



Aquatic Invasive Species (AIS) Highlights:

During FY2010, the AIS Team focused on surveying, detecting, and controlling invasive marine algae, fostering community involvement, and building the knowledge and capacity needed to implement large scale restoration. Early detection surveys were conducted on both Molokai and Oahu to establish the limits of spreading invasive algae. Algae cleanups were coordinated on both Molokai and Oahu with several community groups. Control work in Kaneohe Bay on Oahu using the supersucker was ongoing throughout the year. The priority focus for the year was the replenishment of native grazing sea urchins as a natural biocontrol for invasive algae. DAR has developed and implemented a pilot project for this replenishment on a patch reef in Kaneohe Bay. The results for FY2010 indicate that the replenishment of native grazers is a highly successful tool in the fight against invasive algae. The next stage of the project is captive culture of the urchins in order to provide a sufficient number to restore impacted coral reefs in Kaneohe Bay. When sufficient capacity is achieved, the project is anticipated to expand to other areas of the Bay and possibly other sites throughout the state.

HISC Response and Control: Measures of Effectiveness

Number of Species Detected and Evaluated for Feasibility of Eradication

Early detection of invasive species included extended surveys of the coast of Oahu and Molokai to identify the spreading distribution of established invasive algae. These surveys included a repeat of surveys conducted in 2007 as well as additional surveys of expanded edge zones. On Molokai, the survey indicated that the range of the invasive alga *Gracilaria salicornia* has extended westward four miles past its previously determined boundary.

Number and Area of Priority Invasive Species Eradicated and/or Controlled

Control efforts focused on mangrove, jellyfish, and several species of invasive algae.

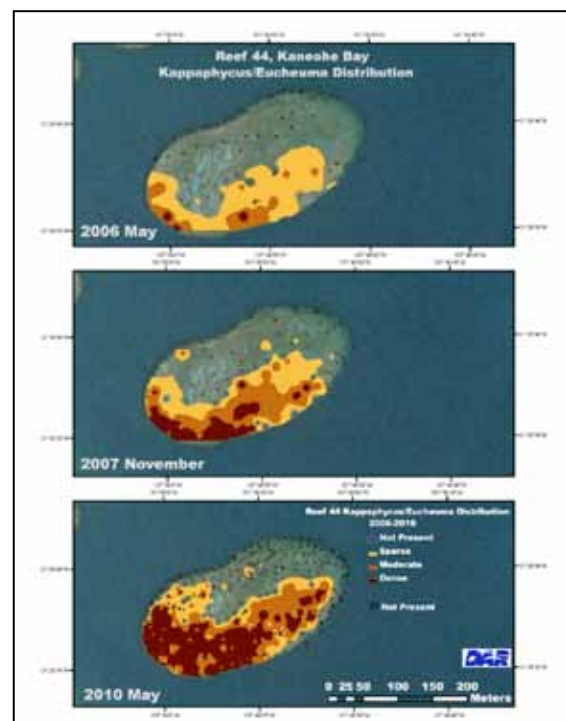
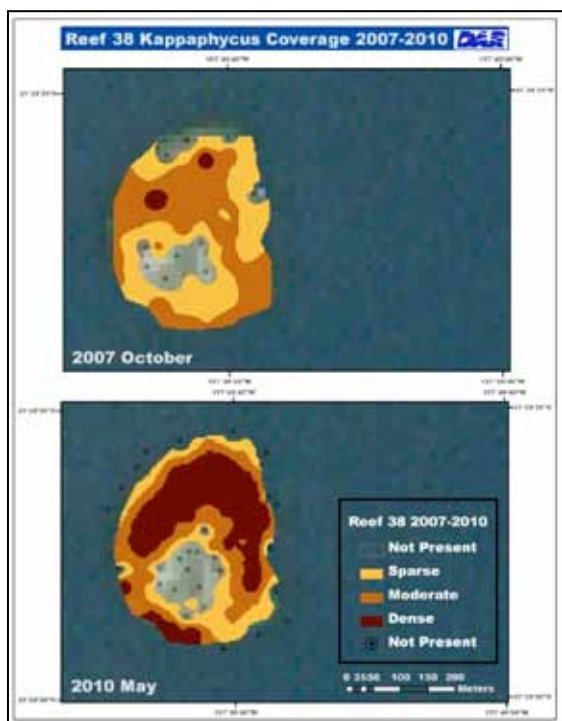
- On Molokai, the AIS team worked with community volunteers to remove over 1,000 red mangrove propagules and over 44,000 pounds of invasive algae
- In Kaneohe Bay, the team removed over 30,000 pounds of invasive algae.
- On Kaneohe Bay reef #16, which serves as the pilot project for the restoration of native grazing sea urchins, the team monitored the urchins and charted their efficacy at controlling the invasive algae on the reef.

Implementation of the Priority Actions of Aquatic Invasive Species Plan

- **Early Detection and Monitoring Surveys**

The AIS Team continued early detection surveys for invasive algae along the windward coast of Oahu above Kaneohe Bay (ground zero for *Kappaphycus*/*Eucheuma*). Four miles of fringe reef areas outside of Punalu'u and north to Lai'e Point were surveyed by snorkelers with GPS units and algae distribution was mapped. Seven incidences of *Kappaphycus* were observed on the fringing reef outside of Punalu'u. Two of these samples were sent to the University of Hawaii's Phycology Lab, and were identified as *Kappaphycus* Clade B.

To provide the information required for informed prioritization of control actions, the team resurveyed Kaneohe Bay reefs #33,34,38 and 44. The results of the surveys indicated that invasive algae have increased in both coverage area and in density.



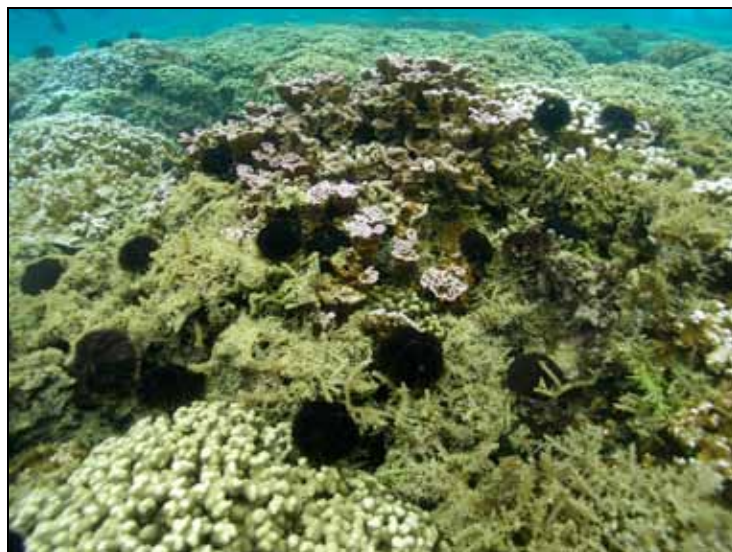
To determine the spreading distribution of *Gracilaria salicornia* on Molokai, the AIS Team surveyed the coastline and discovered that the algae had spread to an area four miles west of the previously determined boundary.



Circled areas represent *G. salicornia* populations.

- **Develop a comprehensive approach to controlling invasive algae by utilizing mechanical removal and the reintroduction of native species**

In accordance with the State's AIS Management Plan, DAR has continued to develop a program to reintroduce the native sea urchin *Tripneustes gratila* to Kaneohe Bay as a biocontrol for invasive algae. This ongoing venture began in 2009 with a pilot project to determine the efficacy of the urchins as algae control, and has grown to incorporate the development of a full time urchin culturing facility. Additional detail about the pilot project and hatchery is discussed later in this report.



Prioritization Process

Criteria for prioritizing target species of invasive algae include:

- The current level of threat posed to high value coral reefs and the potential for recovery of those reefs.
- The geographic distribution and possibility for containment (*Kappaphycus/Eucheuma* sp in Kaneohe Bay).

Priority and target location are chosen by:

- Feasibility of accessing and working in the affected habitat. The AIS Team can work in any areas that can be safely accessed on foot, snorkel, and SCUBA. The three mechanical vacuuming barges (super suckers senior, junior, and manini) make it feasible to work in a variety of habitats from fish ponds to open water.
- Anticipated successful outcome. DAR has prioritized urchin replenishment in Kaneohe Bay because it is expected to reduce the need for manual removal of invasive algae, and is also anticipated to be applicable to other areas in the state that are suffering from an overgrowth of invasive algae.
- Public interest, community involvement, and available partnerships. A longstanding partnership with The Nature Conservancy (TNC) has resulted in the prioritization of the area surrounding the He'eia Fishpond on Oahu, where TNC has an ongoing project of upland restoration and where strong community support has sustained regular public algae cleanups both inside and outside the fishpond wall. Community interest and concern was integral to the success of invasive plant control on Molokai. By prioritizing areas that have strong public involvement, DAR is able to supplement team efforts with community support and ensure that control actions will continue after the AIS Team as concluded their work in the area.

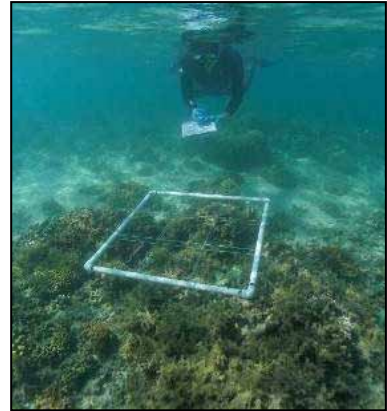
Number and Names of Habitats, Ecosystems, and Managed Areas Protected Because of Control Efforts

- Kaneohe Bay has a variety of habitats that are benefiting from AIS Team control work. The many coral reefs that exist in patches of the bay are being monitored and prioritized for work. He'eia Fishpond and its surrounding fringe habitat have also received regular attention.
- Monitoring also includes the area north of Kaneohe Bay and the z-modules off of Waianae, on Oahu.
- Molokai received significant control efforts focused on Kaunakakai Harbor, Kalokoeli Fishpond, and Ualapue Fishpond.

Other Activities

Urchins used as Bio-Control for Hawaii Institute of Marine Biology, UH (HIMB) projects:

The AIS Team collected and facilitated deployment of collector urchins for an HIMB project designed to protect a rare and endangered species of coral in Kaneohe Bay. Due to the effectiveness of collector urchins as biocontrol agents, the AIS Team was requested to provide urchins to graze down on a *Montipora dilatata* coral colony being over taken by the kappaphycus/ eucheuma species complex. Approximately 300 urchins were collected and distributed on the reef by AIS Team members and HIMB Marine Biology undergraduates. The students will further monitor the reef and urchins and analyze data on the effectiveness of the biocontrol method.



Presentations and Demonstrations:



The AIS Team conducted presentations and demonstrations throughout the year in order to educate, gain feedback and insight from vested counterparts of the community, and to demonstrate the capabilities of the Super Sucker Barge. These events included facilitating an Urchin Workshop at HIMB, presentations at Hawaii Conservation Conference and Kaneohe Bay Civic Club, and Super Sucker Barge demonstrations for the

National Oceanic and Atmospheric Administration (NOAA) congressional representatives, Local Action Strategy (LAS) coordinators, and potential funders for TNC. Public relation activities included providing information about invasive algae removal for an article in Honolulu Star Bulletin, a short segment for KITV Channel 4 News, interview on The Mike Buck Show, and an extensive photo-story for the local fishing magazine Lawai'a. DAR also participated in public workshops for the "Eyes on the Reef" monitoring group.

Public Outreach:

The AIS Team participated in public outreach activities in many locations on both Oahu and Molokai. The Team travelled to Molokai several times to work with community and school groups, providing information and assistance regarding invasive algae control in the harbor and fishponds. On Oahu, the AIS Team consulted for invasive algae issues in Moli'i Pond at Kualoa

Ranch and provided trucks and ground support at algae removal events in Hee'ia Fishpond that included high-school students from Kamehameha Schools. New partnerships were formed with local farmers for additional algae drops sites for compost production. These sites included 400 acres of wetland being converted to lohi (taro) patches directly behind He'eia Fishpond in the same watershed. This partnership contributes to the rehabilitation of the traditional Hawaiian ahupua'a by connecting the coastline and fringe reef to farmland and mountain watershed.

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Super Sucker Algae Removal:

In an effort to eradicate one of the two clades of *Kappaphycus* in Kaneohe Bay and contribute algae to He'eia ahupua'a and Waihole watersheds for compost, the AIS Team concentrated their removal efforts on the fringe reef outside Hee'ia Fishpond. More than 28,500 lbs of *Kappaphycus* Clade B were removed and delivered to farms during 2010. This area is one of the only two areas thought to sustain Clade B, the other being Coconut Island, Oahu. The removal effort will continue until the entire fringe reef has been cleared.



Super Sucker Improvements:

The AIS Team recently added two outboard engines to the Super Sucker barge that allows it to be more efficient and mobile throughout Kaneohe Bay independently. Prior to this, it was necessary for the barge to be towed by a secondary vessel, which decreased its maneuverability and increased the demand for staff due to safety issues. Speed rails were added around the perimeter of the barge as well to increase safety and prevent staff from falling overboard.



Molokai:

The AIS Team held community cleanup events at Kaunakakai Harbor, Kalokoeli Fishpond, and Ualapue Fishpond. The events focused on invasive algae removal, but also provided control of Cassiopeia jellyfish and Red Mangrove seedlings. The Team worked with volunteers, school groups, and stewardship organizations. On April 16th the AIS Team participated in Molokai's Earth Day Event.



Utilizing Native Grazers for Invasive Algae Control

Objective 4D of the State of Hawaii AIS Management Plan is to “*continue to develop and implement a comprehensive approach to remove and control the spread of non-native algae AIS by utilizing mechanical removal, native grazers, and the reintroduction of native species*”. In 2009 DAR initiated a project to use the native sea urchin *Tripneustes gratila* as a biocontrol for invasive algae in Kaneohe Bay. This broad scale project has required several complex stages to achieve success. The pilot project on patch reef #16 required an initial translocation of urchins from another site and follow-up monitoring of both the donor and recipient sites. The pilot project has thus far been successful, and further implementation requires a reliable source of cultured urchins. To that end, DAR has planned and built an urchin hatchery at the Anuenue Fisheries Research Center, on Oahu. The landscape scale implementation of urchin replenishment in Kaneohe Bay will require many years of continued effort.

Translocation of *Tripneustes gratila* to Kaneohe Bay

While the native sea urchin *Tripneustes gratilla* is found within Kaneohe Bay, their numbers are not at the levels necessary to be utilized in our pilot study as a bio-control agent against invasive algae. Therefore, the AIS Team collected urchins from the artificial Z-blocks located off the Waianae Coast. The Z-blocks provide a healthy habitat for new corals, fish, and urchins.

- The AIS Team conducted a baseline survey of the area to determine the population density and average size of urchins. It was necessary to collect approximately 1300 urchins for the pilot study, which would place nearly one urchin per square meter.
- Two areas were established to prevent the over-collection from one area. Within those two areas, take and control sections were created, in addition to a reef section to monitor urchin populations adjacent to the z-blocks.
- Following the removal of 1315 urchins, the AIS Team returned to Waianae monthly to monitor the urchin's recovery to the area. The urchin's were counted and measured according to size: 0-5, 6-10, and 11-15cm. There was a steady increase in the numbers of urchins every month, with over 90% being in the 6-10cm size class. Within one year, their numbers were back to baseline levels.

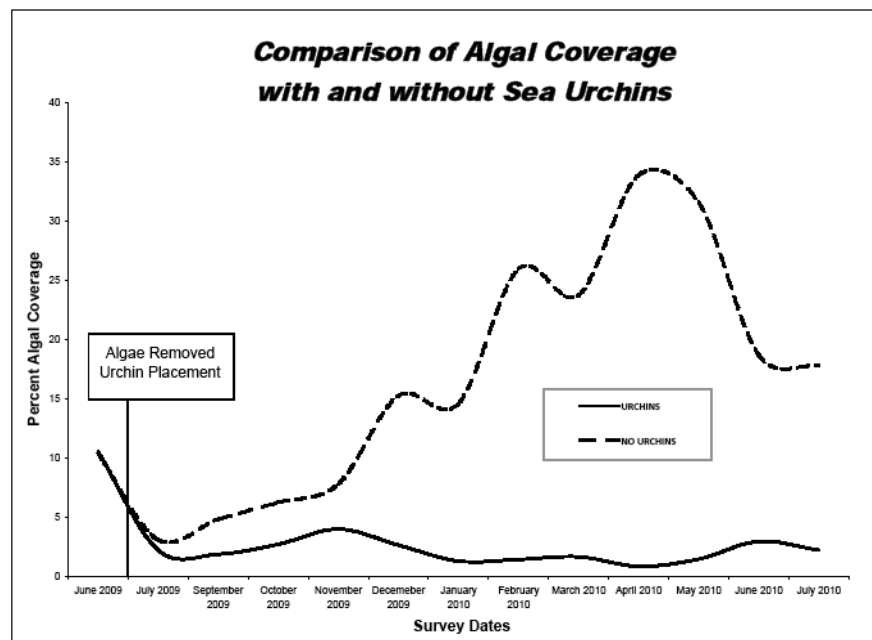


Reef 16 Pilot Study

In 2010, the AIS Team completed the first phase of a two year long benthic and fish monitoring project on the Kaneohe Bay Reef 16 Pilot Study. The Super Sucker Barge was used to remove invasive algae from a small patch reef once in 2008, and again in 2009. After monitoring results confirmed mechanical removal provided only temporary reduction in algae, the removal effort in 2009 was supplemented with the transplantation of 1200 collector urchins (*Tripneustes gratilla*) onto one-half of the reef in order to conduct a



bio-control agent experiment post mechanical removal. After one year, the AIS Teams benthic monitoring effort verified that use of native herbivores as a bio-control method was successful and feasible. The data collected demonstrated that the reef half that was stocked with urchins yielded less than 5% benthic algal coverage for 12 consecutive months. In comparison, the reef half that was not stocked with urchins and left as a control, yielded rates of between 15%-34% of benthic algal coverage over the 12 months. The 2nd phase of the project was initiated in July 2010 by transplanting the urchins to the control side of the reef in order to observe the impact of the native herbivores without the aid of mechanical removal. This phase will continue for 12 months in order to measure the effects of using bio-control agents not supplemented by the efforts of the Super Sucker Barge. The Team also continues to analyze and process two years of data on fish abundance and coral regrowth coverage on Reef 16.



Developing Capacity for Restoration using Cultured Urchins

The success of the pilot project on reef 16 has highlighted a clear need for the availability additional urchins in order to expand the use of this biocontrol to other areas of the Bay. Kaneohe Bay is far too large to even consider stocking with translocated grazers. A steady supply of locally cultured urchins is critical to the implementation of continued algae control. To make these native grazers available in sufficient quantity, DAR initiated development of a sea urchin hatchery at the Anuenue Fisheries Research Center (AFRC) in Honolulu. The hatchery will culture *Tripneustes gratila*, the “collector urchin”, which has been researched, tested and found to be effective at controlling invasive algae. The hatchery is capable of yielding large quantities of sea urchins that will allow the AIS Team to utilize a combination of supersucker mechanical removal with the reintroduction of native grazers to finally realize long-term recovery of coral reefs that are infested with invasive algae.

In FY2010, the DAR Sea Urchin Hatchery was initiated and completed, and is currently housing the first successful yield of post larval animals.

- Two full time staff members, an aquaculture specialist and a hatchery technician, were hired to research, design and run a *Tripneustes gratilla* sea urchin rearing facility.
- The design of the hatchery was adapted from research and from knowledge of existing hatcheries in Japan and Australia.



- AIS Team researched, developed and tested larval rearing techniques that were adapted from standard hatchery methods with guidance from community members. Information was synthesized and then applied to develop a set husbandry techniques that were site appropriate for the facility.



- AIS Team developed a repeatable system for rearing urchin larvae: Techniques were applied to three different cohort groups with similar results. In all cases larvae survived to metamorphosis and settlement occurred. Juvenile urchins are presently growing at the AFRC Sea Urchin Hatchery.
- An older, insufficient microalgae lab was renovated and repurposed to accommodate the planktonic species appropriate for larval urchin culture.
- AIS Team developed appropriate macroalage production techniques to feed juvenile sea urchins: Commercial seaweed culture techniques were adapted to suit the available facilities. The procedures developed were used to grow species appropriate for feeding juvenile sea urchins.

The re-introduction of native urchins into Kaneohe Bay has the potential to dramatically improve the health of the bay by facilitating large scale control of invasive algae. Coupled with the reduction of land-based sources of habitat degradation, this project is poised on the verge of full implementation of landscape scale restoration for a complex marine ecosystem.

