

# **SUBSTANTIVE CHANGE REPORT**

**Submitted to**

**Western Association of Schools & Colleges**

**Master of Science Degree in**

**Tropical Conservation Biology and Environmental Science**

**University of Hawai`i at Hilo**

**200 West Kawili Street**

**Hilo, Hawai`i 96720-4091**

**Spring 2004**

## Table of Contents

	Page
1. Overview .....	1
2. Institutional Summary Data Form .....	2
3. Descriptive Background, History and Context .....	3
4. Institutional Accrediting History Relevant to Substantive Change .....	5
5. Program Need and Planning/Approval Process .....	6
6. Program Description .....	9
7. Faculty .....	13
8. Student Support Services .....	14
9. Technology .....	14
10. Library and Information Resources .....	15
11. Physical Resources .....	15
12. Financial Resources .....	16
13. Plan for Evaluating Educational Effectiveness .....	18
14. Plan For Teach-out Provisions .....	19
Appendices .....	20
A. Course Descriptions	
B. New Course Approvals	
C. Faculty Curriculum Vitae – UH Hilo	

## **1. OVERVIEW**

The overall mission of the proposed Master of Science program is to provide recent baccalaureate graduates and those currently working in conservation biology and environmental science with graduate training that will prepare them for careers as conservation and environmental scientists and managers. The program will also provide students with an excellent foundation for doctoral studies in a variety of theoretical and applied disciplines. The conservation challenges that face tropical ecosystems including Hawai`i are such that solutions require a broad knowledge not only of biology, but of the physical and social sciences. The focus of the program will be on developing the breadth necessary to address applied environmental problems. Using the remarkable biological resources and physical environment of the Island of Hawai`i and, where appropriate, the region, students will be exposed to theory, recent technical advances in the field, and hands-on experience in field and laboratory techniques. The interdisciplinary aspect of the program will be achieved through the participation of faculty across a range of study areas and with affiliated personnel in federal, state and non-government agencies on the Island of Hawai`i.

The nature of the environmental problems being studied requires both breadth and depth of knowledge. Breadth of knowledge is built into the program because it is an interdisciplinary Master of Science degree that involves various departments at UH Hilo, all of which contribute to understanding the multi-faceted issues involved in conservation biology and environmental science. Areas of concentration include: coastal zone and terrestrial land management and assessment, environmental physiology, planning and quantitative analysis, genetics and population dynamics, physical and chemical environmental analysis, population ecology and evolution, and restoration ecology. Depth of knowledge will be acquired either through 1) a thesis and additional coursework in the area of the thesis topic, or 2) an internship and additional coursework concentrated around an area relevant to the student's career plans. These two options will allow us to have a two-track Master of Science program. The coursework concentrations must be approved by the student's advisory committee.

**2. INSITUTIONAL SUMMARY DATA FORM (WASC/02)**

**INSERT**

### **3. Descriptive Background, History and Context**

The University of Hawai`i at Hilo (UH Hilo) is a liberal arts, primarily baccalaureate institution that is gradually developing graduate programs. UH Hilo is part of the University of Hawai`i System, which includes the University of Hawai`i at Manoa, the University of Hawai`i at West Oahu, seven community college campuses, and four University centers. UH Hilo began as a branch of the University of Hawai`i at Manoa in 1947. In 1970, the University was organized under its present name and was first accredited by WASC in 1976.

Currently, the UH Hilo has four colleges. The College of Agriculture, Forestry and Natural Resource Management offers Bachelor of Science degrees in seven specializations. The Colleges of Arts and Sciences offers 31 baccalaureate degrees and two Master of Science degrees in Education and Counseling Psychology. The College of Hawaiian Language, Ka Haka `Ula O Ke`elikolani, offers a Bachelor of Arts in Hawaiian Studies and a Master of Science degree in Hawaiian Language and Literature. The newest college, the College of Business and Economics offers a Bachelor of Arts degree.

Currently student enrollment at UH Hilo averages approximately 3,300 students who come from across the State of Hawai`i, the US mainland and many foreign countries. Our central location between the East and the West makes the state university system a hub for academic and cultural exchanges and partnerships. UH Hilo's teaching and learning environment is enriched by the biological and environmental diversity of the Island and the Pacific region.

Study of Conservation Biology and Environmental Sciences for undergraduate students is emphasized in a number of departments:

- ♦ Biology B.A. and B.S. degrees have tracks in Ecology, Evolution and Conservation Biology.
- ♦ Marine Science B.A. degree has several marine biology and ecology courses.
- ♦ Geography B.A. degree offers Geographical Information Service (GIS) and Natural Resources courses.
- ♦ Geology B.A. degree offers several environmental science related courses.
- ♦ College of Agriculture, Forestry and Natural Resources B.S. degree offers several natural resources courses.

#### **Specific Objectives of the Master of Science Program**

The primary purpose of the MS in Tropical Conservation Biology and Environmental Sciences is to provide graduate training in conservation biology and environmental science to those with baccalaureate degrees and those currently working in the field. The program will utilize the extraordinary biological, physical and cultural complexity on the Island of Hawai`i as a focus of investigation and study. The program will prepare students for technical positions and for entry into Ph.D. programs in related fields.

**Program objectives:**

- Foster knowledge of current trends and issues in conservation biology and environmental sciences including basic and applied research and natural resource problems;
- Provide participants with experiences in conceptual and technical research areas in ecology, evolutionary genetics, geographic analysis, environmental monitoring and assessment in marine and terrestrial environments;
- Promote research and scholarly activities that will enable participants to enter the scientific research community.

**Graduates of the program will:**

- Perform scientific research in the interdisciplinary field of conservation biology and environmental science;
- Develop skills in natural resource and protected area management;
- Use advanced technological equipment, perform quantitative analysis and interpret complex data;
- Present scientific results in oral and written publications;
- Interpret and critique professional scientific literature.

**Strategic Plan, University Mission, and Service to the University and Community**

The proposed graduate program is consistent with UH System strategic goals and with the primary mission of UH Hilo.

UH Goal I. Access to Quality Educational Experiences and Service to the State. The program will enable residents of the Island of Hawai`i to meet the residency requirements for a Master of Science degree in this field without having to move to O`ahu or the mainland. This will remove a formidable barrier to graduate training for many, especially nontraditional students with families and job responsibilities on the Island of Hawai`i.

UH Goal II. Emphasize studies of the environment of Hawai`i, the Pacific, and East Asia and make full use of the Island of Hawai`i, from the tops of the mountains to the bottom of the ocean for hands-on learning and as a research laboratory. The program will advance the understanding of the natural environment in Hawai`i with a special reference to the Island of Hawai`i. The graduate courses and graduate student research will utilize the natural environment of the Island

of Hawai'i and interactions with federal, state and non-profit agencies will augment the program through access to research and course projects and expertise.

The program will also support UH Hilo's primary mission of providing an excellent undergraduate liberal arts education. It will enrich existing UH Hilo undergraduate programs with supplementary courses and activities. The programs in Anthropology, Biology, Chemistry, Geography, Geology, Marine Science, and the College of Agriculture, Forestry and Natural Resources Management will benefit immediately. Honors students and advanced undergraduates may participate in selected activities with the new graduate program.

#### **4. Institutional Accrediting History Relevant to Substantive Change**

UH Hilo was first accredited by WASC in 1976; the last regular WASC site visit was in Spring 2003. The UH Hilo Strategic Plan 1997-2007 defined a new path for UH Hilo, including the gradual addition of "select graduate programs that respond to unmet regional needs".

Following the 2003 WASC site visit to UH Hilo, the WASC Commission's action letter focused on four areas: mission planning and institutional resources, institutional governance and organizational structures, institutional educational effectiveness, and diversity. The letter dated June 30, 2003, observed that the University had made considerable progress in these areas and that the University must make greater efforts to manage institutional resources and address the organizational governance structures.

Educational and institutional effectiveness were the themes for UH Hilo's self study effort, which was presented during the WASC site visit in the Spring 2003 (Preparatory Review) and in Spring 2004 (Educational Effectiveness Review).

Over the past seven years, UH Hilo has submitted substantive change proposals to WASC for new master degree programs. The first, in 1997, was to offer the Master of Arts in Hawaiian Language and Literature. The proposal was accepted, and the program is underway. The substantive change proposal for a Master of Education was accepted in 1999 and that program is now underway. A substantive change proposal for a Master in Counseling Psychology was submitted in 2000 and was accepted. Finally a substantive change proposal for a Master in China-US Relations was submitted in 2002 and was accepted. That program is planned for the first year in 2004-2005.

The ongoing accreditation and self study has heightened campus awareness about student learning assessment and continuous improvement, and plans for the proposal to develop a M.S. Degree in Tropical Conservation Biology have been developed to address these needs.

## **5. Program Need and Planning/Approval Process**

The proposed Master of Science in Tropical Conservation Biology and Environmental Sciences (TCBES) is an interdisciplinary program. It is a logical extension of existing programs at UH Hilo that enhances the academic development of the campus.

The program has emerged from a process of consultation with faculty from 7 different departments and programs on the UH Hilo campus: Anthropology, Biology, Chemistry Geography, Geology, Marine Science and the College of Agriculture, Forestry and Natural Resource Management. In addition, UH Manoa's Ecology, Evolution and Conservation Biology (EECB) program was consulted for advice on program content and coordination. A joint Master of Conservation Biology program with Victoria University in Wellington New Zealand in Conservation Biology has been initiated by the University of Hawai'i System with an eventual exchange program to be established among the UH Manoa EECB graduate program, UH Hilo TCBES graduate program and Victoria University Conservation Biology graduate program.

This Master of Science program has also been developed in recognition of the extraordinary Biological and physical complexity on the Island of Hawai'i as well the state's distinction as the endangered species capital of the United States. The proposed program fills an important need. There is a serious lack of local students involved in scientific research and environmental careers in general and it is well established that the most successful conservation efforts involve the active participation of the local community. Involvement of local students requires accessibility and affordability. UH Hilo provides both to students from across the state and region. Extensive tracts of public land and coastal habitat have been and are proposed to be set aside as critical habitat and it is important that trained personnel are available to manage these fragile ecosystems. As a result several local agencies that we have surveyed regularly seek employees with advanced training and experience with the unique aspects of the physical and biological nature of ecosystems found in Hawai'i. The Island of Hawai'i constitutes the majority of the land area of the state of Hawai'i and encompasses one of the most biologically diverse regions of the world. There may be no other place that exhibits a comparable array of climate zones and eco-types in the same land area. This makes the Island of Hawai'i an ideal setting for advanced research and education. In addition, the knowledge the students gain through this Master of Science Program can be applied throughout the Pacific region and to other ecosystems in the US and the world. Thus the graduates of this Master of Science Program will be able to compete very successfully for positions in Hawai'i, the Pacific region, the mainland US and throughout other regions of the world.

This Master of Science program addresses aspects of the 1997-2007 UH Hilo Strategic Plan that "Hawai'i's incomparable natural and cultural environment serves as a learning laboratory, the setting for many teaching, research, and service activities". This emphasis was reiterated

during the 2001-2002 Strategic Plan Review Process. The Strategic Plan notes that this programmatic stress on the natural and cultural environment has been successful in attracting students to UH Hilo. In addition, local students benefit from an education about their native environment. Thus, the TCBES program is consistent with the UH Hilo Strategic Plan and builds upon the strengths identified in the Strategic Plan. UH Hilo's commitment to academic excellence while accommodating the people and environment of the Pacific is at the heart of this proposal. This program is intended to be one of the select graduate programs that will help to attract and retain top-notch students and faculty.

Inclusion of TCBES into the UH Hilo will do more than simply facilitate the utilization of our local resources as "a hands-on learning and research laboratory". The inclusion of graduate students in the academic experience of undergraduates will enhance the education of both graduate and undergraduate students. "Community partnerships" through local agencies and research centers, and community educational outreach is an operational imperative of our proposed program. Finally this program is designed to produce professionals who will be better prepared to help usher responsible resource development that will aid and develop a sustainable and reinvigorated local economy. These Hawai'i-trained professionals, who will have developed skills and knowledge focused on tropical environments, will be highly competitive for positions of responsibility in tropical conservation biology and environmental sciences.

The TCBES program can take advantage on a daily basis of easily accessible practical examples of theoretical problems discussed in class. The program's proximity to both disturbed and undisturbed ecosystems provides an invaluable instructional advantage. Our students will be far more cognizant of Hawai'i's and other tropical natural systems and more aware of their interdependences with local communities by living within those communities. The research development enabled through this program will facilitate a broadening of the scope of the resources and expertise that we can offer our community.

### **Potential Enrollment**

In the spring of 2002, 139 UH Hilo undergraduate students were surveyed about their interest in advanced study in conservation biology and environmental science. Not all of the students answered all the questions. The results from the survey show distinct interest in the proposed program and several students indicated that they would apply for admission as soon as possible (Table 1). We anticipate that we may have as many as 50 applicants each year of the program. The students who took this survey were from Hawai'i, the Pacific region, and the Mainland US, particularly the west-coast states. Students will be recruited from these areas and more broadly for this Master of Science Program.

This survey highlighted several key points. First, we have a large potential clientele. Thirty percent of respondents said that they were interested in applying to the program proposed here, and more than 20% said they would apply to the program. Second, there is a critical need for this type of program on the Island of Hawai'i due to the demographics of our clientele. Several respondents indicated that they would not apply for graduate school unless one was available at UH Hilo, for various reasons including issues of accessibility, affordability, and family obligations. A program at UH Hilo would therefore appeal to students who already live on the Island of Hawai'i and to selected students from Pacific Islands, which facilitates working within and serving the needs of the community. Thus it is not the intent of this program to compete with other graduate programs (see next section), but rather to offer a different program to an underserved market of students. There will also likely be students from the US Mainland and other countries that will apply to this Master of Science program as the program is marketed.

Table 1. Number of UH Hilo students, mostly among Biology and Marine Science majors, that answered questions in our survey in the Spring of 2002 (n = 139).

1. Level of Interest in TCBES Program	
a. <i>Potentially interested in applying</i>	32
b. <i>If program is ready, will apply</i>	36
c. <i>Interested in topics, but not sure of grad school</i>	14
d. <i>Interested in different type of graduate work</i>	27
e. <i>Not interested in advanced study</i>	7
2. <b><u>Reasons for Applying to UH Hilo TCBES Program</u></b>	
a. <i>Interested in conservation issues in Hawai'i</i>	56
b. <i>Interested in conservation/environmental science employment</i>	43
c. <i>Interested in staying on the Island of Hawai'i</i>	51
d. <i>Other</i>	8

### Similar Programs

Currently, Master of Science and Mater of Arts Degrees in Conservation Biology are offered on the US West Coast at San Francisco State University (MA in Conservation Biology), California State University, Sacramento (MS in Biological Sciences with a concentration in Biological Conservation) and at the University of Hawai'i at Manoa (as a specialization in Ecology, Evolution and Conservation Biology under a Master Degree in one of several primary fields, including Zoology, Botany, Geography or Genetics). This latter is the only similar graduate degree offered in the state of Hawai'i, and differs substantially in that it is offered as a specialization within a different major; the proposed degree program is offered as a stand-alone degree. Also, because the EECB program at Manoa is primarily focused on Ph.D. students, the

proposed program at UH Hilo may be synergistic in that it is likely to provide students interested in further graduate studies to that Ph.D. program.

A number of universities in the same region offer Master Degrees in Environmental Science or a similar field, including the University of California at Berkeley (MS in Environmental Science, Policy and Management), UC Santa Barbara (MS in Environmental Science and Management), the University of Southern California (MA or MS in Environmental Studies), the University of Washington (MS in Quantitative Ecology and Resource Management) and Western Washington University (MS in Environmental Science). UH Manoa does not offer a graduate degree in environmental science, and as such the proposed degree program will provide a unique opportunity for students wanting to enter graduate study in this area.

Another important factor that makes the proposed program ideal at this time is Hawai'i's National Science Foundation Experimental Program to Stimulate Competitive Research (NSF-EPSCoR) initiative, which has defined biodiversity and conservation biology as the major thrust in the growth of research in the UH system. Facilities, equipment, and faculty acquired through the NSF EPSCoR Research Infrastructure Improvement grant will greatly enhance the ability of UH Hilo to offer this Master of Science degree. Since the UH system is making a substantial commitment to conservation research, the proposed program will further the efforts to make the UH system a more comprehensive institution for conservation and environmental research and education.

The TCBES program will have a number of important benefits for UH Hilo and the UH system as a whole. The overt involvement of local state and federal agencies and non-profit educational organizations will ensure increased extra-university collaborations and community outreach. The inclusion of graduate student researchers will increase interaction between research and education at UH Hilo and by extension across the UH System. Increased research activity will necessarily increase the grant procurement potential at UH Hilo and UH overall. The inclusion of a Master of Science program will increase enrollment by an estimated 20 students in the first year and a total of 40 students per year in the subsequent years and, by association, will improve the quality and reputation of undergraduate programs at UH Hilo. The interdisciplinary nature of the program will promote collaborative interactions between faculty from different departments, resulting in elevated research potential.

## **6. Program Description**

The proposed TCBES program will consist of two tracks, both granting a Master of Science Degree. In Plan A, students will complete coursework and a research based thesis, under the supervision of their faculty advisor. In Plan B, students will complete coursework and an internship with a partner government or non-government agency (affiliated faculty). Under both

plans, students will have a graduate committee of at least three faculty members, who will serve as advisors in determining appropriate curricula to meet each student's career objectives, and who will aid research design or in finding and structuring internship opportunities. This committee will be chosen after the student's first semester and must meet at least once a semester.

A multi-disciplinary graduate faculty will be composed of faculty from Anthropology, Biology, Chemistry, Geography, Geology, Marine Science, and the College of Agriculture, Forestry and Natural Resource Management. The current faculty are listed in Section 7 of the main body of this document and their Curriculum Vitae are included in Appendix C. Additional faculty will be hired in the near future to augment the expertise of these current faculty members. Through the NSF EPSCoR program there will be additional faculty hired in Biology, Geography, Marine Science and the College of Agriculture, Forestry and Natural Resource Management who will participate in this Master of Science program.

**Comment:** Master's Masters master's masters

### Expected Educational Outcomes

Graduates of the program will have the following skills:

1. Competence at quantitative analysis and interpretation of data, using advanced technological tools.
2. Skill at planning and executing fieldwork, and observing and recording biological and environmental phenomena.
3. Use of specialized, modern instrumentation standard in the chosen field.
4. Excellent oral communication skills. Presentations at scientific meetings and workshops will be expected.
5. Excellent written communication skills for use in writing scientific publications, environmental assessments, monitoring reports, etc.
6. Professional written/oral communication skills. Presentations to lay public audiences will be expected of all students.
7. Ability to find, interpret, and critique the professional literature.

**Comment:** Your bulleted lists have different paragraph spacing between items, do you want your numbered lists to be compressed specifically or is this just an inconsistency in formatting?

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

1. Terrestrial ecosystems.
2. Aquatic and marine ecosystems.
3. Monitoring and assessment.
4. Planning and policy as applied to environmental problems.
5. Population analysis and conservation of rare species.

6. Importance of genetic diversity within a species and organismal diversity within an ecosystem.
7. Multi-disciplinary understanding of the complexity of ecological systems, at various scales of organization, and the relevance to environmental science and conservation.
8. Familiarity with recent published research and methodological techniques in the chosen field.

### **Courses Required for the Program**

#### ***Plan A (30 credits, Thesis)***

- 1) TCBES 600, 601, 605 (9 credit core);
- 2) TCBES 700 (6 credit thesis); a minimum of 15 elective credits: 6 credits from the each of the technique and conceptual courses listed below.

#### ***Plan B (36 credits, Non-thesis)***

- 1) TCBES 600, 601, 605 (9 credit core);
- 2) TCBES 690 (3 credit internship);
- 3) A minimum of 24 elective credits: at least 6 credits from the each of the technique and conceptual courses listed below.

For full course descriptions, see Appendix A and B. Course titles are provided below for the new courses to be developed under this program. Additionally, 400-level courses currently offered in the departments supporting this Master of Science program could be taken for graduate credit with authorization of the student's graduate committee and the TCBES curriculum committee. A maximum of 6 credits of 400-level courses will be allowed for graduate credit.

#### **Core Courses:**

- TCBES 600 Principles of Tropical Conservation Biology and Environmental Science (3)
- TCBES 601 Field and Laboratory Methods in TCBES (3)
- TCBES 605 Quantitative Research Methods (3)

#### **Technique Courses:**

- TCBES 610 Environmental Chemical Analysis (3)
- TCBES 620 Research Techniques in Molecular Conservation Biology (3)
- TCBES 630 Nearshore Monitoring and Analysis (3)
- TCBES 640 Advanced Remote Sensing and Digital Image Processing (3)
- TCBES 650 Oceanographic Monitoring and Analysis (3)

- TCBES 670 Advanced Techniques in Geographic Information Systems (GIS) (3)
- TCBES 680 Advanced Statistical Analyses and Research Design (3)

**Conceptual Courses:**

- TCBES 615 Global Environmental Change (3)
- TCBES 635 Physical Environment of Ecosystems (3)
- TCBES 645 Applying Social Science to Ecosystem Resource Management (3)
- TCBES 655 Environmental Physiology (3)
- TCBES 665 Environmental Toxicology (3)
- TCBES 675 Conservation Genetics (3)
- TCBES 685 Behavioral Ecology and Evolutionary Analysis (3)

**Other Courses:**

- TCBES 690 Internship for Plan B Students (3)
- TCBES 694 Special Topics in TCBES (1-3)
- TCBES 699 Directed Research (1-3)
- TCBES 700 Thesis Research (1-6)

**Tentative Schedule for Students:**

	Thesis (30 credits required)	Non-Thesis (36 credits required)
Year 1: Fall	600 (3)*, 601(3)*	600 (3)*, 601 (3)*
Spring	605(3)*, 6 credits of electives	605(3)*, 6 credits elective
Summer	700 (3)*	690 (3)*
Year 2: Fall	6 credits electives	9 credits electives
Spring	3 credits electives, 700 (3)*	9 credits electives

\* - required courses

**Admission Requirements**

1. A completed graduate student application form, including statement of research interest and career goals. Official copies of transcripts from all college coursework needs to be submitted with the application form.
2. Prospective students in the program will be encouraged to identify a faculty member participating in the TCBES Master of Science program willing to serve as Graduate Advisor before admission to the program. Prospective students are responsible for contacting TCBES faculty with research interests in common to their own, and establishing a mutual understanding with a faculty member who agrees to serve as the Graduate Advisor. Applications to the

program can be made before this to facilitate establishment of contacts between prospective students and advisors, but students will not be admitted without an Advisor.

3. A baccalaureate degree from a university or college approved by a recognized accrediting agency. Recommended undergraduate coursework includes: two years of chemistry; one year of calculus; one course in geographic information or remote sensing, one course in statistics; two courses in the life sciences; two courses in the physical sciences (in addition to chemistry).
4. An average Grade-point average of at least 3.0 out of a 4.0 for upper division (Junior and Senior classes) letter graded undergraduate coursework completed. (A-4, B-3, C-2, D-1, F-0, W considered as F).
5. GRE scores: applicants should have a combined total score of at least 1000 on the verbal and quantitative sections of the Graduate Record Examination.
6. If English is not the native language, a score of 550 or higher on the TOEFL is required prior to entering the program.
7. Contact information for at least three referees who can comment on the student's academic history and potential.
8. In special circumstances, other academic qualifications, publications, or work experience may compensate for deficiencies in requirements listed above. These will be determined on a case-by-case basis.

## **7. Faculty**

Faculty will include 21 current tenured and tenure track UH Hilo faculty and several new Full-time Faculty positions. The University of Hawai'i has committed to 9 new faculty positions that will be in Biology, Marine Science, Geography and the College of Agriculture, Forestry and Natural Resource Management. These new faculty will be tenure-track and initially supported by an Experimental Program to Stimulate Competitive Research (EPSCoR) program from the National Science Foundation. The University of Hawai'i System including UH Hilo received a Research Infrastructure Improvement grant from the EPSCoR program for \$9 million to purchase equipment, support students and faculty in the general area of conservation biology. The current participating faculty are listed here and their Curriculum Vitae are in Appendix C.

### **Current UH Hilo Faculty Participating in the Master of Science Program**

#### **College of Arts and Sciences:**

**Anthropology** - Dr. Dan Brown, Dr. Craig Severance

**Biology** - Dr. Don Hemmes, Dr. Sue Jarvi, Dr. William Mautz, Dr. Cam Muir, Dr. Rebecca Ostertag, and Dr. Donald Price.

**Chemistry** - Dr. Ernest Kho, Dr. J.P. Michaud.

**Geography** - Dr. Barbara Gibson, Dr. James Juvik.

**Geology** – Dr. Jene Michaud

**Marine Science** - Dr. Marta deMaintenon, Dr. Walter Dudley, Dr. Karla McDermid, and Dr. Michael Parsons, Dr. Tracy Wiegner.

**College Agriculture, Forestry and Natural Resource Management:**

Dr. Kevin Hopkins, Dr. Bruce Mathews, and Dr. Michael Shintaku.

**Affiliate Faculty through Agency Partnerships**

Following approval of this Master of Science Program additional Affiliate Faculty will be recruited to the program. We anticipate 10 or more Ph.D. researchers from the Federal, State and non-government agencies on the Island of Hawai`i will participate as affiliated faculty. These affiliate faculty will serve on graduate student committees and mentor graduate student research projects in conjunction with university faculty. This combination of the 21 current faculty and the 9 new faculty will provide the necessary faculty strength to teach the new graduate courses.

**8. Student Support Services**

Students will receive academic guidance from their advisors throughout their careers at UH Hilo. During the enrollment and admissions process students will discuss with the graduate director and the faculty members concerning their study plan before taking classes. In accordance with the student's interest, an academic advisor will be assigned. To ensure a successful graduate experience, those who lack sufficient academic background in Conservation Biology and Environmental Sciences will be advised to take preparatory courses to make up the deficiency during the first semester or at a suitably early state of study.

Financial aid will be available for students through general and non-general funds. The UH Hilo will work with the NSF EPSCoR program initially to enable 8 graduate student positions that will provide up to \$22,000 per student. Residents of the United States can also apply for loans from the financial aid office of the UH Hilo Student Services. Asia-Pacific Scholarships are available to students from the Asia-Pacific region or committed to serving in or studying the Asia or Pacific region; graduate students are eligible for these awards and 2 of these have been tentatively provided to this program.

**9. Technology**

Students in the proposed program will have adequate no-cost access to computers provided for student use at various UH Hilo sites. All registered students at the University of Hawai`i at Hilo are allowed to have three kinds of UH Hilo computer accounts, available at no cost:

EMAIL accounts, UH Hilo Library PC accounts and Electronic Classroom accounts. Those accounts allow students access to software and to the Web from computer labs all over campus.

Student-use computers at the University of Hawai`i at Hilo make available to students such resources as the Office 2003 Suite, Microsoft Internet Explorer 6.x and WS-FTP. There are currently 8 PC labs open to students at various campus sites, each offering between 10 and 35 stations.

#### **10. Library and Information Resources**

The Edwin H. Mo`okini Library of the University of Hawai`i at Hilo has a collection of 258,862 volumes and is currently staffed by 9 professional librarians, 14 classified support staff and an audiovisual specialist. Documents are accessible to students and faculty through the online CARL (Colorado Alliance of Research Libraries). Other new web-based systems provide access to a network of library catalogs in Hawai`i and on the mainland United States. Periodical indexes such as the Expanded Academic Index, Aquatic Sciences and Fisheries Abstracts, Oceanic Abstracts, and Biological Abstracts indexes provide full-text and abstracts to the most pertinent periodicals for this Master of Science program. Graduate students at the proposed program will have access to major research materials in Hawai`i and throughout the United States.

The library's reference service offers interlibrary loan service provided to faculty and students with easy, ready access to books, periodicals, and other material from UH Manoa and elsewhere. The library maintains a reserve collection for course materials. Librarians regularly conduct training sessions for students on the uses of the PC Lab, electronic data bases, print sources, as well as on using the Internet for research. These sessions are especially useful for students educated outside the U.S.

#### **11. Physical Resources**

Current physical facilities at UH Hilo are sufficient to run the proposed graduate program. These include the classrooms and research facilities in the Anthropology, Biology, Chemistry, Geography, Geology, Marine Science and the College of Agriculture, Forestry and Natural Resource Management. Each of these departments and colleges has research facilities and equipment that faculty and students can use for research projects and hands-on classroom activities. This includes a Genetics Core facility with 3 DNA sequencers and related equipment, a GIS/Remote Sensing Core Facility, and an Ecological Analytical Core Facility. In addition, there is a variety of other research equipment useful for conservation biology and environmental sciences closely aligned to faculty research that has been obtained through faculty research grants and university funds.

In addition, the Island of Hawai'i is an exceptional field research site that is known around the world as possessing unique species and ecosystems that will be available for the graduate students for both classroom and research activities.

## 12. Financial Resources

Resources in support of this program already exist on the UH Hilo campus in the Anthropology, Biology, Chemistry, Geography, Geology, Marine Science departments and in the College of Agriculture, Forestry and Natural Resource Management. The field and laboratory equipment in these departments will provide some of the research and training resources needed for this program. The Hawaii NSF EPSCoR Research Infrastructure Improvement grant will augment the research facilities. Specifically, a core genetics facility, a core environmental analytical facility and a core GIS/remote sensing facility have recently been developed with the EPSCoR program and these facilities will be available for faculty and student research and class projects.

### Estimated Annual Program Costs:

<b>A Budget</b>	<b>University<sup>+</sup></b>	<b>NSF EPSCoR</b>
Professor (Director) I-5 - 5	\$ 75,000	
Assistant Professors I3 - 5 (45,000 x 9)		\$225,000**
Secretary I (SR 12)	\$ 25,000	
Teaching Assistants (22,000 x 6)	\$ 132,000	
Research Assistants (22,000 x 6)		\$132,000
APT (technicians) (35,000 x 3)		\$105,000
<b>Total A Budget</b>	<b>\$232,000<sup>+</sup></b>	<b>\$462,000</b>
<b>B Budget</b>		
Office Supplies	\$10,000	
Teaching & Research Supplies	\$30,000	
Travel (intra/inter state)	\$30,000	
Vehicle usage	\$30,000	
Library resources	\$20,000*	
Publishing fees	\$ 3,000	
Conference fees	\$ 6,000	
Student Recruitment	\$10,000	
<b>Total B budget</b>	<b>\$139,000<sup>+</sup></b>	

\*The UH Hilo Library has performed a program assessment for this Master of Science Program. They estimate approximately \$15,000 in books per year, \$2,500 in intra- and inter-library loans, and at least \$2,500 in new

journals. There could be an additional \$20,000-\$25,000 for electronic journal and data access if funds were available.

\*\* At the end of the EPSCoR grant period, the new faculty will be hired by the University of Hawai'i.

+ A UH Foundation proposal was submitted in February 2003 to obtain an endowment for the University portion of the budget.

### **Sources of funds for Program.**

#### **TUITION:**

**Graduate Student Tuition:** Once the program is running there will be approximately 40 students in the program. 40 students x \$1896 per semester = \$75,840 or \$151,680 per year.

**Undergraduate Student Tuition.** Several undergraduate programs support this Master of Science program. The main departments (number of majors in Fall 2002) are: Anthropology (50), Biology (186), Chemistry (10), Geography (33), Geology (26), Marine Science (234), Natural Science (36), College of Agriculture, Forestry and Natural Resource Management (153).

**Total number of students = 728** (approximately 24% of the total UH Hilo enrollment and an increase of 7.5% in the last year alone). An estimated 450 students are residents and 278 students are non-residents. Tuition from resident students is \$2208 per year, and from non-residents is \$7776 per year. The total tuition from supported undergraduate programs is approximately \$993,600 from resident students and \$2,161,728 from non-residents. A total of \$3,115,328.

The number of undergraduate students is likely to increase in the coming years in each of these departments, in part because of this Master of Science Program.

#### **NSF EPSCoR:**

The EPSCoR Infrastructure Improvement Grant that was awarded in April 2003 has budgeted approximately \$13,500,000 over 3 years for Conservation Biology for the State of Hawai'i. The portion that comes to UH Hilo is approximately **\$4,500,000 over three years**. Some of this funding will support faculty and graduate student salaries, and provide equipment and teaching load reductions that will be necessary for faculty and graduate students to carry out research projects.

Additional funding will be sought from other agencies and programs.

- Faculty are currently seeking funding from the NASA's Earth Science Enterprise and the Minority University Research and Education Division for Earth System Science Education Grants to develop new curricula.
- The increased graduate and research activity associated with this Master of Science program will make UH Hilo Faculty more competitive for research and education grants. The direct

and indirect money coming to UH Hilo will very likely increase significantly after the implementation of this program.

- Government and non-government agencies will also likely support some graduate students through salary and research supplies. These students will perform their research projects in cooperation with these agencies.

### **13. Plan for Evaluating Educational Effectiveness**

The student's committee will have the primary responsibility of assessing the quality of graduate student work. Each student will be required to successfully complete a candidacy exam to defend his or her research proposal (thesis), or to test general knowledge (non-thesis) following his or her first year. Standard examinations and papers for classes will also be a part of academic assessment. Final written thesis and defense will be required of thesis students while a paper suitable for submission to a peer reviewed journal, or comprehensive exam, will be completed by non-thesis students.

Graduate preparedness will be partially assured through active participation of local natural resource agencies (a likely employer of our graduates) in design of classes and availability of research assistantships for students. Students choosing a non-thesis degree will be required to complete an internship with one of the agencies. Local agencies include: US Geological Survey-Biological Resources Division, US Fish and Wildlife Service, US Forest Service, US Department of Agriculture, US Army Pohakuloa Environmental Program, US National Park Service, US Environmental Protection Agency, Nature Conservancy, State Department of Land and Natural Resources, US National Oceanic and Atmospheric Administration, US National Marine Fisheries, State Department of Fish And Wildlife, Department of Health, and Kamehameha Schools. These local agencies were surveyed in the spring of 2002 and an additional 15 -20 respondents indicated their interest in applying to TCBES.

The responses from the agencies indicated that they are eager to support this Master of Science program in several significant ways. First, they are willing to have students and faculty conduct research on the lands they manage: National Park, Fish and Wildlife Survey, Kamehameha Schools, State Department of Land and Natural Resources, Nature Conservancy. The professionals in these agencies are willing to participate in the Master of Science program by serving on graduate student committees and facilitating student research projects. Finally, several agencies indicated that there are recurring position openings in their organizations in Hawai'i, the Pacific Region, and throughout the nation. Students graduating from this Master of Science program will be particularly well qualified for positions in Hawai'i and the tropical Pacific and will also be well qualified for positions on the mainland US.

In addition to prescribed bi-annual student committee meetings, each student will meet annually with a faculty member of the student's choosing, who is not involved in that student's research. Course evaluations will be filled out by students and agency auditors for each course taught in the program. Annual agency surveys of satisfaction with student outcomes will be conducted. Upon graduation, a committee that will include the program director and at least one other faculty member of the student's choosing will conduct student exit interviews.

#### **14. Plan for Teach-out Provisions**

The long and detailed planning of this program makes it appear unlikely that UH Hilo administrators will determine the program is not viable and that students who begin the program will not be able to finish. However, should the program be terminated, UH Hilo faculty will continue to teach the courses and supervise examinations and theses so that students can complete their degrees. Teach-out expenses will be covered by the University.

## **APPENDICES**

**A: Course Descriptions**

**B: Course Proposals**

**C: Faculty Participants in TCBES Program.**

## Appendix A: Course Descriptions

### **New Courses: 22 new courses worth a total of 66 credits**

**TCBES 600 Conservation Biology and Environmental Science (3).** Fundamental principles of ecology, evolution and environmental sciences, with an emphasis on the conservation, management and restoration of organisms and ecosystems. Discussion will include the physical and biological factors that affect and shape tropical organisms and ecosystems: biodiversity, biogeography, climate, genetics, nutrient cycling, population viability, reproductive systems and topography. Tropical organisms and ecosystems worldwide will be compared with an emphasis on Hawai'i.

**TCBES 601 TCBES Field and Laboratory Methods (3).** A practical course in laboratory and field methods and techniques used in conservation biology and environmental sciences. Students will be introduced to methods used for studying, monitoring and experimenting upon animals and plants in a diversity of habitats. Emphasis is placed on the choice of techniques for data collection, followed by rigorous analysis of results with the application of appropriate statistical analyses. The information collected in this course will be more fully analyzed in TCBES 605.

**TCBES 605 Quantitative Research Methods (3).** An intensive lecture and field course designed to prepare students to conduct independent research. Focus on learning how to ask relevant research questions, hypothesis testing, experimental design, and applications of statistics. Presentation of a research proposal both orally and in written form. Current methodological techniques in terrestrial and marine ecology emphasized, with hands-on approaches to learning how to use the latest technological equipment. Most likely team-taught to encompass expertise in terrestrial and marine systems, as well as field, laboratory, and computer skills.

**TCBES 610 Environmental Chemical Analysis (3).** Basic concepts of chemical measurements in environmental media. Analysis in environmental matrices with emphasis on water, soil, air and tissue. Topics include basics of calibration and measurement, sample collection, sample stability, chemical interferences, matrix effects and reporting analyses of chemicals in the environment. Pre: CHEM 124, 125 with labs, CHEM 241, CHEM 330 and 330L required; CHEM 331 recommended.

**TCBES 615 Global Environmental Change (3).** Discusses the natural and anthropogenic processes that regulate the function of the Earth system. The basic understanding of the history

and mechanisms of global change processes and the means by which human activities alter Earth system function at local to global scales will be examined, along with potential consequences of and solutions to global change. Course will focus on interrelationships of the atmosphere, hydrosphere, geosphere and biosphere. Will provide students an understanding of the role that multidisciplinary science and technology have on research of the Earth system.

**TCBES 620 Research Techniques in Molecular Conservation Biology (3)** Major advances in molecular biology important to conservation studies are examined. Molecular techniques that are applied to conservation studies are performed including: PCR, RFLP, AFLP, DNA sequencing, and microsatellite analysis. Data analysis is examined including a number of popular genetics software packages that enable pairwise comparisons of large data sets and the construction of genetic distance matrices and networks. Pre: BIOL 357L and BIOL 481L or equivalent, or permission of instructor.

**TCBES 630 Nearshore Monitoring and Analysis (3)** Theoretical and practical planning and implementation of data collection and analysis of the intertidal and shallow subtidal marine environments. Techniques include measuring geological, chemical, and physical environments and estimating the abundance and diversity of organisms. Pre: MARE 350/350L, TCBES 610 or permission of instructor.

**TCBES 635 Physical Environment of Ecosystems (3).** Examination of the influences of climate, hydrology, geology, and soils on terrestrial and aquatic ecosystems. Emphasis on mechanisms of change, anthropogenic impacts, and monitoring networks. Pre: GEOL 100, 111, or GEOG 101; BIOL 251 or GEOG 309 or equivalent, or permission of instructor.

**TCBES 640 Advanced Remote Sensing and Digital Image Processing (3).** Digital image processing of satellite-derived remotely sensed data for earth resource analysis and applications. Specific applications include image enhancement, classification, post classification analysis, special transformations, and multi-temporal analysis for land cover change detection. Pre: GEOG 470 or equivalent, or permission of instructor.

**TCBES 645 Applying Social Science to Marine and Coastal Resource Management (3).** Social science methods for profiling natural resource dependent communities and assessing the social and economic impacts of ecosystem management and regulation. Marine communities and fisheries in the Pacific region, with some discussion of terrestrial resource management. Relevant laws, policies and management agencies. Public input, best science, realities of management

conflict and compromise. Social impact assessment, case studies and public and professional roles in management.

**TCBES 650 Oceanographic Monitoring and Analysis (3).** Theoretical and practical planning and implementation of data collection and analysis of the neritic and pelagic marine environment from an oceanographic vessel platform. Techniques include measuring geological, chemical, and physical nearshore properties; estimating the abundance and diversity of plankton, nekton, and benthos; and use of modern data recording and analyzing systems. Pre: MARE 350/350L, TCBES 610 or permission of instructor.

**TCBES 655 Ecological Physiology (3).** Physiological adaptations to environmental variation including physiological and biochemical mechanisms for food acquisition and digestion, thermal energetics, respiratory gas exchange, activity metabolism and osmoregulation.

**TCBES 665 Environmental Toxicology (3).** Biochemical basis for toxicity. Chemical distribution and fate in the body; molecular mechanisms and effects of toxic action. Emphasis on environmental toxicants. Pre: upper division courses in biochemistry and physiology, or permission of instructor.

**TCBES 670 Advanced Techniques in Geographic Information Systems (3).** Focus is on advanced techniques in GIS including: database creation and management, complex geographic data analysis and modeling, and benefits and limitation to methodology. Projects are drawn from Earth resource management, conservation and ecological studies, hazards, and cultural landscapes. Pre: GEOG 480 or equivalent, or permission of instructor.

**TCBES 675 Conservation Genetics (3).** Basic concepts of population genetics and molecular evolution as it applies to conservation biology. Specific topics include population dynamics and inbreeding depression, and population genetic structure related to ecological parameters and requirements of an organism.

**TCBES 680 Advanced Statistical Analyses and Research Design (3).** An advanced examination of statistics and research design in conservation biology and environmental science. Emphasis is placed on specific applications and underlying assumptions, design of experiments, and observational schemes for research project. Extensive computer analysis is employed including MINITAB and SAS statistical software. Pre: CBES 610 or permission of instructor.

**TCBES 685 Behavioral Ecology and Evolutionary Analyses (3).** Principles of behavioral ecology and evolution with a focus on conservation biology. Research techniques in behavioral ecology related to analyzing populations in geographically and age-structured populations. The importance of reproductive strategies, habitat selection, foraging behavior, parental care, social organizations, and the importance of migration and movement patterns on the regulation of population sizes and evolution. Population, quantitative and species genetics as it relates to evolution, speciation and biodiversity. Pre: CBES 610 or permission of instructor.

**TCBES 690 Internship (3).** An internship for Plan B Masters students in TCBES with a federal, state, or non-governmental agency with projects in Hawai'i or other Pacific Islands. The internship project will be developed and carried out in consultation with the host agency. The graduate committee in TCBES must approve the internship project. The development of the internship is formalized through a written proposal, periodic written reports and meetings with the graduate advisor and host agency representative. A final report and oral presentation is required at the end of the internship.

**TCBES 694 Special Topics in TCBES (1-3).** The course content will vary as topics are chosen by the instructor. The course may be repeated for credit, provided that a different topic is studied.

**TCBES 699 Directed Research (1-3).** Research in conservation biology and environmental sciences for Plan B Masters students. The development of the research project is formalized through periodic written reports and meeting with the graduate advisor. A final report and oral presentation is required at the end of the research project.

**TCBES 700 Thesis Research (1-6).** Research in conservation biology and environmental sciences for Plan A Masters students.

**Courses already taught for which Graduate Students may receive graduate credit:**

**Biol 443** Ecological Physiology (3)

**Biol 443L** Ecological Physiology

Laboratory (2)

**Mare 425** Chemical Oceanography (3)

**Geog 470** Remote Sensing and Air Photo

Interpretation (3)

**Biol 481** Advanced Theory in Ecology and  
Evolution (3)

**Biol 481L** Research Methods in Ecology and  
Evolution (2)

## **Appendix B: Course Proposals – Approved by CAS Senate and UHH Congress**

### **Course Alpha   Course Title   (number of credits)**

1. TCBES 600 Principles of Tropical Conservation Biology and Environmental Science (3).
2. TCBES 601 Field and Laboratory Methods in Tropical Conservation Biology and Environmental Sciences (3).
3. TCBES 605 Quantitative Research Methods (3).
4. TCBES 610 Environmental Chemical Analysis (3).
5. TCBES 615 Global Environmental Change.
6. TCBES 620 Research Techniques in Molecular Conservation Biology (3)
7. TCBES 630 Nearshore Monitoring and Analysis (3).
8. TCBES 635 (3) Physical Environment of Ecosystems (3).
9. TCBES 640 Advanced Remote Sensing and Digital Image Processing (3)
10. TCBES 645 Applying Social Science to Marine & Coastal Resource Management (3).
11. TCBES 650 Oceanographic Monitoring and Analysis (3).
12. TCBES 655 Ecological Physiology (3)
13. TCBES 665 Environmental Toxicology (3).
14. TCBES 670 Advanced Techniques in Geographic Information Systems (GIS) (3).
15. TCBES 675 Conservation Genetics (3).
16. TCBES 680 Advanced Statistical Analyses and Research Design (3).
17. TCBES 685 Behavioral Ecology and Evolutionary Analysis (3).
18. TCBES 690 Internship (3)
19. TCBES 694 Special Topics in TCBES (1-3)
20. TCBES 699 Directed Research (1-3).
21. TCBES 700 Thesis Research (1-6).

## **Appendix C: Curriculum Vitae of Faculty Participants in TCBES Program**

1. Dr. Dan Brown, Anthropology
2. Dr. Marta deMaintenon, Marine Science
3. Dr. Walter Dudley, Marine Science
4. Dr. Barbara Gibson, Geography
5. Dr. Don Hemmes, Biology
6. Dr. Kevin Hopkins, College Agriculture, Forestry and Natural Resource Management
7. Dr. Sue Jarvi, Biology
8. Dr. James Juvik, Geography
9. Dr. Ernest Kho, Chemistry
10. Dr. Bruce Mathews, College Agriculture, Forestry and Natural Resource Management
11. Dr. William Mautz, Biology
12. Dr. Karla McDermid, Marine Science
13. Dr. J.P. Michaud, Chemistry
14. Dr. Jene Michaud, Geology
15. Dr. Cam Muir, Biology
16. Dr. Rebecca Ostertag, Biology
17. Dr. Michael Parsons, Marine Science
18. Dr. Donald Price, Biology
19. Dr. Craig Severance, Anthropology
20. Dr. Michael Shintaku, College Agriculture, Forestry and Natural Resource Management
21. Dr. Tracy Wiegner, Marine Science

**Supplemental Information for the Substantive Change proposal for the Masters in  
Tropical Conservation Biology and Environmental Sciences**

1. Supplemental information for TCBES Plan for Evaluating Educational Effectiveness.
2. Supplemental information for TCBES Approval Process.
3. Supplemental information for TCBES Fiscal Resources.

## **1. Supplemental information for TCBES Plan for Evaluating Educational Effectiveness**

Program evaluation of the Masters in TCBES will follow the evaluation and assessment procedures for all programs on the UH Hilo campus. The details of this review can be found on the UH Hilo VCAA website (<http://www.uhh.hawaii.edu/uhh/vcaa/ProgramReviewMarch2003.pdf>) and is included in this supplemental material. In addition, all new programs approved by the University of Hawaii Board of Regents are required to be evaluated after 5 years. We plan to begin this evaluation process starting in the 1<sup>st</sup> year of the program as several of the evaluation guidelines are relevant to the organization of the program and how the program will meet the student needs. The Self Study process will continue through the 5<sup>th</sup> year of the program in preparation for the review by the Board of Regents at the end of 5<sup>th</sup> year of the program.

## **2. Supplemental information for TCBES Approval Process**

1. Authorization to plan for the Masters in TCBES was granted by the UHH Chancellor in July 2002.
2. Planning process began in the summer of 2002 and the first draft of the proposal was completed in Fall 2002. This draft proposal was circulated around the faculty involved in the TCBES Masters program and a final proposal was completed in Spring 2003.
3. The TCBES Masters proposal was submitted to the VCAA in Spring 2003 for evaluation.
4. The VCAA submitted the TCBES Masters proposal to the UHH Graduate Council in Spring 2003 for evaluation. The Graduate Council evaluated and passed the TCBES Masters proposal in Fall 2003.
5. TCBES Masters proposal was submitted to the UHH Congress and College of Arts and Sciences Faculty Senate in Fall 2003. It was evaluated and passed by these two faculty governing bodies in Fall 2003.
6. TCBES Masters proposal was submitted to the University of Hawaii Board of Regents and passed at the October 2003 meeting. The minutes of this meeting are available at: <http://www.hawaii.edu/offices/bor/regular/minute/20031017.regular.pdf>
7. The TCBES Masters Course Proposals were submitted, evaluated and passed by the Graduate Council and College of Arts and Sciences Curriculum Review Committee in Spring 2004.