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: Florence I Thomas
Affiliation: Hawaii Institute of Marine Biology, University of Hawaii at Manoa

Permit Category: Research
Proposed Activity Dates: 06/01/12 through 11/15/12
Proposed Method of Entry (Vessel/Plane): R/V Hi'ialakai
Proposed Locations: Shallow water habitats (< 100 feet depth), focused on deploying sensors for high frequency time series analysis.

Sensor deployment will be on islands that will be visited on the subsequent cruise. Thus French Frigate Shoals is our first choice, but any island likely to be revisited will be fine.

Estimated number of individuals (including Applicant) to be covered under this permit: Two berthing positions for my research team, plus available members of researchers from other permitted activities. The persons taking these berths are Òscar Guadayol i Roig and Sherril Leon Soon. These researchers will also work with Donahue's team on data analysis of data related to subsequent cruise.

Estimated number of days in the Monument: Up to approximately 50 days

Description of proposed activities: (complete these sentences):

a.) The proposed activity would…

1) help us understand how coral reefs in different regions of the NWHI will experience changes in physical parameters caused by global climate change. The persistence of coral reefs, under increasing pressure from global climate change, depends on their growth exceeding degradation. Growth and degradation are both tightly coupled to environmental parameters and stressors such as temperature, light, and nutrient loading. Our understanding of how these parameters vary over time is primarily based on long-term changes in average values. However, organisms experience fluctuations in the environment on smaller temporal and spatial scales than are captured in these average values. It is expected that the frequency and intensity of such fluctuations will be altered in the context of global climate change (IPCC 2007). For example, the frequency of extreme meteorological events is predicted to increase. Challenged with the need to manage reefs in the

face of changing climate, it is important to understand how variation in parameters that control coral reef resilience vary at scales that are relevant to the corals themselves. Long-term averages that are meant to represent large spatial scales may not provide the information needed for best management practices. We have developed a protocol for time series analysis, involving cross-spectrum analyses that are designed to examine variation in environmental variables at organism relevant temporal and spatial scales. We intend to apply this technique to examine how some physical parameters vary among islands within Papahānaumokuākea and present a new approach for spatial and temporal analysis of physical data that is essential for management of reef systems within the monument.

b.) To accomplish this activity we would ….

1) deploy an array of *in situ* sensors over one reef system to measure habitat variability (30 x 30 meters) as a function of off shore buoys to demonstrate the applicability of our approach. The array would be composed of small (<300mm x <25mm Ø) stand-alone sensors for oxygen (DO-1060, RBR), temperature (TR-1060P, RBR) and pH (WQL-pH pH Datalogger). In addition, a suite of sensors would be deployed to measure variations in temperature, pH, dissolved oxygen, and water flow. It would include a multiparametric probe (YSI 600XLM Sonde), with *in situ* sensors for temperature, conductivity, pH and dissolved oxygen, and an acoustic Doppler current profiler (Aquadop Profiler, Nortek A.S.). The multiparametric sonde is 638 x 49mm Ø. The ADCP is 628mm x 75mm Ø. All sensors would be fixed to small weights that would be recovered along with the instrument, which would not be directly attached to the bottom. Sandy areas or existing structures from ongoing monitoring projects would be selected to deploy the instruments. These sensors would be deployed on the earliest cruise and collected on the following cruise by Donahue lab members.

The results of these deployments would be compared to both historical and concurrent data from NOAA offshore buoys and monitoring stations in the monument. Current schemes for monitoring of environmental variability in Papahānaumokuākea are centered in the assessment of regional low frequency scales by using buoys. Understanding how variability at such scales may be linked to smaller scales, from inter or intra-island scales down to the size of individual organisms, is of particular importance if we are to predict or manage the effects of the anticipated increase in the frequency of extreme meteorological events. Our goal is to develop a base line at the scale of individual corals on the reef that can be compared to larger scale processes easily characterized by offshore buoys in Papahānaumokuākea.

c.) This activity would help the Monument by …

1) helping understand how information provided by oceanographic buoys may be reflecting perturbations in environmental parameters at scales relevant to coral reef organisms, and assessing the need for finer scale sensor grids. One of the major needs of the Monument is to develop a baseline understanding of how physical parameters will change over time under global climate change. We need baseline data but we also need to develop techniques for data analysis that allow us to compare variability among sites and to compare these variations within reefs to

larger scales of variability detected by ocean buoys. Oceanographic buoys are cheaper to maintain and cover large geographic regions, but they provide little information about variability at the reef or organism scale. Our data would provide information on how small scale variation compares to larger scale measures so that we would know what is happening on specific reefs based on this larger scale data. In summary, our project would i) provide baseline data and ii) develop and test new cross-spectral and cross correlation analyses to describe cross reef variation. This data and analysis would allow the monument to determine how oceanic changes in the physical environment are translated to variation at the organisms scale, and to determine if some reefs are more environmentally resilient than others.

Other information or background:

1) There has been rapid development in sensor technology during the last ten years. We are now able to obtain relatively high frequency data for a large number of important physical parameters. This technology has allowed us to measure high frequency data, which provides an opportunity to use cross correlation analyses to determine how parameters vary or co-vary over small spatial and temporal scales. These emergent technologies and statistical analyses also allow us to develop models comparing small-scale variations to larger scale change in physical parameters. In 2011 under the Donahue permit we were able to deploy sensor arrays and to compare physical parameters and isotope ratios. Results indicated that there are small-scale variations in microhabitats across reefs and led to the development of cross-spectral analysis of data using data from the MHI. We developed the techniques using data from the MHI and compared it to the NWHI because development of the techniques was time consuming and outside of the time frame of a single cruise. We will present our results at the NWHI symposium and it will result in at least two publications that are under development. Our data forms the basis for collaboration with Dr. Donahue's lab on bio-erosion.