Title: Aquatic Invasive Species Program
Organization: Division of Aquatic Resources
Working Group: Established Pests

Aquatic Invasive Species Program

The Division of Aquatic Resources (DAR), Aquatic Invasive Species (AIS) program worked to detect, prevent, and control the spread of alien invasive algae throughout the Main Hawaiian Islands. Energy was mainly focused in Kaneohe Bay, Oahu, as this has been determined to be an area with the most likelihood of success. The AIS program strived to maintain positive working relationships with other governmental, private, non-profit, and university members in order to help each other work towards a common goal of reef restoration.

FY11 Proposed Activities and Measures of Success

1. **Use of mechanical removal suction devices ("Super Sucker") in conjunction with sea urchin bio-control experiments in an effort to control alien algae on coral reefs in Kaneohe Bay.**

Reef 16

In August of 2010, adult urchins that had been on Reef 16 for one year were relocated from the Windward half of the reef to the Leeward half. The previous year's study determined that with prior mechanical removal of algae by the Super Sucker, the urchins were able to maintain the algae at approximately 3%, where the non-urchin side re-grew to almost 35%. The urchins were relocated to the Leeward half to test whether or not they would be able to control the growth of algae without the assistance of prior mechanical removal.

The AIS team determined that the urchins were able to reduce the biomass of algae significantly; however, due to a large loss of the population to predation and other unknown reasons, the results were not as significant as the previous year.

Reef 15

Reef 15 has never been fully cleared of algae and surveys have shown consistent heavy coverage of *Kappaphycus/Eucheuma* sp. This made the reef suitable as an experimental site for our captive raised urchins from the Anuenue Fisheries Research Center sea urchin hatchery.

Fig. 1: Release of juvenile urchins.

- In January 2011, with help from the Kaneohe Bay Canoe Club, the AIS team released 1130 juvenile *Tripneuestes gratilla* sea urchins (Fig.1), ranging in size from 20-40mm, onto Reef 15. Since the initial release, another 3000 juvenile urchins have been transplanted from the hatchery to Reef 15.
- At the start of February the average benthic coverage of *Kappaphycus/Eucheuma sp.* was over 28%. In the months since, the algal coverage decreased to 10% as more urchins were added. With the abundance of available food, the juvenile urchins grew as large as 115mm by July.

- Efforts to count and survey the mortality of urchins is difficult because of the abundance of hiding spots on a highly rugose reef. In June 2011, the AIS team counted only 877 urchins and found only 18 tests as evidence of direct predation on the juveniles. Human collection is also a concern.

He'eia Fringing Reef

Although the AIS team faced many setbacks due to personnel changes and many instances of equipment failure; over 2,700 man hours, (equaling 5 ½ months of in-water removal time by a team of four) was spent on mechanical removal of the alien invasive algae *Kappaphycus*. Removal was conducted on the fringing reef outside He'eia Fishpond. This species of *Kappaphycus* is only located in select regions of Kaneohe Bay and is believed to be a slower growing species. The AIS team set out to remove as much as possible and monitor its re-growth.

Even though the AIS team was only able to access a small portion of the fringing reef; from July 2010 to June 2011, approximately 99,660 pounds of *Kappaphycus* algae were removed from this area. This large amount of algae was given to local farmers in the Kaneohe Bay area to be used as compost and fertilizer for their taro, sweet potato, corn, and flowering plant crops. The alga is high in nutrients and farmers say their crops are growing better than ever.

2. Implementation of sea urchin culture at Anuenue Fisheries Research Center (AFRC) for use as bio-control agents.

FY 2011 saw the first full year of production in the DAR sea urchin hatchery. Hatchery methods and techniques continue to evolve and improve with each larval run. Among the major production accomplishments of the year were:

- 15 induced spawning events yielding 20 larval populations.
- A system of metrics was developed to determine larval competency for settlement.
- 12 of the 20 larval runs were successfully reared to metamorphosis.
- A total of 372,000 *Tripneustes gratilla* larvae were reared to metamorphosis.
- During movement from the larval hatchery to the urchin nursery, the population sizes ranged from 2700 – 81,000 individuals per tank (Fig.2).
- 4023 hatchery raised sea urchins were successfully raised to a transplantable size and released during FY11.

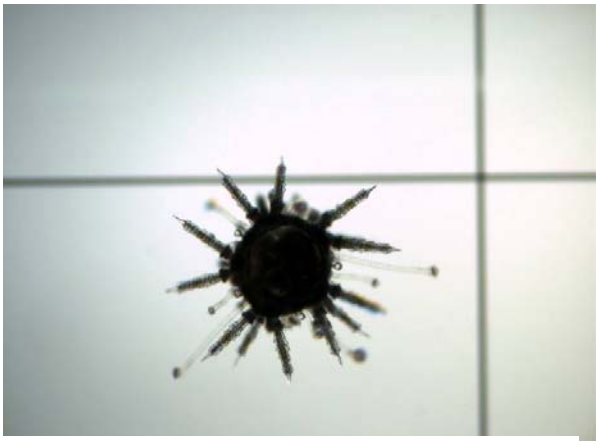

Fig.2. Newly settled urchin larvae 34 days old.

Significant bottlenecks were identified in the post-settlement nursery phase of sea urchin production. Mortalities are believed to be a result of overcrowding and insufficient water flow. New nursery systems were designed to facilitate increased water flow and to spread out young sea urchins during this critical four month period. The first juvenile urchins reared in this modified system are ready for outplanting.

During FY10 the old microalgae lab was renovated and repurposed to accommodate the planktonic species appropriate for larval urchin culture. In FY11 further renovations were made with the addition of new culture vessels and a carbon dioxide infusion system. These improvements have increased food quality and quantity, as well as overall system reliability.
A reservoir was added to the hatchery water supply system to aerate and raise the pH of incoming seawater. The reservoir also serves as a settling tank reducing stress on hatchery filter system.

Fig.3. Upgrades made to microalgae lab.

3. Continue AIST surveys and mapping for alien species.

Approximately 100 algae/benthic distribution maps were generated in FY11 by the AIS Team and approximately 15 sites were surveyed for the first time or resurveyed.

Comprehensive Patch Reef Mapping Interpolations, Kaneohe Bay, Oahu:

All the invasive algal distribution data conducted by the AIS team for the 54 Patch Reefs in Kaneohe Bay from 2007 to 2010 was interpolated for each reef and then compiled into a cumulative document. The values from interpolation were then converted into square meters of coverage for each reef per density. Based on average weights by species per density, a table was created to display the square meter coverage and estimated mass of invasive algae on each reef. This cumulative interpolation report and table were used by DAR to create a reference to calculate mitigation crediting for "in lieu fee" type of restoration efforts

Marker 12 Fringe Reef, Kaneohe Bay:

Conducted algae surveys with snorkel and GPS and mapped distribution of *Kappaphycus/Eucheuma, Gracilaria salicornia, Acanthophora spicifera* and other invasive algae on Marker 12 Fringe Reef (Fig.4) in order to obtain 2010 coverage values as a reference for a rate of spread from earlier surveys conducted in 2007 and 2009. These "rate of spread values" were used as a reference for the possible spread of invasive algae at damaged/impacted sites such as hull groundings, and to calculate mitigation crediting for "in lieu fee" type of restoration efforts.

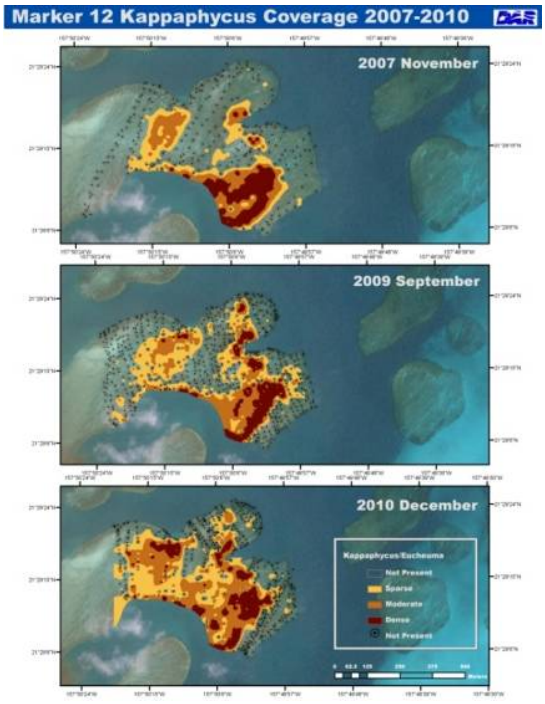

Fig.4. Spread rate of invasive algae on Marker 12 fringe reef.

Patch Reefs 26, 27, and 29 in Kaneohe Bay, Oahu

The AIS team conducted algae surveys with snorkel and GPS to map the distribution of *Kappaphycus/Eucheuma, Gracilaria salicornia, Acanthophora spicifera,* and other native and invasive algae on patch reefs 26, 27, and 29 in order to obtain 2011 coverage as baseline for future removal.

Ma'alaea Bay, Maui:
Conducted snorkel/jet-ski tow surveys with GPS and mapped distribution of live coral and invasive with a primary focus on *Hypnea musciformis* and *Ulva reticulata* (native) (Fig.5). These surveys were aimed at creating baseline algae distribution data in order to protect coral colonies that are currently impacted by invasive algae.

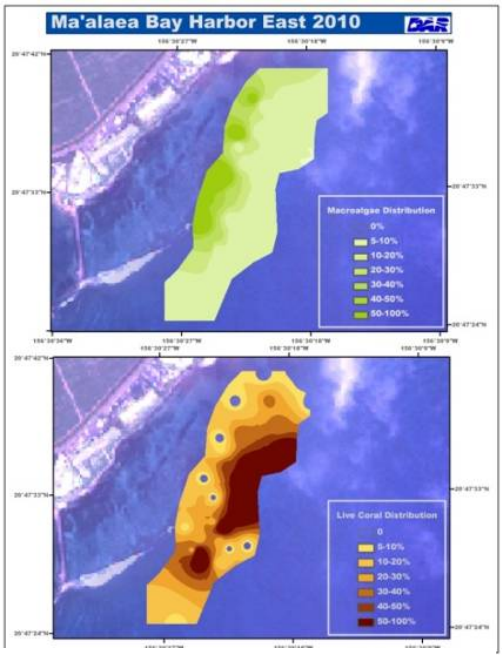

Fig.5. Mapping of invasive algae in Ma'alaea Bay, Maui

4. Partnership with UH researchers to examine role of increased nutrients into Kaneohe Bay.
Assisted University of Hawai'i researchers to conduct nutrient and water chemistry sampling in Kaneohe Bay to determine if land based nutrient input plays a factor on invasive algae growth and how it may vary in different sections of the bay. Sampled four fringe reefs and five patch reefs in different sections of Kaneohe Bay for macro-algae tissue samples and distribution, bottom type, water depth, salinity, temperature, dissolved oxygen, total suspended solids, dissolved nutrients, ambient light, chl-a, and pH.

5. Continue participation in recreational/commercial hull inspections & ballast water program which acts to help prevent movement of potential AIS.
Hull inspections are jointly carried out by DAR and the Papahānaumokuākea Marine National Monument. Since the departure of the Ballast Water and Hull Fouling Coordinator, the Monument has conducted many of the inspections with assistance from the AIS Team. The AIS Team also receives notification from the U.S. Coast Guard (USCG) when they inspect a vessel and observe heavy fouling. Upon notification from the USCG, the AIS Team will further inspect the vessel and obtain samples of the fouling to determine if alien invasive species are present. During FY11, no alien species were detected on any heavily fouled vessels.

6. Increase public awareness of AIS issues.
The AIS team has taken extensive measures to educate the public about the threats alien invasive algae can play on the reefs and fisheries of our local waters.

- The juvenile urchins have been a gateway for the community to get involved with the AIS team and work in Kaneohe Bay. The Kaneohe Canoe Club collaborated with the team to release juvenile urchins in January. In the following months, members from the canoe club have returned to the reef to check on urchin growth and see the changes they have made on the reef. Being that the canoe club is in the bay on a daily basis, this will help to create a greater sense of stewardship towards the reefs in Kaneohe Bay.
- A lecture was given to a University of Hawaii environmental class to teach the students about the threats of aquatic invasive species and how DAR is working to control the issues. Majority of the class deals with terrestrial issues, so the students expressed that it was good to hear about what problems are taking place on the marine side and what is being done to control and prevent their spread.
- A Facebook page, "Hawaii Super Sucker" has been created so that the public can stay up to date on the progress the Super Sucker has made in the fight against invasive algae.

- "Stop Aquatic Hitchhiker" signs (Fig.6), (FY10 funding), were mounted at all harbors where there is an increased chance of invasives to be spread. These signs help to remind boaters to rinse their boats, anchors, gear, etc before leaving the harbor to reduce the spread of invasives to other watersheds.
- "Stop the Invasion" brochures were made and distributed to dive shops across Oahu to get out further information about the problems of spreading alien invasive algae.

Fig. 6: Signs posted at harbors rinse stations

Fig.7: AIS team member with Super Sucker display board.

- The AIS team helped to foster community stewardship by participating in Alien Algae Cleanups in Waikiki (Fig.7). In events sponsored by University of Hawaii Manoa, team members, students, and public volunteers worked to manually remove over 1,000 lbs of Gorilla Ogo from the reef off the Waikiki aquarium. DAR also worked in conjunction with SeaGrant and UH to educate the community about the need for the event and the threat that invasive algae poses to the reefs.

Other activities:
Additional activities also helped achieve HISC objectives

Capacity development: Staff capacity was enhanced by planning and implementing the following training events: the AIS Program Leader was certified as a Nitrox Instructor to allow in-house certifications and dive approvals of future divers; diving skills for the team were refreshed and updated with drift dives in Maunalua Bay, training rescue dives outside the shipping and Sampan Channels in Kaneohe Bay, and deep dives and tech dives including navigation and lift bag exercises in Waianae. The team also took the PADI O_2 Provider, PADI Enriched Air course, Emergency First Response and CPR with Primary and Secondary Care with AED with Child and Infant Care.

Infrastructure improvements: Infrastructure improvements included the refurbishing and redesign of the main pump used on Super Sucker; replaced old and rotten deck on 18' Whaler used to conduct algae surveys; upgrades to the microalgae culture room; and the fabrication of new sea urchin mobile nursery tanks.

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