Initial Observations on Biological Damage Arising from the Cape Flattery Ship Grounding at Barbers Point, Oahu with Recommendations for Quantitative Surveys and Substrate Stabilization to Minimize Further Loss of Coral Reef Resources

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A preliminary assessment of damage to coral reef resources resulting from the grounding and removal of the ship Cape Flattery at the southern entrance of Barbers Point Harbor, Oahu was conducted on 10 and 11 February 2005 by members of the State of Hawaii Division of Aquatic Resources (DAR), U.S. Fish and Wildlife Service (FWS), and the National Marine Fisheries Service Pacific Islands Regional Office (PIRO), in addition to separate surveys by individuals contracted by the responsible party (RP). These surveys were limited in scope and duration and were intended to gain information necessary for planning marine resource related response activities. Investigators utilized snorkel and SCUBA equipment in a limited reconnaissance of the grounding scar and offshore escarpment at depths ranging from 23 to 74 ft (7 to 23 m). Digital photography and still images were collected.

Preliminary Findings:

Coral reef resources in the area occur along gradually sloping fringing reef separated by a near vertical escarpment at a depth of approximately 50 ft (15 m). Coral and fish densities appeared highest along the upper edge of the escarpment. Multiple depressions, caves and caverns occur in the reef and are utilized by green turtles, *Chelonia mydas*, as resting areas (Figure 1). Algae are apparently abundant in inshore regions where turtles are known to forage (George Balazs, pers. comm.). Observed coral species included *Pocillopora meandrina*, *P. eydouxi*, *Porites lobata*, *P. evermanni*, *P. brighami*, *Pavona varians*, *Montipora capitata*, *M. flabellata*, *M. patula*, *M. studeri*, *Leptastrea purpurea*, *Cirrhipathes anguina* and *Antipathes* sp. Members of the genus *Montipora* were encrusting suggesting high wave energy in the area. *Porites lobata*, *Pocillopora meandrina* and *P. eydouxi* were observed to be the most heavily damaged of the coral species due to their spatial dominance and exposure of their three dimensional structure.

At 23 ft (7 m), corals, macro-invertebrates and even fish were pulverized by direct contact with the ship and related equipment (Figures 2 and 3). In addition, large numbers of colonies were broken/sheared, apparently from lines and anchors used in ship stabilization and towing (Figures 4 and 5). Collision and burial by loose substrate and colonies was observed (Figure 6). Reef organisms also succumbed to cement deposited during removal from the ship (Figures 7 and 8). Damage along the upper escarpment was extensive and appeared to result mainly from the use of tow lines and anchors in the area (Figures 9 - 11).

Detached colonies, fragments, cobble, rubble and sediment were generated in an area typically exposed to high wave energy. Movements of these materials have the potential to cause damage to macro-invertebrates survivors through collision and scour. Stabilization of large living corals should enhance their probability of survival (Figures 12 and 13).

Recommendations:

The damaged area is large and will require additional boats and manpower to quantify impacts and stabilize/recover detached substrate and coral colonies. The ability to stabilize detached colonies and to directly identify grounding related impacts is limited to a period of approximately one week from this date. After this time, difficulties in distinguishing grounding related damage by means other than indirect inference will arise, and mortality and movement of detached colonies will continue to occur, increasing the extent of the primary impact and the probability of secondary impacts through collision and scour. Individual teams are recommended for each of the response actions listed below.

1. **Towed-Diver Surveys:** The Coral Reef Ecosystem Division (CRED) should be immediately requested to conduct towed-diver surveys throughout the area to (1) elucidate the geographic extent of the damaged area; (2) video-document and geo-reference damage by type on a broad scale; (3) collect digital images over broad scales for general quantification of impacts to the reef.

2. **Benthic Habitat Surveys:** Detailed benthic surveys of macro-invertebrates should be conducted at selected sites representative of the types of impacts and in control areas. Multiple 10 m transects are recommended at each site. Methods should quantify damaged and undamaged macro-invertebrates, and include information of species, size distributions, partial death, fragmentation, density and projected area cover.

3**. Detached Colony and Substrate Stabilization**: Large coral colonies and pieces of substrate that became detached as a result of ship grounding activities should be reattached using cement (Portland Type II and Molding Plaster mixture) and/or epoxy (Zspar) to reduce further mortality and limit collisions with previously non-impacted corals in the area. Efforts should also be made to remove excess debris from turtle resting holes.

4. **Long term Monitoring**: Frequent monitoring for a period in excess of five years is recommended to assess secondary impacts to adjacent reef areas, recovery in damaged areas relative to non-impacted control areas, and success of stabilization/recovery techniques.

Figure 1. Male green turtle, *Chelonia mydas*, swimming from a resting area at the edge of the escarpment (55 ft depth).

Figure 2. Perspective of the main impact scar of the Cape Flattery from a reef depression (23 ft depth).

Figure 3. Pulverized fish (23 ft depth).

Figure 4. Field of sheared *Pocillopora meandrina* (23 ft).

Figure 5. Damage to *Porites evermannii* (colony size = 3.2 m; 23 ft depth).

Figure 6. Deposition of loosened material on organisms which escaped initial injury.

Figure 7. Cement damage to *Montipora capitata* (23 ft depth)

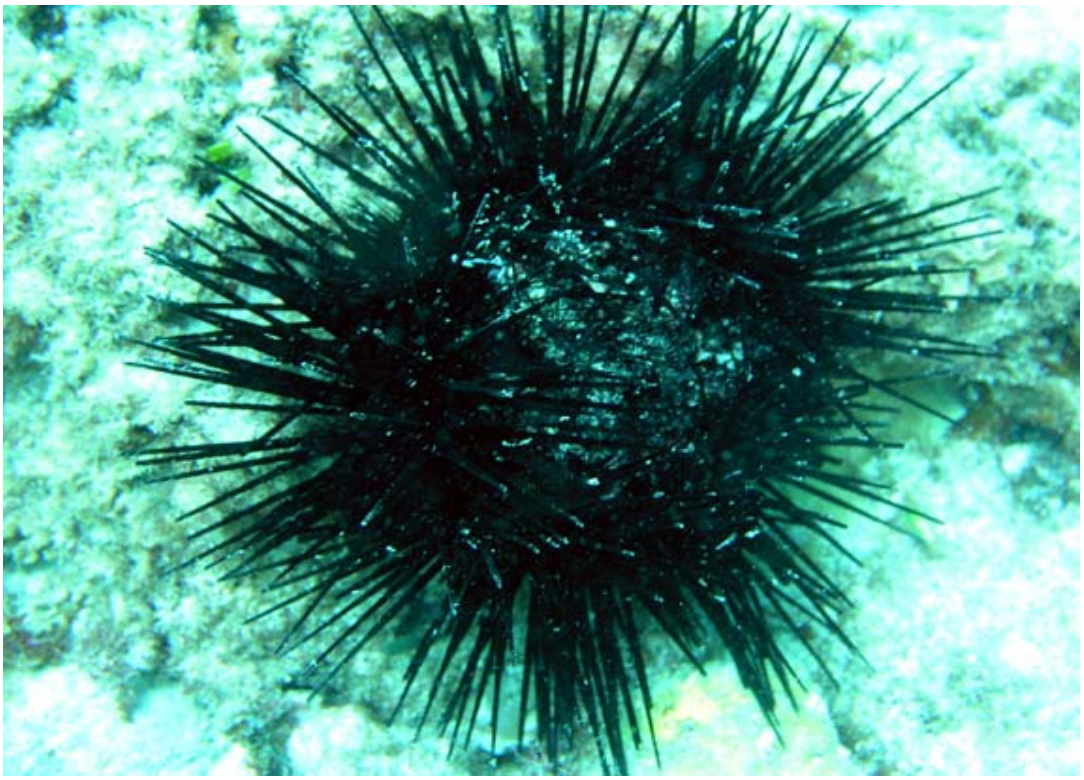

Figure 8. Ailing sea urchin, *Echinothrix calamaris* (23 ft depth).

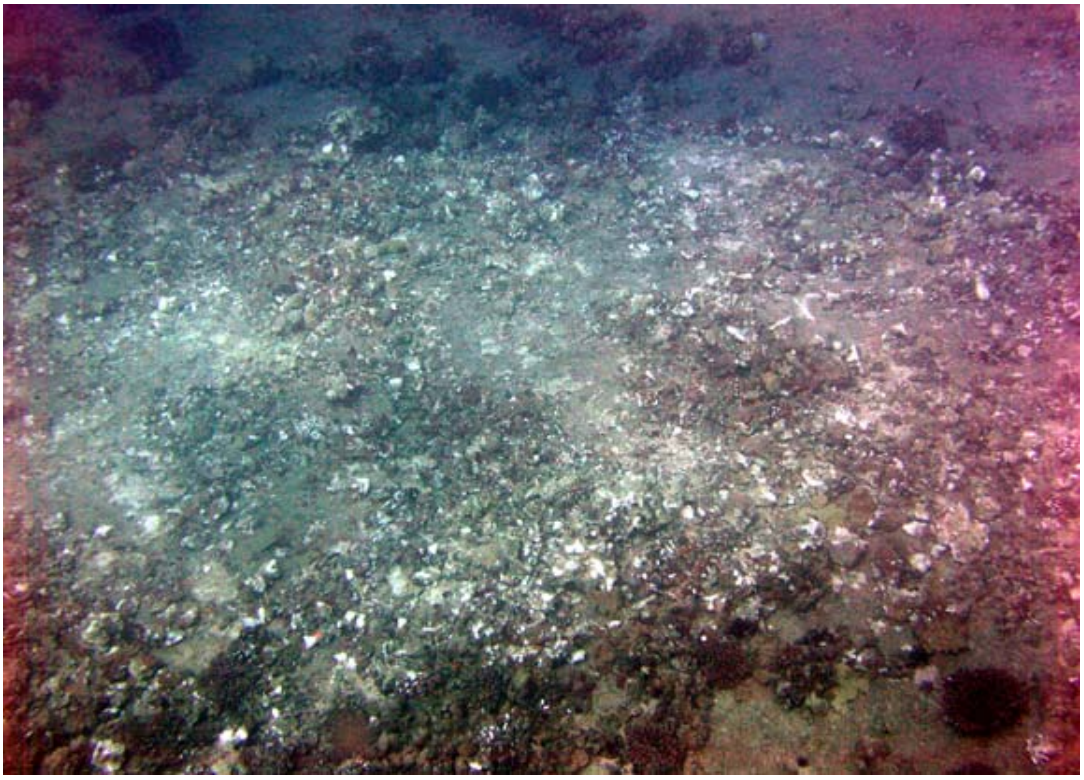

Figure 9. Tow-line damage along reef escarpment (50 ft depth).

Figure 10. Tow line and chain trailing far below the waters surface.

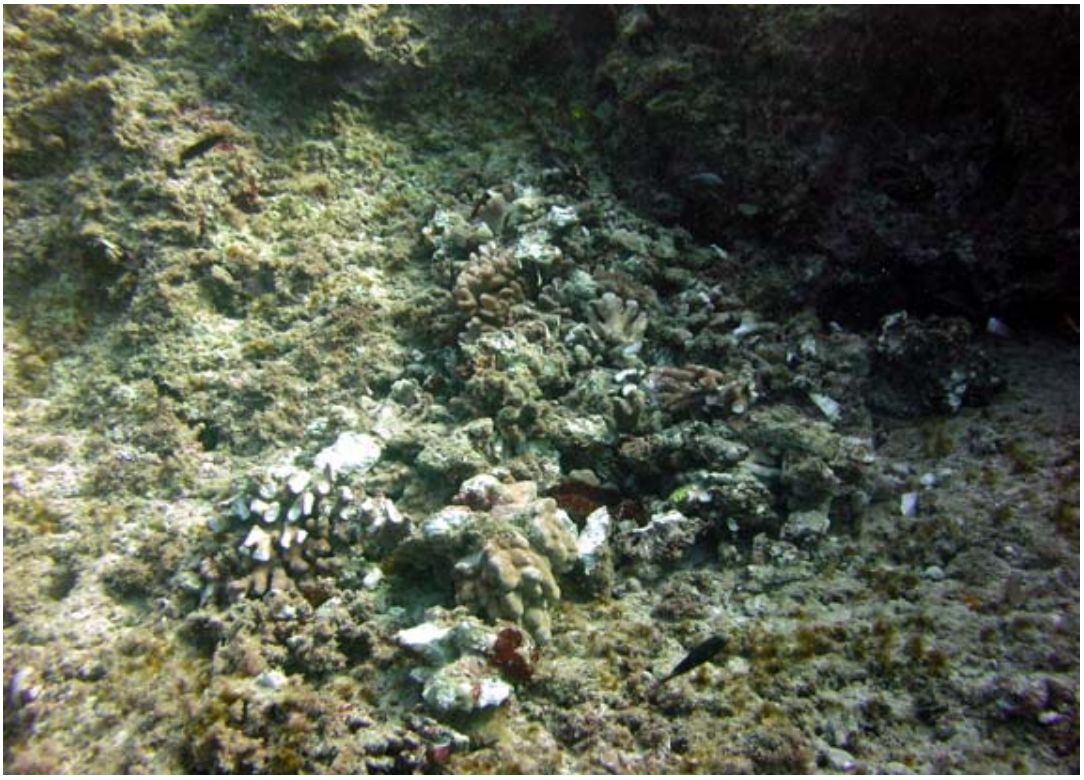

Figure 11. Detached colonies and fragments accumulating below the escarpment (74 ft depth).

Figure 12. Stabilization of this *Porites* head will enhance its potential to survive while reducing its capacity for collision with other colonies in the region.

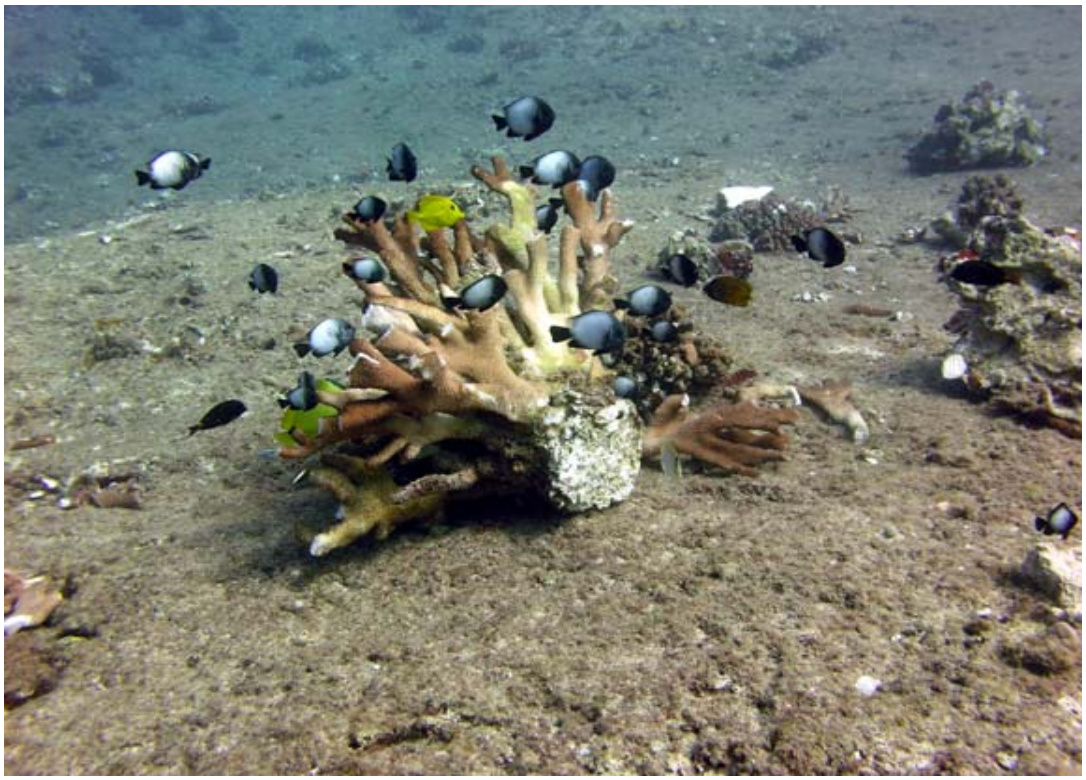

Figure 13. *Pocillopora eydouxi* colony that may survive if reattached.