RESEARCH EXPERIENCES IN ESTUARINE SCIENCE FOR UNDERGRADUATES AT MOTE MARINE LABORATORY, WITH SPECIAL FOCUS ON NATIVE PACIFIC ISLANDERS

Final Report for period: June 2002 – February 2005

SUBMITTED TO:
National Science Foundation

SUBMITTED BY:
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Barbara Kirkpatrick
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Mote Marine Laboratory
1600 Ken Thompson Parkway
Sarasota, Florida 34236

Mote Marine Laboratory Technical Report No. 1388

April 11, 2005
Final Report for Period: 06/2002 - 02/2005
Principal Investigator: Gelsleichter, James J.
Organization: Mote Marine Lab
Title:
Research Experiences in Estuarine Science for Undergraduates at Mote Marine Laboratory, with Special Focus on Native Pacific Islanders

Project Participants

Senior Personnel
Name: Gelsleichter, James
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Kirkpatrick, Barbara
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Zeigler-Chong, Sharon
Worked for more than 160 Hours: Yes
Contribution to Project:
Ms. Zeigler-Chong coordinated efforts to recruit Native Pacific Islander students from colleges and universities in U.S.-held Pacific Islands.

Post-doc

Graduate Student

Undergraduate Student
Name: Perry, Erika
Worked for more than 160 Hours: Yes
Contribution to Project:
Ms. Erika-Perry assisted Sharon Ziegler-Chong in the recruitment of Native Pacific Islanders for participation in this program.

Technician, Programmer

Other Participant
Name: Walsh, Catherine
Worked for more than 160 Hours: Yes
Contribution to Project:
Dr. Walsh will serve as a research advisor and mentor for one REU student during the summer 2003 program.

Name: Kirkpatrick, Gary
Worked for more than 160 Hours: Yes
Contribution to Project:
Dr. Kirkpatrick will serve as a research advisor and mentor for one REU student during the summer 2003 program.

Name: Heupel, Michelle
Worked for more than 160 Hours: Yes
Contribution to Project:
Dr. Heupel will serve as a research advisor and mentor for one REU student during the summer 2003 program.
Name: Simpfendorfer, Colin  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:** 
Dr. Simpfendorfer will serve as a research advisor and mentor for one REU student during the summer 2003 program.

Name: Estevez, Ernest  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:** 
Dr. Estevez will serve as a research advisor and mentor for one REU student during the summer 2003 program.

Name: Reynolds, John  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:** 
Dr. Reynolds will serve as a research advisor and mentor for one REU student during the summer 2003 program.

Name: Wetzel, Dana  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:** 
Dr. Wetzel will serve as a research advisor and mentor for one REU student during the summer 2003 program.

Name: Robbins, Brad  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

Name: Leverone, Jay  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

Name: Dixon, Laura  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

Name: Adams, Aaron  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

Name: Tucker, Tony  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

Name: Culter, James  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

Name: Gannon, Damon  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

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**Research Experience for Undergraduates**

Name: Arredondo, Genevieve  
**Worked for more than 160 Hours:** Yes
Contribution to Project:

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Western Washington University
Home Institution Highest Degree Granted (in fields supported by NSF): Master's Degree
Fiscal year(s) REU Participant supported: 2003
REU Funding: REU site award
Name: Aschliman, Neil
Worked for more than 160 Hours: Yes

Contribution to Project:

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Texas A&M University
Home Institution Highest Degree Granted (in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2003
REU Funding: REU site award
Name: Freitas, Garin
Worked for more than 160 Hours: Yes

Contribution to Project:

Years of schooling completed: Sophomore
Home Institution: Other than Research Site
Home Institution if Other: University of Miami
Home Institution Highest Degree Granted (in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2003
REU Funding: REU site award
Name: Harvey, Elizabeth
Worked for more than 160 Hours: Yes

Contribution to Project:

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Hawaii Pacific University
Home Institution Highest Degree Granted (in fields supported by NSF): Master's Degree
Fiscal year(s) REU Participant supported: 2003
REU Funding: REU site award
Name: Ordonez, Danny
Worked for more than 160 Hours: Yes

Contribution to Project:
Name: Pierre-Charles, Roody
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Barry University
Home Institution Highest Degree Granted (in fields supported by NSF): Master's Degree
Fiscal year(s) REU Participant supported: 2003
REU Funding: REU site award

Name: Schwanger, Cassie
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Carthage College
Home Institution Highest Degree Granted (in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2003
REU Funding: REU site award

Name: Vickery, Ku'lei
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Sophomore
Home Institution: Other than Research Site
Home Institution if Other: Windward Community College, University of Hawai'i
Home Institution Highest Degree Granted (in fields supported by NSF): Associate's Degree
Fiscal year(s) REU Participant supported: 2003
REU Funding: REU site award

Name: Barber, Andrea
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: University of North Carolina at Wilmington
Home Institution Highest Degree Granted (in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2004
REU Funding: REU site award

Name: Broderick, Emily
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: University of the Virgin Islands
Home Institution Highest Degree Granted (in fields supported by NSF): Master's Degree
<table>
<thead>
<tr>
<th>Name</th>
<th>Worked for more than 160 Hours</th>
<th>Contribution to Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brueggan, Katie</td>
<td>Yes</td>
<td>Years of schooling completed: Junior  Home Institution: Other than Research Site Home Institution if Other: College of the Ozarks Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree Fiscal year(s) REU Participant supported: 2004 REU Funding: REU site award</td>
</tr>
<tr>
<td>Gagner, Brooke</td>
<td>Yes</td>
<td>Years of schooling completed: Junior  Home Institution: Other than Research Site Home Institution if Other: Western Washington University Home Institution Highest Degree Granted(in fields supported by NSF): Master's Degree Fiscal year(s) REU Participant supported: 2004 REU Funding: REU site award</td>
</tr>
<tr>
<td>Hansen, Allison</td>
<td>Yes</td>
<td>Years of schooling completed: Junior  Home Institution: Other than Research Site Home Institution if Other: Northland College Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree Fiscal year(s) REU Participant supported: 2004 REU Funding: REU site award</td>
</tr>
<tr>
<td>Lavelle, Candice</td>
<td>Yes</td>
<td>Years of schooling completed: Junior  Home Institution: Other than Research Site Home Institution if Other: Roger Williams University Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree Fiscal year(s) REU Participant supported: 2004 REU Funding: REU site award</td>
</tr>
<tr>
<td>Miller, Trevor</td>
<td>Yes</td>
<td>Years of schooling completed: Junior  Home Institution: Other than Research Site</td>
</tr>
</tbody>
</table>
Home Institution if Other: University of California, Berkeley
Home Institution Highest Degree Granted (in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2004
REU Funding: REU site award

Name: Mouzi, Sara
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Sophomore
Home Institution: Other than Research Site
Home Institution if Other: University of Houston
Home Institution Highest Degree Granted (in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2004
REU Funding: REU site award

Name: Taylor, Holly
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: University of California, Santa Cruz
Home Institution Highest Degree Granted (in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2004
REU Funding: REU site award

Name: Thornton, Bridget
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Eckerd College
Home Institution Highest Degree Granted (in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2004
REU Funding: REU site award

Organizational Partners
University of Hawaii at Hilo
Two participants in this program, Sharon Ziegler-Chong and Erika Perry, are staff members of the University of Hawaii at Hilo Hawaii Sea Grant College Program. NSF project funds supporting the recruitment of Native Pacific Islanders for this program were a sub-contract from Mote Marine Laboratory to this organization.

Other Collaborators or Contacts
1) Dr. Greg Tolley, Florida Gulf Coast University, Ft. Myers, FL. Presented a research seminar to 2003 REU participants, entitled 'Influence of freshwater input on habitat value in three southwest Florida estuaries.'

2) Dr. Aswani Volety, Florida Gulf Coast University, Ft. Myers, FL. Presented a research seminar to 2003 REU participants entitled 'Adaptive management of freshwater releases in the Caloosahatchee estuary using responses of oysters, Crassotrea virginica.'
3) Chris Reich, MS, United State Geological Survey Center for Coastal Geology, St. Petersburg, FL. Presented an overview on USGS coastal research to 2003 REU participants and led a discussion on federal career opportunities in marine geology.

4) Brent Winner, MS, Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, St. Petersburg, FL. Presented an overview on FWRI research to 2003 and 2004 REU participants and led a discussion on state career opportunities in ocean sciences.

5) Brandon Casper and James Locasio, Ph.D. students in Dr. David Mann's Laboratory, University of South Florida, St. Petersburg, FL. Presented overview of their dissertation research to 2003 REU participants and discussed approaches for applying to graduate school.

6) Dr. David White, The Ocean Conservancy, St. Petersburg, FL. Presented an overview of conservation initiatives led by the Ocean Conservancy and discussed career opportunities in ocean sciences in the private sector.

7) Angela Barker, MS student in Dr. Phil Motta's laboratory, University of South Florida, Tampa, FL. Presented a seminar to 2003 REU participants on her thesis research, entitled 'Movement patterns of cownose rays within Charlotte Harbor, Florida.'

8) Nadina Piehl, Assistant Director of Academic Affairs and Admissions Coordinator of the College of Marine Science, University of South Florida, St. Petersburg, FL. Presented an overview of admissions policies in a graduate marine science school to 2004 REU participants.

9) Julie Childers, Education Division, Mote Marine Laboratory. Presented an overview of developing ocean science educational activities for K-12 audiences to 2004 REU participants.

10) Jason Robertshaw, SeaTrek Distance Learning Program, Mote Marine Laboratory. Presented a demonstration of ocean sciences distance learning curriculum for elementary and middle school audiences to 2004 REU participants.

In addition, the following REU mentors also presented research seminars to 2003 and/or 2004 REU participants:

Dr. Ernest Estevez
Dr. James Gelsleichter
Dr. Barbara Kirkpatrick
Dr. Colin Simpfendorfer
Dr. Tony Tucker

Activities and Findings

Research and Education Activities:
Not used for REU-specific material.

Findings:
See attached file.

Training and Development:
See attached file.

Outreach Activities:
See attached file.

Journal Publications


Books or Other One-time Publications

Tucker, T., J. Foote, J. Grimes, S. Condran, P. Clark, C. Brinton-Perz, and T. Miller*, "Effects of beach nourishment on loggerhead nest site selection and reproductive success.", ( ). NOAA Technical Memorandum, Accepted
Bibliography: NOAA

Gelsleichter, J*, "Hormonal regulation of elasmobranch physiology.", (2004). Book, Published
Editor(s): J. Carrier, J. Musick and M. Heithaus, eds.
Collection: Biology and Ecology of Sharks and Their Relatives.
Bibliography: CRC Press, Boca Raton, FL.

Web/Internet Site

URL(s):
http://www.mote.org/~jimg/reu.htm

Description:
This is the main Program Web site, which provides an extensive overview of topics such as student eligibility, application procedures, financial support, research opportunities, and research mentor interests. This Web site also includes a page discussing the representation of Native Pacific Islanders in science careers (http://www.mote.org/~jimg/npis.htm).

Other Specific Products

Contributions within Discipline:
Not used for REU-specific material.

Contributions to Other Disciplines:
No Ethics component included.

**Contributions to Human Resource Development:**
See attached file.

**Contributions to Resources for Research and Education:**
Not used for REU-specific material.

**Contributions Beyond Science and Engineering:**
No RET component.

**Categories for which nothing is reported:**
Any Product
ACTIVITIES AND FINDINGS – MAJOR RESEARCH FINDINGS

Research conducted by Mote REU participants contributed significantly to the following initiatives:

- Conservation of endangered marine species (manatees and turtles) by providing new data on habitat utilization patterns and the use of biomarkers of immune function to characterize environmental health of this species.

- Protection of Essential Fish Habitat for ecologically and economically important fish species by evaluating the use of new techniques for detecting pollutant effects in these species and studying their habitat utilization patterns.

- Development of new approaches for detecting the occurrence and effects of natural toxins and anthropogenic contaminants in the estuarine ecosystem.

- Improved understanding of the evolution of predator-prey relationships, with special focus on the use of acoustic stimuli to hunt prey and avoid predators.

- Expanded knowledge on the effects of natural perturbations, such as hypoxia and algal blooms, on the health and distribution of estuarine organisms.

Rather than provide short research nuggets for a limited number of students, we have opted to provide detailed information on each REU student’s major research findings in this report.

ACTIVITIES AND FINDINGS – TRAINING AND DEVELOPMENT

Goals and Objectives

The Research Experiences for Undergraduates (REU) Site Program at Mote Marine Laboratory (MML) was developed to provide mentored research experiences in estuarine science to U.S. College and University undergraduates with special focus on Native Pacific Islanders; students having origins in any of the original natives of Hawaii, Guam, Samoa, or other U.S.-affiliated Polynesian, Micronesian, or Melanesian Pacific Islands. The goal of the program is to foster positive learning outcomes in participating students. The special emphasis placed on Native Pacific Islanders was motivated by a need to increase the representation of this poorly studied minority group in science and engineering. This REU program represented one of very few programs focused predominantly on increasing the participation of Native Pacific Islanders in science careers.

The objectives of this program were to:

1. Recruit 3-4 Native Pacific Islander students and 4-5 students of other ethnicities (both minority and non-minority) for a 10-week experiential program in estuarine science;
2. Provide hands-on training in research and scientific communication to program participants through completion of an independent research project, written project proposal and final research paper, and oral presentation of project results;

3. Expose students to the cultural aspects of a scientific career by providing opportunities for students to interact with science professionals, graduate students, and peers at Mote Marine Laboratory, other science institutions, and professional conferences; and

4. Inform students about graduate school and employment opportunities in science in federal, state, and private sectors through discussions with representatives from local graduate schools and marine science research facilities.

The ability of the program to fulfill these objectives and meet the overall program goal was determined using formative and summative assessments of student learning and satisfaction.

Student Recruitment

Student recruitment for the summer program began in fall (September–October) of the preceding year. We developed a one-page program announcement that was sent via electronic mail to chairpersons of Marine Science, Biology, and Chemistry departments at over 300 institutions. The schools selected to receive this announcement included all U.S. mainland Colleges and Universities with Marine Science/Oceanography programs, based on Peterson’ s On-line Guide to Colleges and Universities (http://www.petersons.com). Program advertisements were also sent to Biology Program Chairpersons at over fifty 4-year institutions in California, Oregon, and Washington; the U.S. mainland states with the largest populations of Native Pacific Islanders based on earlier U. S. Census reports. The program was advertised on web sites of Mote Marine Laboratory, the National Society of Experiential Education (a professional organization of internship coordinators from a large number of U.S. colleges and universities), the American Elasmobranch Society, the National Association of Marine Laboratories, the American Society of Limnology and Oceanography’s Minorities in Aquatic Sciences Program, and NSF’s REU Program website. In Year 2, approximately 300 additional schools offering Biology degrees were added to the original mailing list of ~350.

Additional recruitment of Native Pacific Islanders was performed by University of Hawaii at Hilo staff members, who currently administer several Pacific Islander-specific internship programs. Program advertisements were sent to a variety of Pacific Island-based community groups and regional contacts, as well as all 2- and 4-year Colleges and Universities in U.S.-held Pacific Islands.

A program web site (http://www.mote.org/~jimg/reu.htm) was developed to provide general information on the application process, student eligibility, financial support, intellectual focus, research opportunities, and research mentor interests. Students were requested to submit a program application form (downloadable at the program web site), official transcripts, and two letters of recommendation by the annual application deadline of March 15th. Students were notified of the status of their applications by April 30th.

Our recruitment efforts were highly successful. In 2003, 127 students from 95 institutions representing 37 states applied for participation in this program. The applicant pool included 5 Native Pacific Islanders, 3 Hispanics/Latinos, 2 African-Americans, 1 Native American, and 116
students of other ethnicities. In 2004, we received applications from 177 students from 130 institutions representing 41 states. This applicant pool included 1 Native Pacific Islander, 7 Hispanics/Latinos, 4 African-Americans, 2 Native Americans, and 163 students of other ethnicities. Overall, we received applications from students at over 190 U.S. Colleges and Universities representing 45 states during the grant period (Fig. 1).

**Figure 1.** Applicant schools for Mote Marine Laboratory’s REU Program, 2003-2004 ($n = 183$). Only U.S. mainland schools are shown. Additional applications received from institutions in Hawaii ($n = 5$), U.S. Virgin Islands ($n = 1$), and Puerto Rico ($n = 2$).

In both 2003 and 2004, the applicant pool was largely composed of female Biology majors in their third year of study. Demographic information for 2003 and 2004 applicants is provided in the table below:

<table>
<thead>
<tr>
<th>Category</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2003</td>
</tr>
<tr>
<td>Total number of applicants</td>
<td>127</td>
</tr>
<tr>
<td>Sex ratio (% male, % female)</td>
<td>25% male</td>
</tr>
<tr>
<td></td>
<td>75% female</td>
</tr>
<tr>
<td>Grade distribution</td>
<td>2% freshman</td>
</tr>
<tr>
<td></td>
<td>20% sophomore</td>
</tr>
<tr>
<td></td>
<td>60% junior</td>
</tr>
<tr>
<td></td>
<td>18% senior</td>
</tr>
<tr>
<td>Major field of study</td>
<td>50% Biological Sciences</td>
</tr>
<tr>
<td>*Other = chemistry, physics,</td>
<td>27% Marine Science</td>
</tr>
<tr>
<td>geology, psychology, liberal</td>
<td>8% Zoology</td>
</tr>
<tr>
<td>arts, etc.</td>
<td>5% Environmental Science</td>
</tr>
<tr>
<td></td>
<td>10% other</td>
</tr>
<tr>
<td>Mean GPA (range)</td>
<td>3.45 ±0.03 (2.7-4.0)</td>
</tr>
</tbody>
</table>
Student Selection

To be eligible for participating in this program, students were required to be citizens or permanent residents of the U.S. or its possessions and hold a minimum grade point average (GPA) of 3.0 (or a B average) at the time of applying. While the program was focused towards students who had completed at least 2 years of study prior to participation (i.e., rising juniors or seniors from 4-year institutions), community college students were also eligible for admission if they belonged to minority groups underrepresented in science and were in the process of transferring to a 4-year institution.

Applicants were required to submit the following items: 1) a standard application form with general information (e.g. name, age, date of birth, home institution, contact information, year of enrollment); 2) two letters of recommendation (preferably from faculty members or research advisors); 3) official college transcripts; and 4) an application essay (2-page maximum) that described the student's interests and career goals, qualifications, objectives for applying to the REU program and preferences for placement (i.e., first and second choice of available mentors) if accepted. Each application was pre-screened to determine if the student in question met the eligibility requirements of the program. When this was not the case, the application was not reviewed further unless the student provided a suitable explanation for their ineligibility. For example, we accepted applications from students who did not meet the GPA requirement because of poor academic performance due to illness, injuries, or family emergencies. In virtually all of these cases, faculty members intervened on the student's behalf.

In the first stage of the selection process, we evaluated the quality of student applications using a scoring rubric that rated the following dimensions:

1. Academic preparation (i.e., the amount of introductory and upper-level courses in science and student performance in these courses).

2. Research experience beyond academic coursework (i.e., the amount of prior experience in scientific research activities outside of the student's normal coursework).

3. Quality of student recommendations (i.e., the student's potential for conducting independent research, as judged by an individual qualified to make this assessment).

4. Special considerations (e.g., if the student was a member of a minority group underrepresented in science).

5. Quality of the application essay (e.g., whether the student addressed all essay questions with sufficient detail and effort, whether the student's interests were aligned with the intellectual focus of the program).

Following this, good and high quality applications were separated into groups corresponding to the students' preferences for placement. Applications were then distributed to mentors, who made the final selection decisions.
Program Activities

Intellectual focus

The intellectual focus of this REU Site program is on estuarine science, basic and applied research on the biological, chemical, and physical features of estuaries. During the initial two years of this program, virtually all students gained research experience through involvement in Mote's multidisciplinary study on Charlotte Harbor, one of Florida's largest and most ecologically and economically important estuaries. Although Charlotte Harbor is less adversely impacted than most Florida estuaries, it is increasingly threatened by several factors including changes in freshwater flow, nutrient loading, and habitat loss/degradation. The objective of Mote's five-year (2000-2005) Charlotte Harbor study was to determine how natural and human-caused changes to freshwater quantity and quality affect the structure, function, and condition of this estuary and its ecosystem components. This study addressed five fundamental questions:

1. How does freshwater inflow influence the ecology and productivity of Charlotte Harbor, and what will be the long-term consequences of flow alterations?

2. How do algal blooms produced by nutrient loading and flow alterations affect the onset, duration, and extent of hypoxia in this estuary?

3. What is the role of natural perturbations, particularly hypoxia, in controlling the distribution of plants and animals in Charlotte Harbor?

4. What processes mediate trophic links in the estuary's food web, and how influential are hydrological and chemical factors in regulating secondary production, especially of fishes and other large carnivores?

5. What estuarine areas are important to large mobile fauna, including endangered species, and how do natural and anthropogenic stressors affect the quality of these areas and animal health?

Core activities

The core activities of both the 2003 and 2004 REU sessions were the individual research project, research proposal, final report, and oral presentation, which are described below:

Research project: Participants were paired with research mentors and learned skills in estuarine science through hands-on experience in the planning, execution, and dissemination of research projects related to the mentor's research interests and expertise. Participants and mentors discussed potential project topics via e-mail and/or phone and selected an appropriate student project prior to the beginning of the REU period. During Week 1, students met with mentors to discuss the objectives, hypotheses, and methodology of their projects and began their research as soon as possible. Descriptions of the independent research projects conducted by 2003 and 2004 REU participants are provided in a later section of this report.
Project proposal: All students completed a 3-page project proposal that included the following components: 1) project title; 2) specific research goals; 3) methods; 4) significance of research; 5) timeframe of study; 6) estimated budget and budget justification; and 7) literature cited. The objective of this activity was to provide students with hands-on experience in grantwriting and, at the same time, improve their understanding of their independent project. The proposal format was identical to that for the Micro Grant Program of the Project AWARE Foundation, providing students with direct experience with preparing grant applications for an agency that sponsors many graduate research projects in ocean sciences.

Project report: All students completed a final research report in mock manuscript format following the Instructions for Authors for submitting a professional manuscript to *Estuaries*, the journal of the Estuarine Research Federation.

Oral presentation: All students presented the results of their research project in a 15-minute PowerPoint presentation at a laboratory-wide symposium that was held during the final week of the REU period.

Adjunct activities

All 2003 and 2004 REU students also participated in the following activities:

Discussion groups: These informal meetings addressed topics related to career development in science in a student-centered manner. The objectives of these meetings were to expose students to essential skills of science that are not the traditional focus of classroom curriculum and foster peer communication and cooperative learning. Topics that were discussed in both 2003 and 2004 included the following:

- Design of Independent Research Projects
- Effective Grantwriting
- Analysis of Research Data
- Oral Presentation of Research Data
- Scientific Writing and Publishing
- Educational Outreach of Scientific Data

Research seminars: Various topics in estuarine science were presented by Mote scientists (including on-site graduate students) and visiting researchers. The objectives of these presentations were to expose students to a broader range of research topics. A list of the research talks presented during the 2003 and 200 sessions is provided below:

2003

- Influence of freshwater impact on habitat value in three southwest Florida estuaries. Greg Tolley, Ph.D., Florida Gulf Coast University.
• Passive hydroacoustic monitoring of fish sound production in Charlotte Harbor, FL. James Locasio, Ph.D. student, University of South Florida.

• Spatial and temporal patterns of two ray species within Charlotte Harbor: a preliminary investigation. Angela Barker, Ph.D. student, University of South Florida.

• The hearing abilities of the nurse shark, *Ginglymostoma cirratum*, and the yellow stingray, *Urobatis jamaicensis*. Brandon Casper, Ph.D. student, University of South Florida.

2004

• Concentrations of organochlorine contaminants in sharks from four sites on Florida's Gulf coast. Jim Gelsleichter, Ph.D., Mote Marine Laboratory.

• Movement patterns of the cownose ray within Charlotte Harbor, Florida: a preliminary assessment. Angela Barker, Ph.D. student, University of South Florida.

• Distribution of immature bull sharks (*Carcharhinus leucas*) in a southwest Florida estuary. Colin Simpfendorfer, Ph.D., Mote Marine Laboratory.

• Human health effects of red tide. Barbara Kirkpatrick, Ed.D, Mote Marine Laboratory.

**Field trips:** All REU participants attended a daylong field trip to four science centers in St. Petersburg, FL: the University of South Florida's (USF) College of Marine Science, the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWRI), the U.S. Geological Survey's (USGS) Center for Coastal Geology, and the Ocean Conservancy. During these trips, students met with graduate deans, graduate students, state and federal researchers, and marine conservation specialists to discuss a variety of topics including graduate study in ocean sciences, estuarine research conducted at these facilities, and job opportunities in the academic, state, federal, and non-profit sectors.

2003 REU participants also attended a daylong field trip to the marine park, Sea World, on the final day of the summer period. Although this trip was largely intended to be a fun activity, students did meet with Sea World aquarists and education staff to discuss career opportunities in aquarium science and informal science education. The 2004 trip to Sea World was canceled due to inclement weather (i.e., Hurricane Charley).

**Research posters:** Although it was not a requirement of the program, all REU participants also prepared research posters with the expectation that they would be needed for certain conferences, including undergraduate student research symposia held at home and/or local institutions. All student posters were also displayed during an annual estuarine research conference at Mote, which was held on October 7-8, 2003 and October 5-6, 2004.
**Student compensation**

All REU participants received full support for travel expenses between their home institution and the host facility. Students also received full support for housing expenses at the dormitories of the Sarasota Opera House ($750 per student) and a stipend of $300 per week. Six students applied for and received travel support for presenting their research results at professional conferences.

**2003 REU Participants**

The 8 students selected for the 2003 program included 2 Native Pacific Islanders, 1 African American, 2 Hispanics, and 3 non-minority students. Two other Native Pacific Islanders were offered positions in 2003, but declined due to previous commitments. Detailed information about the 2003 REU participants and their major research findings is provided below:

- **Genevieve Arredondo** (Junior, Western Washington University, Bellingham WA)
  
  **Minority status:** Hispanic
  
  **Research mentor:** Brad Robbins, Ph.D., Center for Coastal Ecology
  
  **Project title:** The functional equivalency of *Halodule wrightii*, *Syringodium filiforme*, *Thalassia testudinum* seagrass patches in Charlotte Harbor, Florida.
  
  **Abstract:** Understanding the functional equivalency (value) of seagrass is important in guiding management techniques and understanding the effects of anthropogenic activities on habitats. Past studies have indicated that seagrass with differing characteristics may house a variety of animals in varying degrees of abundance. A study was conducted to determine whether seagrass characteristics (species, bed size, shoot density, canopy height) could be used as predictors of faunal diversity and abundance. Nine sites were characterized according to percent cover, bed size, shoot density, and canopy height using 1m² quadrats and 15.25 cm diameter cores. Fauna within each site was sampled using three 1m² haphazardly placed throw traps. Preliminary analysis of the data suggests that the seagrass *Syringodium filiforme* may house a significantly more diverse species assemblage with a higher number of organisms than *Thalassia testudinum* or *Halodule wrightii*.

  **Conference attendance:** 2004 Ocean Research Conference, American Society of Limnology and Oceanography (ASLO), Honolulu, HI (poster presentation).

- **Neil Aschliman** (Junior, Texas A&M University, Houston, TX)
  
  **Research mentor:** Jim Gelsleichter, Ph.D., Center for Shark Research
  
  **Project title:** Western blot immunodetection of heat shock protein 70 in the bonnethead shark, *Sphyrna tiburo*. 

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Abstract: Heat shock protein 70 (HSP70) is a stress response protein inducible through exposure to endocrine disrupting pollutants, such as organochlorine pesticides. We sought to detect the presence of HSP70 in hepatic tissue of the bonnethead shark, *Sphyrna tiburo*, to evaluate the use of this protein as a bioindicator of pollutant exposure in sharks and their relatives. Homogenized hepatic tissue from this small coastal shark was tested through Western blot immunodetection for the presence of HSP70. Liver samples from bonnethead sharks collected from four sites on Florida's Gulf coast (Apalachicola Bay, Charlotte Harbor, Florida Bay, Tampa Bay) with varying levels of organochlorine contamination were examined. Tissues from laboratory animals exposed to 17β-estradiol and the anti-estrogenic β-naphthoflavone were also examined. Weak reactions in most samples yield no evidence that HSP70 is induced with exposure to estrogenic or antiestrogenic signals. Variability in HSP70 expression among wild specimens taken from the same regions was observed. We conclude that through our methodology, HSP70 in *Sphyrna tiburo* is not a reliable biomarker for environmental endocrine disruptors.

Conference attendance: 20th annual meeting of the American Elasmobranch Society, Norman OK (poster presentation).

- Garin Freitas (Sophomore, University of Miami, Miami, FL)

Minority status: Native Pacific Islander

Research mentor: Colin Simpfendorfer, Ph.D., Center for Shark Research

Project title: Utilization of the Caloosahatchee River and Pine Island Sound as nursery grounds for bull sharks (*Carcharhinus leucas*).

Abstract: The Caloosahatchee River and Pine Island Sound in west Central Florida are home to many species of sharks, including the bull shark (*Carcharhinus leucas*). Sharks are known to use estuaries and bays as nursery grounds for their pups. The purpose of this study was to determine how the Caloosahatchee River and Pine Island Sound are used as nursery grounds by bull sharks. Using catch rate information obtained from longlining, the distribution of bull sharks by size and salinity were investigated. There was a significant difference in the size of bull sharks between the river and the sound. Smaller sharks were found to inhabit the river, while the larger sharks were found to inhabit the sound. The bull sharks were found to leave the river upon reaching 100 cm (stretch total length), which corresponds to an age of approximately 2.7 years. These data indicate that bull sharks are being born in the river (primary nursery), and as they grow, they move out of the river and into the sound (secondary nursery). In the Caloosahatchee River, the majority of the bull sharks were found to occupy salinities between 7 and 18 ppt, while in Pine Island Sound, no bull sharks were caught in water that had salinity above 28 ppt. By determining the importance of the Caloosahatchee River and Pine Island Sound as nursery grounds for bull sharks, it can help to understand how natural and man-made changes are impacting Charlotte Harbor.

Elizabeth Harvey (Junior, University of Maine, Orono, ME)

Research mentor: Dana Wetzel, Ph.D., Center for Eco-Toxicology

Project title: Toxicity, due to Permanone31-66, in the inland silverside, *Menidia beryllina* and mysid, *Mysidopsis bahia*.

Abstract: The use of pesticides to control mosquito populations has been a practice implemented by communities along the southwest Florida coast for decades. This investigation details the results of laboratory studies used to evaluate the environmental impact of a mosquito adulticide, Permanone31-66, on Charlotte Harbor Estuary, FL. The acute toxicity of Permanone31-66 to the inland silverside (*Menidia beryllina*) and mysid (*Mysidopsis bahia*) was measured using both static and flow-through experimental design methods, and lethal median concentrations (LC50) values were calculated. Results indicate that the 96hr LC50 values for *M. beryllina* in static conditions are 10.20 g l⁻¹ and in a flow-through environment, 80.92 g l⁻¹ (95% CL: 74.4-87.97 g l⁻¹). Ninety-six hour LC50 values for *M. bahia* in static conditions less than 4.45 g l⁻¹ and less than 1.94 g l⁻¹ in flow-through settings. This indicates that Permanone31-66 lethality to *M. beryllina* is higher in static conditions than in flow-through conditions. Also, based on known application rates around Charlotte Harbor (0.33 fl.oz. acre⁻¹), these findings suggest that Permanone31-66 is not at lethal limits for *M. beryllina*, but could reach them for *M. bahia*.

Conference attendance: 2004 Ocean Research Conference, American Society of Limnology and Oceanography (ASLO), Honolulu, HI (poster presentation).

Danny Ordonez (Junior, Hawaii Pacific University, Kaneohe, HI)

Minority status: Hispanic

Research mentor: Gary Kirkpatrick, Ph.D., Center for Eco-Toxicology

Project title: Analysis of phytoplankton community structure in Charlotte Harbor, FL: comparison of microscopic cell counts with HPLC pigment analysis using ChemTaxÆ.

Abstract: Data were collected to better understand phytoplankton community structure in Charlotte Harbor. The work reported here was an attempt to compare microscopic enumeration to high performance liquid chromatography (HPLC) pigment analysis using ChemTaxÆ. The project was implemented in cooperation with the Charlotte Harbor Program developed by scientific staff at Mote Marine Laboratory to monitor the health of the Charlotte Harbor estuary. The research vessel *Claire G* was employed to characterize chemical and biological properties of Charlotte Harbor. Three separate cruises, consisting of twelve stations each, were completed for this comparison. Hydrographic data and water samples were collected and returned to Mote Marine Laboratory for analysis. Two depths were sampled, near surface and near bottom. Methods for microscopic procedure included preserving samples using Utermöhl's and performing enumeration with aid of settling wells and an inverted microscope. Phytoplankton was categorized into five separate groups (dinoflagellates, diatoms, cyanobacteria, marine
flagellates, and other. Microscopic counts (cells/liter) were calculated and used to compare to ChemTaxÆ.

- Roody Pierre-Charles (Junior, Barry University, Miami, FL)

Minority status: African-American

Research mentor: Dr. Cathy Walsh, Center for Shark Research


Abstract: Florida manatees (Trichechus manatus latirostris) are exposed to many health hazards in their environment, ranging from naturally occurring to anthropogenic. Exposure to various stressors could result in immune system complications, making them more susceptible to infections. In fact, previous research has demonstrated impaired immune function in manatees after exposure to environmental stressors. Additional immune function indicators, however, are necessary to completely understand these immune system effects. Optimal immune function depends on soluble mediators called cytokines, which are responsible for communication between cells of the immune system. They are involved in signal transduction and in activating genes for growth, differentiation, and cell activity. The present study was conducted to investigate the role of cytokines in manatee immune function, and focused on two essential cytokines, interleukin-1 (IL-1) and tumor necrosis factor (TNF). IL-1 plays an important role in T cell activation and in the co-stimulation of B cells. TNF is important in killing both infectious agents and tumor cells. Serum was obtained from 29 manatees. TNF activity was measured using the TNF sensitive cell line, WEHI.164 and IL-1 activity was measured using the IL-1 sensitive cell line, A375.S2. Cell viability was determined using MTT. Protein profiles of serum samples were determined using electrophoresis (SDS-PAGE). Immunoblotting procedures were performed to confirm the presence of TNF. Results indicated detectable, but variable, levels of circulating TNF, but very little circulating IL-1, in manatee serum. Measurement of serum TNF levels may serve as an additional immune function indicator to assess manatee health in response to environmental stressors.


- Cassie Schwanger (Junior, Carthage College, Kenosha, WI)

Research mentor: John E. Reynolds III, Ph.D., Center for Marine Mammal and Sea Turtle Research

Project title: Photo-identification and site fidelity of the Florida manatee in Pansy Bayou.

Abstract: This study investigated the site fidelity and use patterns of the Florida manatee, Trichechus manatus latirostris, of Pansy Bayou, a designated manatee sanctuary in southern Sarasota Bay, Florida. This information helps clarify the importance and effectiveness of
protected habitats. Sightings of individual manatees were documented during 66 photoidentification surveys conducted during June and July, 2003. A total of 29 manatees was successfully photographed, representing approximately 40% of the total manatees sighted. Of the photographed animals, 5 were identified with previously documented slides from Mote Marine Laboratory and through the Manatee Individual Photo-Identification System. On average, three different individual manatees were sighted at the survey site daily. The average monthly residency index shows that of the photographed manatees, 4 (14%) were seen on multiple days. The sighting data were combined with similar data collected during 2000, 2001, and 2002. The combined sighting data resulted in an average annual return rate of 10%. This shows a decrease over the last 4 years from over 16% between 2000 and 2001 to 7% between 2002 and 2003, but it does not consider environmental conditions and population changes. The total number of different manatees sighted also varies among years, ranging from 92 to 29. These results suggest that the Florida manatee shows annual and inter-annual site fidelity patterns. It is evident that Pansy Bayou is a high use area and serves as an important habitat to the Florida manatee.

- Lauren Ku’lei Vickery (Sophomore, Windward Community College, Honolulu, HI)

Minority status: Native Pacific Islander

Research mentor: Michelle Heupel, Ph.D., Center for Shark Research

Project title: Differences of home ranges in male and female bonnethead sharks (*Sphyrna tiburo*) in Charlotte Harbor, Florida

Abstract: Many shark species use the Charlotte Harbor estuary as nursery and feeding grounds. Few studies have been conducted to establish home ranges of sharks in this ecosystem. The purpose of this study is to find the differences of home ranges and movements in bonnethead sharks, *Sphyrna tiburo*, between males and females within Pine Island Sound. Data was collected using Vemco VR2 omni-directional hydrophone receivers and Vemco V16 series acoustic transmitters. 19 receivers were used in the 2002 season, while 40 were used in 2003. Sharks were caught via longline, drumline, and gillnet gear. Measurements, weight, maturity level, and release condition were recorded for each shark caught. 15 individuals were identified and studied for this project. A total of 8 males and 7 females were selected, with one male present for both seasons. Using Arcview GIS, 2002 and 2003 season data was compiled and displayed to show home range area and weekly movements. Weekly home range area was recorded and showed a broad range of habitat usage. Similarities were found between all subjects. Results indicate heavy usage of certain areas and site fidelity.

2004 REU participants

The 10 students eventually selected for the 2004 program included 1 Hispanic and 9 non-minority students. The low percentage of underrepresented minorities participating in the 2004 session was clearly a function of the dates used for postmark of applications and notification of program selections because the initial selection pool actually consisted of 5 minority students, who were unable to accept REU positions due to previous commitments (offers made to additional minority students were met with the same outcome). All of the students (both
minority and non-minority) that declined REU positions indicated that the Mote program was their first choice, but they accepted earlier offers out of concern that they would not be selected for this program. Because of this, earlier dates will be used for the postmark of applications and notification of program selections in future years.

Detailed information about the 2004 REU participants is provided below:

- **Andrea Barber** (Junior, University of North Carolina at Wilmington, Wilmington, NC)

  **Research mentor:** Jay Leverone, Ph.D. candidate, Center for Coastal Ecology

  **Project title:** The effects of *Karenia brevis* on filtration and clearance rates in four species of juvenile bivalve mollusk.

  **Abstract:** Little is known concerning the effects of the toxic dinoflagellate, *Karenia brevis*, on juvenile shellfish. Feeding responses of four important shellfish species (*Mercenaria mercenaria*, *Argopecten irradians*, *Perna viridis*, and *Crassostrea virginica*) exposed to *K. brevis* were calculated. *K. brevis* exposure treatments consisted of three concentrations (10, 100, and 1,000 cells ml⁻¹) and two culture preparations (lysed and whole). Feeding responses included filtration, clearance, and weight-specific clearance rates. A significant (p < 0.05) effect of concentration and culture preparation on clearance rates in *M. mercenaria* was found. There was no significant (p > 0.05) effect of *K. brevis* concentration or preparation on clearance rate for juvenile *A. irradians*, *P. viridis*, or *C. virginica*, although minor responses were observed. Exposure to toxic algal species during the juvenile phase may disrupt normal feeding behavior resulting in poor growth and maintenance. Decreased growth and increased mortality in juvenile bivalves may lead to economic losses due to negative impacts on shellfish industries.

- **Emily Broderick** (Junior, University of the Virgin Islands, USVI)

  **Research mentor:** Brad Robbins, Ph.D., Center for Coastal Ecology

  **Project title:** An investigation of measurement methods and growth success in the seagrass *Thalassia testudinum* and the freshwater grass *Vallisneria americana*.

  **Abstract:** Submerged aquatic vegetation (SAV) forms the basis of many highly productive fresh water and marine habitats. Valued for several ecological functions, SAV has many contributions including erosion control, establishing minimum flow levels, and providing food and refuge for animals such as waterfowl, insects, crabs, fish, as well as endangered species of turtles and marine mammals. Seagrasses and freshwater grasses are types of SAV that are aquatic vascular rooted angiosperms (flowering plants). Due to the important productivity of aquatic grasses, growth measurement techniques and growth patterns of two types of grasses were evaluated to facilitate ecosystem comprehensions and management. The comparison of marking methods used to determine blade growth in the seagrass *Thalassia testudinum* (turtlegrass) provided support for a blade-clipping technique that seems to be an improvement on a hole-punching technique because it allows for the collection of more data per effort. Also, preliminary results from various studies on the growth and reproduction of a seldom-studied
fresh water grass *Vallisneria americana* (Wild celery) were collected and will be enhanced at the conclusion of these experiments this fall.

- **Katie Brueggen** (Junior, College of the Ozarks, Point Lookout, MO)

**Research mentor:** Damon Gannon, Ph.D., Center for Marine Mammal and Sea Turtle Research

**Project title:** Effects of bottlenose dolphin, *Tursiops truncatus*, sounds on the acoustic behavior of spawning spotted sea trout, *Cynoscion nebulosus*.

**Abstract:** Many predators use acoustic-mediated hunting techniques. This is especially true in marine environments, where visibility can be limited. One such predator is the bottlenose dolphin, *Tursiops truncatus*, which uses passive listening to detect soniferous prey. In order to avoid detection by such predators, sound-producing prey must be able to alter their acoustic behavior. This paper examines the effects of two types of dolphin sounds, whistles and echolocation clicks, on the acoustic behavior of spotted sea trout, *Cynoscion nebulosus*. Several other stimuli, including the disturbance call of Atlantic croaker, *Micropogonias undulatus*, were played back as well. Stimuli were played back to nocturnal spawning choruses. Playbacks of dolphin clicks and disturbance calls of Atlantic croaker caused a significant decrease in sound production by spotted sea trout. No other stimuli caused any significant difference. The low frequency components of echolocation clicks fall overlap the probable hearing range of sea trout while whistles occur at a higher frequency. Therefore, clicks may be audible to sea trout while whistles are not. Thus, acoustic behavior could be altered in response to one dolphin sound but not another. Atlantic croaker, like sea trout, are members of the family Sciaenidae. Both species are common prey for bottlenose dolphins. Therefore, it is understandable that a disturbance call produced by one prey species would be likely to affect other, heterospecific, prey in the same area.

**Conference attendance:** 2005 Aquatic Sciences Meeting, American Society of Limnology and Oceanography (ASLO), Salt Lake City, UT (poster presentation).

- **Brooke Gagner** (Junior, Western Washington University, Bellingham, WA)

**Research mentor:** James Culter, Center for Coastal Ecology

**Project title:** Tolerances of select Charlotte Harbor benthic invertebrates to hypoxic conditions.

**Abstract:** Research on hypoxia (low dissolved oxygen) tolerances of benthic invertebrates is sparse and has been primarily conducted in temperate latitudes. There has been little research conducted on subtropical invertebrates and no laboratory research on the effects of hypoxia for Charlotte Harbor, FL benthic invertebrates. Hypoxia is a common occurrence in the upper Charlotte Harbor due to salinity stratification resulting from freshwater inflows from the Myakka and Peace Rivers during the summer months. Three species of Charlotte Harbor invertebrates are representative of the crustaceans (*Palaemonetes pugio*), polychaetes (*Pectinaria gouldii*), and brachiopods (*Glottidea pyramiditata*) found in the estuary system were selected for study. The tolerances of these three species to hypoxic conditions were examined. Dissolved oxygen levels
were artificially reduced through the addition of nitrogen into a closed chamber. Results showed
that *Palaemonetes pugio* was the most sensitive invertebrate, followed by *Glottidea pyramiditata*, and then *Pectinaria gouldii*. Behavioral activities from decreasing dissolved oxygen levels were also observed and correlated to a specific hypoxic level. It was found that *Pectinaria* was better able to slow down its activity and respiration. Thus *Pectinaria* was better able to conserve its oxygen supply, which in turn corresponded to its higher tolerance to hypoxia.

- **Allison Hansen** (Junior, Northland College, Ashland, WI)

**Research mentor:** Gary Kirkpatrick, Ph.D., Center for Eco-Toxicology

**Project title:** Detecting the red tide, *Karenia brevis*.

**Abstract:** During times of a red tide bloom, *Karenia brevis* can create a series of adverse effects that impact the aquatic ecosystem and local economy due to massive fish kills, shellfish contamination, and public health concerns. Current methods for detecting *Karenia brevis* lack the ability to forecast a bloom prior to dangerous cell concentration levels. The BreveBuster is an automated system designed to discriminate *Karenia brevis* from other algae through the utilization of a similarity index. Laboratory cultures consisting of four species of algae (*Karenia brevis, Tetraselmis impellucida, Dactyliosolen fragilissimus*, and *Gyrodinium instraitum*) and field samples were analyzed by microscopic enumeration, high performance liquid chromatography (HPLC), CHEMTAX, and BreveBuster similarity index values. A linear relationship of the similarity index value and percent biomass contributed by the four species of algae was found. A confidence interval was also established to determine the BreveBuster's ability to measure the amount of chlorophyll a contributed by each species. Further applications of this linear relationship and confidence interval will allow the phytoplankton community dynamics to be monitored. During times of increasing *Karenia brevis* levels, public warnings will allow for proper mitigation efforts to be initiated and the effects of the bloom to be reduced or eliminated.

- **Candice Lavelle** (Junior, Roger Williams University, Bristol, RI)

**Research mentor:** Jim Gelsleichter, Ph.D., Center for Shark Research

**Project title:** Using liver slices and hepatocyte cultures for *in vitro* vitellogenin induction in Atlantic stingrays.

**Abstract:** Vitellogenin is the precursor to egg yolk proteins produced in the liver after 17β-estradiol binds to the estrogen receptor. Both male and female oviparous animals have the ability to produce vitellogenin but it is found in low levels in males and immature females unless induced by estrogen or an estrogenic mimic. Many estrogen mimics are thought to be responsible for endocrine disruption and ultimately the inability for many species to reproduce successfully. The objective of this experiment was to examine if vitellogenin is an appropriate biomarker for estrogen pollutants in *D. sabina* and potentially all other elasmobranchs by subjecting cultured liver slices and hepatocytes to various 17β-estradiol concentrations and observing vitellogenin production. SDS-PAGE analysis showed no distinguishable difference in liver and media
samples from liver slice culture and media samples from hepatocyte culture. Vitellogenin presence was detected in stingray liver slices as well as the hepatocyte culture media using western blotting with a swordfish vitellogenin antibody. However, no signs of induction were present because control samples and estradiol treated samples showed similar levels of reaction with the antibody using western blotting. Cell viability seems to be the reason for the lack of induction. LDH analysis suggested that the viability of cells substantially decreased over the culture period for tissue slice culture as well as hepatocyte culture.

- **Trevor Miller** (Junior, University of California Berkeley, Berkeley, CA)

**Research mentor:** Tony Tucker, Ph.D., Center for Marine Mammal and Sea Turtle Research

**Project title:** Research on the effects of beach nourishment and upland lighting on the nesting preferences of the loggerhead (*Caretta caretta*) sea turtle in Sarasota County.

**Abstract:** When a sea turtle emerges from the ocean and crawls onto the beach to nest its environment overlaps with that of people more so than at any other point in its life. Consequently, at this point it is most prone to human influences. Florida beaches are vital nesting grounds for *Caretta caretta* (loggerhead sea turtles) and Sarasota County represents the largest concentration of nesting turtles on the west coast. The Sea Turtle Program at Mote Marine Laboratory has been collecting and maintaining records of nesting sea turtles along the beaches of Sarasota County since 1990. This research project utilizes this wealth of data to determine the effects of beach nourishment on nesting *C. caretta* on Longboat Key. Longboat Key has been a frequently nourished beach since 1993 and as my treatment site is compared to the natural beaches of Siesta Key as a control. Using the street addresses that are attached to every nest record the nests of both keys have been given geographic coordinates and overlaid on a map of the Sarasota coastline to produce a spatial distribution of *C. caretta* nests and false crawls. This has allowed for the visual comparison of the beaches in question from 1991 to 2003 and through five beach nourishment projects. Nesting success, nesting frequency per km, and hatching success are also compared for the two beaches. Beach nourishment appears to have an impact primarily on *C. caretta* nesting success and frequency on Longboat Key. Both figures are significantly reduced on nourished beaches for two years following nourishment.

- **Sara Mouzi** (Sophomore, University of Houston, Houston, TX)

**Minority status:** Hispanic

**Research mentor:** Jim Gelsleichter, Ph.D., Center for Shark Research

**Project title:** Analyzing estrogenic activity in the Myakka River.

**Abstract:** Environmental pollutants that imitate estrogen, a female sex hormone, are known to disrupt hormone-regulated functions such as development, immune, reproductive, and neurological processes in marine organisms and increase the frequency of breast and testicular cancer in humans. These xenoeostrogens make their way to the water by both natural and commercial means. It is necessary to locate and absolve this issue before these endocrine
disrupters harm aquatic and terrestrial organisms. Samples to be tested for this study were collected in amber bottles from various sites along the Myakka River. These river samples were then extracted using dichloromethane and transferred to dimethyl sulfoxide (DMSO) solvent. Following this, an E-SCREEN assay with concentrated river samples, blank samples, 17β-estradiol control and DMSO control was performed. Cell proliferation was identified using a Sulforhodamine B (SRB) substrate and read through an optical density reader at wavelength of 490nm. Estrogen levels found in the Myakka River were below the DMSO and 17β-estradiol maximum proliferation control values, thus concluding levels are not significant. Studies on estrogen levels will continue on various rivers and estuaries throughout southern Florida.

- Holly M. Taylor (Junior, University of California Santa Cruz, Santa Cruz, CA)

Research mentor: Laura Dixon, Ph.D. candidate, Center for Coastal Ecology

Project title: Measuring septic system impacts to receiving waters using optical brighteners in Charlotte County, Florida.

Abstract: Techniques were developed to detect Optical Brighteners (OB), fluorescent laundry additives, in selected residential canals of Charlotte County, FL, to determine where On-site Sewage Treatment and Disposal Systems (OSTDS) in the area may be failing. Canals were selected for sampling based on the known waste treatment technique of the homes. OB was measured with two approaches. The first employed absorbent, dye-free cotton pads that were placed in the canals for approximately 48 hours and then recovered. Pads were analyzed for UV fluorescence both visually and with a spectroradiometer to detect any absorbed OB. The second method used paired flow-through fluorometers to obtain a continuous record of fluorescence along selected canals. Tests of mixtures of OB, humic water and sea water indicated that the pad and the fluorometer method both had a quantitative response under lab conditions, increasing in fluorescence with increasing OB concentrations, provided that varying fluorescence due to humic substances was accounted for. Humics present in the water did not interfere with pad absorption of OB. However, in comparison to the fluorometer, the pad method was less sensitive and provided more variable results due to a range of natural organic mater in the field, biofouling, and pad degradation. Pad and fluorometer data were mapped using GPS coordinates and the resulting distribution of OB response indicates that some regions including both sewered and OSTDS served areas warrant further investigation. Analysis of OB retention times and the effect of seasonal fluctuation of residents on fluorometric readings is also recommended.

- Bridget Thornton (Junior, Eckerd College, St. Petersburg, FL)

Research mentor: Aaron Adams, Ph.D., Center for Fisheries Enhancement

Project title: Evaluation of PIT (passive integrated transponder) tagging as a method for tracking the movements of juvenile common snook, *Centropomus undecimalis*.

Abstract: Essential nursery habitat for the juvenile common snook (*Centropomus undecimalis*) has not been well defined, in part because identification requires long-term tracking ability of habitat shifts accompanied different life stages. In this study, PIT (passive integrated
transponder) tagging is investigated as a possible method for tracking juvenile snook. Juveniles from an estuarine pond and creek system were fitted with PIT tags for individual identification if recaptured. Such recapture data is used to determine movements and survivorship. Some of the tagged snook were caged in situ to evaluate the effects of the tagging process and tag retention, and a control group of snook was retained under controlled conditions at Mote Marine Laboratory. PIT tags may be read by handheld scanners, or an antenna array can be installed at a site to augment the readable area of the tags and provide constant monitoring. In this study, an experimental antenna array was installed in a creek to monitor snook movements into and out of the study pond. Tag retention was 100% for both caged field and control populations. Observations suggest the tagging incisions close within 6 days of tagging and are barely visible within 19 days. The tagging process appears to have little effect on the health and behavior of the fish, therefore PIT tags are valid tools for tracking juvenile snook. Further results from increased sampling and monitoring by the antenna array will provide valuable data on juvenile snook movements.

Conference attendance: Charlotte Harbor Conference: Sound Science in 2003-2004, Mote Marine Laboratory, Sarasota, FL (poster presentation); 2005 Aquatic Sciences Meeting, American Society of Limnology and Oceanography (ASLO), Salt Lake City, UT (poster presentation).
ACTIVITIES AND FINDINGS – OUTREACH ACTIVITIES

Public Outreach

Public outreach on this program was conducted using both electronic and print media:

**Electronic media:** Detailed information about this program and its participants was presented on Mote Marine Laboratory's web site, which has averaged approximately 1.2 million base page requests per year over the last 7.5 years, with the demand increasing.

**Print media:** An article on this program was published in the Spring 2004 issue of Mote’s science magazine, *Mote Magazine* (reprinted on the following page). *Mote Magazine* is a publication for the general public that focuses on the research being conducted by Mote Marine Laboratory and its research partners. The magazine has a current print distribution of 20,000 with an estimated pass-around of 2 times that or approximately 40,000. An electronic version of the magazine averages between 800 and 1000 hits a month for a combined audience exposure of 30,800 not including pass-around, or 61,600, including pass-around. *Mote Magazine*’s distribution reaches several different audiences including:

- 8,500-9,000 members of the Mote Aquarium
- Government employees, legislators and other decision-makers
- Mote research and education partners
- Florida public and private libraries
- 100-250 media journalists, including print and TV outlets nationwide
- Members of the American Zoological Association
- Clients of our subscription partners, organizations that underwrite *Mote Magazine* subscriptions for their customers.

*Mote Magazine* has an established track record with many media outlets in generating interest in the topics covered in the magazine. Stories about Mote Marine Laboratory research programs and scientists run regularly in newspapers across the country as the result of news releases written in conjunction with *Mote Magazine* stories. Stories are regularly picked up by the Associated Press, Reuters and National Public Radio. Stories sent on the wire by the AP are picked up on a regular basis by some of the nation’s largest daily newspapers, including the Detroit Free Press, the LA Times, and the Miami Herald. Mote has also garnered attention in USA Today and on the national networks CNN, ABC, NBC and CBS. Magazine coverage has included publications such as National Geographic online and Southern Living Magazine. In addition, Mote is often asked for permission to reprint articles from the magazine in independent publications such as Key West Magazine.
All roads led to the past

Carl Crowe worked in a high school math class in the 1950s, a radium convertor was in his cardboard box, and Dr. R. B. Crowe Club was his name. His passion for a petradon was his undoing. He was a volunteer and his daughter, Miss Crowe, was a volunteer too. The club was formed to keep the radium in place.

In 1950, Crowe was working on a commercial idea when he found a radium convertor. He named it Crowe's Radium Club.

The club was formed in 1950, and it flourished. Crowe was a volunteer and his daughter, Miss Crowe, was a volunteer too. The club was formed to keep the radium in place.

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In 1950, Crowe was working on a commercial idea when he found a radium convertor. He named it Crowe's Radium Club.
Professional Outreach

Presentations

Overviews of this program and the preliminary results of program assessment activities were presented at 4 professional conferences:


Publications

We expect to publish the results of program assessment activities in an educational journal in the near future.
PUBLICATIONS AND PRODUCTS

Publications with REU students as co-authors (* denotes REU student)

**Published**


**In Press**


**In Preparation**


**Planned**


Publications in which REU students are acknowledged (* denotes mentor)

**Published**


**In Review**

concentrations, reproductive physiology, and immune function in unique populations of freshwater Atlantic stingrays (*Dasyatis sabina*) from Florida’s St. Johns River. *Chemosphere.*

**In Preparation**


CONTRIBUTIONS TO HUMAN RESOURCES DEVELOPMENT

Student Recruitment

As discussed in the section entitled iActivities and Findings ti Training and Developmenti, our recruitment efforts were highly successful. Approximately 120 and 180 students applied for the 2003 and 2004 sessions, respectively. Because of this high application rate, we continue to use email- and web-based program advertisements as our primary means for recruiting program applicants. Our ability to maintain a high application rate (i.e., 172 applicants for the 2005 session) despite a one-month change in the application deadline (see below for further explanation) is further justification for retaining this approach.

Minority Recruitment and Participation

Our ability to recruit minority applicants was commendable, but fell slightly below our expectations. Approximately 8-10% of our 2003 and 2004 applicants were members of a minority group underrepresented in science and engineering. In an effort to improve minority recruitment, we recently updated the list of schools that receive our program advertisement to include all of the >400 schools identified as minority-serving institutions (i.e., Historically Black Colleges and Universities, Hispanic-serving Institutions, Tribal Colleges and Universities, and Alaskan Natives/Native Hawaiian Institutions) by the U.S. Department of Housing and Urban Development's (2003) summary report. Despite this, only 7% of the applications received for the 2005 session were from students belonging to underrepresented minority groups. Because of these results, we are considering other approaches for improving the recruitment of minority applicants including conducting site visits and/or videoconferences to minority-serving institutions and distributing promotional materials (e.g., calendars, pens) to science majors at these schools.

The overall number of underrepresented minorities participating in the first two years of this program (6 of 18 or 33%) was slightly lower than our target goal of 50% due to a low number of minority participants in the 2004 session. This was believed to be a function of the dates used for the postmark of applications (March 15th) and notification of program selections (April 15th) because the initial selection pool actually consisted of 5 minority students, who were unable to accept REU positions due to previous commitments (offers made to additional minority students were met with the same outcome). All of the students (both minority and non-minority) that declined positions in our program indicated it was their first choice, but they accepted earlier offers from other programs as a precautionary measure. Because of this, we used earlier dates for the postmark of applications (February 15th) and notification of program selections (March 15th) for the 2005 session. This change has significantly improved our ability to obtain commitments from our top selections. In fact, 4 minority students have accepted positions for the upcoming session.

During the initial two years of funding, this program placed special emphasis on recruiting and involving Native Pacific Islanders because of their exceptionally low rates of college enrollment/completion and the limited number of experiential programs focused on increasing the representation of this poorly studied minority group in science. However, despite strong efforts to recruit these students (and enrollment of 2 Native Pacific Islanders in the 2003 session), we received few applications from Native Pacific Islanders on an annual basis (i.e., 4 in
2003 and 1 in 2004). Given the success of our general recruitment efforts, the low number of applications received from members of this minority group was considered to be a function of the limited size of the potential applicant pool and/or (as suggested by UHH collaborators) the unwillingness of Pacific Islanders to pursue positions in the U.S. mainland. In addition, the special emphasis placed on recruiting Native Pacific Islanders often led students from other minority groups (as well as non-minority students) to incorrectly assume that they were ineligible for this program. In a few instances, some students were also led to believe that the program took place in Hawaii or other Pacific Islands. Due to these issues, we recently began to place new emphasis on targeting students from all underrepresented minority groups rather than this one, extremely small sub-group.

Assessments of Student Learning and Satisfaction

We used two approaches to assess the educational quality of this program:

Student learning

The effects of program involvement on student learning were evaluated using self-assessment tools that were completed by REU participants both prior to and after the REU period. These forms contained 10 Likert-scaled questions that were designed to determine a student's self-perception of their subject matter competence, technical skills (e.g., written, verbal, computer, field or laboratory), ability to work with others, and interest in graduate study and/or a career in science. Students were asked to respond to questions using a scale ranging from 1 to 4, where 1 = strongly disagree, 2 = disagree, 3 = agree, and 4 = strongly agree. An increase in a student's self-assessment rating was considered to reflect a favorable effect of the program on enhancing the trait in question. We used a pre-post test approach to reduce the bias that is often associated with the sole use of post hoc surveys. Data obtained from these surveys were analyzed using the Wilcoxon signed-rank test. A list of survey questions used for the 2003 and 2004 assessments is provided in the table below:

<table>
<thead>
<tr>
<th>Question No.</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I am very comfortable asking questions.</td>
</tr>
<tr>
<td>2</td>
<td>I am a self-starter and need little motivation from other people to get started on a project.</td>
</tr>
<tr>
<td>3</td>
<td>I have strong computer skills (word processing, spreadsheets, power point).</td>
</tr>
<tr>
<td>4</td>
<td>People easily understand me when I express myself verbally.</td>
</tr>
<tr>
<td>5</td>
<td>I am comfortable with my writing skills.</td>
</tr>
<tr>
<td>6</td>
<td>I am confident with my field or laboratory skills.</td>
</tr>
<tr>
<td>7</td>
<td>My research skills are adequate.</td>
</tr>
<tr>
<td>8</td>
<td>I work well with different types of people.</td>
</tr>
<tr>
<td>9</td>
<td>I have a strong interest in continuing on to graduate school.</td>
</tr>
<tr>
<td>10</td>
<td>I have a strong interest in a career or job in science.</td>
</tr>
</tbody>
</table>
Student satisfaction

The effectiveness of the program in meeting student learning objectives was assessed using student reaction tools, which were also completed by participants before and after the REU period. These forms compared the knowledge and skills that participants hoped to gain from involvement in the program with that they actually obtained, using a series of open-ended questions. A list of the open-ended questions used for the 2003 and 2004 assessments is provided in the table below:

<table>
<thead>
<tr>
<th>Question No.</th>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Describe the knowledge you want to obtain during this internship.</td>
<td>Describe the knowledge you obtained during this internship.</td>
</tr>
<tr>
<td>2</td>
<td>List the skills you want to obtain during this internship.</td>
<td>List the skills you obtained during this internship.</td>
</tr>
<tr>
<td>3</td>
<td>Is there one experience you look forward to the most?</td>
<td>Can you describe the most educational experience (s) during your internship?</td>
</tr>
</tbody>
</table>

Additional assessment activities

Student assessments by mentors and Principal Investigators

Based upon the nature of the student-mentor relationship, mentors are expected to regularly provide informal comments to the student on their performance in the research program. At the end of the REU period, mentors complete a summative assessment of the participants' learning based on their achievement in the independent project, project report, and seminar presentation. This tool is similar to the self-assessment tools completed by students prior to and after the REU period. A list of the Likert-scaled (scale ranges to 1 to 4, where 1 = strongly disagree, 2 = disagree, 3 = agree, and 4 = strongly agree) survey questions used in this tool is provided in the table below:

<table>
<thead>
<tr>
<th>Question No.</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The student asked appropriate and timely questions.</td>
</tr>
<tr>
<td>2</td>
<td>The student was self-starter and need little motivation or encouragement to start on an activity or project.</td>
</tr>
<tr>
<td>3</td>
<td>The student demonstrated computer skills appropriate for the education level.</td>
</tr>
<tr>
<td>4</td>
<td>The student verbally expressed himself/herself well.</td>
</tr>
<tr>
<td>5</td>
<td>The student used effective writing skills.</td>
</tr>
<tr>
<td>6</td>
<td>The student exhibited improved field or laboratory skills.</td>
</tr>
<tr>
<td>7</td>
<td>The student used effective research skills.</td>
</tr>
<tr>
<td>8</td>
<td>The student worked well with different types of people.</td>
</tr>
<tr>
<td>9</td>
<td>I would encourage this student to pursue graduate study in the sciences.</td>
</tr>
<tr>
<td>10</td>
<td>I would encourage this student to pursue a career in science.</td>
</tr>
</tbody>
</table>
In addition to responding to the questions above, mentors were also asked to indicate if any publications or scholarly activity was or would be produced based on the work of the participant.

The Principal Investigator assessed student performance on the research proposal, final paper, and oral presentation using activity-specific grading rubrics. Afterwards, we discussed these assessments with the student in order to provide timely feedback. We also sought feedback from other researchers that were capable of providing it (e.g., attendees of the research symposium).

**Result of Student Assessments**

**Student learning**

All participants of the 2003 session rated at least one of their traits higher following completion of the REU period. Based on these data, the most consistent improvements were in field and/or laboratory skills (7 of 8 students) and the ability to develop and conduct independent research projects (6 of 8 students). Moderate gains were also observed in computer skills (3 of 8 students), motivation level (4 of 8 students), and writing ability (3 of 8 students). Statistical analysis of the survey data indicated a significant change in students' perceptions of their field/laboratory skills and ability to conduct independent research following the REU period (Wilcoxon signed-ranks test, P<0.05, Figure 3).

![Bar chart](image)

**Figure 2.** Results of student self-assessment surveys completed prior to and after the 2003 REU session. Values are medians scores for n = 8 participants. Asterisk denotes a significant difference between pre- and post-test data (Wilcoxon signed-ranks test, P<0.05).
All participants of the 2004 session rated at least three of their traits higher following completion of the REU period. Based on these data, the most consistent improvements were in field and/or laboratory skills (8 of 10 students), the ability to develop and conduct independent research projects (9 of 10 students), motivation level (7 of 10 students), and computer skills (7 of 10 students). Moderate gains were also observed in writing ability (5 of 10 students), verbal skills (3 of 10 students), interpersonal skills (3 of 10 students), and comfort in seeking advice (4 of 10 students). Statistical analysis of the survey data indicated a significant change in students’ perceptions of their field/laboratory skills, ability to conduct independent research, motivation level, and computer skills following the REU period (Wilcoxon signed-ranks test, \( P < 0.05 \), Figure 3).

**Figure 3.** Results of student self-assessment surveys completed prior to and after the 2004 REU session. Values are medians for \( n = 10 \) participants. Asterisk denotes a significant difference between pre- and post-test data (Wilcoxon signed-ranks test, \( P < 0.05 \)).

**Student satisfaction**

In general, the Mote REU program fulfilled the learning objectives identified by students in the pre-test survey. Virtually all students reported improved research and presentation skills and a better understanding of the scientific method as both goals and outcomes of program involvement. Although it was not a learning objective of most participants, a greater sense of graduate school and/or career opportunities in marine science was another favorable outcome of the program reported by students in the post-test survey. This appeared to be an outcome of the St. Petersburg field trip, which was lauded as a highly positive experience by virtually all students. Lastly, most students reported improvements in their ability to trouble-shoot and revise
research plans when difficulties in data collection are encountered as an unexpected benefit of program involvement.

**Mentor/PI assessments of student learning**

We received student assessment data from 16 of the 18 mentors that participated in the 2003 and 2004 sessions (Fig. 4). In general, mentors reported that students performed well in all aspects of the program and exhibited noticeable improvements in their research skills as a result of program involvement. Most mentors strongly encouraged their advisees to pursue graduate study and/or a career in the sciences.

![Graph showing median scores for student assessment surveys](image)

**Figure 4.** Results of student assessment surveys completed by mentors after the 2003 and 2004 REU session. Values are medians for \( n = 16 \) mentors.

Formal assessments of student performance on the written and oral requirements of the program were generally positive. However, there were certain areas for improvement that we intend to address in upcoming years. Two of these topics are summarized below:

- **Written activities (proposal and research paper):** Despite providing well-defined directions, many students still failed to strictly adhere to the page-limit requirements for preparing research proposals and the Instructions for Authors for preparing research
manuscripts. In most cases, these students followed more familiar guidelines with the expectation that they were close enough. In future years, we intend to re-emphasize the need to follow formal requirements for the preparation of professional documents and discuss the unfortunate consequences that may occur when these materials are non-compliant.

- **Presentation of research results:** The most obvious and consistent errors that students made in preparing research papers and oral presentations concerned the graphical and tabular presentation of research data (e.g., design of graphs, writing informative captions, etc.). In future years, we intend to provide additional instruction regarding this important topic.

**Program Evaluation**

Based on the results of our assessment procedures, we conclude that our program is effective in addressing several needs for improving the training of undergraduate science students and the general state of undergraduate science education. These include:

- Improving the participation of underrepresented minority groups in science;
- Improving the training of future scientists by providing direct experience with the methods and process of inquiry;
- Exposing students to essential career skills in science that are often not addressed in a traditional classroom setting (e.g., grantwriting, written and oral presentation of research findings, etc.); and
- Providing students with a clearer understanding of the available opportunities and requirements for a career in science.