Habitat Restoration in Kaneohe Bay, Hawaii
Division of Aquatic Resources
Report Period: April 1, 2012 – September 30, 2012

The Division of Aquatic Resources (DAR), Aquatic Invasive Species (AIS) team is working to restore 13 acres of coral reef habitat that is overgrown by a variety of alien invasive algae species. Upon initial removal of algae, the AIS team will transplant hatchery raised native collector sea urchins onto the patch reef to help control the re-growth of invasive algae. Monitoring of native/alien algae, fish abundance/diversity, and coral recovery/recruitment will be monitored throughout the initial restoration phase and continue 5 years thereafter. This progress report covers the period from April 1, 2012 through September 30, 2012.

Algal Removal/Field Team

During this reporting period, the AIS team completed removal of invasive algae on Reef 27 with over 14,713 pounds of invasive seaweed (*Euchema/Kappaphycus/Gracilaria*) removed. Removal then began on Reef 29, where 9600 m^2 of patch reef was cleared, totaling 42,608 lbs of algae, over the course of 16 days. Kappaphycus/Euchema presence is more than five times thicker on Reef 29 compared to Reef 26 and Reef 27. The crew has been removing an average of 2700 lbs of algae per day. The Super Sucker has cleared approximately 20% of Reef 29 so far.

The team assisted the Monitoring Coordinator to conduct surveys on all five patch reefs, where during this reporting period, each reef was surveyed twice. The surveys involved fish, benthic, urchin, and rugosity transects to monitor algae removal and biocontrol efforts on the reef.

Urchin outplanting

The team conducted six sea urchin spawns where broodstock urchins were collected and spawned. During this time, an additional 22,348 hatchery raised urchins were released onto Reef 26, to bring the total to over 29,000 urchins released. Urchins were also released on Reef 27, with 4350 urchins released so far. Due to being very cryptic and their small size at the time of release, survey methods were modified to better determine the actual population density on the reef. Preliminary surveys have shown a greater than 80% survival rate; with that number more than likely higher due to some urchins not detected because of hiding. Our stocking density goal is to maintain 2 urchins per square meter.

Outreach

- AIS technician Tristan Walker participated in a Science Night outreach event at Ben Parker Elementary School. Tristan brought in samples of invasive algae and collector urchins and gave a hands-on demonstration of the invasive species problems on the island.
- The entire AIS team participated in the Waikiki Clean-up and celebration for Dr. Isabella Abbot's Birthday. The event had a great turn-out with over 1000 lbs. of invasive algae (*Gracilaria salicornia*) removed and 400 urchins released. The event raised a lot of interest and several local news stations covered the event to highlight the threats of invasive algae and urchin biocontrol program.
- AIS Program Leader, Jono Blodgett, and Urchin Hatchery Manager, David Cohen, participated in "DLNR Revealed: Protecting Hawaii's Reefs from Invasive Seaweed". This is a short series on local channel Olelo 16 that depicts the hard work Hawaii's environmental managers are doing to protect our native resources. See YouTube link: http://youtu.be/wxFZ2cDyW9Y

- The AIS team hosted a booth at the 2012 Hawaii Conservation Conference and the 2012 National Hunting and Fishing Day, where we provided information highlighting the Super Sucker program, sea urchins, and other invasive threats to the Hawaiian Islands.
- In partnership with The Nature Conservancy (TNC), the AIS program was featured on KITV news for the release of TNC's Super Sucker II barge. http://www.kitv.com/news/hawaii/Super-Sucker-II-deisgned-to-suck-up-invasive-marine-algae/-/8905354/16772836/-/13iwud9z/-/index.html

Training

The AIS Team attended the Reef Resilience Training hosted by DAR and TNC. The workshop focused on developing management and assessment tools to conserve reef ecosystems which are under significant environmental threats such as invasive species, climate change, over fishing, and watershed degradation.

Reef 29 Summary
Date started: 8/22/12
Date completed: Not yet complete
Days of removal: 16
Pounds Removed: 42,608 lbs
Area Cleared: 9,600 sq. meters
Urchins outplanted: none

Reef 27 Summary
Date started: 3/21/12
Date completed: 08/22/12
Days of removal: 25
Pounds Removed: 15,630lbs
Area Cleared: 12,000 sq. meters
Urchins outplanted: 4350

Reef 26 Summary
Date started: 11/15/12
Date completed: 03/20/12
Days of removal: 23
Pounds Removed: 11,053 lbs
Area Cleared: 12,000 sq. meters
Urchins outplanted: 29,463

Urchin Hatchery

April: Spawns were conducted on April 2nd. Four larval rearing tanks were stocked. Three tanks were stocked at an approximate density of 5 larvae per milliliter; one tank was stocked at an approximate density of 2.5 larvae per milliliter. All tanks were treated similarly. One of the three higher density tanks crashed on day 16. The exact cause of the demise is unknown. However, the animals were exhibiting multiple types of deformity and pink coloration in the gut prior to the population crash. This has been observed on previous runs with similar results.

Group 'A' was divided into two populations on day 24. The rationale was that the population was still quite high (>400,000 larvae) for this time in the lifecycle and tank space was available.

It is believed that if larvae are given more room they will be healthier, develop faster, and have a higher rate of survival. These groups were moved into settlement on Day 25. The two populations were at approximately 160,000 and 126,000 exhibiting >50% competency. Group 'B' was moved into settlement on Day 23. The population was approximately 120,000 with > 33% competent.

A total of 5,644 urchins were transplanted from the hatchery to Kaneohe Bay for outplanting during April.

May: Spawns were conducted on May 7th. Four larval rearing tanks were stocked. The cohorts were designated as groups E, F, G & H. Samples from Group "F" were preserved daily for future histology work with the State Animal Industries vet lab. Photographs of the same cohort were taken daily. The hatchery staff and the state vet lab are collaborating on a histological atlas of larval *T. gratilla*.

The effect of photoperiod on overall larval health was addressed. It had been posited that larval urchins might benefit from 24 light as a method of keeping phytoplankton both photosynthesizing and in suspension, thus making food both more available and more nutritious. Since September of 2011 the larval room has operated with 24 hour light. During the May 7th larval run, lights were left on 24 hours per day, but one tank, Group "H", was shaded approximately 14 hours per 24 hour cycle. There was no significant difference in overall health of these larvae during this trial. It was decided to shut off lights at the end of the day, to save electricity. Midge flies and other nocturnal insects had been attracted by the light. Incidence of pest insects has diminished greatly as well.

A total of 6,604 urchins were transplanted from the hatchery to Kaneohe Bay for outplanting during May.

June: A spawn was conducted on June 18th. Four larval rearing tanks were stocked. A single urchin was used as the female gamete donor for three of the four cohorts. Multiple females were used in the fourth group. There larvae in the groups with single female parent stock seem to be more consistent, but more trials need to be performed to verify.

A total of 2700 urchins were transplanted from the hatchery to Kaneohe Bay for outplanting during June.

July: A spawn was performed on July 23rd. This spawn resulted in very low numbers of larvae. While the population density is low, the larvae appear healthy. It was decided to consolidate the run into one tank and perform another spawn to restock on August 6th. All cohort groups from the June 18th spawn were moved to settlement on July 12th. All groups achieved competency for metamorphosis by day 24. Competency refers to the time that the free swimming urchin larvae are ready or "competent" to go through metamorphosis, settle down, and begin their lives on the bottom as sea urchins. A single larva is considered competent when one or more well-developed tube feet are present and internal structures (the "rudiment") have developed sufficiently to indicate larval maturity. Hatchery metrics dictate that a minimum of 30% of larvae be competent before larvae are transferred to settlement tanks. 50% is considered very good, anything above 60% is excellent. In the case of the June 18th spawn, the groups attained competency rates of 50%, 64%, 72% and 82%. Animals were moved into nine FUNSY units (floating urchin nursery system tanks) and one 30 foot long tank. Post-settlement assessments were performed on August 2nd. There appears to be a loose correlation between competency rates and post-larval populations. Groups with higher rates of competency appear to have higher post-settlement survival. Overall settlement is excellent in all groups.

A total of 5300 urchins were transplanted from the hatchery to Kaneohe Bay for outplanting during July.

Aug/Sept: A spawn was conducted on August 6th to compensate for a poor fertilization event from the July 23rd spawn, and a follow up spawn was completed on September 10th. Between the July, 23 and the August, 6 spawns, 284,000 competent larvae were moved into settlement tanks. Resident adult urchins have been placed in settlement tanks (outside of FUNSYS) prior to settlement to act as grazers and for the possible settling cues they may provide.
Harvesting habits have changed in the last several months in response to several good settling events. Urchins have been moved out of the FUNSYS and into barrels more quickly to prevent overcrowding and to keep urchins in a cleaner environment. Preparation for expansion of the microalgae room during the winter months has also begun.

A total of 6,450 urchins were transplanted from the hatchery to Kaneohe Bay for outplanting during August/September.

Phytoplankton Production:
A new *Chaetoceros muelleri* culture was acquired from Oceanic Institute in March. This is a Hawaii strain isolated by CCMP in Maine. The new cultures are working well but contain ciliates. Isolation and dilution techniques are being used to eliminate the contaminants.
The standard feeding regime in the hatchery is 75% *Rhodomonas sp*., 24% *Chaetoceros muelleri* by cell count. Culturing a single specie or strain of phytoplankton would streamline production and reduce labor. One of the four larval tanks was fed a diet of 100% Rhodomonas. While the treated animals made it through the larval cycle to settlement, their numbers were comparatively reduced and they seemed less healthy than the other three groups. This trial has been performed in previous runs, usually resulting in complete mortality prior to settlement. Further investigation and discussion with staff will determine the fate of future dietary trials.

Macroalgae Production:
All five 4-ton "H" series tanks in the greenhouse were refitted to accommodate macroalgae production. A starter culture of *Halymenia formosa*, a red sea lettuce, was acquired and put into production in one of the newly refitted "H" tanks. Consumption of all macroalgae continues to outstrip production. Present combined macroalgae production is about 24 Kg per week.

Obstacles and/or Delays:
Lack of manpower to move urchins as quickly as they should be continues to be an issue. New trials using a very dilute concentration of KCl are being tested in attempt to make the urchins release themselves from the sides of their tanks and allow for easier and faster harvesting. There was no mortality associated with this experiment, and it seems to work as intended, so this may be a new technique to use in the future.
In addition, determining urchin mortality in the field has been difficult due to their small size at the time of outplanting. They are very cryptic and can easily hide in small holes, so conducting thorough counts is a challenge. Partnering with The Nature Conservancy, we have tested a variety of survey methods to better understand detectability and actual urchin density.

Monitoring

Accomplishments:

- Survey Method Testing
    - Developed and tested new survey method: Urchin Quad Survey

    - Systematic survey method for density and population estimation of urchins on patch reefs in Kaneohe Bay, Oahu. Patch reef is overlaid with 5x5m grid. Grid is intersected with patch reef outline to determine valid grid cells. The center of each valid grid cell is determined and loaded into a handheld GPS. Surveyors navigate to predetermined positions in the field using GPS and blindly drop a $0.5m^2$ quadrat. For each quad, all urchins (with center of test inside quad area) are counted and tallied.
    - *Population Estimate = (mean urchin density per quad ± standard error of mean) x 2 (to convert from urchins/$0.5m^2$ to urchins/m^2) x known area of reef m^2.*
- Monitoring Surveys Completed
    - Fixed Permanent Sites (fish, benthic, echinoderm):
        - Reef 16: June 2012, September 2012
        - Reef 26: May 2012, August 2012
        - Reef 27: May 2012, August 2012
        - Reef 28: April 2012, June 2012, Sept 2012
        - Reef 29: April 2012, July 2012
    - Random Benthic Quads:
        - Reef 16: June 2012
        - Reef 26: August 2012
        - Reef 27: August 2012
        - Reef 28: June 2012
        - Reef 29: July 2012
    - Urchin Population Assessment:
        - Reef 26: July 2012, August 2012, Sept 2012
        - Reef 27: August 2012 (2x), Sept 2012 (2x)
- Database Development
    - Continued development of monitoring database front end, user interface and automation of summary statistics.
    - Began development of invasive algae removal database to track and summarize removal efforts.

Setbacks:

- Equipment failure (boat motors). Weather.