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, 2012
Proposed Method of Entry (Vessel/Plane): NOAA research vessel Hiialakai
Proposed Locations: shallow water reefs throughout the Monument (Nihoa, Necker, FFS, Gardner, Pearl and Hermes, Maro, Laysan, Lisianski, Midway, Kure,)

Estimated number of individuals (including Applicant) to be covered under this permit: 8
Estimated number of days in the Monument: 21-28 days

Description of proposed activities: (complete these sentences):

a.) The proposed activity would…

Determine the prevalence and incidence (change in levels through time) of coral disease within the Monument. Examine degree of recovery of colonies or reefs affected by disease. Compare the microbial communities between healthy and diseased coral to investigate disease pathogenesis and etiology. If Montipora white syndrome is found, microbial studies will tell us whether the pathogen is the same or different as what is found in the MHI. Determine whether intrinsic factors such as genetic relatedness or zooxanthellae clade may help explain the high prevalence of Acropora growth anomalies (~40% of the colonies) within "tumor city" at FFS as compared to disease levels elsewhere within the Monument and the Indo-Pacific (<1% of the coral colonies).

b.) To accomplish this activity we would ….

Survey reefs for coral disease, mark and photograph individual colonies exhibiting signs of disease, and repair permanent sites. Coral colonies are tagged by placing a cable tie through a natural hole in the colony thereby producing no harm to the coral. GA-affected and healthy table corals would be sampled for follow-up molecular studies for relatedness and zooxanthellae clade by the Toonen lab. Genetic analysis requires a minimum of 50 small samples from individuals

within a population. White syndrome and healthy table and rice corals will be sampled for follow-up microbial studies by the Callahan lab. If we encounter any new coral diseases then we need to sample these for histological analyses to determine what the disease is doing to the coral at the cellular level. We will collect one healthy and one disease sample per colony. I am asking to be able to sample 20 diseased colonies (1 healthy and 1 diseased sample/colony) per island, which I estimate, based on disease prevalence from past surveys, as being sufficient to cover all the surveys at each of the islands. This request should cover our ability to adequately investigate any disease outbreaks we might encounter.

c.) This activity would help the Monument by …
giving them information as to the health status of their reefs, ability to predict amount of damage to reefs from coral disease through time, and a measure of the degree of resilience (ability to recover) of their reefs. Tissue loss diseases on corals throughout the Indo-Pacific have been found to be caused by pathogenic bacteria with Vibrio corallyticus identified in 3 different regions. In the main Hawaiian Islands we have identified three different bacterial pathogens causing tissue loss disease in Montipora. Identifying bacteria in healthy and disease corals will tell us whether the same pathogens are killing coral within the PMNM or if they are novel. A comparison of microbial communities is also the first step in identifying the pathogen. Pathogen identification allows us to start to understand where the diseases may be coming from and allows for the development of disease treatment to help contain the diseases. Montipora White Syndrome (MWS) has emerged as a serious problem on reefs within the MHI. We will also screen the reefs of PMNM for this disease and if found, the microbial community will be examined to determine if the disease is caused by the same pathogens as in the MHI. Is MWS spreading up into PMNM? The prevalence of disease at "tumor city" is unusually high and could be due to intrinsic factors such as the genetic relatedness or zooxanthellae clade of the table corals at that site and/or extrinsic factors such as contaminants. Molecular studies on coral colonies with this disease will help answer this question.

Other information or background: Coral reef ecosystems are at risk locally and globally due to global climate change and human activities. 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).

In the western Atlantic 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. We also need to start understanding the underlying etiology of disease and we will be comparing the microbial community of AWS and healthy coral as a first step. Within the MHI, Montipora white syndrome is becoming a problem with two separate disease outbreaks reported from Kaneohe Bay. Our disease surveys will document whether MWS is occurring in the PMNM and if so, microbial comparisons will inform us whether they are caused by the same or different pathogens as found in the MHI. This work will be conducted in collaboration with the Callahan lab.

"Tumor city" at FFS has an unusually high prevalence of Acropora growth anomalies (40%) as compared to other areas (<1%). We hypothesize this could be due to intrinsic factors (genetic susceptibility, zooxanthellae clade, etc) or extrinsic factors such as contaminants in the environments. As a first cut in understanding why disease levels are so high on that reef, we will examine the genetic relatedness and zooxanthellae clades of affected vs. unaffected colonies found on that reef. This work will be conducted in collaboration with the Toonen lab and will complement the work proposed by the Karl lab.

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, modes of transmission and assessing its geographic extent. Management 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. Corals are the very foundation of the entire coral reef ecosystem and as such threats to their survival must be managed using the best available science. Our studies, past, present and

proposed, are suppling critical information about coral disease and disease dynamics, which are a serious threat, within the NWHI.