FORMAT for Annual Progress Report

A. Grant Number: UH#655940

B. Amount of Grant: $72,000

C. Project Title: Conservation and Restoration Approaches for Hawaiian Seagrasses Displaced by Invasive Macroalgae

D. Grantee: Hawaii Coral Reef Initiative

E. Award Period: From: January 2006 To: December 2006

F. Period Covered by this Report: From: May 2006 To: October 2006

G. Summary of Progress and Expenditures to Date:

1. Work Accomplishments: (as related to project objectives and schedule for completion)
   a. Provide a brief summary of progress, including results obtained to date, and their relationship to the general goals of the grant; and

   Invasive macroalgae have overgrown extensive areas in certain locations in the Hawaiian Islands. Two species, the green alga *Avrainvillea amadelpha* and the red alga *Gracilaria salicornia*, negatively impact *Halophila hawaiiana* and *Halophila decipiens*, respectively.

   *Halophila decipiens* and *Gracilaria salicornia*: In Waikiki, an estimated >100,000 kg of *Gracilaria salicornia* has accumulated as tumbleweeds within a *Halophila decipiens* meadow. A Before-After-Control-Impact (BACI) experimental design is being used to assess the impact of removal of the alga on the seagrass. Aerial coverage of the seagrass is greater in the control site (alga absent) compared to the impacted area, where the invasive alga smothers the seagrass. The number of *H. decipiens* flowers/fruits per m² is 10x greater in the impacted site compared to the control site (3600 vs. 310), however leaf pair densities and biomass per m² did not differ between the two sites prior to removal of the invasive alga. To date only 10,000 kg have been cleared via community education and outreach events sponsored by DAR. As over 90% of the invasive alga remains, we are still in the before removal partition of the BACI design. In order to begin to measure the affect the impact, we need to significantly increase efforts associated with the biomass removal at this site. We have discussed this need with DAR but have not resolved the problem.

   *Halophila hawaiiana* and *Avrainvillea amadelpha*. *Avrainvillea amadelpha*, which was first reported in the shallow waters of Maunalua Bay (Oahu) in 1987 in areas that historically supported *H. hawaiiana*. The invasive alga was dug out of treatment plots and the experiment monitored every 120 days. A two-year study was completed during the previous award period using fixed plots where seagrass and invasive alga co-occur. However, since the stakes delimiting the experimental plots continue to hold, we have decided to extend this experiment. As such, we now have 2 years and 4 months of continuous monitoring of the interaction between the native seagrass and the invasive
alga in Maunalua Bay (from June 2004 to October 2006). *H. hawaiiana* grew into the open space created by removal of *A. amadelpha* during the first monitoring period (June to October 2004) and has maintained its mean aerial coverage (96% in June and 84% in October 2006) and, over the same time period, mean blade pair densities (3554 and 2596 pairs per m²). Remarkably, *A. amadelpha* had only re-established mean 21% in June 2006 but was reduced to mean 15% cover in October 2006 in the treatment plots. One explanation for the lost in coverage for both macrophytes during the June to October 2006 monitoring period is the strong south swell this year that impacted Oahu’s south shore including Maunalua Bay. Evidence of physical disturbance was noted in September 2006 as many blow-out gaps (erosional escarpments) were observed in the bay. Such physical is common in soft-sediment environments. Based on the results of this experiment to date, we predict that if physical disturbance is minimal during the October 2006 to January 2007 monitoring period the seagrass will respond to the open substrate by increasing its percent cover whereas the slow growing invasive alga will require additional time. We conclude that spread of the slow-growing *A. amadelpha* into extant seagrass meadows can be managed in Hawaii.

**Characterization of sand-dwelling macrophytes in Hawaii.** We are examining how the native seagrass *Halophila hawaiiana* and the invasive alga *Avrainvillea amadelpha* allocate resources across a range of depths and locations. The data being collected include: total biomass per unit area; aboveground biomass per unit area; belowground biomass per unit area; and photosynthetic surface area per unit area. Additional native species of sand-dwelling macrophytes being sampled for comparison are *Halophila decipiens* and the green alga *Halimeda kanaloana*. Samples have been processed.

<table>
<thead>
<tr>
<th>Species</th>
<th>Number of samples collected to date</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Avrainvillea amadelpha</em></td>
<td>33</td>
</tr>
<tr>
<td><em>Halophila hawaiiana</em></td>
<td>19</td>
</tr>
<tr>
<td><em>Halophila decipiens</em></td>
<td>51</td>
</tr>
<tr>
<td><em>Halimeda kanaloana</em></td>
<td>16</td>
</tr>
</tbody>
</table>

**Replanting seagrass and native algae.** Two experiments underway are assessing best methods for the planting the seagrass *Halophila hawaiiana* and the native red alga *Spyridia filamentosa* in areas cleared of the invasive alga *Avrainvillea amadelpha*. The *Halophila hawaiiana* experiment is located in a natural blow-out (erosional escarpment) where sediment has been maintained for over 10 months. This experiment is a two-factor design that tests for the type of donor material (seagrass fragments vs. seagrass cores) and application of fertilizer (control=no fertilizer).

A second experiment is underway that is testing potential culture techniques for seagrass in flow through seawater tanks under conditions with and without fertilizer.

**Molecular experiments.** The goal of these experiments is to describe population level diversity in the two species of *Halophila* in Hawaii. An additional native seagrass species has been added to this work, *Ruppia maritima*. Over 250 samples of seagrass have been collected from 24 sites and extracted. Three markers (5 chloroplast and 1 nuclear) have been successfully amplified for the Hawaiian seagrass species and 3 other potential markers are being tested.
b. Provide a brief summary of work to be performed during the next year of support, if changed from the original proposal; and indication of any current problems or favorable or unusual developments; and any other significant information pertinent to the type of project support by COP, or as specified by the terms and conditions of the grant.

*Halophila decipiens* and *Gracilaria salicornia* experiment in Waikiki. DAR had agreed to support this work by removing the invasive alga biomass via their public education and outreach efforts for marine invasive species. DAR made the decision to change sites in August for removal of the invasive biomass via their public education and outreach efforts but agreed to help us at the seagrass study site by removing the alga with DAR personal. To date DAR has not made any additional efforts to the remove the invasive biomass at the seagrass study site. The new site DAR is using for their public education and outreach efforts is an unvegetated sand bottom with high wave exposure (not a likely site for seagrass meadow development) therefore we cannot use this site for our research. While the invasive biomass is likely to be removed in the future by the DAR, it is unlikely that this effort will occur during the course of this funding as originally agreed by DAR. We will continue to monitor this site and collect before impact data for this BACI designed experiment.

2. Applications:
   a. Publications, presentations, workshops:

   Maruska, Karen P, and Peyton, Kimberly A. In Press. Interspecific Spawning between a recent immigrant and an endemic damselfish (Pisces: Pomacentridae) in the Hawaiian Islands Pacific Science 61(2)


   Peyton, Kimberly. Educational presentation: Limu of Maunalua Bay. Thursday Evenings at Hanauma Bay. 12 October 2006


   b. Applications to management or research;

   As a result of this research we have gained insights into the growth strategies of the invasive alga *Avrainvillea amadelpha* and the native seagrass *Halophila hawaiiana* which have direct applications in management of these species. Growth rates differ significantly between these two species. *H. hawaiiana* has significantly higher growth rates than the invasive *A. amadelpha* in all experiments conducted to date. For example, in experimental plots where *A. amadelpha* was removed by hand, it has reoccupied only 15 percent cover over a 28-month period. In similar experiments with other invasive algae species investigated in Hawaii, these species (*Gracilaria salicornia* and *Kappaphycus/Eucheuma* spp.) reoccupied hand-cleared areas to nearly 100 percent cover over an eight-month period. Further, the seagrass *H. hawaiiana*
expanded into the open substrate created when \textit{A. amadelpha} was removed and the seagrass has maintained its coverage over the 28-month study period. Removal of the invasive alga \textit{A. amadelpha} coupled with replanting the seagrass \textit{H. hawaiiana} appears to be feasible in shallow water sites such as Maunalua Bay.

c. Data and/or information products;

d. Partnerships established with other federal, state, or local agencies, or other research institutions (other than those already described in the original proposal).

3. Expenditures:

a. Describe expenditures scheduled for this period..

b. Describe actual expenditures this period.

c. Explain special problems, differences between scheduled and actual expenditures, etc.

Prepared By:

Signature of Principal Investigator Date

NOAA COP Annual Progress Report Form
NOTICE

Subsequently, all NOAA COP recipients with approved grants will be asked to file a COP Annual Progress Report in the specified format. The first section of the proposed format is taken from the COP implementation plan and has some advantages in that previously-funded investigators will be familiar with the format. Consistency in reporting requirements for competitive research grant programs is desirable and this is behind COP’s efforts in proposing a standardized format. This annual report format will enable COP program staff to monitor each project supported by an award.

Public reporting burden for this collection of information is estimated to average 300 minutes per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed and completing and reviewing the collection of information.

Send comments regarding this burden estimate or any other aspects of this collection of information, including suggestions for reducing this burden, to the National Ocean Service, CSCOR/COP Office, 1315 East-West Highway, Silver Spring, MD 20910. Grant files are subject to the Freedom of Information Act (FOIA). Confidentiality will not be maintained--the information will be made available to the public. However, unpublished research results shall not be published without prior permission from the recipient.

Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the Paperwork Reduction Act, unless that collection of information displays a currently valid OMB Control Number.