# 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:** Fenny Cox
**Affiliation:** UH West Oahu

**Permit Category:** Research
**Proposed Activity Dates:** between May 15th and September 15th, 2008
**Proposed Method of Entry (Vessel/Plane):** NOAA research vessel
**Proposed Locations:** shallow water reefs throughout the Monument (Nihoa, Necker, FFS, Gardner, Maro, Kure, Midway, Pearl & Hermes, Laysan, Lisianski)

**Estimated number of individuals (including Applicant) to be covered under this permit:** 5
**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 (change in disease levels through time) of coral disease at several sites within the Monument; document the virulence (damage from disease) of Acropora white syndrome and Acropora growth anomalies and test a method for managing damage from Acropora growth anomalies. Fish (Ctenochaetus strigosus) with skin cancer would also be surveyed to determine prevalence of the disease in fish populations and collected to determine 1) affect of disease on body condition of fish, 2) collect tissue for further analysis such as electron microscopy to determine if viruses are associated with the disease. Taape (Lutjanus kasmira) and several species of native goatfish (Mulloidichthys vanicolensis, M. flavolineatus, Parupeneus multifasciatus, P. pleurostigma, and M. pflugeri) will be collected and examined for disease (nematode infection) to determine whether the nematode infection was introduced into the Hawaiian ecosystem with the introduction of taape.

b.) To accomplish this activity we would ….

Survey reefs for coral disease, mark and photograph individual colonies exhibiting signs of disease, repair permanent sites, sugically remove growth anomalies off of corals (Acropora cytherea) to determine efficacy of this method for managing this disease. Kole with skin cancer

will be surveyed, collected, photographed and necropsied. Taape and goafish will be collected and necropsied.

c.) This activity would help the Monument by …
giving them information as to the health status of their reefs, ability to predict damage from coral disease through time, and a potential method to control Acropora growth anomalies. Studies of fish disease will give them information on how virulent the Kole skin cancer is (affect on body condition of fish) and whether it may be infectious and whether the nematode infection found in taape is introduced and the rate of speed it is spreading in the fish populations from the main Hawaiian Islands up into the NWHI.

**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. 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 potential 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 through re-surveying of our permanent sites and continuing to map the spread of this disease.

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 test a method for controlling this disease in acroporids.

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 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 gut nematode that may 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 originally 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 taape 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. We will be working with Brian Bowen's group on this disease who will use molecular techniques to determine whether the nematode is an introduced species. From our 2005 and 2006 studies we found that the surgeonfish, Ctenochaetus strigosus, with a pigment discoloration had pathology consistent with cancerous lesions. We would like to conduct further studies of this disease.

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. 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. Our studies, past and proposed, are supplying critical information into disease dynamics in both coral and fish within the NWHI.