HAWAII CORAL REEF INITIATIVE RESEARCH PROGRAM: WEST HAWAII PROJECTS

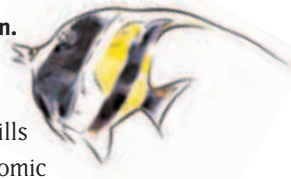
Fish Herding (Jan Dierking). *Some of the most skilled fishermen in Hawaii are those who harvest aquarium fish.*

Hawaii Coral Reef Initiative

RESEARCH PROGRAM: WEST HAWAII PROJECTS

Some of the most skilled fishermen in Hawaii are those who harvest aquarium fish among the finger coral of west Hawaii and elsewhere. These professionals must know where yellow tang and other decorative marine animals live, hide, and eat. They must have patience and skill to net live animals and safely transport them – a difficult and challenging feat. Finally, they must balance their financial needs with those of the resource, including respecting areas set aside for the growth and survival of targeted species.

Hawaii's aquarium fishery's gross annual sales are an estimated $3.2 million.



Hawaii's resource managers are aware of the skills demonstrated by aquarium fishermen, the economic importance of the fishery, and the critical importance of well-managed marine reserves for the resource's long-term survival. As illustrated through the West Hawaii Regional Fisheries Management Area, a successful reserve system

benefits the aquarium fishery and this, in turn, contributes to Hawaii's economy.

Economic Benefits

The aquarium fish industry provides one of the most economically valuable nearshore fisheries in Hawaii. A study by Dutch economists and funded by the Hawaii Coral Reef Initiative Research Program (HCRI-RP) estimates the industry's gross annual revenues to be $3.2 million for collecting and wholesale. Of this amount, 80% is generated from the west coast of the big island and 84% of that area's catch is yellow tang. If retail and equipment sales were included, this amount would substantially increase.

Monitoring Aquarium Fishes

The state legislature established the West Hawaii Regional Fisheries Management Area in 1999. In response, nine fisheries replenishment areas (FRAs) were designated. Prior to their closure to aquarium fish collection in 2000, HCRI-RP sponsored scientists from UH Hilo, Washington State University, and the state's Division of Aquatic Resources to establish study sites that included harvested, fisheries replenishment, and long-term protected areas.

Taking Action (Risa Minato). *The 19th Hawaii State Legislature passed Act 306 in 1999, establishing the West Hawaii Regional Fisheries Management Area.*

Not Just a Pretty Fish (Lisa Huynh). *Nearshore fisheries provide food fish for recreational and subsistence fishing. Food and aquarium fishermen target many of the same species, including achilles and clown tangs, koles, and manini.*

Scientists have identified positive effects emerging from the establishment of FRAs. Seven of the 10 most heavily harvested species are found in greater numbers where protective measures have been implemented, particularly yellow tang and black surgeonfish.

Seven of nine FRAs have increased aquarium fish populations.

In addition to overall increases in the populations of many species, seven of the nine FRAs have shown significant increases in yellow tangs. These increases are associated with wide reefs that have high densities of adult fish and high abundance of finger coral, an important habitat for juvenile yellow tangs.

The catch for fishermen targeting aquarium fish has also increased to levels not seen for a decade. Catch rates, both total and for the top two species (yellow tang and kole), are the highest on record and the wholesale price per yellow tang has increased 33%. FRA compliance has been favorable.

Yellow Tang

Initial studies provided information on population density. Other projects are beginning to answer questions on the move-

ment, reproduction, survival, and recruitment of this commercially valuable species.

Juvenile and medium-sized adult yellow tangs remain in specific home sites on a reef. HCRI-RP funded researchers from the Hawaii Cooperative Fishery Research Unit have found that over 90% of tagged individuals are in the same location three months later. Furthermore, molecular analyses by HCRI-RP sponsored scientists at Washington State University have found that populations on different reefs are more genetically distinct than previously thought.

Yellow tang can live over 20 years. HCRI-RP sponsored scientists from UH Manoa and the US National Park Service have found their larval stage lasts for about 50 days. This duration is longer for several other reef fishes, and may result in higher larval mortality rates. Once fish larvae change and settle onto a reef, their initial growth rates are fast, at just under one-half of a millimeter per day.

Other Fishes and Invertebrates

Stocks of manini, a popular food fish, may be declining. Unlike yellow tang, larvae of this fish change and settle in tidepools and shallow nearshore areas, making them more vulnerable to the effects of water pollution.

Fish Tagging (Sarah McTee). *Weekly monitoring indicates yellow tang of all sizes have strong fidelity to a home site.*

Fish Earbone Rings (David Shafer). *Otoliths are created by daily deposits of calcium carbonate in the inner ear of a fish. Like tree rings, they provide a growth record for the animal.*

An invasive sergeant fish apparently has displaced Hawaii's endemic species. The new species has a shorter larval duration (19 days) and higher larval survival rates, which may favor the invasive in competition with the native species.

Schindler's fishes, while very small, may comprise over 80% of total reef fish numbers. They grow quickly and reproduce at a few weeks old. Their large populations, short generation times, and fast growth rates suggest they may play an important role in the dynamics of nearshore ecosystems. That role, however, is still unknown.

HCRI-RP sponsored scientists from UH Manoa and the US National Park Service found invertebrate recruitment has so far been dominated by mollusks (80%), crustaceans (10%) and sea urchins (6%). Coral recruitment has been low, limited to the northern portion of the Kona coast, and occurred in the late summer months. There has been no observed recruitment of octopus, lobster, or opihi.

HCRI-RP scientists found no observed recruitment of octopus, lobster, or opihi.

Water Quality

Reef health is not only about fish. Other HCRI-RP sponsored researchers from

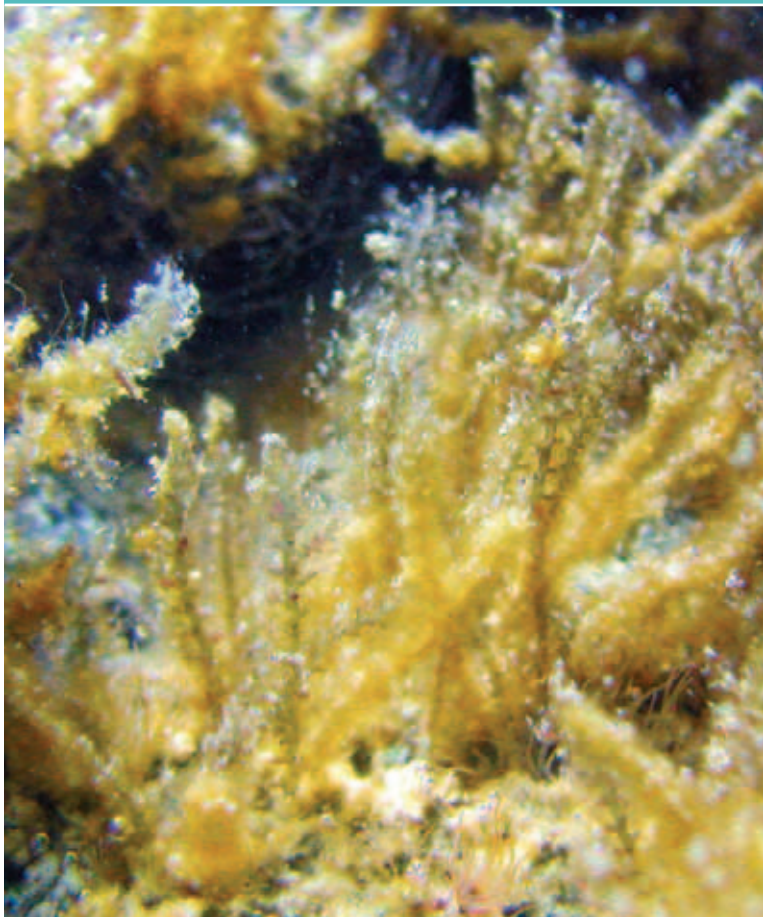
UH Hilo are studying nearshore water quality to determine if the amount of nitrates and nitrites from land-based sources has increased. Such an increase could stimulate algal growth, which without enough plant-eating fish, can lead to a shift in the ecosystem from high coral cover to algal domination. This, in turn, would reduce the number of fish recruiting to the area. Kealakekua Bay's nitrate-nitrite levels are 400% higher today than they were forty years ago. In Honokohau Bay, nutrients have increased 156% over the last thirty years.

Algae

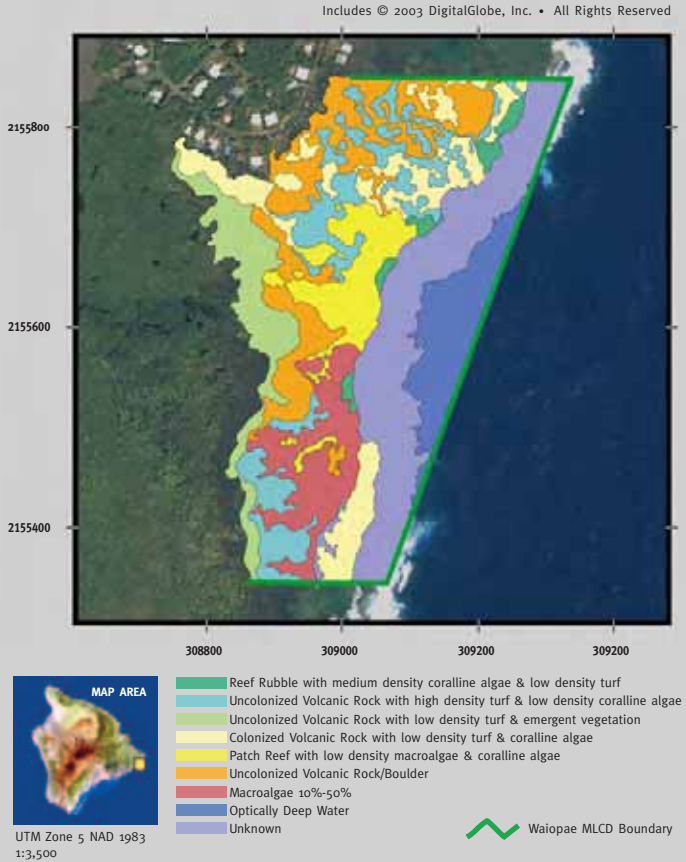
Although west Hawaii has abundant coral, algae covers much more area. Reef surveys found extensive coverage of leafy, coralline, and turf algae. HCRI-RP funded researchers from UH Manoa have described and documented a wide variety of algae growing in west Hawaii's nearshore areas.

While the presence of alien algae is localized, the threat is constant. *Acanthophora spicifera* is found at both Kawaihae and Kaloko. Other species potentially pose a greater threat to west Hawaii's reefs. *Gracilaria salicornia,* for instance, remains limited to the Hilo area. Should nutrients increase and herbivores decrease, these alien algae could spread.

Acanthophora spicifera (Larry Basch). *This alien alga is found off of the west coast of Hawaii in the Kaloko fishpond and at Kawaihae.*



Waiopae MLCD (Lisa Wedding). *In 2003, east Hawaii became home to the most recent marine life conservation district. Benthic maps provide a mechanism for scientists to better understand the life history of nearshore species.*



Roi

Due to the lack of fishing pressure and absence of native predators, the introduced grouper roi has become common sight. Many reef users perceive roi as voracious predators, and believe the alien is diminishing native reef fish populations. HCRI-RP sponsored researchers from the Hawaii Cooperative Fishery Research Unit found roi do feed on reef fishes. Nearly half of those captured, however, have little to no prey in their stomachs. Laboratory experiments show their digestion is extremely slow (up to two days). In addition, roi feed on a variety of fish, reducing their effect on any particular species.

Although the effect of an individual roi is minimal, they are found in densities approaching 7-8 fish per quarter acre. Further research is needed to determine the impact of this level of roi abundance.

Originally introduced to create a fishery, roi were found to be infected with ciguatera. Researchers did not find an area along west Hawaii completely free of ciguatoxic roi. Therefore, a fishery cannot be recommended at this time, although incident rates may be similar to other reef fish.

Implications for Management

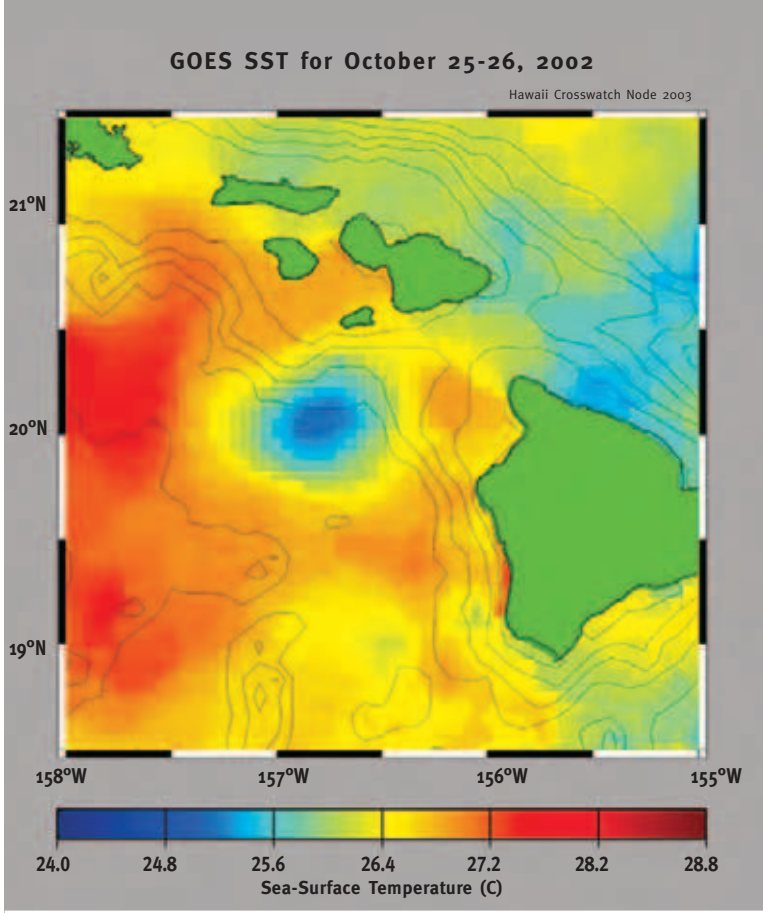
Protecting spawning stocks in marine protected areas alone does not increase the number of fish and invertebrates. Other factors, such as ocean currents or sea surface temperatures, influence growth and survival rates of larvae and are still being investigated. Actively managed areas, however, do protect those fishes that settle in the area, thereby enhancing overall numbers.

If spatially distinct or seasonal oceanic changes impact recruitment of fish and invertebrate larvae, then recognizable patterns in recruitment location and timing may emerge. Knowledge of these patterns could guide marine protected area placement by revealing low and high recruitment areas. While identifying causes of low recruitment is important, just recognizing its existence can focus ecosystem management efforts.

Individual roi do not have a large impact on reef fishes.

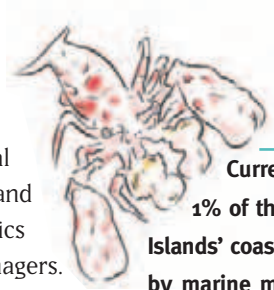
Recomendations

- Recruitment and oceanographic research should be funded to obtain the multi-year information on



Ocean Eddies and Aquarium Fish (www.coastwatch.nmfs.hawaii.edu). *Cold water eddies may transport fish larvae from the deep ocean to nearshore reefs. To detect the location, extent, and type of eddy researchers use sea surface temperature satellite images.*

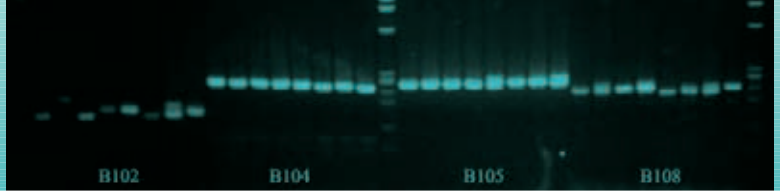
Perpetuation of a Resource (Lisa Huynh). *Through active management and legislative protection, west Hawaii's reefs will sustain its fish populations well into the future.*



what drives coral reef ecosystem and resource dynamics required by managers.

Currently less than 1% of the main Hawaiian Islands' coastline is protected by marine managed areas.

- Continue the current fisheries replenishment area (FRA) network, as no compelling reasons exist to modify.
- Dedicate funding for monitoring to meet Act 306 reporting requirements.
- Monitor at least four times a year, with two surveys during summer recruitment.
- Require species-specific harvesting limitations for rare species in open areas.
- Establish similar FRA system on Oahu to protect aquarium stocks.
- Revise existing aquarium catch report system to improve accuracy and provide for catch verification.
- Revoke permits of collectors who continually fail to abide by the permit's terms.



publication notes

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It is based on research projects sponsored by HCRI-RP in 1998-2004. Projects include: *Macroalgal assessment* (Abbott, Smith, & Okano), *Recruitment dynamics and dispersal* (Basch), F*eeding biology of the introduced fish roi and its impact on Hawaiian coral reef fishes and fisheries* (Birkeland & Dierking), *Assessment of genetic diversity and connectivity in fish replenishment areas in the Hawaiian yellow tang* (Noakes & Tissot), *Studying the linkages between water quality, fishing pressures, and management practices* (Parsons), *Post-settlement life history of key coral reef fishes in a Hawaiian MPA network* (Parrish & Claisse), *Effectiveness of FRAs to replenish aquarium fish* (Tissot, Walsh, & Hallacher). Information about these and other HCRI-RP projects can be downloaded from the website (www.hcri.hawaii.edu).

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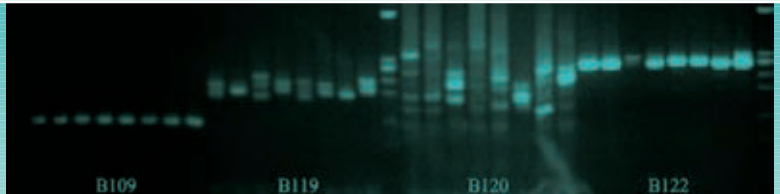
Illustrations by Solomon Enos

This Page: ***Yellow Tang Genetic Code*** (Marc Noakes). *Researchers are using genetics to determine the extent of population dispersal across west Hawaii.*

Front Cover: ***Yellow Tang*** (Keoki Stender). *84% of the west Hawaii aquarium harvest is yellow tang. Alga on cover is Halymenia formosa, an edible species high in protein* (Kintaro Okamura).

Back Cover: ***Potter's Angelfish*** (Keoki Stender). *Endemic to Hawaii, this angelfish is born a female and, over time, changes into a male.*



Hawaii Coral Reef Initiative Research Program
University of Hawaii at Manoa
2424 Maile Way #718 Honolulu, HI 96822
Phone (808) 956.7479 Fax (808) 956.2884
hcri_rp@hawaii.edu www.hcri.hawaii.edu