Papahānaumokuākea Marine National Monument
Permit Application Cover Sheet

This Permit Application Cover Sheet is intended to provide summary information and status to the public on permit applications for activities proposed to be conducted in the Papahānaumokuākea Marine National Monument. While a permit application has been received, it has not been fully reviewed nor approved by the Monument Management Board to date. The Monument permit process also ensures that all environmental reviews are conducted prior to the issuance of a Monument permit.

Summary Information

Applicant Name: Greta Smith Aeby
Affiliation: HIMB

Permit Category: Research
Proposed Activity Dates: May 1 - Sept 30, 2010
Proposed Method of Entry (Vessel/Plane): NOAA research vessel Hiialakai
Proposed Locations: shallow water reefs throughout the Monument

Estimated number of individuals (including Applicant) to be covered under this permit:
2
Estimated number of days in the Monument: 21-28 days

Description of proposed activities: (complete these sentences):

a.) The proposed activity would…

Determine the incidence of coral disease at several sites within the Monument and test a method for managing damage from Acropora growth anomalies. Fish (surgeonfish and butterflyfish) with skin cancer would be surveyed to determine distribution and prevalence of the disease in fish populations. Determine the effect of skin cancer on the body condition of fish. Baseline studies on the parasites of zooplankton will be initiated.

b.) To accomplish this activity we would ….

Survey reefs for coral disease, mark and photograph individual colonies exhibiting signs of disease, repair permanent sites, surgically remove growth anomalies off of table corals to determine efficacy of this method for managing disease. Surgeonfish and butterflyfish populations wll be surveyed. Surgeonfish with skin cancer would be collected to examine the effect of the disease on the body condition of the fish. Plankton tows and light traps will be used to collect zooplankton at the different islands to be screened for parasite infections.

c.) This activity would help the Monument by …

giving them information as to th health status of their reefs, ability to predict damage from coral disease throught time, and a potential method to control Acropora growth anomalies. Studies of

fish disease will give them information on how widespread cancer is in fish population within the Monument.

Other information or background: Global climate change and human activities are placing coral reef ecosystems at risk. Coral reefs worldwide are now declining at an alarming rate. Mass bleaching events have increased dramatically since the 1980's and have usually been linked to El Nino or global warming-related increases in annual sea surface temperature (Brown 1997, Barber et al. 2001). The El Nino Southern Oscillation (ENSO) conditions during 1997 to 1998 resulted in worldwide bleaching from the Western Atlantic to the Great Barrier Reef. ENSO events have increased in frequency and duration in the past two decades (Barber et al. 2001, Walker 2001) and it has been predicted that the frequency and severity of coral bleaching will also continue to rise (Hoegh-Guldberg 1999).

Disease in coral reef ecosystems has received great attention, particularly in the western Atlantic where coral disease has been incriminated in the marked degradation of reef habitats. (Santavy and Peters 1997, Green and Bruckner 2000). Coral disease is reported to be responsible for the dramatic decline of Acroporids, one of the major frame-building corals in the Florida Keys, changing the structure and function of the coral reef ecosystem (Aronson & Precht 2001). Despite the major impact disease can have on reef systems, the etiology of most coral diseases remains unclear (Santavy and Peters 1997, Richardson 1998). The causative agents, mechanism of pathogenesis and link to environmental or anthropogenic stress are still largely unknown (Richardson 1998, Green & Bruckner 2000).

The reefs of the Northwestern Hawaiian Islands (NWHI) are considered to be relatively healthy but they are not immune to the conditions that have led to the decline of other reef systems. In September 2002 the first mass-bleaching event was recorded on the reefs of the NWHI with a second bleaching event occurring in 2004. In the three northwestern most atolls of the Archipelago (Pearl & Hermes, Midway and Kure) over half of all sites had significant bleaching (Aeby et al. 2003, Kenyon et al., 2005). Ten coral disease states have now been described from the NWHI (Aeby 2006) and we have established permanent sites which allow us to determine both temporal and spatial changes in diseases through time and the ultimate affect of disease on the health of the ecosystem. We will measure changes in disease levels through time, rates of tissue loss from different diseases, patterns of disease transmission among colonies, rate of spread of disease and evaluate changes in coral cover and coral species composition. In addition, two diseases of concern have been identified, Acropora white syndrome and Acropora growth anomalies which we are targeting for focused studies.

Acropora white syndrome (AWS) is a disease which causes acute tissue loss in acroporids and has been reported from across the Indo-Pacific. Acropora white syndrome appeared on one reef in the northwestern Hawaiian Islands (NWHI) in 2003 (Aeby 2006) and has since spread. Our prior studies in 2005 and 2006 found this disease to be highly virulent having killed over 19 large table acroporids with numerous other colonies suffering massive tissue loss from the disease. The disease occurs predominantly at French Frigate Shoals (FFS) within the NWHI, which is the center of abundance and diversity of acroporids in Hawaii. We plan to continue to follow the dynamics of this disease by re-surveying permanent sites to measure coral mortality and disease spread.

Disease can affect coral communities directly through mortality of colonies (partial or whole) resulting in reduced coral cover (such as we found for AWS) or indirectly through sub-lethal events such as reduced growth, resilience or reproduction. From our 2006 study we

discovered that Acropora cytherea with growth anomalies suffer a significant reduction in reproductive output. We would now like to determine whether this disease also affects the growth of colonies and whether removal of growth anomalies could be an effective management tool. During our prior studies we documented the occurrence of "dead zones" within "tumor city" at one of our permanent sites. This suggest that this disease is slowing killing corals through time. By tagging individual affected colonies for growth studies we will also be able to determine the lethality of this disease through time.

Diseases in marine ecosystems are not only limited to corals. Fibropapillomatosis of green turtles has been known in Hawaii since the 1950s (Balaz 1991). More recently, high levels of infections with bacteria and protozoa have been seen in taape (Lutjanus kasmira) (Work et al. 2003). Taape were introduced into Hawaii in the 1950s (Randall 1987) and have spread all the way to Midway Atoll. Taape are closely associated with certain native fish such as goatfish (Mulloidichthys sp.) (Friedlander et al. 2002) and goatfish from the main Hawaiian Islands have been found to be infected with some of the same diseases as taape (Work et al. unpub. data). Given that taape were introduced into Hawaii, there is the concern that the recently documented diseases may have been introduced with them from the Marquesas. Taape are infected with a parasitic gut nematode that is thought to have been brought into the Hawaiian ecosystem with the introduction of the fish. This nematode infection has also been found in co-occurring native goatfish species. Taape were orginally introduced into Oahu and have recruited out to other islands and up into the NWHI. The question now arises as to whether disease transmission has occurred from the main HI out to the NWHI.

From our 2006 study we found that taape from FFS had the nematode infection yet this disease was not found in fish from Midway. It appears that there is a lag in the time required for taape to establish in the NWHI as compared to the establishment of fish disease. The spread of both taape and its diseases up into the NWHI may be reflective of real time ecological linkages between islands within the Hawaiian archipelago. We have a rough timeline of the spread of taape from Oahu out to Midway and could correlate that with the eventual emergence of this disease at Midway. From studies in 2006, we also found that species of native goatfishes from FFS also have the nematode infection. We would like to also sample goatfishes from the other islands we are visiting to determine whether the pattern of disease is similar to that found in taape.

Based upon studies of similar nematodes, we hypothesized that the first intermediate host of the potentially introduced parasitic red nematode is a planktonic copepod which could be the mechanism of disease dispersal throughout the Hawaiian Islands. Preliminary work at our lab in Honolulu has potentially identified the copepod hosts species as Lobidocera madurae and Undinula vulgaris. During this study we also found that the zooplankton in Kaneohe Bay contained a variety of different larval parasites. Parsites transmitted through the foodchain, such as these within the copepods, are useful as potential indicators of ecosystem health. Parasites can only remain in host populations if all hosts within the life cycle are present and in sufficient numbers to maintain the disease. Hence, healthy ecosystems may have higher levels of certain types of parasites as compared to more degraded regions where host abundance is reduced. We would now to compare the parasite levels of the zooplankton within the NWHI with our finding within the MHI and explore whether there is evidence that copepods infected with the larval stage of the red nematode may be the mechanism of disease spread within the Hawaiian Archipelago.

From our 2005 and 2006 studies we found that the surgeonfish, Ctenochaetus strigosus, (kole) with a pigment discoloration had pathology consistent with cancerous lesions. Further survey work within the MHI found diseased kole on Oahu, Maui, Kauai and Molokai. We also observed several other species of surgeonfish with similar patterns of discoloration. Using the same survey method used in the MHI we would now like to compare distribution and prevalence of diseased fish in the NWHI.

It is important for management agencies to have a through understanding of the vulnerability of these reefs to disease and the first steps in managing disease are developing an understanding of the causes of disease and assessing its geographic extent. Mangement of disease in wildlife populations usually involves either reducing or removing the source of infection or reducing the spread of the disease. However, before appropriate management plans can be made the epizootiology of diseases must be understood. Our studies, past and proposed, are suppling critical information into disease dynamics in both coral and fish within the NWHI.