Coral Relocation Project in Kaneohe Bay, Oahu, Hawaii

Report on Phase I

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Background

Rehabilitating reefs through coral transplantation.

Previous work on coral reef restoration has been summarized by Naughton and Jokiel (2001). Recommendations for undertaking such activity have been published by Jokiel and Naughton (2001). In recent years we have learned a great deal about coral reef restoration (e.g. Jokiel and Brown 1998, Jokiel et al. 1999, Jokiel et al. in press). Maragos (1974) demonstrated that transplantation of corals is a viable technique for restoring reefs in Kaneohe Bay. Kolinski and Jokiel (1996) moved corals destined to be destroyed by dredging in Kaneohe Bay Yacht Harbor to reef that was dredged circa 1938 at the east end of Kaneohe Bay. The transplanted corals have transformed the dredged sandy area into a rich coral reef. Dr. Steve Dollar (personal communication) conducted a similar transplant in order to salvage corals that were destined to be buried under the runway extension into Kaneohe Bay. During 2004 the opportunity arose to expand reef restoration work in Kaneohe Bay, based on established procedures. Corals needed for this restoration became available through a project directed at removing navigation obstructions in the channels leading to the Hawaii Institute of Marine Biology (HIMB) at Coconut Island. In the past 50 years corals in the shallow entrance channel in front of the laboratory grew to a considerable size and obstructed boat passage in the channel at low tide. Moving of the corals to the restoration site was accomplished with assistance of a U.S. Army dive and salvage team as part of their training. Kolinski (manuscript) has advocated such transplantation of corals that are blocking navigation as a means of restoring damaged reefs.

Selection of damaged reef in need of restoration.

Many of the coral reefs in Kaneohe Bay were severely damaged between 1937 and 1944 by a dredge and fill operations undertaken to create ship channels and seaplane runways during construction of the Kaneohe Naval Air Station (Devaney et al. 1982). A recent study (Uchino 2004) evaluated coral and fish communities at a dredged patch reef off Coconut Island in comparison to a nearby patch reef that was not dredged (Fig. 1). The study by Uchino demonstrated that the dredged reef has failed to recover substantially over the past 60 years, although environmental conditions for coral growth at that location are highly favorable. The limiting factor is the layer of fine sand on the dredged reef that has blocked new coral recruitment. Coral larvae cannot settle and grow on sand, but transplanted coral colonies will do extremely well under these conditions. This reef is close to the source of the salvaged corals and is an ideal site for restoration efforts

Evaluation of the dredged reef in comparison to an undredged counterpart or "control".

Even after 60 years, there is substantially less coral cover at the dredged reef at all depths and along both the windward and leeward edge (Uchino 2004). The dredged reef flat, which is devoid of coral, is capable of supporting good coral development as shown by high coral cover on the few ridges left by the dredging operation. Corals moved onto the sand-rubble areas of the flat will thrive and grow into large coral formations in areas where only sandy gravel exists now. Previous transplant operations in Kaneohe Bay demonstrated that transplanted corals grow and spread across the substratum into large thickets over a period of only a few years. Seeding the extensive sandy reef flat with salvaged coral colonies would increase coral cover and promote the formation of a rich coral reef fish community.

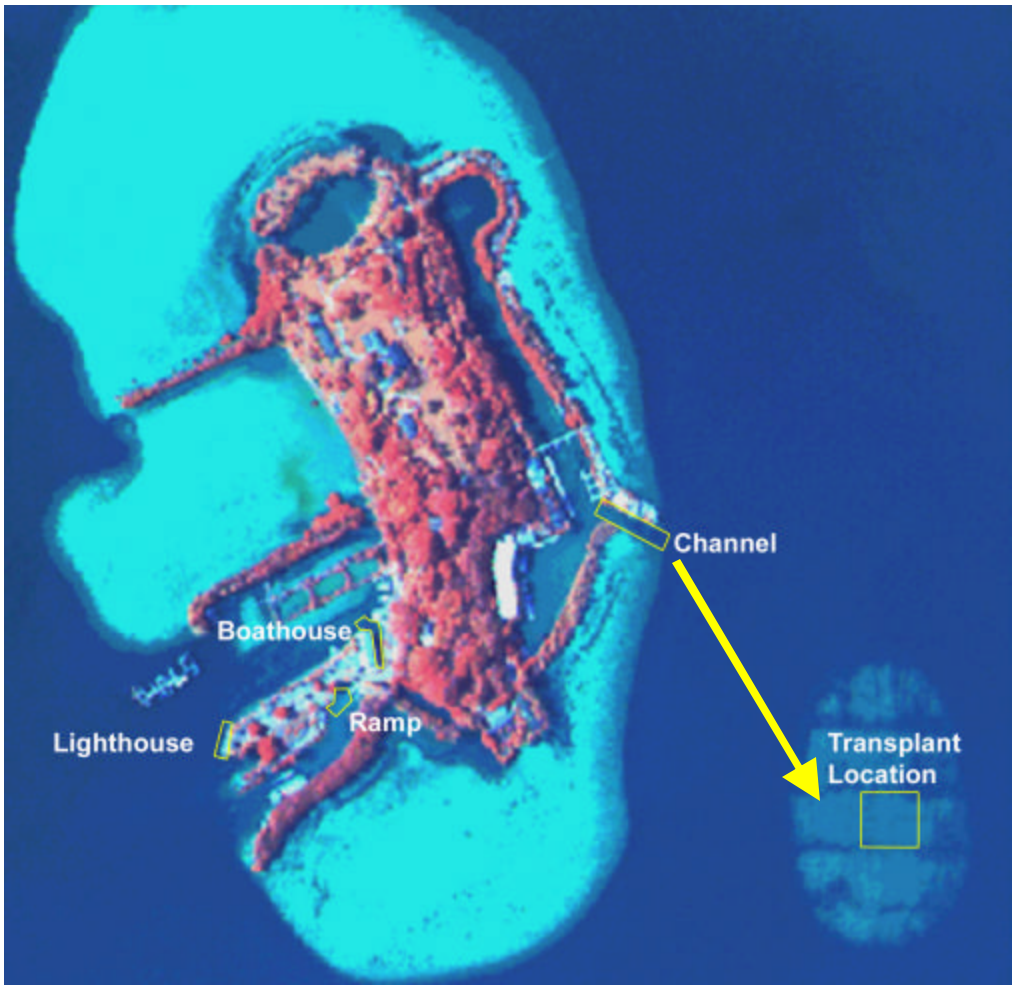

Figure 1. Aerial photograph showing location of the source area (channel) and the transplant location for the corals during Phase I of the project.

During Phase 1 of the project corals that had grown to the point that they were blocking the main navigation channel were removed and transplanted to the dredged patch reef (Fig. 1). The coral was moved by the U.S. Army divers. Care was taken so that no invasive algae are moved with the corals to the new site. The corals were placed in a large basket suspended under a boat and moved slowly to the site while submerged (Fig 2). After the corals are moved, scientific divers began to monitor these salvaged corals.

Work Completed to Date

As of March, 31, 2005, live coral was successfully transported from the navigation channel on the NW side of Moku o Lo‘e to the dredged reef approved by the Department of Land and Natural Resources-Division of Aquatic Resources and stipulated in the Special Activity Permit No. 2005-25. These locations are shown in Fig. 1. Colonies were gently freed from the substrate with a large pry bar and placed in baskets constructed of soft wire netting to prevent abrasion resulting from shifting during transport. This created a stable platform for

transit to the relocation site. Lift bags provided neutral buoyancy for ease of movement. Baskets suspended under inflatable vessels remained entirely submerged during transport to prevent desiccation.

Figure 2. Moving corals from channel to patch reef using basket slung under boat with winch system used to lower or raise basket.

Army divers of the 7th Engineering Detachment's 29th Engineering Battalion stationed at Fort Shafter, O'ahu, Hawai'i successfully removed all corals blocking the navigation channel. The work was conducted by two groups of divers. The first group of men under the direction of Capt. Scott Milller remained on site from November 30th to December 10th, 2004, working 12 hr weekdays and 6 hours on Saturday. The second group included 16 men under the direction of Capt. George Mitroka. They worked 8 hrs/day excluding Sundays from March 14th through March 24th, 2005. During this time over 100 baskets of *Porites compressa* (finger coral) and *Montipora capitata* (rice coral) were relocated to the specified site. This represents an estimated 200 square meters of coral. Each basket contained an estimated 1500 pounds buoyant weight (weight while submerged).

The initial documentation and monitoring was carried out under the direction of Dr. Paul Jokiel and Dr. Kuulei S. Rodgers. Continued assessment and monitoring of the activity is being conducted through the University of Hawaii Marine Option Program (MOP). Two MOP undergraduate students, Eric Moennich and Louise Giuseffi are being trained and are in the process of developing long-term MOP Skill Projects focused on the restoration effort. Their projects will focus on the transplant areas and document changes in the coral communities over a course of three years

Prior to relocation efforts, flora and fauna at both the donor and the receiving sites were found to be similar. The invasive orange sponge *Mycales* was found to be present at both sites. The invasive algal species *Gracilaria salicornia* was not found at the receiving site since this

species has not been found to occur in deeper waters. Although physical and biological limitations prevent the spread of the invasive algal species *G. salicornia* to deeper patch reefs, extreme care was taken to exclude from transport any corals with *G. salicornia* attached. All divers were trained in recognizing and avoiding this alga. Spreading of fragments were minimized by divers, gear, and equipment remaining on island during the operations, gear inspection and cleaning, supervision by HIMB coral reef ecologists, and inspection of corals at the receiving site. Exceptional care was taken to avoid any damage to marine life during all operations. Some of the corals from the inner portion of the channel did have attached *G. salicornia*, so these were placed on the Coconut Island reef immediately outside of the entrance channel in an area where this alien alga is already established.

Baseline data was gathered using an Olympus 5050 camera with underwater housing attached to a monopod. Each image covers a 0.5 m area. 200 digital images taken along a 100 meter transect line. In addition, fifty colonies were randomly selected, tagged, and photographed for future growth comparisons. Baseline fish data was conducted prior to relocation efforts on October 31st, 2004. Subsequent fish surveys were conducted on December 15th and March 2nd. Spatial complexity was immediately enhanced, increasing the numbers and species of fishes recorded on subsequent surveys. Sediment samples were collected from both the donor and receiving sites.

Initial observations indicate that the salvaged coral remains in good condition. No major damage to any of the colonies was incurred during transport. As of this reporting, no mortality has been noted. This observation is in agreement with other transplantation projects in Kaneohe Bay which showed initial transplant mortality to be very low. However, longer term mortality can often result from periodic adverse environmental conditions so monitoring of will continue over the next three years. Long-term survival and growth is expected to be high as in previous Kaneohe Bay transplant projects. Coral fragments and branches that fell on hard substratum are attaching to the bottom (Fig. 3) and other colonies placed on sand are thriving (Fig. 2). Rapid coral growth is evident as overgrowth of the wires used to secure tags to the corals (Fig. 3). Large branched corals placed on their sides have formed new branchless that are growing vertically (Fig. 4). Small colonies placed on sand also are growing rapidly (Fig. 4).

As far as we can determine, this project did not impact any public recreational activities, historical, economic or open space resources or impact any scenic areas. No adverse environmental effects occurred as a result of this coral removal and relocation project.

The Transplant Reef as a Navigational Hazard:

The vertical growth rate of Hawaiian corals is approximately 1 cm per year (Maragos and Jokiel 1974). However, there are spaces between coral branches and between coral colonies. These spaces must be filled in as the reef grows towards the surface. Thus the average long-term accretion rate of areas of high coral coverage in Kaneohe Bay is only about 2 mm/yr (Grigg 1998). Long ridges of hard material remained on the reef flat after the transplant reef was dredged circa 1938. These can be clearly seen in Figure 1. The shallowest portions of these ridges are now within approximately 1.5 – 1.8 m (5-6 feet) of the surface at low tide, which then is the safe navigational depth for the reef. The corals transplanted from the channel were all

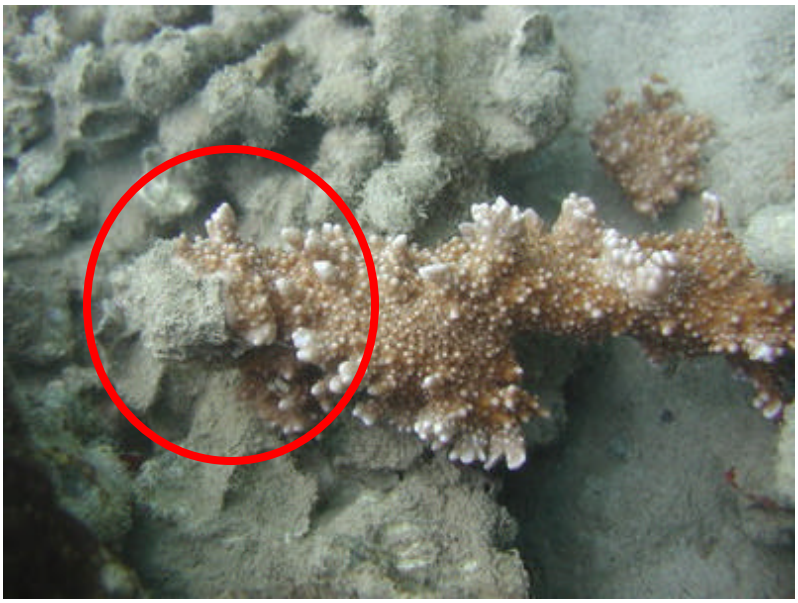

Figure 2. Transplanted rice coral (*Montipora capitata*) branch fragment that fell on hard substratum and has subsequently attached (area in red circle). Small fragment in upper part of the picture is growing on sand. Survival of broken fragments was very high and they are growing into larger colonies. Photograph taken on April 21, 2005.

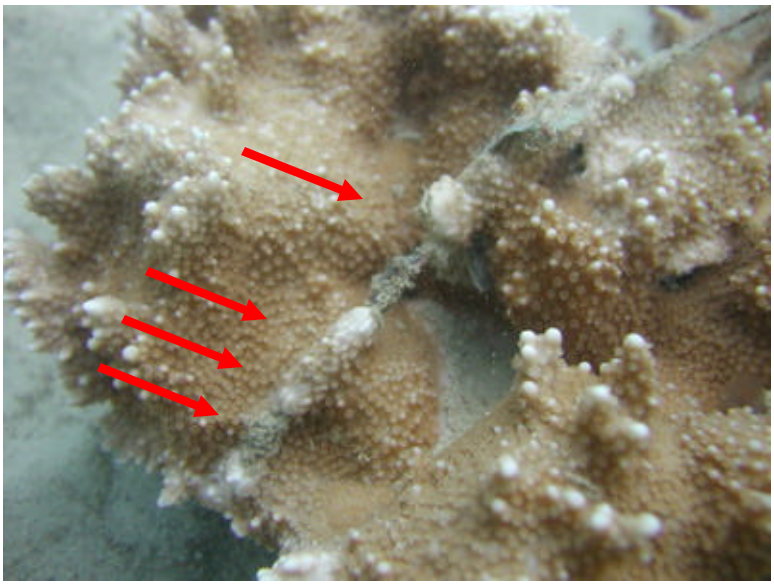

Figure 3. Transplanted rice coral (*Montipora capitata*) that is overgrowing wire used to secure the tag. Photograph taken on April 21 2005.

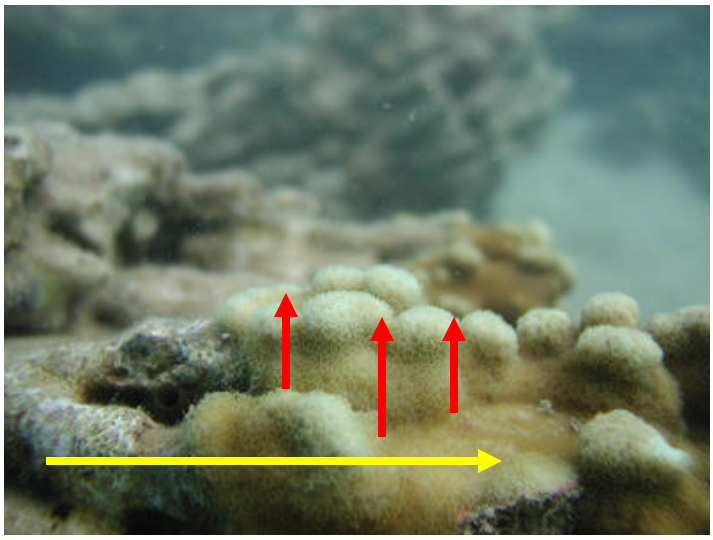

Figure 4. Transplanted finger coral (*Porites compressa*) branch fragment lying on its side sandy bottom. The yellow arrow shows the direction of growth of the original colony prior to transplantation. The branch is sprouting many smaller vertical branches (red arrows) that will gradually extend to form a larger colony. Photograph taken on April 21, 2005.

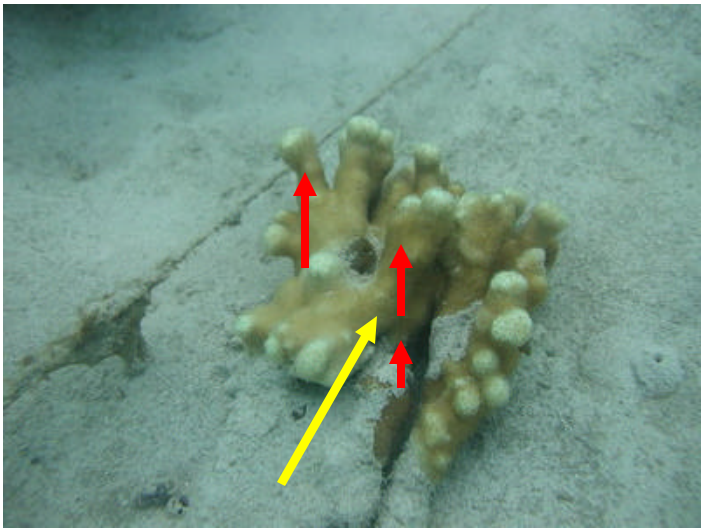

Figure 5. Transplanted finger coral (*Porites compressa*) branch fragment lying horizontally and partially buried on sandy bottom (yellow arrow) is beginning to grow vertical branches (red arrows). The branch is sprouting many smaller branches that will gradually extend to form a larger colony. Photograph taken on April 21 2005.

moved onto the sandy bottom which occurs at depths of from 12.3 to 4.5 m (11 to 15 feet). Thus there is a margin of safety of approximately 1.8 to 3.0 m (6 to 10) feet in the areas that received coral transplants. It will take a number of years before the coral cover in the transplant reaches a high level. Thus even with very high coral cover it will take a minimum of 900 years (i.e. 1.8 m divided by 2 mm per year) for corals in the transplant area to reach the safe navigation depth. By that time the ridges would have reached the surface to form small patch reefs. There should be no concern about the transplantation causing a navigation problem. The concern should be for the ridge lines which are now growing closer the surface.

Summary of observations to date:

There was little or no initial mortality aside from some of the small fragments that fell into mud on the bottom of the main channel during the transplant process. Small fragments that fell on rubble, sand or hard bottom were observed to grow and begin to attach to hard substratum. Growth is very high. The vinyl covered wire used to fasten tags to corals along the transect are already being overgrown. Coral colony branches that were placed in a horizontal position have formed many small branches that are beginning to grow vertically. The cleared boat channel has a rubble bottom covered with broken fragments from the transplant operation. These fragments are growing rapidly and it appears that the bottom will be covered again with live coral within a few years, but the large colonies that obstructed the channel will no longer be a problem. In sum, the channel and transplant sites are optimal environments for the corals and we are observing rapid growth with little or no mortality. No alien algae have appeared in the transplant site due to precautions taken by the divers along with the fact that the deeper environment is not favorable to the algal species of concern.

Outcomes

This project is producing a number of benefits:

1. Areas of reef damaged 60 years ago is being restored to high coral cover which provides essential fish habitat and increased recreational value.
2. The methodology and value of such methodology is being established through scientific studies.
3. This project is providing valuable undergraduate training for two Marine Option Program students.
4. The project is providing public education on the value of reefs and the importance of protecting this resource. Media coverage to date includes but is not limited to: KHON Channel 2 News December 8, 2004 and KGMB Channel 9 News December 8, 2004. A number of newspaper articles also appeared including and article by Honolulu Advertiser Suzanne Roig in the December 9, 2004edition of the Honolulu Advertiser.

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