Habitat Restoration in Kaneohe Bay, Hawaii
Division of Aquatic Resources
Report Period: October 1, 2012 – March 31, 2013

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. **All numbers given in this report are from preliminary analysis only and should not be used in any published or final material. This progress report covers the period from October 1, 2012 through March 31, 2013.**

Algal Removal/Field Team

During this reporting period, the AIS team completed removal of invasive algae on Reef 29 with 68,758 pounds of invasive seaweed (*Euchema/Kappaphycus/Gracilaria*) removed from 19,800 m^2 over 21 working days. Kappaphycus/Euchema presence was more than five times thicker on Reef 29 compared to Reef 26 and Reef 27; therefore, an average of 2355 lbs of algae was removed per day. With the additional help from The Nature Conservancy's new Super Sucker barge, this completed the removal of invasive algae from Reef 29 with a total of 129,850 pounds of algae removed.

Reef 29 Summary
Date started: 8/22/12
Date completed: 01/03/2013
Days of removal: 39
Pounds Removed: 129,850 lbs
Area Cleared: ~29,000 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: 40,735

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: 34,777

Urchin Hatchery

October: The September 10th spawn / larval run was completed on October 2nd with competent animals being moved into settlement systems. Three of four larval populations were stocked into nine settlement tanks, with the fourth larval population discarded due to poor development.

A spawn was performed on October 15th, four larval rearing tanks were stocked. Each tank was stocked with eggs from one of four females. The sperm from nine males was mixed and used to fertilize each of the four groups.

November: The October 15th spawn / larval run was completed over the course of three days, November 8th – November 10th. Competent animals were transferred to nine settlement tanks. In addition, a new 12' x 4' x 2' tank was outfitted for settlement for the first time. Settlement was observed in all tanks within a week. Settlement cubes were spread to other tanks within a few weeks to decrease post-larval and juvenile density.

A spawn was conducted on November 26th, four larval tanks were stocked. Two tanks were stocked with eggs from 2 females each (4 females); and two tanks were spawned using one female each. All eggs were fertilized with a mixture of sperm from 13 males.

December: From the November spawn, larval populations were maintained successfully at exceptionally high levels. The hatchery staff performed tank changes every two days rather than every four days. This, coupled with renewed vigor in phytoplankton production resulted in a record number of animals being brought to competency. Animals were moved into 17 separate settlement tanks, with variable success between the groups.

January/February: Larval rearing & phytoplankton culture was suspended during January and February. In general, the urchins have found poor fecundity during the winter months; therefore, it was decided to take advantage of this down time to increase phytoplankton capacity through the expansion of the phytoplankton algae room.

The constituent organisms that comprise the biofilm communities in the hatchery are not entirely known. It is believed that communities experience a natural seasonal succession throughout the year that corresponds to day length and temperature changes. In addition, populations within biofilm communities change as individual tanks mature. To complicate matters further, growth and seasonal succession patterns may be different depending upon tank placement with the facility.

In an effort to document the benthic diatom community portion of the biofilms, the hatchery staff has started sampling biofilms from various tanks. Micrographs have been taken and many algae have been identified to a generic level. These micrographs will be used as reference for further observations. New micrographs will be added as needed and methods for quantitative analysis will be determined in the coming months.

March: It has been confirmed that animals need to be moved from settlement tanks at about 3 months after metamorphosis for health reasons. Buildup of detritus, fecal material and biofilms contribute to increased organic load leading to depressed growth rates and mortality. Protocol has been changed to reflect these findings. Animals are moved from settlement tanks within three months to ensure better health and faster growth. In addition, movement of post-settlement, 3 month old urchins provides an opportunity to more accurately quantify populations. This in turn will add a greater degree of predictability to the system.

Urchin Outplanting

Efforts continued to reduce post-settlement mortality by spreading juvenile urchins out as much as possible in order to reduce competition.

October: 14,200 urchins were released to Kaneohe Bay.

November: 5,000 urchins were released to Kaneohe Bay.

December: 6,350 were released to Kaneohe Bay. 15 urchins were given to the Waikiki Aquarium for use in their display tanks.

January: 1,550 urchins were released to Kaneohe Bay.

February: 4,950 urchins were released to Kaneohe Bay. 120 urchins were donated to the Hale Kula School project.

March: 6,335 urchins were released to Kaneohe Bay. 36 urchins were donated to a cage growth/survival study in March.

A total of 38,385 urchins were outplanted onto Reefs 26/27 in Kaneohe Bay. Both Reef 26 and 27 are currently stocked with urchins at a density of $1.5/m^2$.

Macroalgae & Phytoplankton Production

Construction and renovations began for the expansion of the phytoplankton algae room in November and continued through February. Phytoplankton was restarted in the renovated algae room on March 5.
G. parvispora, used to feed juvenile urchins, grew poorly during January and February due to seasonally low light conditions. Through cooperative efforts among urchin hatchery staff and other facility staff/volunteers, enough G. parvispora was produced to feed juvenile urchins as needed. Seaweed growth and production is expected to improve as day length increases.

We continue to donate seaweed to the Hale Kula School urchin grow-out project about twice per month.

The feasibility of growing Limu Kala continues to be examined. Surge tank and dump bucket designs are being considered for adaptation to existing AFRC facilities and equipment.

Monitoring

Accomplishments:

- Monitoring Surveys Completed:
  Fixed Permanent Sites (fish, benthic, echinoderm):
  - Reef 16: January 2013, March 2013
  - Reef 26: November 2012, February 2013
  - Reef 27: November 2012, February 2013
  - Reef 28: December 2012, March 2013
  - Reef 29: October 2012, January 2013

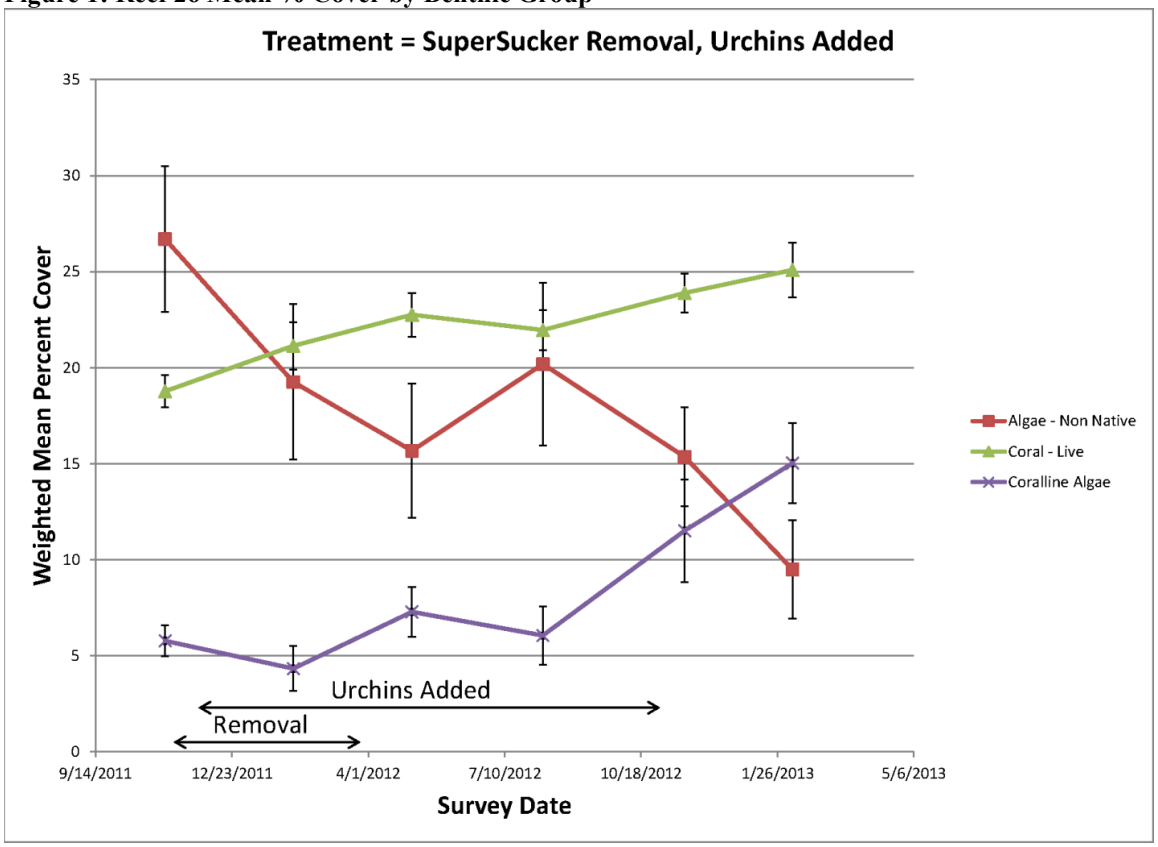
  Random Benthic Quads:
  - Reef 16: December 2012
  - Reef 26: February 2013
  - Reef 27: February 2013
  - Reef 28: December 2012
  - Reef 29: January 2013

  Urchin Population Assessment:
  - Reef 26: January 2013, March 2013
  - Reef 27: January 2013, March 2013

Monitoring Preliminary Analysis

Reef 26 was the first patch reef removed and fully stocked with hatchery raised urchins. Since this is the longest dataset we have so far for this project, the figures that follow are from Reef 26 only. Similar results are being seen on Reef 27 which is also now fully stocked.

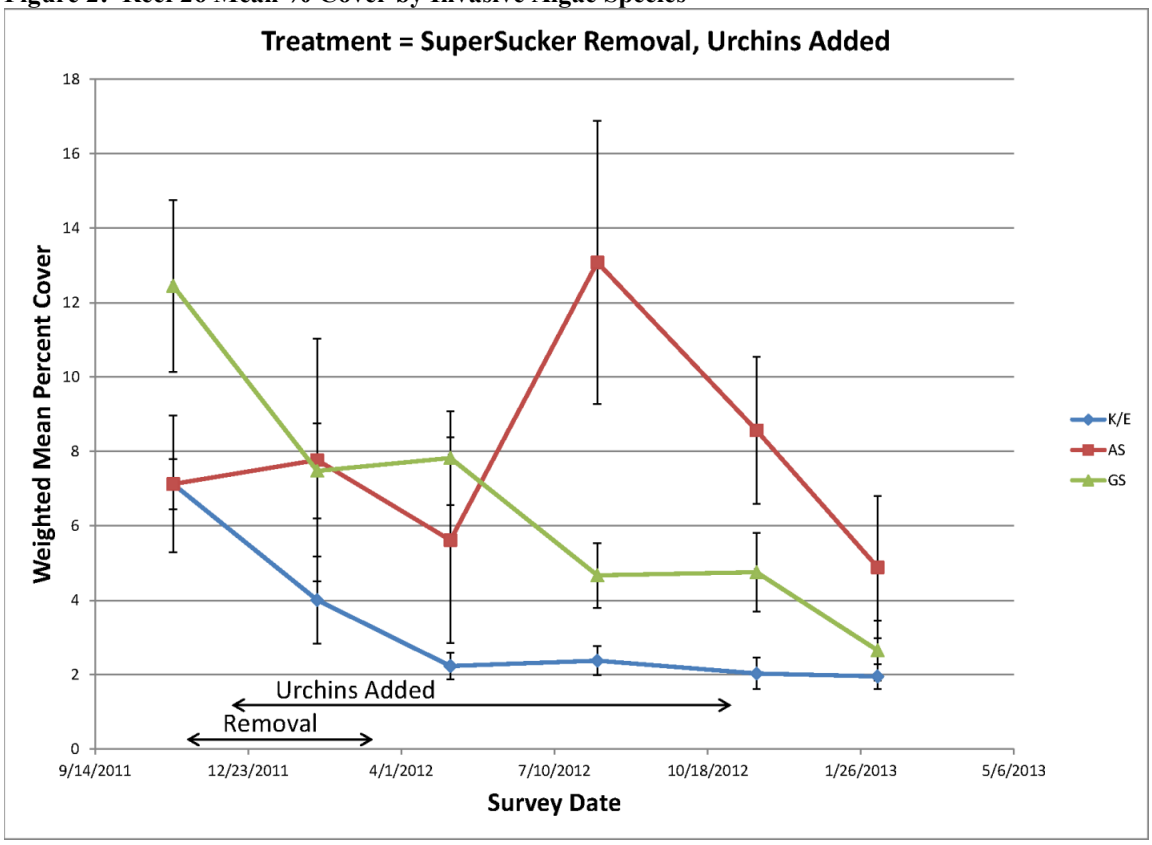
Figure 1: Reef 26 Mean % Cover by Benthic Group



Mean % cover of non-native invasive algae on the reef has decreased by 67% from baseline levels.

Mean % cover of live coral has increased by 34%. Since this data was collected on fixed transects over a short time period, new coral recruitment is unlikely. We are now seeing more coral because it was previously covered by invasive algae. This coral was saved by removing the non-native algae.
Mean % cover of coralline algae has increased by 160%. Coral larvae settle on crustose coralline algae. By reducing the amount of invasive algae we have exposed a much larger area of suitable settlement habitat for new coral recruits.

Figure 2: Reef 26 Mean % Cover by Invasive Algae Species



All non-native invasive algae species found on Reef 26 were reduced substantially by management efforts. K/E (*Kappaphycus*/*Eucheuma* spp. complex) was reduced by 73%, GS (*Gracilaria salicornia*) was reduced by 79% and AS (*Acanthophora spicificera*) was reduced by 31% from baseline levels.

The spike in AS is consistent with data collected on other reefs (accounts for the spike in Fig.1) in Kaneohe Bay. It appears that this species bloomed in this area of the bay during the summer of 2012. The area where AS grows on Reef 26 was also the last area to be stocked with urchins. Urchins will eat AS and we expect to see further reduction in the percent cover of this species over time.

K/E and GS are now below our target threshold of 3%.

Outreach

October: DAR had an outreach booth at the Seafood and Fishing Festival held at Pier 38, where the AIS team displayed outreach material about the invasive algae problem and methods used to control its spread.

DAR's Kaneohe Bay Monitoring Coordinator gave a presentation at the Hawaii Pacific University to a group of 40 students taking the MARS 2062: Marine Biology Lecture course. This course gave basic background knowledge of marine biology to include: biology, diversity, distribution, interactions, etc. The presentation gave the students a more in-depth knowledge of how alien invasive algae can be harmful to coral reef ecosystems and how DAR is using the Super Sucker and native sea urchins to control its spread.

The Nature Conservancy hosted their first community invasive algae pull. With the help of the AIS team, Paepae o He'eia's team, and about 150 volunteers, 40,000 pounds of algae was removed from inside and outside the fishpond. The alga removed was taken to Kako'o 'Oiwi wetland where it will be turned for

compost. The event was such a hit that local television stations turned out to get a story on what was happening.

November: AIS Program Leader presented at the Ocean Awareness Training event held at the NOAA Sanctuary office in Hawaii Kai. Information about all aquatic invasive species was touched upon, to include: invasive algae, sea urchins for biocontrol, invasive invertebrates (upside down jellyfish, zebra mussels, Mycale), marine debris, and invasive fish (roi, tilapia).

AIS Outreach technician gave a presentation at the University of Hawaii, Manoa to a group of 40 students taking an advanced marine biology lecture course. This course gave basic background knowledge of marine biology to include: biology, diversity, distribution, interactions, etc. The presentation gave the students more in-depth knowledge of how alien invasive algae can be harmful to coral reef ecosystems and how DAR is using the Super Sucker and native sea urchins to control its spread. In addition to the presentation, juvenile urchins were brought as display.

December: AIS Program Leader gave an invasive species presentation at the Eyes of the Reef training seminar. Hosted by Greta Aeby and with about 30 people present, he addressed the major species of interest, their impacts, and how to identify each species.

AIS Outreach technician participated in the release of juvenile urchins in the MPA of the Waikiki Aquarium. Hale Kula Elementary fed and maintained the health of the urchins until they were of appropriate size. 4 teachers/staff members from the Hale Kula released the 9 urchins.

January: Members of the AIS team participated in the Legislature briefing hosted by Senator Mike Gabbard and Russell Ruderman from the Committee on Energy and Environment. The briefing targeted the successes and challenges of protecting Hawaii from invasive species. AIS Program Leader presented the AIS Super Sucker and the Sea Urchin Hatchery project goals and operations. Senator Gabbard vowed to give his continued support for the environment, specifically invasive species. Juvenile sea urchins were brought as display.

February: Members from the AIS team helped coordinate an invasive algae pull at The Kainalu, a condominium complex in Waikiki. The facility manager contacted the AIS team in hopes of helping the residents clean their private beach. They removed invasive algae with 12 residents and helped them identify species, both native and invasive. The Kainalu residents plan to continue algae pulls on their own in the future.

March: AIS Outreach technician gave a presentation to an 8th grade class at Punahou School about invasive algae and what the State is doing to control its spread. After the presentation the students were able to look at tanks of invasive algae and sea urchins. The school group is scheduled to participate in an algae pull on April 18th, 2013.

AIS Outreach technician gave a presentation at Ben Parker Elementary and Kapunahala Elementary in partnership with The Nature Conservancy. After a brief presentation, the students, grades 4th-6th, got a hands-on look at invasive and native algae. About 300 students were reached.

The AIS team hosted a community algae pull at the Waikalua Loko Fishpond in support of HISC's Hawaii Invasive Species Awareness Week. 47 volunteers participated and over 6,000 pounds of invasive algae and 1,700 pounds of invasive mangrove seedlings were removed from the pond. The Star Advertiser and KITV were there to get the story which aired that evening. The Nature Conservancy partnered with the event.

Members of the AIS team participated at "Science Alive", an event hosted by Bishop Museum. 3,762 visitors attended the event. The event hosted 35 community partners from science organizations statewide. The Super Sucker program and the Urchin Hatchery had a display equipped with information board, Super Sucker video, live urchin tank, and invasive algae touch tank. Volunteer sign-up sheet captured 10 new contacts.

AIS Research Associate participated at the KEY projects community open house. She was able to share information about the Super Sucker project to community members, largely from the Kaneohe Bay area.

Obstacles and/or Delays

Hatchery; The air conditioning unit in the algae room was replaced on October 12th. Temperature in the algae room had been climbing steadily since mid-July and coincided with poor algae production. It is likely that this was a contributing factor to sub-par larval settlement for the August 6th and September 10th spawns. As soon as the new AC unit was installed and proper temperature restored (22C), phytoplankton quality and production increased dramatically.

Construction and renovations began for the expansion of the phytoplankton room in November and continued through March. Larval rearing & phytoplankton culture was suspended during January, February, and March.

Nursery: While biofilm development was normal at the time of settlement, biofilm communities diminished during the addition of larvae in December. It is believed that whatever caused the biofilms to crash also prevented the larvae from settling. High winds at the time may have kicked up pollutants from the greenhouse, the harbor, or the Coast Guard Station and caused the system to be affected. Measures have been taken to mitigate this in the future.

Monitoring: Holidays, weather and permanent transect pins missing/tampered. Required time and maintenance to repair missing/damaged permanent transect pins.

Adaptive Management

While full scale removal of algae was completed on Reef 29, no urchins have been outplanted to this reef as of yet. It was necessary to fully stock Reefs 26/27 to the target density of $2/m^2$ and due to some natural mortality, this required supplemental urchins to maintain the density near the $2/m^2$. There would not have been enough urchins to fully stock Reef 29 and therefore because of the size of this reef, it would not have been efficient to stock at a lower density.

Therefore, we have partnered with a graduate student from Hawaii Pacific University and The Nature Conservancy to conduct smaller cage trials on Reef 29 to answer questions about the optimal stocking density, outplant size differences, and coral recruitment. The cage trials will continue through November of this year and analysis of the results will help to properly stock this reef with the correct density of urchins. Using this data, Reef 29 will be cleared of algae again beginning in September and at that time urchins will be added.