineering design and management for several international aquaculture facilities, including marine shrimp hatcheries in Philippines and India and growout facilities in Indonesia.

Carpenter/Construction Superintendent

1972-1980

- Residential and commercial construction for several small to medium-sized contractors. Also responsible for numerous rural development projects as U.S. Peace Corps Volunteer in Fiji.

Education:

B.S. Civil Engineering

1980–1983 University of Texas Austin, Texas

- Concentration in Water Resources/ Environmental

M.S. Agricultural Engineering

1984-1986 University of Hawaii Honolulu, Hawaii

- Concentration in Aquaculture

Organizations: National Society of Professional Engineers, Water Environment Federation

Licenses: Registered Professional Engineer in Hawaii – Civil No. 6618
Certified Construction Contract Administrator

Activities: Family, Tennis, Boating, Soccer Coach, Part-time University Instructor

References: Available on Request

Julie H. Bailey-Brock
Professor, Department of Zoology
(Chair, Marine Biology Graduate Program)
Department of Zoology, University of Hawai`i
2538 McCarthy Mall, Edmondson 152
Honolulu, HI 96822
phone: (808) 956-6149
fax: (808) 956-9812
jbrock@hawaii.edu

Ph.D. University of Wales (Zoology), 1969

Research Interests: Marine invertebrate zoology; coral reef polychaetes; brackish water shrimp

My research is about invertebrates and especially polychaetes. Three large projects have been undertaken in my lab over the last 5-6 years: the disposal site deep benthic communities for the Army Corps of Engineers, the Mamala Bay studies for the Mamala Bay Commission, and the biomonitoring of benthic communities at the sewage outfalls for the City and County of Honolulu. Our work has focused on the polychaetes as this is the most species-rich taxonomic group found live at the outfalls, the 300-500m deep disposal sites, and at shallower depths in Mamala Bay. The sewage outfall study is designed (by EPA) to meet the requirements of the 301h waiver permit for the City to release advanced primary treated sewage at the Sand Island outfall. This is a great opportunity to study polychaetes and so far many new families and over 100 spp have been added to Hawaii's fauna. We have gained an enormous insight into the community structure, trophic response and ecology of benthic invertebrates at these depths. I also continue to identify polychaetes and other invertebrates from West Pacific and Hawaiian coastal habitats. I am working on collections from harbor waters, marinas and coastal habitats of Oahu, Guam, Fiji, Tonga, E. Australia, Malaysia and New Caledonia.

Representative Publications:

Bailey-Brock JH., J.Dreyer & R.Brock 2003. Three new species of *Saccocirrus* (Polychaeta) from Hawai‘i. *Pac Sci* 57:463-467.

Bailey-Brock JH.2003. Coral reef polychaetes of Guam and Saipan, Mariana Islands. *Micronesica* (35)36: 200-217.

Bybee, D. Bailey-Brock J.H. 2003. Effect of a Hawaiian open ocean fish culture system on the benthic community. World Aquaculture Society. 119-128.

Bailey-Brock et al. 2002. Polychaetes associated with a tropical ocean outfall: a synthesis Pac.Sci. 56:459-479.

Bailey-Brock JH, Brock VR, Brock RE. 1999. Intrusion of anchialine species in the marine environment: the appearance of an endemic Hawaiian shrimp, *Halocaridina rubra*, on the south shore of O‘ahu (Hawaii). *Pac Sci* 53:367-369.

Bailey-Brock JH. 1999. Nerillidae of Hawai‘i: two new records of interstitial polychaetes. *Pac Sci* 53:299-304.

Brock, R. , J.H. Bailey-Brock, J.Goody. 1999. A case study of the efficacy of fresh water immersion in controlling the introduction of alien marine fouling communities: the USS Missouri. Pac.Sci. 53: 223-231.

Bailey-Brock JH. 1995. Polychaetes of Western Pacific Islands: review of their systematics and ecology. Marine and Coastal Biodiversity in the Tropical Island Pacific Region. Vol. 1. Honolulu: E-W Center and Pac. Sci. Ass. 121-134.

Patricia A. Cooper

Interim Associate Dean (current), School of Ocean and Earth Science and Technology
University of Hawaii at Manoa, POST 802, 1680 East-West Road, Honolulu, HI 96822
808-956-9513 (tel); 808-956-9152 (fax); cooper@soest.hawaii.edu

Professional Preparation:
Rutgers University, New Jersey, 1971, B.A., with honors and with college honors
University of Hawaii, M.S., 1974, Geology and Geophysics
University of Hawaii, Ph.D., 1985, Geology and Geophysics
University of Hawaii, Hawaii Institute of Geophysics, 1986-1988, Postdoctoral Fellow

Appointments:
Specialist, School of Ocean and Earth Science and Technology (current)
Special Assistant to the Senior Vice President for Research and Dean of Graduate Division, University of Hawaii at Manoa , 1995-1998
Acting Assistant Dean, Graduate Division, 1994-1995
Associate Researcher, University of Hawaii, Geology and Geophysics Department, 1994-present
Assistant Researcher, University of Hawaii, Geology and Geophysics Department,1988-1994
Science Coordinator, Joint Oceanographic Institutions, 1988-90.

Representative Publications:
1998 Bryan, C. and P. Cooper, Ocean-bottom seismometer observations of seismic activity at Loihi Seamount, Hawaii, *Marine Geophysical Researches*, 17:485-501.

1994 Cooper, P. and L.W. Kroenke, Deep Seismicity in the North Fiji Basin, in L.W. Kroenke and J.V. Eade (eds.), *Basin Formation, Ridge Crest Processes and Metalogenesis in the North Fiji Basin, Earth Science Series*, Circum-Pacific Council for Energy and Mineral Resources, Houston, Texas 4:109-115.

1989 Cooper, P. and B. Taylor, Seismicity and focal mechanisms at the New Britain Trench related to lithospheric flexure, *Tectonophysics*, 164:25-40.

1987 Cooper, P., P. D. Milholland, and F. K. Duennebier, Microseismicity at the Galapagos 95.5° W propagating rift, *J. Geophys. Res*., 92:14091-14112.

1985 Cooper, P. and B. Taylor, Polarity reversal in the Solomon Islands, *Nature*, 314:428-430. [See also Reply to Comments by W.R.H. Ramsay, *Nature*, 318:392.]

Synergistic Activities:
Manoa International Education Committee, Vice-Chair
Hawaii Academy of Science, Past President
Association for Women in Science, Hawaii Chapter, Past President
Women Faculty Caucus, Chair, 1994-95
University of Hawaii Commission on the Status of Women, Chair, 1994-96, 2002-present
University of Hawaii Space Grant College, Mentor, 1990-91, 1994-95

Member of a three-member team which investigated and piloted the concept of "school without walls" where the community has become the schoolhouse for grade 5 level students at Kahala Elementary School, 1992.

Summer Program for the Enhancement of Basic Education (SPEBE) Center for Planetary Studies, Director, 1991, 1992 (enrichment program for high-school students)

Graduate Advisor: L. Neal Frazer, University of Hawaii at Manoa

Post-doctoral Advisor: Fred K. Duennebier, University of Hawaii at Manoa

Graduate Student Committees:
Martha Systrom (MS, 1991)
Carol Bryan (Ph.D., 1992)
Rick Hagen (Ph.D., 1993)
Devi Joseph (Ph.D., 1993)
Mark Dustman (MS, chair, 1994)
Zhiyong Zhao (Ph.D., 1997)
Jack Kronen (Ph.D., 1998)
Thomas Gorgas (Ph.D., 2001)
James Foster (Ph.D., chair, 2002)

Graduate Student/Post-Doctoral Support Provided:
Martin Kleinrock (postdoc, 1987)
Carol Bryan (1991)
Douglas Bergersen (1993)
James Foster (1994)
Mark Dustman (1994)

Eric DeCarlo

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Honolulu, Hawaii 96822
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Academic Degrees:

Ph.D. Chemistry (1982), University of Hawaii, Honolulu, Hawaii
M.S. Chemistry (1978), Old Dominion University, Norfolk, Virginia
B.S. Oceanography (1975), Cum Laude, Florida Institute of Technology, Melbourne, Florida.

Professional and Honor Societies:

American Chemical Society (member of Analytical, Geochemistry, and Environmental Chemistry Divisions), Hawaii Section: Secretary 1987, 1988, Chair-elect 1989, Chair 1990, Executive Committee 1991, Treasurer 1992, P.R. Committee 1993, Chair-elect 1999, Chair 2000)
American Geophysical Union
Geological Society of America
Hawaii Academy of Sciences (Treasurer, 2001)
International Association of Geochemistry and Cosmochemistry
Sigma Xi, (Admissions Committee 1989)

Military Service:

U.S.N.R., Mar 1973 Jul 1974, Aviation Reserve Officer Candidate (AVROC), Honorable Discharge.

Courses Taught:

(no date indicated for courses taught prior to 1996; level of effort expressed as percentage for team taught courses)

CHM 151, 161, 162, General Chemistry
CHM 253, Survey of Analytical Chemistry
CHM 274 and 274L, Principles of Analytical Chemistry and Lab
CHM 333, and 333L Instrumental Analysis and Lab
CHM 731, Special Topics in Analytical Chemistry: Atomic Spectroscopy (course I developed)
G&G 735, Analytical Methods in Geochemistry (team taught, 33%)
OCN 201, Science of the Sea (team taught: Fall1999, Fall 2000, Spring 2002, 33%; Sole Instructor: Summer 1996, 1999, 2000, 2001), Course Coordinator (Spring 2003)
OCN 201L, Science of the Sea Laboratory (team taught: Fall 2001, Spring 2002, 33%; This is a new course first taught in Fall 2001; I developed the geology section laboratories)
OCN 310L, Global Environmental Change Laboratory (team taught Fall 2001, 33%)
OCN 320, Aquatic Pollution (Summer 1997)
OCN 622, Geological Oceanography (guest lectures, various years)
OCN 623, Chemical Oceanography (guest lectures, various years)
OCN 631, Ocean Minerals (guest lectures, various years)
OCN 633, Chemical Oceanography Lab Methods (team taught, Fall 1996, Fall 1999, 33%, Fall 2002, Course Coordinator, 50%)
OCN 644, Sedimentary Geochemistry (guest lectures)
OCN 735, Heavy Metals in the Environment (course I developed)
OCN 780, Seminar in Oceanography (organizer, Fall 1999, Fall 2001)

Oceanographic Expeditions:

1982: USNS De Steiguer: February 12 25, 1982, Hawaii, Loihi Seamount, Puna Canyon.

1983: R/V Kana Keoki: Hawaiian glass cruise. March 1983 (ten days). Submarine rift zones of Hawaiian volcanoes. Hualalai, Mauna Loa, Loihi, Kilauea, Mauna Kea, Kohala.

1984: R/V Kana Keoki: Cruise KK84-04, Hawaiian EEZ manganese crust project. July 15 August 5, 1984. Northeast Hawaiian Islands.

1987: R/V Moana Wave. CCOP/SOPAC Mineral assessment program. February 5 March 3, 1987. Cruise MW87 02, Samoa, Cook Islands, Kiribati.

1988: D/V Joides Resolution. Ocean Drilling Program Leg 122. June 29 August 28, 1988. Exmouth Plateau, Australia

1991: D/V Joides Resolution. Ocean Drilling Program Leg 136. March 2-20, 1991. Central Pacific Ocean.

1996: D/V Joides Resolution. Ocean Drilling Program Leg 166. February 22-April 11, 1996. Bahamas Tansect.

1998: D/V Joides Resolution. Ocean Drilling Program Leg 180. June 10-August 11, 1998. Woodlark Basin.

2000: R/V Roger Revelle, May 24-June 28, 2000, EPREX cruise, East North Tropical Pacific Ocean

Other Research Expeditions:

1990: Pingelap Atoll, State of Pohnpei, Federated States of Micronesia, Hydrological/Water quality investigation, March 1990

1991: Sapwhafik Atoll, State of Pohnpei, Federated States of Micronesia, Hydrological/Water quality investigation, June 1991

CHARLES H. FLETCHER, III (Chip)
Professor of Geology and Geophysics
School of Ocean and Earth Science and Technology, University of Hawaii at Manoa
1680 East-West Road, Honolulu, HI 96822 , (808) 956-2582 ph, (808) 956-5512 fx
fletcher@soest.hawaii.edu

PROFESSIONAL PREPARATION

Ph.D.	1986, University of Delaware, Coastal Marine Geology
M.Sc.	1982, University of Delaware, Coastal Marine Geology
B.Sc.	1979, Albion College, Michigan, Geological Sciences & English Literature

APPOINTMENTS

2004-2007	Chair, Department of Geology and Geophysics
1997 - present	Professor, University of Hawaii
1993 - 1996	Associate Professor, University of Hawaii
1991 - 1992	Assistant Professor, University of Hawaii
1986 - 1990	Assistant Professor, West Chester State University (Pennsylvania)

RESEARCH INTERESTS AND ACTIVITIES

Coastal Sedimentary Geology Coastal sediment budget processes; coastal hazards; coastal morphodynamics and large-scale coastal change; inner shelf sedimentation.

Carbonate Reefs Coral reef history and sedimentation processes; carbonate substrate variability, sediment production and stratigraphy; remote sensing and reef community mapping.

HONORS, AWARDS, BOARDS

2004	Chairpersons Advisory Board – Hawaii Department of Land and Natural Resources
2003-present	Pan-Pacific Geology Workgroup – National Park Service
2003-present	National Research Council, National Needs for Coastal Mapping and Charting,
2002-present	Hawaii State Multi-Hazard Science Advisory Council (State Civil Defense)
2002	Fellow, The Geological Society of America
2002-present	JIMAR Senior Fellow, Joint Institute for Marine and Atmospheric Research, University of Hawaii at Manoa
2001-2003	Senator, University of Hawaii at Manoa Faculty Senate (elected)
2001-2003	Representative, Kailua Neighborhood Board (elected)
2001	Robert W. Clopton Award for Outstanding Service to the Community, University of Hawaii Board of Regents
2001	Hawaii Board of Land and Natural Resource, Resolution in Recognition of Distinguished Public Service
2000	Presidential Citation for Meritorious Teaching, University of Hawaii Board of Regents

GRADUATE STUDENTS - PRINCIPAL ADVISOR

In progress, Chris Conger (M.Sc.) Carbonate shelf substrate variability.
In progress, Ayesha Genz (M.Sc.) Forecasting using historical shoreline position.
2003, Mary Engels (M. Sc.) Environmental controls on reef accretion history – Molokai.
2002, Dolan Eversole (M.Sc.) Kaanapali, Maui shoreline variability this century.

2002, Tara Miller (M.Sc.) Sedimentology and shoreline variability at Waikiki, Oahu.
2002, John Rooney (Ph.D.) Littoral processes, sediment budget & shoreline history of Maui.
2001, Eric Grossman (Ph.D.) Hawaii sea-level history and reef development.
2001, Ebitari E. Isoun (M.Sc.) MultiSpectral mapping of reef habitat variability.
2001, Zoe Norcross (M.Sc.) Large-scale alongshore meanders on a carbonate beach.
2000, Jodi Harney (Ph.D.) The carbonate sediment factory.
2000, Clark Sherman (Ph.D.) Accretion and diagenesis of a submerged Pleistocene reef.
1999, Scott Calhoun (Ph.D.) A sediment budget for Hanalei Bay, Kauai.
1998, Melanie Coyne (M. Sc.) Historical shoreline mapping.
1997, Eric Grossman (M. Sc) Kapapa Stand of the sea: sea level in Hawaii 5000 BP to present.
1996, Rob Mullane (M. Sc.) Beach loss on Oahu.
1995, Scott Calhoun (M.Sc.) Geologic History of Hanalei Coastal Plain

FIVE RECENT PUBLICATIONS

1. Fletcher, C.H., Grossman, E. G., Sherman, C.E., Harney, J.N., Rubin, K., Murray-Wallace, C., Edwards, E. (accepted, in revision) Complex origin and structure of the Oahu carbonate shelf: Hawaiian Islands. Quaternary Science Reviews
2. Grossman, E.E. and Fletcher, C.H. (2004) Holocene Reef Development Where Wave Energy Reduces Accommodation Space, Kailua Bay, Windward Oahu, Hawaii, USA. Journal of Sedimentary Research, v. 74, no. 1, p. 49-63.
3. Harney, J.N., and Fletcher, C.H. (2003) A budget of carbonate framework and sediment production, Kailua Bay, Oahu, Hawaii. Journal of Sedimentary Research, v. 73, no. 6, p. 856-868.
4. Rubin, K.H., Fletcher, C.H., and Sherman, C. (2000) Fossiliferous Lana'i deposits formed by multiple events rather than a single giant tsunami. Nature (article), p. 675-681, v. 408, Dec. 7.
5. Sherman, C., Fletcher, C.H., and Rubin, K. (1999) Marine and meteoric diagenesis of Pleistocene carbonates from a nearshore submarine terrace, Oahu, Hawaii. Journal of Sedimentary Research, v. 69, no. 6.

ADDITIONAL PUBLICATIONS

1. Fletcher, C., Rooney, J., Barbee, M., Lim, S.-C., and Richmond, B. (2003) Mapping shoreline change using digital orthophotogrammetry on Maui, Hawaii. Journal of Coastal Research, Special Issue No. 38, p. 106-124.
2. Isoun, E., Fletcher, C.H., Frazer, N., and Gradie, J. (2003) Multi-spectral mapping of reef bathymetry and coral cover. Coral Reefs, v. 22, p. 68-82.
3. Harney, J.N., Grossman, E.E., Richmond, B.M., and Fletcher, C.H. (2000) Age and composition of carbonate shoreface sediments, Kailua Bay, Oahu, Hawaii: Coral Reefs, v. 19, pg. 141-154.
4. Fletcher, C.H., Jones, A.T. (1996) Sea-level highstand recorded in Holocene shoreline deposits on Oahu, Hawaii. Journal of Sedimentary Research. 66.3, p. 632-641.
5. Fletcher, C.H. and Sherman, C. (1995) Submerged shorelines on Oahu, Hawaii: Archive of episodic transgression during the deglaciation? Journal Coastal Research, Special Issue 17 Holocene Cycles: Climate, Sea Level, and Sediment, p. 141-152.

CURRICULUM VITAE

NAME: E. Gordon Grau
TITLE: Professor of Zoology, 1989
Director, University of Hawai`i Sea Grant College Program

EDUCATION:

BS, 1968	Loyola College, Baltimore, Maryland
MS, 1973	Morgan State University, Baltimore, Maryland
Ph.D., 1978	University of Delaware, Newark, Delaware
1979-1982	University of California, Berkeley, Postdoctoral Studies

REPRESENTATIVE PUBLICATIONS:

Shepherd, B. S., Sakamoto, T., Mori, I., Nishioka, R. S., Richman III, N. H., Madsen, S., Hirano, T., Bern, H. A. and E.G. Grau. 1997. Somatotropic actions of the homologous growth hormone (tGH) and prolactins in the euryhaline tilapia, *Oreochromis mossambicus*. Proc. Nat. Acad. Sci. 94: 2068-2072.

Borski, R. J., Helms, L. M. H., Richman, N. H. and Grau, E. G. 1991. Cortisol rapidly reduces prolactin release, and cyclic AMP and $^{45}Ca^{++}$ accumulation in the cichlid fish pituitary, *Oreochromis mossambicus, in vitro*. Proc. Nat. Acad. Sci. 88: 2758- 2762.

Grau, E. G., Shimoda, S. K., Ford, C. A., Helms, L. M. H., Cooke, I. M. and Pang, P. K. T. 1986. The role of calcium in prolactin release from the pituitary of a teleost fish *in vitro*. Endocrinology 119: 2848-2855.

Grau, E. G., Brown, C. L. and Stetson, M. H. 1985. Photoperiodic regulation of thyroid responsiveness to TSH in *Fundulus heteroclitus*. J. Exp. Zool. 234: 199-205.

Grau, E. G., Dickhoff, W. W., Nishioka, R. S., Bern, H. A. and Folmar, L. C. 1981. Lunar phasing of the thyroxine surge preparatory to seaward migration of salmonid fish. Science 211: 607-609.

PROFESSIONAL EXPERIENCE:

2000-present	Director, University of Hawai`i Sea Grant College Program
1994-2000	Interim Director, Hawai`i Institute of Marine Biology, University of Hawaii
1990-1993	Associate Director, Hawai`i Institute of Marine Biology, University of Hawaii
1990	Distinguished Visiting Professor, Ocean Research Institute, Tokyo University
1989-present	Professor, Department of Zoology and Hawai`i Institute of Marine Biology, Univ. of Hawaii
1987	Distinguished Visiting Professor, Department of Physiology, University of Alberta
1985-1989	Assoc. Professor, Dept. of Zoology and Hawai`i Institute of Marine Biology, Univ. of Hawaii
1982-1985	Assistant Professor, Dept. of Zoology and Hawai`i Institute of Marine Biology, Univ. of Hawaii
1979-1982	Postdoctoral Fellow, Department of Zoology, University of California, Berkeley
1968-1973	Biology and Chemistry Teacher, Loyola Blakefield, Baltimore

PEER-REFEREED PUBLICATIONS (most recent of 127; does not include abstracts):

Kajimura, S., Hirano, T., Moriyama, S., Vakkuri, O., Leppauluoto J. and Grau E. G. 2003. Changes in plasma concentrations of immunoreactive ouabain in the tilapia in response to changing salinity: Is ouabain a hormone in fish? Gen. Comp. Endocrinol. Accepted for publication

Hyde, G. N., Seale, A. P., Grau, E. G. and Borski, R. J. 2003. Cortisol rapidly suppresses intracellular calcium and voltage-gated calcium channel activity in prolactin cells. Amer. J. Physiol. Accepted for publication.

Uchida, K., Yoshikawa-Ebesu, J., Kajimura, S., Yada, T. Hirano, T. and Grau, E. G. 2004. Effects of cortisol on the release and gene expression of prolactin and growth hormone in the tilapia, *Oreochromis mossambicus.* Gen. Comp. Endocrinol. Accepted for publication.

Riley, L. G., Hirano, T., and Grau, E. G. 2004. Disparate effects of gonadal steroid hormones on plasma and liver mRNA levels of insulin-like growth factor-I and vitellogenin in the tilapia, *Oreochromis mossambicus*. Fish Physiol. Biochem. Accepted for publication

Collier, J. T., Kaneko, T., Hirano, T. and Grau, E. G. 2004. Seasonal changes in reproductive activity in the Potter's angelfish (*Centropyge potteri)* in Kaneohe Bay, Hawaii. Environ. Biol. Fish. Accepted for publication.

Seale, E A. P., Cooke, I., Hirano, T. and Grau, E. G. 2004. Evidence that IP3 and ryanodine-sensitive intracellular Ca2+ stores are not involved in acute hyposmotically-induced prolactin release in tilapia. Cell Physiol Biochem. Accepted for publication.

Uchida, K., Yoshikawa-Ebesu, J., Kajimura, S., Yada, T. Hirano, T. and Grau, E. G. 2004. *In vitro* effects of cortisol on the release and gene expression of prolactin and growth hormone in the tilapia, *Oreochromis mossambicus.* Gen. Comp. Endocrinol. 135: 116-125.

Kajimura, S., Hirano, T., Moriyama, S., Vakkuri, O., Leppauluoto J. and Grau E. G. 2004. Changes in plasma concentrations of immunoreactive ouabain in the tilapia in response to changing salinity: is ouabain a hormone in fish? Gen. Comp. Endocrinol. 135: 90-99.

Riley, L.G., Hirano T. and Grau E.G. 2003: Effects of Transfer from Seawater to Fresh Water on the Growth Hormone/Insulin-like Growth Factor-I Axis and Prolactin in the Tilapia, Oreochromis mossambicus. Comp. Biochem. Physiol.. 136: 647-655.

Sparks, R. T., Ron, B., Shepherd, B. S., Shimoda, S. K., Iwama, G.K. and Grau, E. G. 2003. Effects of environmental salinity and 17alpha-methyltestosterone on growth and oxygen consumption in the tilapia, *Oreochromis mossambicus*. Comparative Biochemistry and Physiology, Part 136: 657-665.

Kajimura, S., Hirano, T., Visitacion, N., Moriyama, S., Aida, K., and Grau, E. G. 2003. Dual mode of cortisol action on GH/IGF-I/IGFBPs in the tilapia, *Oreochromis mossambicus.* J. Endocrinol. 178: 91-99.

Kaiya, H., Kojima, M., Hosoda, H., Riley, L. G., Hirano, T., Grau, E. G., and Kangawa, K. 2003. Identification of tilapia ghrelin and its effects on growth hormone and prolactin release in the tilapia, *Oreochromis mossambicus*. Comp. Biochem. Physiol. 135B: 421-429.

Leedom, T.A., Hirano, T., and Grau, E.G. 2003. Effect of blood withdrawal and angiotensin II on prolactin release in the tilapia, *Oreochromis mossambicus*. Comp. Biochem. Physiol. 135A: 155-163.

Larson, E. T., Norris, D. O., Grau, E. G., Summers, C.H. 2003. Monoamines stimulate sex reversal in the saddleback wrasse. General and Comparative Endocrinology 130: 289–298

Kajimura, S. Uchida, K., Yada, T., Riley, L. G., Byatt, J. C., Collier, R. J., Hirano, T. and Grau, E. G. 2003.Stimulation of insulin-like growth factor-I production by recombinant bovine growth hormone in the euryhaline tilapia, *Oreochromis mossambicus.* Fish Physiol. Biochem. 25: 221–230.

MARIA C. HAWS, Ph.D.
Director, Pearl Research and Training Program
Pacific Aquaculture and Coastal Resources Center
University of Hawaii-Hilo
Hilo, Hawaii 96720
Ph. (808) 933-9460 Fax (808) 974-7674 Email: haws@aol.com

E D U C A T I O N

Ph.D. in Wildlife and Fisheries Management, Texas A&M University.
Dissertation topic: Mortality and biochemical correlates during metamorphosis of the Pacific oyster (*Crassostreagigas*) and Eastern Oyster (*Crassostrea virginica*). 1988-1993.

Bachelor of Science in Biology, Reed College, Portland, OR. 1980-1985.

E M P L O Y M E N T A N D E X P E R I E N C E

Director of Pearl Research Training Program/Sea Grant Extension Specialist/Associate Professor of Aquaculture. August 1999 to present. Pacific Aquaculture and Coastal Resources Center/University of Hawaii-Hilo and University of Hawaii Sea Grant Program. Duties: program development and administration of international pearl research and training program at University of Hawai'i Hilo. Lead PACRC Coastal Management efforts in the Pacific Islands. Program emphasizes technical assistance for mariculture and ICZM, capacity building, institutional strengthening and training/educational efforts.

Coastal Ecologist and Mariculture Policy Specialist. September 1996 to present.
Coastal Resources Center, University of Rhode Island. Duties: providing technical assistance to community-based coastal zone management programs in Latin America and Africa. Responsible for planning and implementation of applied research programs, environmental monitoring, extension activities, and habitat restoration efforts linked to coastal management. Design and delivery of Training-ofTrainer courses in ICZM.

Director of Operations. January 1996 to October 1999. BioPacific Development, Inc. Oakland, CA. Duties: development and testing of biotechnology applications to improve pearl grafting and pearl quality. Oversight of research and development, field trials and economic analysis. Administrative oversight of company personnel and budget management. Provides technical assistance to aquaculture producers.

Regional Aquaculture Extension Agent. May 1996 to August 1996. Center for Tropical and Subtropical Aquaculture. Duties: managed regional aquaculture extension program in the U.S.-Affiliated Pacific Islands for promotion of sustainable use of marine resources. Designed and implemented training courses, wrote and produced extension materials, and rendered technical assistance to the public and private sector. Initiated applied research and development. Conducted public outreach with communities, government institutions, and universities.

Chief of Party and Senior Scientist. July 1994 to August 1995.Cook Island Black-lip Pearl Culture Project (USAID/RDA International, Inc.). Duties: team Leader and Senior Scientist for USAID-sponsored international environmental program in the Cook Islands to establish environmentally sustainable pearl production.

Pearl Oyster Hatchery Specialist and Senior Scientist. November 1993 to July 1994. Cook Island Black-lip Pearl Culture Project (USAID/RDA International, Inc.). November 1993 to July 1994. Duties: led research team in planning and implementation of USAID environmental monitoring and pearl culture program in the Cook Islands.

SELECTED RECENT PUBLICATIONS AND EXTENSION MATERIALS

Paynter and Haws, 2003. (submitted). Natural growth enhancers to accelerate pearl formation in the Black-lip pearl oyster, *Pinctada margaritifera*.

Paynter and Haws. 2003. (submitted). Methods of reducing inefficiency and impacts of Black-lip pearl oyster (*P. margaritifera*) farms.
Wise, D., S.C. Ellis, and M.C. Haws. 2003. Hatchery methods for spawning and larviculture of black-lip pearl oysters (*Pinctada margaritifera*). College of the Marshall Islands.
Haws, M.C. 2003 (in preparation). Pearl grafting-a manual. University of Hawaii Sea Grant Extension Service. Honolulu, HI.
Haws, M. and S. Ellis. 2003. Pearl farming and coral reefs in Micronesia. Extension Brochure. Produced at the Pacific Aquaculture and Coastal Resources Center.
Yamada, T. and M.C. Haws, 2002. Pearl farming and coral reef conservation. Video, produced at the Pacific Aquaculture and Coastal Resources Center, UH-Hilo.
Haws, M.C. 2002. Pearl production: a manual of basic methods. University of Hawaii Sea Grant Extension Service. Honolulu, HI.
Haws, M.C., C.E. Boyd and B.W. Green. 2002. Methods for Improving Shrimp Culture in Central America. Universidad Centroamericana University Press. 292 pp.
Haws, M.C. and 20 co-authors. 2001. Tanzania Mariculture Guidelines Source Book. Tanzania Coastal Management Partnership (Coastal Resources Center-University of Rhode Island/USAID/Government of Tanzania). Dar es Salaam, Tanzania. 206 pp.
Haws, M.C. and 20 co-authors. 2001. Mariculture Investor's Guide. Vice President's Office, Ministry of Natural Resources and Tourism. Dar es Salaam, Tanzania. 78 pp.
Boyd, C.E., Haws, M.C. and B.W. Green. 2001. Improving Shrimp Culture in Latin America: Good management practices to reduce environmental impacts and improve efficiency of shrimp aquaculture in Latin America and an assessment of practices in the Honduran Shrimp Industry.
Haws, M. and S. C. Ellis. 2000. Aquafarmer Information Sheet: Collecting Black-lip pearl oyster spat. Center for Tropical and Subtropical Aquaculture, Publication Number 144. Waimanalo, Hawaii, USA. 8 pp.
Haws, M.C., M. Ogden, and A.O. Orcutt-Bailey. 2000. Black Pearl Grafting Educational Module (manual, in preparation and video, in press). University of Hawaii Sea Grant Extension Program.

SELECTED RECENT GRANTS AND PROJECTS

Co-Principal Investigator. Management, Sustainable Farming, and Conservation of Pearl Oysters and Sponges in the Federated States of Micronesia-Phase II. (awarded by David and Lucille Packard Foundation). 1/2004 to 6/2005. $50,000.

Principal Investigator. Pearl Farming Development in Micronesia-Hatchery and Nursery Improvement. (awarded by CTSA/USDA). 1/2004 to 12/2004.). $63,000.

Co-Principal Investigator and Project Director. Bridging gaps to insure long-term viability of small and medium mariculture ventures in Hawaii and the U.S.-Affiliated Islands. (awarded by IFAFS/USDA). 1/2002 to 12/2004. $1,600,000.

Co-Principal Investigator. Outer islands aquaculture vocational training in the Marshall Islands. (Awarded by RMI Ministry of Education/ADB). 9/2003 to 8/2004. $94,000.

Co-Principal Investigator and Project Director. Regional Shrimp Farming Initiative. Curriculum and Training Development for small and medium shrimp farmers with an emphasis on Best Management Practices to enhance post-Hurricane Mitch recuperation in Central America. (Awarded by CRSEES/USDA/USAID). 8/2001 to 2/2003. $350,000.

Co-Principal Investigator. A Regional Pacific Island-Hawai'i Partnership to Strengthen and Expand Capacity in Applied and Vocational Aspects of Marine Science Education for Improved Management and Conservation. (awarded by National Sea Grant Program). 11/2001 to 10/2004. $180,000.

Co-Principal Investigator. Pearl Farming Development in Micronesia, Year 1. (Awarded by the Center for Tropical and Subtropical Aquaculture/USDA). 11/2001 to 6/2003. $56,000.

Recipient. Development of the Pearl Research and Training Program at the Pacific Aquaculture and Coastal Resources Center, UH-Hilo. (awarded by County of Hawaii Office of Research and Development, matching funds from University of Hawaii Sea Grant Extension Program). 8/1999 to 1/2001. $30,000.

VITA
Michael P. Hamnett

Relevant Research and Management Experience

1996-present: Director, Social Science Research Institute, University of Hawaii. Duties include the management of the Institute's $11 million problem oriented research program, program planning, supervision of research staff, development and implementation of research, training, and service projects in the Resource Management, Sustainable Development and Futures Research program area.

2000-present: Program Director, Statewide Hazard Mitigation Forum, "Forces of Mother Nature" public information and education campaign. Program consists of a media campaign and development of a website (www.mothernature-hawaii.com) on the risks of natural disaster in Hawaii and what can be done to reduce the risk. Funded by FEMA and NOAA/OCRM through State Civil Defense and the Hawaii Coastal Zone Management Program. Total Program Budget: $155,000 plus private sector contributions.

1998-present: Principal Investigator, State Substance Abuse Prevention Needs Assessment: Family of Studies. Duties include management of research teams engaged in student use and abuse survey, community resources assessment and social indicators study for the Alcohol and Drug Abuse Division, Hawaii State Department of Health. Project funded by the Center for Substance Abuse Prevention through ADAD. Total Project Budget: $626,000.

1998-present: Program Director, Hawaii Coral Reef Initiative Research Program. Duties include facilitating development and managing a collaborative coral reef research and monitoring program as a joint venture of the University of Hawaii and the Hawaii State Department of Land and Natural Resources. Total 2000-2001. Program Budget: $1,000,000.

1994-present: Co-Principal Investigator, Pacific ENSO Applications Center. Duties include securing funding and managing network of researchers and applications specialists to provide forecast and climate information to the US affiliated Pacific Islands and facilitating transfer of that technology to the South Pacific. Funding from Office of Global Programs and US National Weather Service. Annual Budget: $130,000.

1997-1998: Principal Investigator, The Impact of the ENSO Cycle on Tuna Fisheries in the Pacific Islands Region. Duties include management of a small research team to conduct interviews and administer surveys in American Samoa and Guam as phase one of a two-phased effort. Project funded by NOAA's Office of Global Programs. Total Project Budget: $23,100.

1998-1999: Co-Principal Investigator (part-time) on the Impact of ENSO Cycles on Water-borne and Water-related diseases in the Pacific Islands. Research involved statistical and spatial analysis of seasonal to inter-annual climate variability and reportable diseases in the Pacific Islands region from 1982-1996.

1995-1996: Project Director, Hawaii Coastal Hazard Mitigation Planning Project, Phase II. Duties included planning and managing a project to facilitate the implementation of coastal hazard

mitigation efforts through public education, development of financial incentives for mitigation, and technical assistance to county governments. Project funded on a contract with the Coastal Zone Management Program in the Office of Planning with grant (NA470Z0264) support from NOAA's Office of Ocean and Coastal Resource Management. Total Project Budget: $115,397.

1993: Project Director, Hawaii Coastal Hazard Mitigation Planning Project, Phase I. Duties included planning and managing an inter-disciplinary participatory hurricane hazard mitigation planning project for the Office of State Planning and the development of recommendations to the State Legislature and county councils. Total Project Budget: $119,680.

1990: Project Director, Assessment of the Hawaii State Coastal Zone Management Program. Duties included project development and management, design of evaluation methods, and development of recommendations for changes in the program. Project funded under contract with the Office of State Planning through the Pacific Basin Development Council and Social Science Research Institute. Total Project Budget $50,000.

Books, Monographs and Edited Volumes

With co-authors A. Franco, K. Sere, F. Seui, K. Matsumoto, J. Roughan, J. F. Dupon, R. Staff and J. Makasiale, *Coping with Crisis: Disaster Preparedness and Disaster Experience in the South Pacific.* Honolulu: Pacific Islands Development Program, 380 pages, 1982.

Disaster Mitigation in the Pacific Islands: A Policy Guide for Decision-Makers. Suva: UN Department of Humanitarian Affairs, South Pacific Programme Office, 48 pages, 1996.

Relevant Published Reports and Papers

Hamnett, M. and Palahad, J. Climate Forecasting in the Pacific Islands Region. Report prepared for the WMO Climate Outlook Forum Workshop in Pretoria, South African, November 2000.

Lewis, N., Hamnett, M. Tran, L. 1999 ENSO events and human health in the Pacific islands. Project Summary, NOAA EHDCG P.I. Meeting, Tucson, Arizona, April 1999.

Charles (Chip) Guard, Michael Hamnett, Charles J. Newmann, Mark A. Lander, and H. Galt Siegrist, Typhoon Vulnerability Study for Guam. Prepared for the Government of Guam through a grant from the Federal Emergency Management Agency by the Water and Energy Research Institute, University of Guam, 151 pages, February 1999.

Lewis, N., Hamnett, M., Prasad, U., Tran, L, Hilton, A. 1998 Climate, ENSO and health in the Pacific: research in progress, *Pacific Health Dialog* 5(1): 187-190.

M. Hamnett, Hurricanes in Hawaii: What are the Risks of Damage? What Can Home Owners Do to Reduce Their Risks. Prepared for the Hawaii Hurricane Relief Fund. Honolulu: Social Science Research Institute, 5 pages, 1996.

Michael P. Hamnett and Kristine Davidson Oh. *Hawaii Coastal Hazard Mitigation Planning Project Phase II Report: Findings, Recommendations and White Papers.* Honolulu: Social Science Research Institute, University of Hawaii and Office of Planning, 1996.

Education

University of Hawaii, Honolulu, Hawaii -- M.A. and Ph.D, in Social-Cultural Anthropology with an ethnographic focus in Oceania. Additional course work in Geography and Linguistics. December 1977.

Upsala College, East Orange, New Jersey -- B.A. (Dual Major: Philosophy and English Literature.) June 1969.

Present Status

Executive Director
Research Corporation of the University of Hawaii
2800 Woodlawn Drive, Suite 200
Honolulu, Hawaii 96822
Phone: (808) 988-8311
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Researcher
Social Science Research Institute
University of Hawaii
Saunders Hall, Suite 704
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RESUME

KEVIN DOUGLAS HOPKINS

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University of Hawaii at Hilo
200 West Kawili Street
Hilo, Hawaii 96720

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Facsimile: (808) 933-0704
E-mail: hopkins@hawaii.edu

Education

Degree	Major Field	University	Date
Ph.D.	Fisheries	Auburn University	8/1979
M.B.A.	Business Admin.	Auburn University	8/1979
M.S.	Fisheries	Auburn University	6/1977
B.S.	Zoology	University of Oklahoma	8/1972

Professional Experience

Interim Director, Pacific Aquaculture and Coastal Resources Center (PACRC), University of Hawaii at Hilo (UHH), Hilo, Hawaii, USA. July 2000 to present. Responsible for the design, construction and operation of the PACRC.

Professor of Aquaculture, College of Agriculture, Forestry & Natural Resource Management, UHH, Hilo, Hawaii, USA. July 1997 to present. Responsible for the administration of the UHH undergraduate aquaculture program.

Associate Professor of Aquaculture, College of Agriculture, University of Hawaii at Hilo (UHH), Hilo, Hawaii, USA. July 1991 to June 1997

Assistant Professor of Aquaculture, College of Agriculture, University of Hawaii at Hilo (UHH), Hilo, Hawaii, USA. August 1988 to June 1991.

Principal investigator of University of Hawaii research activities under the Collaborative Research Support Program in Pond Dynamics/Aquaculture (funded by USAID). 1988 to 1996. Responsibilities included the design and operation of tilapia research projects in Thailand, Philippines and Egypt and the management of the program's global database.

Executive Director of the Consortium for International Fisheries and Aquaculture Development based at Oregon State University, Corvallis, Oregon, USA. July 1986 to June 1988. Responsible for development and management

of international fisheries projects in Southeast Asia, the Middle East, Africa and Latin America.

Associate Program Manager of the Collaborative Research Support Program in Pond Dynamics/Aquaculture , Oregon State University, Corvallis, Oregon. September 1985 to June 1988. Designed and managed the program's database.

Research Associate, Department of Fisheries and Wildlife, Oregon State University, Corvallis, Oregon, USA. June 1985 to June 1986. Developed bioeconomic models of the Oregon trawl fishery and responsible for the management of the OSU chum salmon hatchery.

Associate Research Scientist and Project Leader, International Center for Living Aquatic Resources Management (ICLARM), MCC P.O. Box 1501, Makati, Metro Manila, Philippines. September 1981 - June 1985. Assigned to the Kuwait Institute for Scientific Research (KISR) to manage a tilapia mariculture project and to develop intensive culture systems. Also provided technical assistance to projects cultivating sea bream and groupers.

Post-Doctoral Fellow, Rockefeller Foundation, New York. September 1979 - August 1981. Worked with ICLARM as project co-leader of the Integrated Animal-Fish Farming Project. Conducted research and documented the development of integrated pig-fish, duck-fish, and chicken-fish systems.

Publications

Author or co-author of 19 papers in international journals and symposia proceedings, three book chapters, nine miscellaneous published articles/reports, 13 unpublished technical reports, and three invited discussion papers.

Professional Certification

Certified Fisheries Scientist by American Fisheries Society.

Additional information available upon request.

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Sea Grant Extension Service
Maui Community College
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EDUCATION Ph.D. 1991, Aquaculture and Fisheries Science, Auburn University
M.Sc. 1988, Zoology, University of Hawaii
B.A. 1985, Aquaculture, University of Hawaii

WORK EXPERIENCE

6/97-present. Sea Grant Aquaculture Extension Specialist for Maui County (University of Hawaii).
6/94-5/97. Sea Grant Aquaculture Extension Agent for Maui County (University of Hawaii).
7/92- 6/94. NOAA Aquaculture Demonstration Center Project Manager/ Kentucky State Extension Aquaculture Specialist (Kentucky State University).
1/81-8/88. Undergraduate and Graduate Research Assistant, Hawaii Institute Marine Biology
9/88-12/91. Graduate Research Associate, Auburn University

SELECTED PUBLICATIONS

Howerton, R. D., and Boyd, C.E. 1993. Design and performance of a horizontal axial flow water circulator. J. of Applied Aquaculture (3) ½, p163-183

Kuyawe, T.T. Okimoto, D.K., Howerton, R.D., Shimoda, S.K., Lin, H.-R., Pang, P.K., and Grau, E.G. 1993. Effect of 17a-methyltestosterone on the growth of the euryhaline tilapia, *Oreochromis mossambicus*, in fresh water and in sea water. Aquaculture, (113), p. 137-152.

Howerton, R. D., and Boyd, C. E. 1992. Measurement of water circulation in ponds with gypsum blocks. Aquacultural Engineering (11) 3, p. 141-155.

Howerton, R. D., Okimoto, D. K., and Grau, E. G., 1992. The effect of orally administered 17a-methyltestosterone and 3,3,5-triiodo-L-thyronine on growth of seawater-adapted tilapia (*Oreochromis mossambicus*). Aquaculture and Fisheries Management. (23), p. 123-128.

Boyd, C. E., and Howerton, R. D., 1991. Lecture notes for a post-graduate course "Water Quality Management in Fishponds". Deakin University, Australia.

Kuyaye, T. T., Howerton, R. D., Okimoto, D., Lin, H., Pang, P., and Grau, E. G., 1990. Effects of methyltestosterone on growth of the tilapia, *Oreochromis mossambicus*, in tank and pond culture. World Aquaculture 1990 Abstracts. IMPRICO, Ville Mont-Royal, Quebec, Canada pp 80.

Reshkin, S. J., Grover, M. L., Howerton, R. D., Grau, E. G., and Ahearn, G. A., 1989. Dietary hormonal modification of growth, intestinal ATPase, and glucose transport in tilapia. Am. J. Physiol. 256 (Endocrinol. Metab. 19): E610-E618.

Howerton, R.D., Okimoto, D.K. and Grau, E.G., 1988. Changes in the Growth rate of *Oreochromis mossambicus* following treatments with the hormones, triiodothyronine and testosterone. In R.S.V. Pullin, T. Bhukaswan, K. Tonguthai and J.L. Maclean (editors), The International Symposium on Tilapia in Aquaculture, Bangkok, Thailand.

Dexter, M. and Howerton, R. D., 1988. Determination of the effects of hormones used as growth promoters in aquacultured warmwater finfish grown under actual environmental conditions. (HIMB report).

TEACHING EXPERIENCE

1990-91. Graduate Teaching Assistant, Auburn University. Fisheries & Aquaculture 602-Water Quality in Aquaculture, Fisheries & Aquaculture 603L-Water Quality Testing Procedures, Fisheries & Aquaculture 605-Hydrology in Aquaculture.
Fall, 1996. Maui Community College. Oceanography 201-Introduction to Oceanography.
Spring, 1997. Maui Community College. Zoology 200- Marine Biology.
Spring, 1997. Maui Community College-VITEC PACE (non-credit classes). Introduction to Aquaculture.
Fall, 1998. Maui Community College. Oceanography 201-Introduction to Oceanography.
Spring, 1999. Maui Community College. Zoology 200- Marine Biology.
Spring 1999. Maui Community College-VITEC PACE (non-credit classes). Introduction to Aquaculture.
Spring, 2000. Maui Community College. Marine Science 190V- Topics in Aquaculture.
Summer, 2000. Maui Community College. Oceanography 201- Introduction to Oceanography.
Fall, 2002. Maui Community College/ UH-Hilo. Marine Science 262- Introduction to Aquaculture.

FUNDING

Principal Investigator Maui County—Maui County Aquaculture Program--$60,000. 2004
Principal Investigator Maui County—Maui County Aquaculture Program--$60,000. 2003
Principal Investigator U.S.D.A. Center for Tropical and Subtropical Aquaculture—Hatchery Methods for Sturgeon Culture Year 2-- $12,500. 2003.
Principal Investigator Maui County—Maui County Aquaculture Program--$60,000. 2002.
Principal Investigator, US Fish & Wildlife—Assessment of Fish Populations in Kealia Pond--$49,000. 2002.
Principal Investigator Maui County—Maui County Aquaculture Program--$60,000. 2001
Principal Investigator Maui County --Maui County Aquaculture Program--$56,254. 2000.
Co-Principal Investigator State of Hawaii, Aquaculture Development Program--$8,511. 2000.
Principal Investigator Maui County --Maui County Aquaculture Program--$76,500. 1999.
Principal Investigator Maui County --Maui County Aquaculture Program--$71,700. 1998.
Principal Investigator Maui County --Maui County Aquaculture Program--$130,000. 1997.
Co-Principal Investigator Maui County --Maui County Aquaculture Program--$75,000. 1996.
Principal Investigator U.S.D.A. Center for Tropical and Subtropical Aquaculture-- Best Management Practices $10,000. 1998.
Co-Principal Investigator Sea Grant College Program--Water Quality in Hawaiian Fishponds--$40,000. 1997-1999.
Co-Principal Investigator USAID CRSP Program--Tilapia Hatchery Efficiency and Consistency in Philippines--$100,531. 1998-2001.

RESUMÉ

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PROFESSIONAL TITLE:

Associate Professor of Law and Co-Director, Environmental Law Program
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LEGAL EDUCATION:

LL.M. in Law and Marine Affairs, University of Washington School of Law
Seattle, Washington, 1985

Juris Doctor, University of Mississippi School of Law, University, Mississippi 1981

NON-LEGAL EDUCATION:

M.S., Counseling Psychology, Florida International University, Miami, Florida, 1974

B.A., English, Magna Cum Laude, Barry University, Miami, Florida, 1971

LEGAL EMPLOYMENT:

August, 1991 - Present

Associate Professor of Law, William S. Richardson School of Law
University of Hawaii at Manoa
Teaching specialties include environmental law, administrative law, ocean and coastal law, wildlife and natural resources law, legal writing.

January, 1999 - Present

Associate Professor of Law and Director, Environmental Law Program
William S. Richardson School of Law, University of Hawaii at Manoa

June, 1994 - July, 1994

Visiting Associate Professor of Law, University of Mississippi School of Law
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August, 1987 - August, 1991

Assistant Professor of Law, William S. Richardson School of Law
University of Hawaii at Manoa

June, 1985 - July, 1987

Director, Coastal and Marine Law Research Program
Mississippi Law Research Institute, University of Mississippi Law Center
University, Mississippi 38677

September, 1981 - June 1985

Staff Attorney, Mississippi Law Research Institute
University of Mississippi Law Center, University, Mississippi 38677

SELECTED UNIVERSITY SERVICE

Chair, Professional Development Committee (Law School, 2001-2002)
Member, Program Review Committee, University of Hawai`i at M_noa (2001-2002)
Faculty Advisor, Environmental Law Society (1992 - present)
Steering Committee, Graduate Ocean Policy Certificate (1990 - present)
Member, Committee on Human Studies (1991-1999)
Senator, University of Hawai`i at M_noa Faculty Senate (Fall, 1998- Spring, 2000)
Member, University of Hawai`i at M_noa Faculty Senate Executive Committee (Fall, 1999- Spring, 2000) (Parliamentarian and Liaison to Student Services Committee)
Member, Richardson School of Law Dean Search Committee (1995)

SELECTED COMMUNITY SERVICE

Commissioner, Land Use Commission, State of Hawai`i (1994 - 2002)
Board of Directors, Hawai`i Wildlife Fund (1996 - present)
Pro Bono Adoptions, Volunteer Legal Services, Hawai`i (1997 - present)
Community Empowerment Workshops (1995, 1997, 2002)
Hike Leader for Visually Impaired, State of Hawai`i Services for the Blind (1991-1997)
Board of Directors, Hawai`i Audubon Society (1991-1993) (President, 1992)

PROFESSIONAL AFFILIATIONS

Member, Hawai`i State Bar
Member, Mississippi State Bar
Associate Member, Native Hawaiian Bar Association
Charter Member, Natural Resources Law Section, Hawai`i State Bar
Steering Committee Member, Ocean Governance Study Group
Member, Hawai`i Women Lawyers Foundation
Member, Hawai`i Women Lawyers

RECENT PUBLICATIONS:

Jarman, M. Casey, *Administrative Law in Hawai`i* (in progress) (a book that describes agency law and practice in the state of Hawai`i)

Jarman, M. Casey, Verchick, Robert, "Beyond the 'Courts of the Conqueror': Balancing Private and Cultural Property Rights Under Hawai`i Law," 5 *The Scholar: St. Mary's Law Review on Minority Issues* 201 (2003).

Jarman, M. Casey, Antolini, Denise, eds., *He Mau Mo`olelo o ka `_ina* (Student Paper Series), University of Hawai`i Environmental Law Program (2000-2002).

Jarman, M. Casey, *Making Your Voice Count: A Citizen's Guide to Contested Case Hearings*, University of Hawai`i Environmental Law Program (2002).

Jarman, M. Casey, Codiga, Doug, *Hawaii Environmental Law*, in ENVIRONMENTAL LAW PRACTICE GUIDE (Matthew Bender, 2002)

Jarman, M. Casey, Hildreth, Richard, "The Use of Science in Marine Resource Management: Can We Reconcile the Paradigms of Science, Law and Politics?", *Proceedings of the MTS/IEEE International Oceans 2001 Conference* (2001).

Jarman, M. Casey et al., "Federal Agency Response to Executive Order 12898 on Environmental Justice: An Empirical Study," 31 *Environmental Law Reporter* 11133 (October 2001).

Jarman, M. Casey (Executive Producer), *Presenting Your Case: Highlights of an Agency Hearing* (30 minute educational video) University of Hawai`i Environmental Law Program (February 2001).

Jarman, M. Casey, *Tribute, Professor Jon Jacobson*, JOURNAL OF ENVIRONMENTAL LAW AND LITIGATION (Fall, 2000).

Jarman, M. Casey, *Real Life Learning: Teaching Students the Ways of the Administrative World*, THE LAW TEACHER 8 (Spring 1998).

Jarman, M. Casey, McLaughlin, Richard, *Commentary on Professor Tarlock's Paper: The Influence of International Environmental Law on U.S. Pollution Control Law*, VERMONT LAW REVIEW (Winter 1997).

Jarman, M. Casey, Haia, Moses, McCarty, Joyce, Martin, Elizabeth, eds., E ALU LIKE MAI: COMING TOGETHER FOR JUSTICE (1997).

Jarman, M. Casey, Oana, Mia S., Perry, Kekailoa, eds., KUPA`A MAHOPE O KA _INA: A WORKBOOK FOR ENVIRONMENTAL JUSTICE FOR NATIVE HAWAIIANS (1995).

Jarman, M. Casey, Cole, Luke W., *A New Approach to Expanding Resources for Environmental Justice: the Professor-in-Residency*, 96 WEST VIRGINIA LAW REVIEW 4:1165 (1994).

Jarman, M. Casey, *The Use of the Public Trust Doctrine for Resource Based Area-wide Management*, 3 ALBANY JOURNAL OF SCIENCE AND TECHNOLOGY (1993).

Jarman, M. Casey; Lowrey, Kem; Machida, Susan, *Federal-State Coordination in Coastal Management: An Assessment of the Federal Consistency Provision of the CZMA*, 19 COASTAL MANAGEMENT 2:1, 1993.

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Education
B.A., Economics, Goshen College, Indiana, 1988
Ph.D., Economics, University of Colorado at Boulder, August 1993

Courses on the Internet
Principles of Microeconomics: ECON 130
International Trade and Welfare: ECON 660
Research Seminar: ECON 730

Research Interests
International trade, direct foreign investment, regional integration, and computational economics.
Egyptian Trade Liberalization Webpage : http://www2.hawaii.edu/~konan/egypthome.htm

Selected Recent Publications
"Prospects for FDI in the AFTA," with J. Heinrich, ASEAN Economic Bulletin, 2001.

"Deep Integration, Nondiscrimination and Euro-Mediterranean Free Trade," with Bernard Hoekman, "Deep Integration, Nondiscrimination and Euro-Mediterranean Free Trade," with Bernard Hoekman, in J. von Hagen and M. Widgren, editors, *Regionalism in Europe: Geometries and Strategies After 2000*, Boston/Dordrecht/London: Kluwer Academic Publisher, 2001.

"Joint Trade Liberalization and Tax Reform in a Small Open Economy: The Case of Egypt," with K. E. Maskus, *Journal of Development Economics* 61(2), April 2000. (PDF file available if accessing this page from a subscribing ULR).

"The Vertical Multinational Enterprise and International Trade," Review of International Economics 8(1), 2000.

"Rents, Red Tape and Regionalism: Economic Effects of Deeper Integration," with Bernard Hoekman, in B. Hoekman and J. Zarrouk, editors, *Catching Up with the Competition: Trade Policy Challenges and Options for the Middle East and North Africa*, Ann Arbor: University of Michigan Press, 2000.

"Foreign Direct Investment and Host-Country Trading Blocs," with Jeffery Heinrich, Journal of Economic Integration 15(4), 2000.
"Bilateral Trade Patterns and Welfare: An Egypt-EU Preferential Trade Agreement," with Keith E. Maskus, in S. Katayama, editor, New Development of International Trade: Theoretical and Empirical Investigation, REIB Kobe University, 2000.

"An Egypt-U.S. Free Trade Agreement: Economic Incentives and Effects," with Bernard Hoekman and Keith Maskus, reprinted in Julia Devlin, Sebastien Dessus, and Raed Safadi, editors, The Dynamics of Open Regionalism in MENA, Paris: OECD Publications, 2000.

"Foreign Direct Investment in the Restructuring of the Japanese Economy," with Magnus Blomström and Robert Lipsey, in M. Blomström, B. Gangnes, and S. Lacroix, editors, *Japan in the Twenty-first Century*, Oxford University Press, 2000.

"An Egypt-U.S. Free Trade Agreement: Economic Incentives and Effects," with Bernard Hoekman and Keith Maskus, in Robert Lawrence and Will Martin, editors, *Building Bridges: An Egypt-US Free Trade Agreement*, Brookings Institution, 1998.

"Strategic Taxation of the Multinational Enterprise: A New Argument for Double Taxation," *Journal of Public Economics* 63(2), January 1997.

"Egyptian Trade Liberalization," with Keith E. Maskus, Review of Development Economics, 1(3), 1997.

"A Computable General Equilibrium Analysis of Egyptian Trade Liberalization Scenarios," with Keith E. Maskus, in: *Regional Partners, Global Markets: Limits and Possibilities of the Euro-Mediterranean Agreements*, Ahmad Galal and Bernard Hoekman, eds., London, Center for Economic Policy Research in Europe (CEPR) and Brookings Institution, 1997.

"Intellectual Property Rights in China," with Sumner La Croix, in Zhang Yunling, ed: *Transitional Relations on China, Japan, and the United States* (in Chinese), 1997.
"Transfer Pricing and the Strategic Taxation of Globally-Joint Inputs," Review of International Economics 4(2), June 1996.

"A Unified Treatment of Horizontal Direct Investment, Vertical Direct Investment, and the Pattern of Trade in Goods and Services," with James R. Markusen, Anthony J. Venables, and Kevin H. Zhang, National Bureau of Economic Research, Working Paper Series, No. 5696, August 1996.

"The Need for Common Investment Measures within ASEAN," *ASEAN Economic Bulletin*12(3), March 1996.

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Education

- A.B. 1967 - Chemistry, Harvard University, Cambridge, Mass.
- Ph.D. 1971 - Chemical Physics, Harvard University, Cambrige, Mass

Research Interests

- Phytoplankton Ecology
- Aquatic Pollution
- Aquaculture

Teaching Activities

- OCN 320 - Aquatic Pollution
- OCN 650 - Math Techniques for Oceanography

Ten Selected Publications

1. Laws, E. A., E. Sakshaug, M. Babin, Y. Dandonneau, P. Falkowski, R. Geider, L. Legendre, A. Morel, M. Sondergaard, M. Takahashi, and P. leB Williams. 2002. Photosynthesis and primary productivity in marine ecosystems: Practical aspects and application of techniques. JGOFS Report No. 36. Bergen, Norway, 93 pp.

2. Laws, E. A., B. N. Popp, N. Cassar, and J. Tanimoto. 2002. 13C discrimination patterns in oceanic phytoplankton: The likely influence of CCMs and the implications for palaeoreconstructions. Functional Plant Biology 29: 1-11.

3. Cassar, N., E. A. Laws, B. N. Popp, and R. R. Bidigare. 2002. Sources of inorganic carbon for photosynthesis in marine diatoms. Limnology and Oceanography 47: 1192-1197.

4. Miller, A. J., M. A. Alexander, G. J. Boer, F. Chai, K. Denman, D. J. Erickson, R. Frouin, A. J. Gabric, E. A. Laws, M. R. Lewis, Z. Liu, R. Murtugudde, S. Nakamoto, D. J. Neilson, J. R. Norris, J. C. Ohlmann, R. I. Perry, N. Schneider, K. M. Shell, and A. Timmermann, 2003. Potential feedbacks between Pacific Ocean ecosystems and interdecadal climate variations. Bulletin of the American Meteorological Society, 84, 617-633.

5. Laws, E. A. 2003. Partitioning of microbial biomass in pelagic aquatic communities: Maximum resiliency as a food web organizing construct. Aquatic Microbial Ecology 32: 1-10.

6. Laws, E. A. and L. Ferentinos. 2003. Human impacts on the fluxes of nutrients and sediment in Waimanalo Stream, Oahu, Hawaiian Islands. Pacific Science 57(2) (in press).

7. Laws, E. A. 2003. Mesozooplankton grazing and primary production: An alternative assessment. Limnology and Oceanography 48: 1357-1359.

8. Selph, K. E., M. R. Landry, and E. A. Laws. 2003. Heterotrophic nannoflagellate enhancement of bacterial growth through nutrient remineralization in chemostat culture. Aquatic Microbial Ecology 32: 23-37.

9. Falkowski, P. G., E. A. Laws, R. T. Barber, and J. Murray. 2003. Phytoplankton and their role in primary, new, and export production. pp 99-121 in M. J.. R. Fasham (Ed.), Ocean Biogeochemistry: The Role of the Ocean Carbon Cycle in Global Change, Springer, Berlin.

10. Laws, E.A. 2000. Aquatic Pollution: An Introductory Text. 3rd edition. Wiley-Interscience. New York. 639 pp.

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Education

Ph.D. in Aquaculture, University of Tokyo, Japan, Department of Fisheries. 1979
M.S. in Marine Biology, National Taiwan University, Institution of Oceanography, 1972
B.S. in Fishery Biology, National Taiwan University, Department of Zoology, 1970

Selected Positions

Oceanic Institute: Program Manager, Aquaculture Interchange Program (AIP); Scientific Director, Finfish and Asia programs 1997 - present; Assistant Vice President, 1992 - 1996
Director, Center for Tropical and Subtropical Aquaculture, Director, 1997 - present
Research Associate, conducting research in improving induced spawning and larval rearing technology. 1980 - 1981
Postdoctoral Research Associate, participated in the work on induction of milkfish and mullet spawning and larval rearing.
Tungkang Marine Laboratory, Taiwan Fisheries Research Institute, Taiwan, Aquatic Biologist. 1973 - 1976

Experience

Principal Investigator for Technical Assistance in Finfish Aquaculture project. 1991 - 1995
Principal Investigator for Development of Marine Finfish Hatchery Technology in Egypt project. 1989 - 1992
Principal Investigator for Technology Transfer of Fish Fry Production project. 1984 - 1992
Principal investigator for Improvement of Shrimp Farming Technology in Hawai‘i project. 1983 - 1985
Co-principal Investigator for Utilization of Cattle manure in Marine Shrimp Farming project. 1981 - 1982

Jo-Ann C. Leong, Ph. D., Professor & Director
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Professional Preparation:

University of California, Berkeley	Zoology	B.A.	1964
University of California, San Francisco Med.Sch.	Microbiology	Ph.D.	1971
University of California, San Francisco Med.Sch.	Biochemistry		1971-74
University of California, San Francisco Med.Sch.	Cancer Res.		1974-75

Appointments:

Director, Hawaii Institute of Marine Biology, University of Hawaii	2001-
Professor, School of Ocean & Earth Sciences Technology, Univ. Hawaii	2001-
Asst., Assoc., Full Professor of Microbiology, Oregon State University	1975-1992
Distinguished Professor of Microbiology, Oregon State Univ.	1993-
Chairperson, Dept. of Microbiology, Oregon State Univ.	1996-2001
Emile Pernot Endowed Professor of Microbiology	1998-
Panel Manager, USDA SBIR Program for Aquaculture	1994-95
Panel Manager, USDA Competitive Grants Program Virology Study Section	1992-93
Visiting Scientist, Genentech, S.F., Calif.	1984-85
Asst. Res. Virologist, Cancer Res. Inst., Univ. Calif. S.F. Med Sch. with J. Levy	1974-75

Research Grants and Awards:

DNA Vaccine for IHNV – Development of a Suicide Vector (Jo-Ann Leong & Marta Alonso & Doug Leisy)	Oregon Sea Grant	$264,232	2/1/02-1/31/05
Planning grant for Professional Masters (Stella Coakley, Bill Warren, Jo-Ann Leong, Steve Giovannoni, Bill Winner)	Sloan Foundation	$400,000	4/01/01-3/31/05
HIMB Connectivity and Access Grid Node Installation Jo-Ann Leong (University of Hawaii)	NSF	$13,200	6/1/02-5/30/03
Development of a DNA Vaccine Against the Ectoparasite C. irritans for Use in the Aquaculture of Opakapaka (P. filamentosus) Teresa Lewis, Jo-Ann Leong, Christopher Kelley, Michael Kent	Hawaii Sea Grant	$86,178	3/1/03-2/28/05
IMUA Hawaii EPSCoR – NSF			
PI: Deane Neubauer/David McClain	NSF	$2,989,947	4/01/03-3/31/04
Prog Dir: Edward Laws, Don Price		$2,995,044	4/01/04-3/31/05
Prog.Admin: Terrilani Chong		$3,010,534	4/01/05-3/31/06
EPSCoR Focus Areas: Evolutionary Genetics Thrust Leader: Jo-Ann Leong (UH Manoa) Ecosystems Thrust Leader: Ken Kaneshiro Information Technology Thrust Leader: Stephen Itoga			
Renovation of Classroom Laboratory Building at HIMB PI: Jo-Ann Leong	NSF	$75,000	9/16/03-12/31/06

Selected Refereed Publications:

1..Trobridge, G.D., P.P. Chiou, and J. C. Leong. 1997. Cloning of the rainbow trout (Oncorhynchus mykiss) Mx2 and Mx3 cDNAs and characterization of trout Mx protein expression in salmon cells. **J. Virology** 71:5304-5311.
2. B. Robertsen, G. Trobridge, and J. C. Leong. 1997. Molecular cloning of double-stranded RNA inducible Mx genes from Atlantic salmon (Salmo salar L.). **Developmental & Comparative Immunology** 21 (5):397-412.
3. Trobridge, G.D., S. E. LaPatra, C. H. Kim, and J. C. Leong. 2000. Mx mRNA expression and RFLP analysis of rainbow trout (*Oncorhynchus mykiss*) genetic crosses selected for susceptibility or resistance to IHNV. **Diseases of Aquatic Organisms** 40:1-7.
4. J. C. Leong, G. D. Trobridge, C.H.Y. Kim, M. Johnson, and B. Simon. 1998. Interferon-inducible Mx proteins in fish. **Immunological Reviews** 166:349-363.
5. Johnson, M.C., B. E. Simon, C.H. Kim, and J. C. Leong. 2000. Production of recombinant snakehead rhabdovirus (SHRV): the NV protein is not required for viral replication." **J. Virology** 74:2343-2350.
6. Kim, C. H., M. C. Johnson, J. D. Drennan, B. E. Simon, E. Thomann, and J. C. Leong. 2000. DNA Vaccines encoding viral glycoproteins induce non-specific immunity and Mx protein synthesis in fish. **J. Virology 74**: 7048-7054.
7. Chiou, P. P., C. H. Kim, P. Ormonde, and J. C. Leong. 2000. The infectious hematopoietic necrosis virus matrix protein inhibits host-directed gene expression and induces morphological changes of apoptosis in cell cultures. **J. Virology** 74:7619-7627.
8. Nygaard, R., S. Husgard, A-I. Sommer, J. C. Leong, and B. Robertsen. 2000. Induction of Mx protein by interferon and double-stranded RNA in Salmonid cells. **Fish & Shellfish Immunology** 10:435-450.
9. T. L. Crippen, L. M. Bootland, J. C. Leong, M. S. Fitzpatrick, C. B. Schreck, and A. T. Vella. Analysis of Salmonid Leukocytes Purified by Hypotonic Lysis of Erythrocytes. 2001. **Journal of Aquatic Animal Health** 13:234-245.
10. Alonso, M. and J. C. Leong. 2002. Suppressive subtraction libraries to identify interferon-inducibe genes in fish. **Marine Biotechnology** 4:74-80.
11. Alonso, M., M. Johnson, B. Simon, and J. C. Leong. 2003. A specific expression vector containing the interferon regulatory factor 1A (IRF1A) promoter for genetic immunization of fish. **Vaccine** 21:1591-1600..
12. Milston, R.H., A.T. Vella, T. L. Crippen, M. S. Fitzpatrick, J. C. Leong, and C. B. Schreck. 2003. In Vitro Detection of Functional Humoral Immunocompetence in Juvenile Chinook Salmon (Oncorhynchus tshawytscha) using Flow Cytometry. **Developmental and Comparative Immunology** 15:145-58.

Syngergistic Activities:

1. Collaborative studies with Carl Schreck (Fisheries & Wildlife, OSU) and Anthony Vella (Microbiology, OSU and UConn) to examine the effects of endocrine disrupters on the immune system of aquatic animals. We have obtained two grants for the work and published two papers with three additional papers in preparation.
2. Collaborative studies with Thomas Chen (University of Connecticut) to determine if a modified cecropin gene in transgenic fish cells protects those cells against virus infection. The studies have been successful and we are now proceeding with the construction of transgenic fish.

Collaborators:

Thomas Chen	University of Connecticut, Storrs, CN	tchen@uconnvm.uconn.edu
Martin Fitzpatrick	Dept. Enviro. Quality, Portland, OR	Fitzpatrick_Martin@deq.stat.or.us
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Anthony Vella	University of Connecticut Health Center	vellaa@orst.edu
James Winton	USGS, Seattle, WA	jim_winton@usgs.gov
Gordon Grau	University of Hawaii, Zoology	SGDir@hawaii.edu

CURRICULUM VITA FOR PINGSUN LEUNG

OVERVIEW:

PingSun Leung is a professor and researcher in biosystems economics and modeling at the Department of Molecular Biosciences and Bioengineering at the University of Hawaii at Manoa. He also serves as a cooperating graduate faculty with the Department of Economics. He is an honorary guest professor of management science at Jilin University, China. Before joining the College of Tropical Agriculture and Human Resources, he has served as econometrician at the State of Hawaii and has taught management science in the College of Business Administration and the Japan-America Institute of Management Science. His current teaching responsibility is in biosystems modeling, biosystems simulation and operations research for management. He has published extensively in professional journals. His international experience includes spending a year as a Fulbright Scholar in China, a recent sabbatical leave at the Norwegian College of Fisheries Sciences, City University of Hong Kong, UN Food and Agriculture Organization, and short-term assignments with Network of Aquaculture Centres in Asia-Pacific, Asian Development Bank, Mekong River Commission, UN Food and Agriculture Organization, and UN Development Program. He is very active in international and local aquaculture economics research and is currently the editor of *Aquaculture Economics and Management* and serves on the editorial board of *Aquaculture*. He also serves as a member of the Technical Advisory Committee for the Center for Tropical and Subtropical Aquaculture and was chair of the committee in 2002.

PUBLICATIONS AND INVITED PRSENATATIONS:

Authored and co-authored over 180 journal articles, edited volumes, and research reports (following is a representative list of most recent work).

R. N. Cantrell, M. Garcia, P.S. Leung and D. Ziemann. 2004. "Recreational anglers' willingness to pay for increased catch rates of Pacific threadfin (*Polydactylus sexfilis*) in Hawaii," *Fisheries Research*, in press.

J. Cai and P.S. Leung. "An alternative interpretation of the 'pure' linkage measures," *Annals of Regional Science*, forthcoming.

P.S. Leung. "Multiple-criteria decision making (MCDM) applications in fishery management," invited paper in a special issue on Planning Support Systems for Environmental Management, *International Journal of Environmental Technology and Management*, forthcoming.

N.C. Pradhan and P.S. Leung. 2004. "Modeling trip choice behavior of the longline fishers in Hawaii," *Fisheries Research*, in press.

N.C. Pradhan and P.S. Leung. 2004. "Modelling entry, stay, and exit decisions of the longline fishers in Hawaii," *Marine Policy*, 28:311-324.

J. Cai and P.S. Leung. 2004. "Linkage measures: a revisit and a suggested alternative," *Economic Systems Research*, 16(1):63-84.

P.S. Leung and Y.C. Shang. 2003. "A historical review of aquaculture economics research," Chapter 13 in *Aquaculture: Retrospective and Outlook. An* Aquaculture Summit, C.S. Lee, Editor, Asian Fisheries Society and World Aquaculture Society, pp. 205-217.

L.W.C. Lai and P.S. Leung. 2003. "Economic indicators of sustainable development in fish culture," Chapter 6 in Understanding and Implementing Sustainable Development, L.W.C. Lai and F.T. Lorne, Editors, Nova Science, pp.111-130. (Also published in UNESCO's online Encyclopedia of Life Support Systems)

A.W. Fast and P.S. Leung. 2003. "Rise and fall of freshwater prawn (Macrobrachium rosenbergii) culture in Hawaii: 1965-1999," Reviews in Fisheries Science, 11(3):243-290.

N.C. Pradhan, K.R. Sharma and P.S. Leung. 2003. "Analyzing technological and economic interrelationships in Hawaii's longline fishery," Marine Resource Economics, 18:167-193.

K.R. Sharma, N.C. Pradhan, and P.S. Leung. 2003. "Technological and economic interrelationships in Hawaii's troll and handline fisheries," North American Journal of Fisheries Management, 23:869-882.

H.M. Gunatilake and P.S. Leung. 2003. "Technology and management of bottomfish fisheries in Northwestern Hawaiian Islands," Marine Policy, 27:59-67.

L.E.Y.W. Kam, F.J. Martinez-Cordero, P.S. Leung, and A.C. Ostrowski. 2003. "Economics of milkfish (Chanos chanos) production in Hawaii," Aquaculture Economics and Management 7(1/2):95-123.

K.R. Sharma and P.S. Leung. 2003. "A review of production frontier analysis for aquaculture management," Aquaculture Economics and Management 7(1/2):15-34.

L.E.Y.W. Kam, P.S. Leung, and A.C. Ostrowski. 2003. "Economics of a Pacific threadfin (Polydactylus sexfilis) cage culture in Hawaii," Aquaculture, 223:63-87.

Selected invited presentations:

P.S. Leung and Y.C. Shang. "A historical review of aquaculture economics research," invited paper delivered at the Aquaculture Summit on Aquaculture: Retrospective and Outlook, November 3- 7, 2002, East-West Center, Honolulu, Hawaii., USA.

P.S. Leung and Y. Yuan. "Land and water use in aquaculture: experience with the ADB/NACA farm performance study from an economic perspective," invited paper delivered at the FAO Expert Consultation on Land and Water Use in Aquaculture, FAO Headquarters, Rome, 7-10 October 2002.

L.W.C. Lai, P.S. Leung and F.T. Lorne. "Economic indicators of sustainable development in fish culture," invited paper delivered at the FAO Expert Consultation on Indicators of Sustainable Aquaculture Development, FAO Headquarters, Rome, 24-27 September 2001.

P.S. Leung. "Applications of economic analysis to the management of aquaculture," Invited keynote address presented at the Conference on Aquaculture Economics and Marketing, Debrecen Agricultural University, Debrecen, Hungary, 1999.

CURRICULUM VITAE

DANIEL P. LINDSTROM

Coordinator, Coastal and Marine Resources Program
University of Hawaii at ManoaHawaii Institute of Marine Biology, P.O. Box 1346, Kaneohe, HI 96744 U.S.A.
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Education

1998 **Ph.D. Zoology**, **University of Hawaii**, Department of Zoology/ Hawaii Institute of Marine Biology, Honolulu, HI.

1991 **M.A., Biology**, **Boston University**, Department of Biology/ Boston University Marine Program, MBL, Woods Hole, MA.

1985 **B.A., Biology**, **Westmont College**, Santa Barbara, CA.

Present Position

2003-Present **Associate Specialist, Coordinator, Coastal and Marine Resources Program**
University of Hawaii at Manoa, SOEST, Honolulu, HI.
-Coordinate the proposal and planning for new graduate program in coastal and marine resources.

Past Employment/Experience

1995-2003 **Associate Professor of Biology, Director of Marine Science Program and Tropical Biology Semester Program**
Gordon College, Wenham, MA, Silliman University Marine Laboratory, Dumaguete, Philippines.
-Taught undergraduate courses in invertebrate and vertebrate zoology, ichthyology, marine science, marine biology, ecology, cell biology, tropical field biology and advanced genetic techniques. Proposed, implemented and directed tropical biology focused study abroad program in the Philippines and built and maintained a molecular laboratory there.

1991-95 **Research Assistant**
University of Hawaii/Hawaii Institute of Marine Biology, Kaneohe, HI.
- Field and laboratory research of the reproductive ecology, early larval development, genetics and life history of the five species of endangered Hawaiian endemic amphidromous gobioid fish as well as basic tropical stream ecology.

1989-90 **Laboratory Technologist**
Baxter-Travenol, Clinical Assays, Dade Division, Cambridge, MA.
- Large-scale laboratory production of medical diagnostic kits employing the radio-immuno-assay technique.

1987-88 **Charter Sailboat Captain**
Oriental Yacht Charter, Republic of Singapore.
- Skipper and engineer of 53' sailing vessel operating in open ocean and coastal areas in the vicinity of Thailand, Malaysia and Singapore.

1984-85 **Museum Curatorial Laboratory Assistant**
Santa Barbara Museum of Natural History, Santa Barbara, Ca
- Assisted in the curation of vertebrate collection consisting of mostly fish and marine mammals.

1982 **Research Vessel Bo'sun's Mate**
Ocean Research and Education Society, Gloucester, MA.
- Data collection, watch keeping and ships maintenance aboard RV "Regina Maris" in the Caribbean and extending north of the Arctic Circle west of Greenland.

Publications, Reports and Abstracts

Lindstrom, D.P., W.O. MacMillan & E. Birmingham (In Prep.) Molecular biogeography of tropical amphidromous gobioids based on MtDNA sequences.

Lindstrom, D.P. 1999. Molecular species identification of newly hatched Hawaiian amphidromous gobioid larvae. *Mar. Biotechnol.* 1, 167-174.

Breithaupt, T., D.P. Lindstrom & J. Atema. 1999. Urine release in freely moving catheterized lobsters (*Homarus americanus*) with reference to feeding and social activities. *J. Exp. Biol.* 202(7): 837-844.

Lindstrom, D.P. 1998. Reproduction, early development and larval transport dynamics of amphidromous Hawaiian gobioids. Ph.D. Dissertation, University of Hawaii at Manoa, Honolulu, Hawaii.

Kinzie III, R.A., Chong, C., Devrell, J., Lindstrom, D.P., Moser, D. & Wolff, R. 1997. Final report on effect of flow regimes on productivity in Hawaiian stream ecosystems. Report to Hawaii Department of Aquatic Resources. 40 pp.

Lindstrom, D.P. & C.L. Brown. 1996. Captive breeding and rearing of native amphidromous Hawaiian gobioids: Findings and ramifications for ecosystem management. In: Will stream restoration benefit freshwater, estuarine, and marine fisheries? Proceedings of the October 1994 symposium on Hawaiian stream restoration. Devick, W.S. (ed) Department of Land and Natural Resources Division of Aquatic Resources Technical Report 96-01:112-131.

Lindstrom, D.P. 1994. Early larval development of the endemic Hawaiian stream goby, *Lentipes concolor*. Pac. Sci. 48(2):204.

Lindstrom, D.P. & C.L. Brown. 1994. Early development and biology of the amphidromous Hawaiian stream goby *Lentipes concolor*. In: Systematics and Evolution of Indo-Pacific Fishes: Proceedings of the Fourth Indo-Pacific Fish Conference, Kasetsart University, Bangkok, Thailand, 397-409.

Lindstrom, D.P. 1991. Crustacean sex pheromones: A new technique for collection of urine from the American lobster, *Homarus americanus*. Masters Thesis, Boston University Marine Program, Woods Hole, MA.

Recent Collaborative Efforts

Bermingham, E., Ph.D of the Smithsonian Tropical Research Institute Naos Island, Republic of Panama and McMillan, W.O., Ph.D of the University of Puerto Rico, Rio Piedras. "Genetics and Biogeography of Tropical Amphidromous Gobioids."

McMillan, W.O., Ph.D of the University of Puerto Rico, Rio Piedras. "Genetic Differentiation of the Caribbean Sicydine Goby Species Complex."

Yuji Ikeda of the Biological Laboratory, Imperial Household, Tokyo, Japan. "Systematics of Gobioidae using Mitochondrial DNA Sequences."

Anne Brasher, Ph.D, Aquatic Ecologist, Oahu NAWQA U.S. Geological Survey, Honolulu, HI. "Larval Gobioid Drift Abundance as a Stream Assessment Tool."

International and Other Scientific Activities

2003 Invited presenter and participant, Biogeography of the Western Pacific. Academia Sinica, Taiwan.

2000 Participant, 9th International Coral Reef Conference, Bali, Indonesia.

1999 Extensive field studies of amphidromous stream gobioids in Hawaii, Guam, Indonesia, Bornean Malaysia, Thailand, Cambodia, Southern Japan, Philippines and Taiwan.

1999 Fall semester sabbatical at University of Puerto Rico in the lab of W.O. MacMillan. Involved in several projects obtaining and studying genetic sequences of stream gobies, hamlet fish and dengue virus.

1996-0 Expedition leader and instructor of several four week tropical biology classes of 15 –20 students to Borneo, Philippines, Southern China, Belize and Guatemala.

1996, 00 Visiting Scientist, Imperial Household Ichthyological Laboratory, Tokyo, Japan.

1996-7 Invited speaker and participant, annual meetings of the American Society of Ichthyologists and Herpetologists.

1997 Participant, Hawaii Conservation Conference, Maui.

1997 Guest Lecturer, Visiting Scientist Lecture Series, Silliman University, Dumaguete, Philippines.

1994 Invited speaker, 4th Indo-Pacific Fish Conference. Bangkok, Thailand.

1994 Guest lecturer, University of the Philippines-Diliman, Marine Science Institute, Quezon City, Philippines.

1993 Participant, NSF-US\Japan Workshop: New Approaches to Developmental Endocrinology. Hawaii, U.S.A.

1993,99 Participant, Hawaii Institute of Marine Biology Summer Program. Kaneohe, HI.

1992 Participant/Organizational Assistant, Hawaii Institute of Marine Biology Summer Program. Kaneohe, HI.

1991 Student, Massachusetts Institute of Technology/Woods Hole Oceanographic Institution Joint Program, Oceanography Megacourse. Woods Hole, MA.

1990 Student, Boston University Marine Program, Marine Semester. Woods Hole, MA.

Research Interests Summary

Molecular approaches to biogeography and systematics of tropical diadromous fish and invertebrate species. Identification of fish larvae using molecular techniques. Life history and behavior evolution. Early ontogeny and physiology of larval fishes. Tropical river ecology and conservation.

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Education

Het Nederlands Opleidings Instituut voor het Buitenland, The Netherlands, 1963, certificate
Washburn University, Topeka, Kansas, 1964, B.A. (with honors), Political Science
George Washington University, Washington, D.C., 1964-66, International Relations
University of Hawai`i, Honolulu, Hawai`i, PhD, 1976, Political Science

Teaching Experience

2001-	Professor and Chair
1993-00	Professor
1986-91	Associate Professor and Chair, Department of Urban and Regional Planning, University of Hawaii at Manoa
1978-86	Assistant Professor, Department of Urban and Regional Planning, University of Hawaii at Manoa
1978	Visiting Assistant Professor, Department of City and Regional Planning, University of North Carolina
1976-77	Assistant Professor, Pacific Urban Studies and Planning Program, University of Hawaii at Manoa
1973-76	Acting Assistant Professor, Pacific Urban Studies and Planning Program, University of Hawaii (part-time)

Selected Projects

1998-1999	Coastal Resources Center, University of Rhode Island. Development of a manual and a process for assessing coastal management projects
1999-2002	Coastal Resources Center, University of Rhode Island. Assistance with the development of coastal management projects in Indonesia.
2000-2002	Tetra Tech. Assistance with the development of coastal management projects in the Philippines.
1983-2000	Coastal Resources Center, University of Rhode Island. Assistance with the development of coastal management projects in Sri Lanka.
1990-1991	Department of Business and Economic Development. Hawaii Ocean Management Plan
1975-1977	Department of Business and Economic Development. Hawaii Coastal Management Plan

Selected Publications

Monographs

1999 **Choosing Change: A Self Assessment Manual for Non-Profit Organizations**. Hawaii Community Foundation. With Holly Henderson.

1999 **A Manual for Assessing Progress in Coastal Management**.

Coastal Management Report #2211. Coastal Resources Center. University of Rhode Island. With Stephen Olsen and James Tobey.

Chapters in Books

2003 **"**Whose Reality Matters". With Juliana Birkhoff**. The Promise and Performance of Environmental Conflict Resolution** (O'Leary and Bingham, eds.) Washington, D.C.: Resources for the Future.

1993 "Evaluating Community Justice Programs," **The Possibility of Popular Justice**. Edited by Milner and Merry. University of Michigan Press:89-121

Journals

2002 "The Landscape of ICM Learning Activities." **Coastal Management**. 30, 4: 299-324.

2002 "Introduction to Special Section on Learning from the Practice of Integrated Coastal Management." **Coastal Management**. 30, 4:299-324.

1999 "Donor Evaluations of ICM Initiatives: What Can Be Learned From Them" 42 **Ocean and Coastal Management**: 767-789. With Stephen Olsen and James Tobey.

1999 "Policy-Relevant Assessment of Community Level Coastal Management Projects in Sri Lanka." 42 **Ocean and Coastal Management**: 717-745. With Dr. Nirmalie Pallewatte and R.N. Dainis.

1997 "Notes on Evaluating Coastal Management Programs." **Coastal Management.**

1993 "Federal-State Coordination in Coastal Management. An Assessment of the Federal Consistency Provision of the Coastal Zone Management Act," 19 **Ocean and Coastal Management** 2:1-23.with Casey Jarman and and Susan Machida

1987 "Assessing Intergovernmental Coordination in the Coastal Zone," 6 **Policy Studies Review** 2: 321-329. With Tim Eichenberg.

1985 "Assessing the Implementation of Federal Coastal Policy," 51 **Journal of the American Planning Associatio**n 3: 288-298.

1983 "Institutionalized Evaluation and Intergovernmental Relations: The Case of Coastal Zone Management," 13 **Publius** 4: 79-96. With Norman Okamura.

1980 "Policy-Relevant Assessment of Coastal Zone Management Programs," 8 **Coastal Zone Management Journal** 2: 227-255.

1980 "Evaluating State Land Use Control," 18 **Urban Law Annual**: 85-117.

Selected Honors and Awards

1985-86 Marine Policy Fellow, Woods Hole Oceanographic Institution, Woods Hole, MA

1990-91 Excellence in Teaching Award, College of Social Science, UH Manoa

1992 Distinguished Leadership Award, American Planning Association, Hawaii Chapter, Honolulu

1994 Outstanding Student Project in the U.S., American Institute of Certified Planners

1999 Robert Clopton Award for Outstanding Community Service, UH Manoa

2004 Hung Wo and Elizabeth Lau Ching Community Service Award

FRED T. MACKENZIE

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Sedimentary and Global Geochemistry
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School of Ocean and Earth Science and Technology
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Honolulu, HI 96822
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Education

BS 1955 - Upsala College, Physics and Geology
MS 1959 - Lehigh University, Geology and Geochemistry
Ph.D 1962 - Lehigh University, Geology and Geochemistry

Research Interests

Evolution of Earth's Surface Environment
Biogeochemical Cycles and Global Environmental Change
Kinetics and Thermodynamics of Mineral-Water Reactions
The Carbon and Nutrient Cycles and Role in Climatic Change

Teaching Activites
OCN 310: Global Environmental Change
OCN 638: Earth System Science and Global Environmental Change
OCN 643: Topics in Marine Geochemistry
OCN 644: Sedimentary Geochemistry
OCN 735: Seminar in Oceanography
OCN 699, 700, 800: Directed, Thesis and Dissertation Research

Selected Publications
Dr. Mackenzie is the author or co-author of more than 200 scholarly publications including 8 books and 8 edited volumes in ocean and earth science and biogeochemistry. His latest book, *Our Changing Planet*, is an introductory text in Earth System Science and Global Change. He and his research colleagues and students have presented more than 100 research papers for which there are abstracts at national and international meetings.

NOTE: *Reprints* available for download where indicated by **[pdf]**

Arvidson, R.S. and **F.T. Mackenzie**, The dolomite problem: Control of precipitation kinetics by temperature and saturation state, American Journal of Science, 299, 257-288, 1999.

Arvidson, R.S. and **F.T. Mackenzie**, Temperature dependence of mineral precipitation rates along the $CaCO_3$-$MgCO_3$ join, Aquatic Geochemistry, 6 (2), 249-256, 2000. [pdf]

Arvidson, R.S., **F.T. Mackenzie**, and M.W. Guidry, Ocean/atmosphere history and carbonate precipitation rates: A solution to the "dolomite problem", in Marine Authigenesis: From Global to Microbial, edited by C.R. Glenn, L. Prevot-Lucas, and J. Lucas, pp. 1-5, Society of Sedimentary Geology, Tulsa, OK, 2000.

Andersson, A.J., **F.T. Mackenzie**, and L.M. Ver, Solution of shallow-water carbonates: An insignificant buffer against rising atmospheric CO_2, Geology, 31 (6), 513-516, 2003. [pdf]

Colman, A.S., **F.T. Mackenzie**, and H.D. Holland, Redox stabilization of the atmosphere and oceans and marine productivity, Science, 275 (January 17), 406-407, 1997.

Falkowski, P., R. Scholes, E. Boyle, J. Canadell, D. Canfield, J. Elser, N. Gruber, K. Hibbard, P. Hogberg, S. Linder, **F.T. Mackenzie**, B.I. Moore, T. Pedersen, Y. Rosenthal, S. Setizinger, V. Smetacek, and W. Steffen, The global carbon cycle: A test of our knowledge of earth as a system, Science, 290, 291-296, 2000.

Guidry, M., **F.T. Mackenzie**, and R.S. Arvidson, Role of tectonics in Phanerozoic phosphorus and carbonate distribution and cycling, in Marine Authigenesis: From Global to Microbial, edited by C.R. Glenn, L. Prevot-Lucas, and J. Lucas, pp. 35-51, Society of Sedimentary Geology, Tulsa, OK, 2000.

Guidry, M.W. and **F.T. Mackenzie**, Apatite weathering and the Phanerozoic phosphorus cycle, Geology, 28 (7), 631-634, 2000.

Guidry, M. and **F.T. Mackenzie**, Igneous and sedimentary apatite dissolution and the long-term phosphorus cycle, Geochimica et Cosmochimica Acta, 2003.

Li, Y.-H., D.M. Karl, C.D. Winn, **F.T. Mackenzie**, and K. Gans, Remineralization ratios in the Subtropical North Pacific Gyre, Aquatic Geochemistry, 6 (1), 65-85, 2000.

Mackenzie, F.T., Our Changing Planet: An Introduction to Earth System Science and Global Environmental Change, 2nd edition, 486 pp., Prentice Hall, New Jersey, 1998.

Mackenzie, F.T., Our Changing Planet: An Introduction to Earth System Science and Global Environmental Change, 3rd edition, 580 pp., Prentice-Hall, Inc., Upper Saddle River, N.J., 2003.

Mackenzie, F.T., Global Biogeochemical Cycles and the Physical Climate System, 69 pp., University Corporation for Atmospheric Research, Boulder, CO, 1999.

Mackenzie, F.T., A. Lerman, and L.M. Ver, Role of the continental margin in the global carbon balance during the past three centuries, Geology, 26, 423-426, 1998.

Mackenzie, F.T., A. Lerman, and L.M.B. Ver, Recent past and future of the global carbon cycle, in Geological Perspectives of Global Climate Change, edited by L.C. Gerhard, W.E. Harrison, and B.M. Hanson, pp. 51-82, American Association of Petroleum Geologists Special Publication, Tulsa, Oklahoma, 2001.

Mackenzie, F.T. and L.M. Ver, Land-Sea Exchanges: Global Transfers, in Encyclopedia of Ocean Sciences, edited by J.H. Steele, K.K. Turekian, and S.A. Thorpe, pp. 1443-1453, Academic Press, 2001.

Extended Abstracts Volume: Sixth International Symposium on the Geochemistry of the Earth's Surface, edited by **F.T. Mackenzie** and L.M. Ver, pp. 404, Honolulu, HI, 2002.

Mackenzie, F.T., L.M. Ver, and A. Lerman, Coupled biogeochemical cycles of carbon, nitrogen, phosphorus, and sulfur in the land-ocean-atmosphere system, in Asian Change in the Context of Global Change, edited by J.N. Galloway, and J.M. Melillo, pp. 42-100, Cambridge University Press, Cambridge, 1998.

Mackenzie, F.T., L.M. Ver, and A. Lerman, Carbon cycle in the past 300 years and future projections, in Geochemistry of the Earth's Surface, edited by H. Armannsson, pp. 11-17, Balkema, Rotterdam, The Netherlands, 1999.

Mackenzie, F.T., L.M. Ver, and A. Lerman, Coastal-zone biogeochemical dynamics under global warming, International Geology Review, 42, 193-206, 2000.

Mackenzie, F.T., L.M. Ver, and A. Lerman, Century-scale nitrogen and phosphorus controls of the carbon cycle, Chemical Geology, 190 (1-4), 13-32, 2002. [pdf]

Mackenzie, F.T., L.M. Ver, and A. Lerman, Coastal-zone biogeochemical dynamics under global warming, in Frontiers in Geochemistry: Organic, Solution, and Ore Deposit Geochemistry. Konrad Krauskopf Volume 2, edited by W. Ernst, pp. 27-40, Bellwether Publishing, Ltd., Columbia, MD, 2002.

Milliman, J.D., P.J. Troy, W.M. Balch, A.K. Adams, Y.-H. Li, and **F.T. Mackenzie**, Biologically mediated dissolution of calcium carbonate above the chemical lysocline, Deep Sea Research, 46, 1653-1669, 1999. [pdf]

Morse, J.M. and **F.T. Mackenzie**, Hadean ocean carbonate geochemistry, Aquatic Geochemistry, 4, 301-319, 1998.

Rabouille, C., **F.T. Mackenzie**, and L.M. Ver, Influence of the human perturbation on carbon, nitrogen, and oxygen biogeochemical cycles in the global coastal ocean, Geochimica et Cosmochimica Acta, 65 (21), 3615-3639, 2001. [pdf]

Tribble, J.S. and **F.T. Mackenzie**, Recrystallization of magnesian calcite overgrowths on calcite seeds suspended in seawater, Aquatic Geochemistry, 4, 337-360, 1998.

Troy, P.J., Y.-H. Li, and **F.T. Mackenzie**, Changes in surface morphology of calcite exposed to the oceanic water column, Aquatic Geochemistry, 3, 1-20, 1997.

Ver, L.M., **F.T. Mackenzie**, and A. Lerman, Partitioning of anthropogenic CO_2 by C-N-P-S cycle coupling on land and in coastal oceanic environment, Mineralogical Magazine, 62A, 1589-1590, 1998.

Ver, L.M., **F.T. Mackenzie**, and A. Lerman, Biogeochemical responses of the carbon cycle to natural and human perturbations: Past, present, and future, American Journal of Science, 299, 762-801, 1999.

Ver, L.M., **F.T. Mackenzie**, and A. Lerman, Carbon cycle in the coastal zone: Effects of global perturbations and change in the past three centuries, Chemical Geology, 159, 283-304, 1999. [pdf]

Winn, C.D., Y.-H. Li, **F.T. Mackenzie**, and D.M. Karl, Rising surface ocean dissolved inorganic carbon at the Hawaii Ocean Time-series site, Marine Chemistry, 60, 33-47, 1998. [pdf]

Woodwell, G.M., **F.T. Mackenzie**, R.A. Houghton, M. Apps, E. Gorham, and E. Davidson, Biotic feedbacks in the warming of the earth, Climatic Change, 40, 495-518, 1998.

LORENZ MAGAARD, Short Biography

Professional Preparation

Christian-Albrechts-Universitaet zu Kiel, Kiel, Germany

Vordiplom (BS)	Mathematics and Physics	1958
Diplom (MS)	Mathematics and Physics	1961
Dr.rer.nat. (PhD)	Mathematics, Physics, and Oceanography	1963

Appointments

University of Hawaii at Manoa

1975- Professor of Oceanography, Department of Oceanography
1998- Executive Associate Director, International Pacific Research Center (IPRC), SOEST
2003- Director, International Center for Climate and Society (ICCS), SOEST
1992-2000: Associate Dean, SOEST
1984-1990: Chairman, Department of Oceanography
1984-1990: Chairman, Graduate Field of Study in Oceanography

Christian-Albrechts-Universitaet zu Kiel, Kiel, Germany

1972-1975: Professor an einer Wissenschaftlichen Hochschule (Associate Professor with tenure)
1969-1972: Dozent (Associate Professor without tenure)
1964-1968: Wissenschaftlicher Assistant (Assistant Professor)
1961-1964: Wissenschaftlicher Mitarbeiter (Assistant Scientist)
1958-1961: Studentische Hilfskraft (Graduate Assistant)

Selected Recent Publications

Grossmann, W. D., J. B. Marsh, L. Magaard, and H. von Storch. Two-region analysis of changing economic and environmental risks. Climatic Change (submitted).

Yun, J.-Y., L. Magaard, K. Kim, C.-W. Shin, C. Kim, and S.-K. Byun. 2004. Spatial and temporal variability of the North Korean Cold Water leading to the near-bottom cold water intrusion in Korea Strait. Progress in Oceanography, 60, 99-131.

Grossmann, W. D., L. Magaard, and H. von Storch. 2003. Using economic change for adaptation to climate risks – a modeling study. GKSS Report 2003/3.

Yun, J.-Y., J. M. Price, and L. Magaard. 2000. Recalculated radiating instabilities using the correct matching and boundary conditions. J. Phys. Oceanogr., 30, 2379-2390.

Graef, F. and L. Magaard. 1994. Reflection of nonlinear baroclinic Rossby waves and the driving of secondary flows. J. Phys. Oceanogr., 24, 1867-1894.

Synergistic Activities

1. Founder of the International Center of Climate and Society (ICCS) in SOEST, University of Hawaii at Manoa (2003).

2. Major role in the establishment of the International Pacific Research Center (IPRC) in SOEST, University of Hawaii at Manoa (1997).

3. Major role in the establishment of the School of Ocean and Earth Science and Technology (SOEST) at the University of Hawaii at Manoa as well as in the establishment of the Graduate Ocean Policy Certificate Program (1986-88).

4. Teaching of graduate courses at the University of Hawaii: Ocean Waves I, Ocean Waves II, Oceanic Turbulence I, Oceanic Turbulence II, Dimensional Analysis, Ocean Policy Seminar.

Bruce Mathews

Associate Professor of Soil Science

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Hilo, HI 96720
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E-mail: bmathews@hawaii.edu

Education
B.S. 1986, University of Hawai`i at Hilo
M.S. 1989, Louisiana State University
Ph.D., 1992, University of Florida

Courses Taught
Sustainable Agriculture (AG230)
Tropical Silviculture (FOR350)
Tropical Soils (SOIL304)
Agronomic Crop Production in the Tropics (AGRON310)
Soil Fertility & Nutrient Cycling (SOIL350)
Soil-Plant-Herbivore Interrelations (AGRON410)
Soil Conservation & Environmental Quality (SOIL461)

Research Interests

Current areas of research focus on macronutrient cycling in pasture-based livestock systems and the sustainable management of tropical pastures, soils, and alternative/exotic crops. Additional work is being conducted in the areas of tropical silviculture, rural development, and extension.

Selected Publications

Mathews, B.W., S.C. Miyasaka, and J.P. Tritschler II. 2000. Mineral nutrition. In L.E. Moser et al. (ed.) Warm-season grasses. ASA, Madison, WI (in prep.).

Mathews, B.W., J.R. Carpenter, L.E. Sollenberger, and K.D. Hisashima.2000. Macronutrient, soil organic carbon, and earthworm distribution in subtropical pastures on an Andisol with and without long-term fertilization (in review).

Mathews, B.W., and K.D. Hopkins. 2000. Superiority of S-shaped (sigmoidal) yield curves for explaining low-level nitrogen and phosphorus fertilization responses in the humid tropics. J. Hawaiian Pacific Agric. 10:(in press).

Mathews, B.W., J.P. Tritschler II, J.R. Carpenter, and L.E. Sollenberger. 1999. Soil macronutrient distribution in rotationally stocked kikuyugrass paddocks with short and long grazing periods. Commun. Soil Sci. Plant Anal. 30:557-571.

Mathews, B.W., J.P. Tritschler II, and S.C. Miyasaka. 1998. Phosphorus management and sustainability. p. 193-222. In J.H. Cherney and D.J.R. Cherney (ed.) Grass for dairy cattle. Center for Agriculture and Biosciences (CAB) International, Wallingford, Oxon, UK.

Mathews, B.W., L.E. Sollenberger, and J.P. Tritschler II. 1996. Grazing systems and spatial distribution of nutrients in pastures: Soil considerations. p. 213-229. In R.E. Joost and C.A. Roberts (ed.) Nutrient cycling in forage systems. Vol. I., Proc. Nutrient Cycling Symposium, Columbia, MO. 7-8 March 1996. Potash and Phosphate Institute (PPI) and the Foundation for Agronomic Research (FAR), Manhattan, KS.
Contact Information

VITA

Name: Karla J. McDermid
Title: Professor, Marine Science Department
Campus Address: University of Hawaii at Hilo, 200 W. Kawili St.
City, State, Zip: Hilo, HI 96720
Telephone Number: 808-933-3906
Fax Number: 808-974-7693
E-Mail Address: mcdermid@hawaii.edu

Education

Ph. D. Botanical Sciences, University of Hawaii at Manoa, 1988
Joint Program in Biological Oceanography, WHOI/MIT, 1980-1982
B.S. Biological Science, Stanford University, 1980
B.A. Spanish, Stanford University, 1980

Professional Experience

Professor, UH Hilo, 2004-present
Associate Professor, UH Hilo, 1999-2004
Affiliate Researcher, Bishop Museum, 2001-2004
Chairperson, Marine Science Department, UH Hilo, 1999-2000
Assistant Professor, UH Hilo, 1994-1999
Assistant Professor, UH Manoa, 1991-1994
Lecturer, Windward Community College, 1989-1990
Postdoctoral Researcher, UH Manoa, 1988-1989

Current & Recent Funding

NOAA/NURP/HURL, The Lower Limit of Light Harvesting, 2004-2005, 14 submersible dives valued at $348,000

MBRS/NIH, Nutritional Composition of Edible Hawaiian Seaweeds, 2001-2004, $305,512

National Fish and Wildlife Foundation, Reef Explorers, Reef Stewards: Coral Reef Ecosystem Summer Education Program, 2003, $25,000

NOAA EPP/MSI Program, Atolls and Oceans—An Ecosystem Learning Experience, 2001-2002, $58,363

Hawaii Sea Grant, Workshop on the Taxonomy and Diversity of Economic Seaweeds in the Pacific Basin, 2002, $8174

UH Hilo Research Council Seed Money, Seaweed Taxonomy Workshop, $8704, 2001-2 California Sea Grant, Seaweed Taxonomy Workshop, 2002, $8700

Peer-reviewed Publications

McDermid, K. 1981. Preliminary studies on the association between *Pleonosporium squarrosum* (Rhodophyta) and *Cryptochiton stelleri* (Polyplacophora). *Veliger* 23(4):317-320.

McDermid, K. & R. Naiman. 1983. Macrophytes: the freshwater forests of lakes and rivers. *Am. Bio. Teacher* 45(3):144-150.

McDermid, K. 1985. Mosaic pattern and patch dynamics of an intertidal algal community in Hawai'i. *Proc. Vth Int. Coral Reef Congress, Tahiti*. 5:67-72.

McDermid, K. 1988. *Laurencia* (Rhodophyta, Rhodomelaceae) Introduction. In: *Taxonomy of economic seaweeds: with reference to some Pacific and Caribbean species, vol.2,* I.A. Abbott (ed.), Calif. Sea Grant College Program, La Jolla, CA, pp.221-229.

McDermid, K. 1988. *Laurencia* from the Hawaiian islands: Key, annotated lists, and distribution of the species. In: *Taxonomy of economic seaweeds: with reference to some Pacific and Caribbean species, vol.2,* I.A. Abbott (ed.), Calif. Sea Grant College Program, La Jolla, CA, pp.231-247.

Zablackis, E. & K. McDermid. 1988. Agar from a species of *Laurencia,* a red seaweed from the Hawaiian Islands. In: *Taxonomy of economic seaweeds: with reference to some Pacific and Caribbean species, vol.2,* I.A. Abbott (ed.), Calif. Sea Grant College Program, La Jolla, CA, pp.253-256.

McDermid, K. 1988. Spatial relationships among subtropical intertidal algae: quantifying the kaleidoscope. *J. Phycol.* 24(s):9.

McDermid, K. 1989. *Laurencia crustiformans* sp. nov. (Ceramiales, Rhodophyta) from the Hawaiian islands. *Phycologia* 28(3):352-359.

McDermid, K. 1990. Life history and growth of *Laurencia brachyclados* (Rhodophyta, Ceramiales). *J. Phycol.* 26(2):338-391.

McDermid, K. The big class. 1993. *Teaching and Learning* Spring:3.

Stimson, J., S. Larned & K. McDermid. 1996. Seasonal growth of the coral reef macroalga *Dictyosphaeria cavernosa* (Forskal) Borgesen and the effects of nutrient availability, temperature and herbivory on growth rate. *J. Exp. Mar. Biol. Ecol.* 196:53-77.

McDermid, K. 1998. Ocean haiku. *Kanilehua* p.21.

McDermid, K. & A. Edward. 1999. Seagrass community composition and biomass at Nahpali Island, Pohnpei. *Micronesica* 31:255-262.

Hodgson, L. & K. McDermid. 2000. Marine plants of Pohnpei and Ant Atoll: Chlorophyta, Phaeophyta and Magnoliophyta. *Micronesica* 32(2):289-307.

Abbott, I.A. & K. McDermid. 2001. *Dudresnaya babbittiana* (Dumontiaceae, Gigartinales), a new red algal species from Midway Atoll, North Central Pacific. *Cryptogamie Algologie* 22(3):249-261.

Abbott, I.A. & K. McDermid. 2002. On two species of *Kallymenia* (Rhodophyta) from the Hawaiian Islands, Central Pacific. *Pacific Science* 56(2):149-162.

McDermid, K.J., M.C. Gregoritza & D.W. Freshwater. 2002. A new record of a second seagrass species from the Hawaiian Archipelago: *Halophila decipiens* Ostenfeld. *Aquatic Botany* 74(3):257-262.

Abbott, I.A. and K. McDermid (co-editors). 2002. *Taxonomy of economic seaweeds with reference to some Pacific species, vol 8.* Calif. Sea Grant Program, Report #T-048, 332 pp.

McDermid, K. 2002. Phenology and spore germination in a *Halymenia* population at Mahai'ula Bay, Hawai'i. In: *Taxonomy of economic seaweeds* vol. 8, I.A. Abbott & K. McDermid, (eds.), Calif. Sea Grant. Pp. 279-288.

Kawaguchi, S., K. Lewmanomont & K. McDermid. 2002. Morphology of *Halymenia maculata* J. Ag. from Vietnam. In: *Taxonomy of economic seaweeds* vol. 8, I.A. Abbott & K. McDermid (eds.), Calif. Sea Grant. Pp. 259-266.

Abbott, I.A., J. Fisher & K. McDermid. 2002. Newly reported and revised marine algae from the vicinity of Nha Trang, Vietnam. In: *Taxonomy of economic seaweeds* vol. 8, I.A. Abbott & K. McDermid (eds.), Calif. Sea Grant. Pp. 291-321.

McDermid, K., L. Hodgson & I.A. Abbott. 2002. Marine plants of Pohnpei and Ant Atoll: Rhodophyta, with biogeographic comparisons to other Pacific atolls and islands groups. *Micronesica* 34(2):113-140.

McDermid, K.J., M.C. Gregoritza, J.W. Reeves & D.W. Freshwater. 2003. Morphological and genetic variation in the endemic seagrass *Halophila hawaiiana* (Hydrocharitaceae) in the Hawaiian Archipelago. *Pacific Science* 57(2) 199-209.

McDermid, K.J. & B. Stuercke. 2003. Nutritional composition of edible Hawaiian seaweeds. *Journal of Applied Phycology* 15:513-524.

Abbott, I.A. and K. McDermid (co-editors). 2004. *Taxonomy of economic seaweeds with reference to the Pacific and other locations, vol 9.* Hawaii Sea Grant Program, Report # UHIHI-SEAGRANT-CR-02-04, 281 pp.

McDermid, K. J. & B. Stuercke. 2004. A comparison of the nutritional composition of Hawaiian *Gracilaria* species. In: *Taxonomy of economic seaweeds* vol. 9, I.A. Abbott & K. McDermid (eds.), Hawaii Sea Grant, Pp. 211-226.

Hodgson, L.M, H.T. Pham, K. Lewmanomont & K.J. McDermid. 2004. An annotated checklist of species of *Caulerpa* and *Caulerpella* (Bryopsidales, Caulerpaceae) from Vietnam, Thailand, and the Hawaiian Islands. In: *Taxonomy of economic seaweeds* vol. 9, I.A. Abbott & K. McDermid (eds.), Hawaii Sea Grant, Pp. 21-38.

McDermid, K.J. & T.L. McMullen. 2004. Quantitative analysis of small-plastic debris on beaches in the Hawaiian archipelago. *Marine Pollution Bulletin* 48(7-8): 790-794.

Stuercke, B. and K. J. McDermid. In press. Variation in algal turf species composition and abundance on two Hawaiian shallow subtidal reefs. *Cryptogamie Algologie.*

McDermid, K.J., B. Stuercke and O.J. Haleakala. Submitted. Total dietary fiber content in Hawaiian marine algae. Botanica Marina

McDermid, K.J., B. Stuercke and G.H. Balazs. In manuscript. Nutritional composition of marine plants in the diet of the green sea turtle (*Chelonia mydas*) in the Hawaiian Islands.

Past Honors and Grants

NSF Graduate Fellowship, 1980-1983
McNaughton Scholarship, 1982
Albert L. Tester Symposium Best Paper Award, 1985
Western Society of Naturalists Outstanding Paper Award, 1986
Graduate Student Organization Travel Grant, 1986
Pacific Tropical Botanical Society Research Grant, 1987
Junior Faculty Excellence in Teaching Grant, 1991
University Research Council Seed Money Grant, 1991
Women's Campus Center Supplies Grant, 1992
Excellence in Teaching Nomination, 1994
Education Improvement Fund Grant, 1998
University Research Council Travel Grant, 1999

Professional Memberships

Sigma Xi
Phi Beta Kappa

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Education

- B.A. 1989- Environmental Sciences, University of Virginia
- M.S. 1991- Biological Oceanography, Old Dominion University
- Ph.D. 1996- Physical Oceanography, Old Dominion University Center for Coastal Physical Oceanography

Active Research Programs

THIN LAYERS http://www.gso.uri.edu/criticalscales/

NEOCO http://es.ucsc.edu/~neoco/

PISCO http://www.piscoweb.org/what/index.html

CIMT http://cimt.ucsc.edu/

AOSN http://www.mbari.org/aosn/>

Recent News

http://www.piscoweb.org/outreach/events/AAAS2003.htm

Ten Selected Publications

Drake PJ, MA McManus and C Storlazzi. In press. Local wind forcing of the Monterey Bay area inner shelf. *Continental Shelf Research.*

McManus MA, AL Alldredge, A Barnard, E Boss, J Case, TJ Cowles, PL Donaghay, L Eisner, DJ Gifford, CF Greenlaw, C Herren, DV Holliday, D Johnson, S MacIntyre, D McGehee, TR Osborn, MJ Perry, R Pieper, JEB Rines, DC Smith, JM Sullivan, MK Talbot, MS Twardowski, A Weidemann and JRV Zaneveld. 2003. Changes in Characteristics, Distribution and Persistence of Thin Layers Over a 48-Hour Period. *Marine Ecology Progress Series*. 261: 1-19.

Storlazzi C and MA McManus. 2003. Long-term, high-frequency current and temperature measurements along central California: Insights into upwelling relaxation and internal waves on the inner shelf. *Continental Shelf Research*. 23: 901-918.

McManus MA, J Largier, E Palomino, L Wilkinson, L Washburn, K Stolzenbach, B Sanders, S Morgan, M Stacey, E Palomino, F Wright and JS Scott. 2003. Data Management Techniques for NEOCO, the Network for Environmental Observations of the Coastal Ocean. *Sea Technology*. 44(8): 54-60

Holliday DV, PL Donaghay, CF Greenlaw, DE McGehee, MA McManus, JM Sullivan and JL Miksis. Advances in Defining Fine- and Micro-scale Pattern in Marine Plankton. 2003. *Aquatic Living Resources*. 16(3): 131-136.

Alldredge AL, TJ Cowles, S MacIntyre, JEB Rines, PL Donaghay, CF Greenlaw, DV Holliday, MM Dekshenieks*, JM Sullivan and JRV Zaneveld. 2002. Occurrence and mechanism of formation of a dramatic thin layer of marine snow in a shallow Pacific fjord. *Marine Ecology Progress Series*. 233: 1-12.

Rines JEB, PL Donaghay, MM Dekshenieks*, JM Sullivan and MS Twardowski. 2002. Thin Layers and Camouflage: Hidden Pseduo-nitzschia populations in a fjord in the San Juan Islands, Washington, USA. *Marine Ecology Progress Series*. 225: 123-137.

Dekshenieks* MM, PL Donaghay, JM Sullivan, JEB Rines, TR Osborn and MS Twardowski. 2001. Temporal and Spatial Occurrence of Thin Phytoplankton Layers in Relation to Physical Processes. *Marine Ecology Progress Series*. 223: 61-71

Dekshenieks* MM, EE Hofmann, JM Klinck and EN Powell. 2000. Quantifying the effects of environmental variability on an oyster population using a coupled oyster-circulation model. *Estuaries*. 23(5): 593-610.

Dekshenieks* MM, EE Hofmann, JM Klinck and EN Powell. 1996. Modeling the vertical distribution of oyster larvae in response to environmental conditions. *Marine Ecology Progress Series*. 136: 97-110.

(*please note, McManus formerly Dekshenieks)

James D. Parrish

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Leader, Hawai'i Cooperative Fishery Research Unit
Department of Zoology, University of Hawai`i
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E-mail: parrishj@hawaii.edu

Education

Ph.D. University of Rhode Island (Oceanography), 1972

Research Interests: Marine community ecology

My major research interests are in aquatic species interactions and community ecology. I am particularly interested in various aspects of predation, in trophic ecology, and in the trophic structure of communities. Approaches include theoretical models and field studies. My long range aim is to incorporate realistic data from sizable aquatic systems into practical analytical frameworks. I am glad to work with students on projects of smaller scope, particularly where results can be contributory to describing a larger system. The group I am most familiar with is the fishes, particularly coastal marine fishes.

The Hawai'i Cooperative Fishery Research Unit conducts research projects in fishery biology and related ecology.

Representative Recent Publications

Friedlander AM, Parrish JD. 1998. Temporal dynamics of fish communities on an exposed shoreline in Hawaii. Environ Biol Fishes 253:1-18.

Friedlander AM, Parrish JD. 1998. Habitat characteristics affecting fish assemblages on a Hawaiian coral reef. J Exp Mar Biol Ecol 224:1-30

Friedlander AM, Parrish JD. 1997. Fisheries harvest and standing stock in a Hawaiian bay. Fisheries Res 32:33-50

DeMartini EE, Parrish FA, Parrish JD. 1996. Interdecadal change in reef fish populations at French Frigate Shoals and Midway Atoll, Northwestern Hawaiian Islands: statistical power in retrospect. Bull Mar Sci 58:804-825.

Dee AJ, Parrish JD. 1994. Reproductive and trophic ecology of the soldierfish, *Myripristis amaena,* in tropical fisheries. Fish Bull 92:516-530.

Michael L. Parsons

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Ph.D. Louisiana State University, Phytoplankton ecology and taxonomy

RESEARCH INTERESTS

My research interests are in the field of phytoplankton population dynamics, toxic phytoplankton & paleoecology and address the basic question "How do phytoplankton assemblages respond to perturbations (human/natural)?" As I pursue the answer to this question (and future related ones), I plan to expand the scope of the question into a larger regional or global scale to address overall ecological disturbances (e.g., global warming).

CURRENT PROJECTS

One facet of my research utilizes the recent sediment record as a proxy for the changing environment (e.g., nutrient loading, salinity, acute events like hurricanes) and phytoplankton responses to these changes as revealed by preserved diatom remains. Another area of research I am currently pursuing involves the study of the modern phytoplankton community present in the coastal waters of Hawai'i. One aspect of this research is focused on the study of harmful algae, such as dinoflagellates that are responsible for ciguatera poisoning. This research is revealing how phytoplankton populations react to the changing environment, which opens many interesting research opportunities.

CURRICULUM VITAE

NAME: SAMUEL G. POOLEY

ORGANIZATION: National Oceanic & Atmospheric Administration
National Marine Fisheries Service
Pacific Islands Fisheries Science Center
2570 Dole Street, Honolulu, Hawaii 96822-2396
(808) 983-5303
Samuel.Pooley@noaa.gov

PRESENT POSITIONS: Director, Honolulu Laboratory
Acting Regional Administrator, Pacific Islands Region

DISCIPLINE: Economics and policy analysis

EDUCATION:

B.A., Economics, Dartmouth College, 1970
M.S., Economics, University of Birmingham, U.K. 1977
Ph.D., Political Science, University of Hawaii, 1987

EXPERIENCE:

1998-present	Affiliate graduate faculty Department of Political Science and Center on Globalization University of Hawaii-Manoa, Honolulu, Hawaii
1994	Rotational assignment, NMFS Office of International Affairs, Silver Springs, MD. Preparations for the United Nations Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks.
1993-present	Affiliate Graduate Faculty, Department of Agricultural & Resource Economics University of Hawaii-Manoa Honolulu, Hawaii Ocean Policy Faculty, University of Hawaii-Manoa Honolulu, Hawaii
1992	Visiting Lecturer, Department of Agricultural & Resource Economics, University of Hawaii-Manoa, Honolulu, Hawaii

1981-2002	Industry Economist National Marine Fisheries Service, Honolulu, Hawaii
1980-1981	Staff Economist, Western Pacific Regional Fishery Management Council, Honolulu, Hawaii
1977-1980	Instructor of Economics and Chairperson of Social Science Honolulu Community College, Honolulu, Hawaii
1978-1979	Economist/Planner, Hawaii Fisheries Development Plan Project Hawaii Department of Land & Natural Resources Honolulu, Hawaii
1976-1977	Economist & Research Statistician Pacific Tuna Development Foundation Hawaii Department of Planning & Economic Development Honolulu, Hawaii

RESEARCH INTERESTS:

Applied microeconomic theory and property rights

PROFESSIONAL AFFILIATIONS:

Contributing Editor, *Marine Resource Economics*, 1992-Present
Graduate Thesis Committees, Department of Agricultural & Resource Economics, University of Hawaii, 1990-Present
Editorial Board, Social Process in Hawaii, University of Hawaii, 1983-1985
American Economics Association, 1976-Present

RECENT PUBLICATIONS:

Townsend, R. E., S. G. Pooley, and R. Clarke.
2003. Evidence of producer bargaining in the Northwestern Hawaiian Islands lobster fishery. Marine Resource Economics 18(2):195-203.

Leung, P. S., and S. G. Pooley.
2002. Economy-wide impacts of reductions in fisheries production: a supply-driven approach. Marine Resource Economics 16(4):251-262.

Pan, M., P. S. Leung, and S. G. Pooley.
2001. A decision support model for fisheries management in Hawaii--a multilevel and multiobjective programming approach. North American Journal of Fisheries Management 21(2):293-309.

Pan, M. and S. G. Pooley.
2000. Factors affecting the prices of pelagic fish in the Hawaii markets: a simple statistical analysis. SOEST JIMAR Contribution (forthcoming).

Leung, P., M. Pan, F. Pi, S. T. Nakamoto, and S. G. Pooley.
1999. A bilevel and bicriterion programming model of Hawaii's multifishery. *In* U. Chakravorty and J. Sibert (eds.), Ocean-scale management of pelagic fisheries: economic and regulatory issues, p. 41-63. Proceedings of an International Workshop organized by the Pelagic Fisheries Research Program, Joint Institute for Marine and Atmospheric Research, University of Hawaii at Manoa, Honolulu, Hawaii, November 12-13, 1997. SOEST 99-01, JIMAR 99-321.

Pan, M., P. S. Leung, F. Ji, S. T. Nakamoto, and S. G. Pooley.
1999. A multilevel and multiobjective programming model for the Hawaii fishery: model documentation and application results. vi, 84 p., SOEST 99-04, JIMAR Contribution 99-324.

Sharma, K. R., A. Peterson, S. G. Pooley, S. T. Nakamoto, and P. S. Leung.
1999. Economic contributions of Hawaii's fisheries. Pelagic Fisheries Research Program SOEST 99-08, JIMAR 99-327, 40 p.

Schroeder, Thomas A.

My research interests include mesoscale circulations, tropical meteorology, and tropical cyclones. I have spent much effort in study of weather and climate in Hawai'i and severe weather and its impacts upon society. Current work includes analysis of the Hawaiian Rain Band Project data set, the impacts of hurricanes (especially Hurricane Iniki) in the central Pacific, and impacts of interannual climate variability in the Pacific.

- Foster, J., M. Bevis, T. Schroeder, M. Merrifield, S. Businger, S. Dorn, S. Marcus, J. Dickey and Y. Bar-Sever, 2000: El Nino, water vapor and the Global Positioning System. *Geophys. Res. Lett.,* **27**, 2697-2700.
- Ramage, C.S., and T.A. Schroeder, 1999: Tradewind Rainfall Atop Mt. Waialeake, Hawaii. *Mon. Wea. Rev.* (In Press)
- Yu, Z.P., P.S. Chu, and T.A. Schroeder, 1997: Predictive skills of seasonal to annual rainfall variations in the U.S. Affiliated Pacific Islands: Canonical correlation analysis and multivariate priniciple component regression approaches. *J. Climate*, **10**, 2586-2599.
- Fletcher, C. H., B. M. Redmond, G.M. Barnes, and T. A. Schroeder, 1995: Marine flooding on the coast of Kauai during Hurricane Iniki: Hindcasting inundation components and delineating washover. *J. Coastal Res.*, **11**, 1, 188-204.
- Schroeder, T. A., (with 12 others), 1994: *Voyage of Rediscovery*. University of California Press, 401pp.
- Schroeder, T. A., (with M. Sanderson et al), 1993: *Prevailing Trade Winds*. University of Hawaii Press. 126 pp.
- Schroeder, T. A., (with J. Dracup et al), 1991: The New Year's Eve Flood on Oahu, Hawaii, December 31, 1987 - January 1, 1988. *Natural Disaster Studies*, Vol.1, pp.72.

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A R E A S O F E X P E R T I S E

Broad background in marine biology, including estuarine ecosystems, population biology, benthic ecology and fisheries. Expert in population modeling and non-linear statistical parameter estimation and optimization. Fisheries management policy analysis and recommendations. Current areas of activity include:

Stock assessment modeling, data collection, and analysis. Developing models of large scale movement, growth and mortality of pelagic fish populations. Designing tag-and-release studies to enhance information on pelagic stocks in the western Pacific. Analyzing catch and effort data for pelagic fisheries to ascertain stock condition.

Fisheries management policy analysis and recommendations. Integrating local, national, and international fisheries regulations and conventions with stock assessment data to reach policy conclusions about fisheries management. Advising the United States Western Pacific Regional Fisheries Management Council on fisheries policy in the Western Pacific region. Coordinating with national and international organizations such as the U. S. National Marine Fisheries Service, the Secretariat of the Pacific Community, the Forum Fisheries Agency, the Inter-American Tropical Tuna Commission, and the United Nations Food and Agriculture Organization on fisheries stock assessment and management policies.

Research program development and management. Facilitating communication and collaboration among scientists from different disciplines. Communication of research results to research clients. Conceptualization of fisheries as systems requiring new research initiatives in social science and economics to complement on-going biological and oceanographic research.

PROFESSIONAL EXPERIENCE

University of Hawaii *1992 to Present*
Honolulu, HI
MANAGER, PELAGIC FISHERIES RESEARCH PROGRAM.

Otter Research Ltd. *1987 to 1992*
Nanaimo, BC, Canada
PRESIDENT, OTTER RESEARCH LTD.

South Pacific Commission *1982 to 1987*
Noumea, New Caledonia
COORDINATOR, TUNA AND BILLFISH ASSESSMENT PROGRAM
SENIOR FISHERIES SCIENTIST, TUNA AND BILLFISH ASSESSMENT PROGRAM

Department of Fisheries and Oceans *1971 to 1982*
Pacific Biological Station, Nanaimo, B.C., Canada
RESEARCH SCIENTIST

University of British Columbia *1968 to 1971*
Vancouver, B.C., Canada
POSTDOCTORAL FELLOW AND SPECIAL TEACHING FELLOW

EDUCATION

Ph.D., Columbia University, 1968
B.A., University of Pacific, 1962

RECENT ADVISORY POSITIONS

International Technical Expert Workshop On Marine Turtle Bycatch In Longline Fisheries, Feb 11-13, 2003; member of steering committee.

Member of United States Delegation to Preparatory Conference for the Commission for the Conservation and Management of Highly Migratory Fish Stocks in Western and Central Pacific (2002, 2003)

Member of United States Delegation to the Scientific Coordinating Group of Preparatory Conference for the Commission for the Conservation and Management of Highly Migratory Fish Stocks in Western and Central Pacific (2002)

Methods Working, Standing Committee on Tuna and Billfish (Chair, ongoing)

Scientific and Statistical Committee, Western Pacific Fisheries Management Council (ongoing)

National Research Council Committee on Improving the Collection and Use of Fisheries Data, 1999

James P. Szyper

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Sea Grant Extension Service
Cooperative Extension Service
875 Komohana St., Hilo, HI 96720-2757
telephone: 808 981-5199; fax: 808 981-5211; email: *jszyper@hawaii.edu*

Education

University of Hawaii, Honolulu, Hawaii. Ph.D., Biological Oceanography, 1976.
University of Hawaii, Honolulu, Hawaii. M.S., Biological Oceanography, 1972.
NDEA Title IV Graduate Fellow, 1969-1972.
University of Wisconsin, Milwaukee, Wisconsin. B.S. (honors), Zoology, 1968.

Affiliations

University of Hawaii at Manoa, Sea Grant Extension Service and Cooperative Extension Service (1999 - present): Aquaculture Specialist

University of Hawaii at Hilo, College of Agriculture, Forestry, and Natural Resource Management (2000-present): Affiliate Professor of Aquaculture

University of Hawaii at Hilo, College of Arts and Sciences, Department of Marine Science (1998 - 1999): Visiting Associate Professor of Marine Science

University of Hawaii at Manoa, School of Ocean and Earth Science and Technology, Hawaii Institute of Marine Biology (1972 - 1998): Associate Researcher, 1991 - 1999; Assistant Researcher, 1985 - 1991.

Asian Institute of Technology, School of Environment, Resources and Development, Agriculture and Aquatic Systems Program (1993-1996): Research Scientist, Affiliated Faculty (resident 1993-1995).

Professional Memberships

World Aquaculture Society
Network of Tropical Aquaculture Scientists (World Fish Center)
Hawaii Aquaculture Association
American Fisheries Society
American Society of Limnology and Oceanography
Hawaii Academy of Science

Selected Bibliography

Szyper, J.P., 2002. Water temperature regimes in aquaculture systems in East Hawaii. *Journal for Hawaiian and Pacific Agriculture* 12:15-27.

Szyper, J.P., C.S. Tamaru, R.D. Howerton, K.D. Hopkins, A.W. Fast, and R.P. Weidenbach, 2001. *Maturation, hatchery, and nursery techniques for Chinese catfish,* Clarias fuscus*, in Hawaii*. UNIHI-SEAGRANT-AB-01-01, University of Hawaii Sea Grant College Program, Honolulu, HI, 8 p.

Szyper, J.P., K.D. Hopkins, W. Malchow, and W.Y. Okamura, 2000. History and prospects of tilapia stocks in Hawaii, U.S.A., pp. 663-672. In: Fitzsimmons, K., and J. Carvalho Filho (eds.), *Tilapia Culture in the 21st Century* – Proceedings of the Fifth International Symposium on Tilapia Aquaculture, Rio de Janeiro, Brazil.

Szyper, J.P., 1999. Practical mass culture of microalgae, p. 79-82. In: *Marine Ornamentals 99*, C. Brown and L. Young (eds.), University of Hawaii Sea Grant College Program UNIHI-SEAGRANT-CP-00-04.

Szyper, J.P., B.A. Yoza, J.R. Benemann, M.R. Tredici, and O.R. Zaborsky, 1998. Internal gas exchange photobioreactor, p. 441-446. In: *Biohydrogen*, O.R. Zaborsky et al. (eds.), Plenum Press, New York.

Szyper, J.P., 1996. Observations and model predictions of daily areal primary production in a eutrophic brackish water culture pond. *Ecological Modelling* 88:83-92.

Szyper, J.P.,1996. Comparison of three mixing devices in earthen culture ponds of four different surface areas. *Aquacultural Engineering* 15:381-396.

Szyper, J.P., C. K. Lin, D. Little, S. Setboonsarng, A. Yakupitiyage, P. Edwards, and H. Demaine, 1995. Techniques for efficient and sustainable mass production of tilapia in Thailand. In: *Proceedings of the PACON International Sustainable Aquaculture 95 Symposium*, Pacific Congress on Marine Science and Technology, Honolulu, Hawaii.

Szyper J.P., and J.M. Ebeling, 1993. Photosynthesis and community respiration at three depths during a period of stable phytoplankton stock in a eutrophic brackish water culture pond. *Marine Ecology Progress Series* 94:229-238.

Szyper, J.P., 1989. *Backyard Aquaculture in Hawaii: a Practical Manual*. University of Hawaii, Windward Community College, 87p.

Szyper, J.P., and S.D. Maynard, 1988 (invited). Experiential education in small scale aquaculture. *Sea Grant Quarterly*, Vol. 10, No. 2, Fall 1988, p. 1-5. University of Hawaii Sea Grant College Program.

Bienfang, P.K., and J.P. Szyper, 1981. Phytoplankton dynamics in oceanic waters off Keahole Point, Hawaii. *Deep Sea Research* 28:981-1000.

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ACADEMIC

University of Tokyo, Tokyo, Japan. Ph.D., Faculty of Agriculture, Department of Fisheries. 1988.
University of Hawaii at Manoa, Honolulu, Hawaii. M.S., Zoology. 1981.
University of Hawaii at Manoa, Honolulu, Hawaii. B.S., Biology. 1976.

TRAINING

Agriculture Leadership Foundation of Hawaii, University of Hawaii College of Tropical Agriculture and Human Resources, Agricultural Leadership Training Program Class IX. June 2001 - November 2002.

POSITIONS AND EXPERIENCE

Sea Grant Extension Service, University of Hawaii/Department of Agriculture. January 1995 - present. Aquaculture Specialist, Specialist 5, 7/01. Projects during the last four years.

Principal Investigator - Aquaculture of Hawaiian Marine Invertebrates for the Marine Ornamental Trade - Year 2. USDA Center for Tropical and Subtropical Aquaculture, Sea Grant Extension Service, $55,000. 10/03 - 9/04. FMIS# 652203

Co-Principal Investigator - Multi-cropping strategies for aquaculture, United States Department of Agriculture CSREES, University of Hawaii College of Tropical Agriculture and Human Resources, $115,985, 9/02 - 8/05. Contract #2002-34167-12759.

Principal Investigator - Aquaculture Extension Project (Sea Grant Extension Service, Aquaculture Development Program) State of Hawaii Department of Agriculture, $89,319. 8/02-9/03. FMIS# 436453

Principal Investigator - Transitioning Hawaii's Freshwater Ornamental Fish Industry - Year 3, USDA Center for Tropical and Subtropical Aquaculture, Sea Grant Extension Service, $70,000. 10/02 - 9/03. FMIS# 659068

Principal Investigator - Aquaculture of Hawaiian Marine Invertebrates for the Marine Ornamental Trade - Year 1. USDA Center for Tropical and Subtropical Aquaculture, Sea Grant Extension Service, $55,000. 10/02 - 9/03. FMIS# 659069

Principal Investigator - Aquaculture Extension Project (Sea Grant Extension Service, Aquaculture Development Program) State of Hawaii Department of Agriculture, $89,000. 8/01-9/02. FMIS #436076.

Principal Investigator - Transitioning Hawaii's Freshwater Ornamental Fish Industry - Year 2, USDA Center for Tropical and Subtropical Aquaculture, Sea Grant Extension Service, $70,000. 10/01 - 9/02. FMIS# 6-57984

Co-Principal Investigator - Aquaculture Extension Project (Sea Grant Extension Service, Aquaculture Development Program) Department of Agriculture, $81,714. 9/00 - 12/01. FMIS #4-35715.

Principal Investigator - Aquaculture of Marine Ornamental Fishes (Center for Tropical and Subtropical Aquaculture) United States Department of Agriculture $50,000, August 2000 - November 2001. FMIS# 6-56013.

Principal Investigator - Aquaculture Extension Project (Sea Grant Extension Service, Aquaculture Development Program) Department of Agriculture, $81,714. 8/99 - 9/00. FMIS #4-33556.

Principal Investigator - Transitioning Hawaii's Freshwater Ornamental Fish Industry - Year 1, USDA Center for Tropical and Subtropical Aquaculture, Sea Grant Extension Service, $100,000. 1/1/00 - 12/31/00. FMIS #6-56013.

Principal Investigator - Development of culture methods for marine ornamental fishes. Year 2. NOAA, National Sea Grant College Program, $50,724. 3/1/99 - 2/28/00. FMIS # 6-56673.

Principal Investigator - Development of culture methods for marine ornamental fishes. Year 1. NOAA, National Sea Grant College Program, $50,724. 3/1/99 - 2/28/00. FMIS # 652022.

Principal Investigator - Water Quality of Hawaiian Fishponds, NOAA, National Sea Grant College Program, Year 31, $26,000. 3/99 - 12/99. FMIS #655940.

The University of Hawaii at Manoa, January 2001 - present. Affiliate Researcher, University of Hawaii at Manoa, School of Ocean Earth Science and Technology, Hawaii Institute of Marine Biology, Kaneohe, Hawaii.

PUBLISHED MATERIALS

Author or co-author of 38 published peer reviewed journal manuscripts.
Author or co-author of 21 invited oral presentations at national and international conferences.
Author or co-author of 18 invited summary manuscripts.
Author of 61 technical reports.
Author or co-author of 74 newsletter articles in various local, national and international periodicals.

Andrew D. Taylor

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Education

Ph.D. Duke University (Zoology), 1984
M.A.S. Ohio State University (Applied Statistics), 1989

Research

I am interested generally in the **population dynamics of species interactions**. My specific interests are in the dynamics of **parasitoid–host interactions**, and how these are affected by **parasitoid characteristics** and by population **spatial structure**. I am also interested in the effects of alien species (especially biocontrol agents) on endemic Hawaiian insects, and in modeling the population dynamics of threatened species.
I also have an interest in robust methods of data analysis.

Current projects

- Study of the population dynamics of "sublethal" parasitoids: lab and theoretical studies of the parasitoid *Trichopoda pilipes* and its host the Southern green stink bug (*Nezara viridula*).
- Study of the effects of stink bug biocontrol parasitoids on native bugs.
- Theoretical study of host-parasitoid and predator-prey metapopulation dynamics.
- Simulation studies of various robust statistical methods, including rank-based alternatives to multifactor ANOVA.

Representative recent publications

- Turchin, P., A. D. Taylor, and J. D. Reeve. 1999. "Dynamical role of predators in population cycles of a forest insect: an experimental test." *Science* 285: 1068-1071
- Taylor, A. D. 1998. "Environmental variability and the persistence of parasitoid-host metapopulation models." *Theoretical Population Biology* 53: 98-107.
- Taylor, A. D. 1997. "Density dependent parasitoid recruitment per parasitized host: effects on parasitoid-host dynamics." *American Naturalist* 149: 989-1000.
- Taylor AD. 1996. Sources of stability in host-parasitoid dynamics. In: Floyd RB, Sheppard AW, De Barro PJ, editors. Frontiers of Population Ecology. Melbourne: CSIRO Publishing. p 257-267.

- Harrison S, Taylor AD. 1996. Empirical evidence for metapopulation dynamics. In: Hanski I, Gilpin M, editors. Metapopulation Dynamics: Ecology, Genetics and Evolution. New York: Academic Press. p 27-42.

Courses Taught:

- Biometry (Zool 631)
- Advanced Biometry (Zool 632)
- Population Biology (Zool 652; taught with Curt Daehler and cross-listed as Bot 652)
- Undergraduate Seminars (Zool 490):
  Insects of Hawai‘i; AIDS Dynamics; Mathematical Models in Biology
- Graduate Seminars and Topics Courses (Zool 691, 710, 719):
  Statistics Clinic; Metapopulation Dynamics; Species Diversity in Biological Communities; Readings in Community Ecology; Mathematical Modeling in Ecology and Evolution; *The Ecological Detective*

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Office: Hale Aloha 205

Education

M.S., Universtiy of South Carolina, Human and natural resource management.

As Associate Director for the University of Hawaii at Hilo Pacific Aquaculture and Coastal Resources Center (PACRC), I assist with the coordination of Center programmatic activities, including education, research and outreach programs in the Pacific Basin region. I oversee efforts related to internships, technical training programs, and other educational efforts, including coordination of projects with university, agency, and community partners. As part of this, I work with the UH EPSCoR effort and regional partners to coordinate several summer internship programs focused on involving more underrepresented minorities, especial Native Pacific Islanders, in career exploration related to our insular environments. Additionally, I am involved with the development of a new PACRC facility slated for completion in 2005, which will serve as a demonstration and research center in East Hawaii for aquaculture and coastal resources management. Finally, I manage the Hawaii Cooperative Studies Unit (HCSU), a cooperative program between USGS BRD and UH-Hilo located within the PACRC that coordinates USGS-BRD research efforts focused on the conservation of Hawaii's natural resources.