Papahānaumokuākea Marine National Monument

RESEARCH Permit Application

NOTE: ***This Permit Application (and associated Instructions) are to propose activities to be conducted in the Papahānaumokuākea Marine National Monument. The Co-Trustees are required to determine that issuing the requested permit is compatible with the findings of Presidential Proclamation 8031. Within this Application, provide all information that you believe will assist the Co-Trustees in determining how your proposed activities are compatible with the conservation and management of the natural, historic, and cultural resources of the Papahānaumokuākea Marine National Monument (Monument).***

ADDITIONAL IMPORTANT INFORMATION:

- Any or all of the information within this application may be posted to the Monument website informing the public on projects proposed to occur in the Monument.

- In addition to the permit application, the Applicant must either download the Monument Compliance Information Sheet from the Monument website OR request a hard copy from the Monument Permit Coordinator (contact information below). The Monument Compliance Information Sheet must be submitted to the Monument Permit Coordinator after initial application consultation.

- Issuance of a Monument permit is dependent upon the completion and review of the application and Compliance Information Sheet.

INCOMPLETE APPLICATIONS WILL NOT BE CONSIDERED

Send Permit Applications to:
Papahānaumokuākea Marine National Monument Permit Coordinator
6600 Kalaniana'ole Hwy. # 300
Honolulu, HI 96825
nwhipermit@noaa.gov
PHONE: (808) 397-2660 FAX: (808) 397-2662

SUBMITTAL VIA ELECTRONIC MAIL IS PREFERRED BUT NOT REQUIRED. FOR ADDITIONAL SUBMITTAL INSTRUCTIONS, SEE THE LAST PAGE.

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.

Section A - Applicant Information

1. Applicant

Name (last, first, middle initial): Florence I Thomas

Title: Associate Researcher, Hawaii Institute of Marine Biology

1a. Intended field Principal Investigator (See instructions for more information):
Oscar Guadayol i Roig

2. Mailing address (street/P.O. box, city, state, country, zip):
Hawaii Institute of Marine Biology
[redacted]

Phone: [redacted]

Fax: [redacted]

Email: [redacted]

For students, major professor's name, telephone and email address:
Florence I Thomas, HIMB
[redacted]

3. Affiliation (institution/agency/organization directly related to the proposed project):
Hawaii Institute of Marine Biology,
School of Ocean & Earth Science & Technology,
University of Hawaii at Manoa.

4. Additional persons to be covered by permit. List all personnel roles and names (if known at time of application) here (e.g. John Doe, Research Diver; Jane Doe, Field Technician):
Florence Thomas, PI
Oscar Guadayol i Roig Field PI and research diver
Sherril Leon Soon research diver
Unnamed individual replacement research diver.

Section B: Project Information

5a. Project location(s):

		Ocean Based	
☒ Nihoa Island	☐ Land-based	☒ Shallow water	☐ Deep water
☒ Necker Island (Mokumanamana)	☐ Land-based	☒ Shallow water	☐ Deep water
☒ French Frigate Shoals	☐ Land-based	☒ Shallow water	☐ Deep water
☒ Gardner Pinnacles	☐ Land-based	☒ Shallow water	☐ Deep water
☒ Maro Reef			
☒ Laysan Island	☐ Land-based	☒ Shallow water	☐ Deep water
☒ Lisianski Island, Neva Shoal	☐ Land-based	☒ Shallow water	☐ Deep water
☒ Pearl and Hermes Atoll	☐ Land-based	☒ Shallow water	☐ Deep water
☒ Midway Atoll	☐ Land-based	☒ Shallow water	☐ Deep water
☒ Kure Atoll	☐ Land-based	☒ Shallow water	☐ Deep water
☐ Other			

NOTE: There is a fee schedule for people visiting Midway Atoll National Wildlife Refuge via vessel and aircraft.

Location Description:

We would use one location to deploy sensors. The specific island location would depend on the sequence of cruises as we need to deploy the sensors on the first cruise and have them picked up by the Donahue lab on a later cruise. Each sensor group, Temperature, Oxygen, pH (20 cm long by 3 cm wide) would be deployed on or near a CRED site and would be retrieved by the Donahue group. The values listed below are potential sites and represent general shallow water areas within the monument.

Specific locations

Specific locations for the study would depend on cruise logistics, but our target sites are associated with those of the Donahue lab:

Island/Atoll	Site Name	Latitude	Longitude	
FFS	H6	23.88048529	-166.2730727	28
FFS	21	23.84694519	-166.3269911	40

FFS	R46	23.76932046	-166.2618196	27
FFS	12	23.63830604	-166.1800664	33
FFS	34	23.6280284	-166.1353977	31
KUR	12	28.38231395	-178.3244947	33
KUR	R33	28.41675653	-178.3784283	51
KUR	2	28.45365015	-178.3439881	38
KUR	4	28.42664827	-178.2858767	37
KUR	6	28.38678209	-178.347914	32
LIS	18	26.00425931	-173.99409	26
LIS	R10	25.94461746	-173.9536197	44
LIS	R14	26.07838458	-173.9970317	48
LIS	R9	26.03954921	-174.0124643	27
LIS	9	25.9580487	-173.8823619	48
PHR	R26	27.78571439	-175.7804599	47
PHR	33	27.78546679	-175.8236217	43
PHR	R39	27.94045941	-175.8613056	38
PHR	R44	27.91097866	-175.9046626	45
PHR	R42	27.75312882	-175.9489414	47

However, cruise logistics will influence the specific locations for our study, so I have listed all possible sites below. This ensures maximum flexibility due to weather or unforeseen changes to our cruise schedule. All activities would occur within the area outlined by the following coordinates.

Location:	**Longitude**	**Latitude**
Kure Atoll	-178.19706492000	28.55825235580
Kure Atoll	-178.19623585400	28.29958375730
Kure Atoll	-178.45987884800	28.29958375730
Kure Atoll	-178.46070791400	28.55742328970
Midway Atoll	-177.19638223300	28.37419969920
Midway Atoll	-177.19721129900	28.13377055310
Midway Atoll	-177.52800864100	28.13459961920
Midway Atoll	-177.52800864100	28.37419969920
Pearl and Hermes Atoll	-176.08850981800	28.04643025580
Pearl and Hermes Atoll	-175.63289162600	28.04539944540
Pearl and Hermes Atoll	-175.63289162600	27.70729363750
Pearl and Hermes Atoll	-176.08954062900	27.70626282710
Lisianski Island	-173.67292570900	26.25150771120
Lisianski Island	-173.67292570900	25.83942708400
Lisianski Island	-174.23095155800	25.83942708400
Lisianski Island	-174.23095155800	26.25150771120
Laysan Island	-171.47900122300	25.96027179830
Laysan Island	-171.47725234300	25.65596666490
Laysan Island	-171.97918092500	25.65771554490
Laysan Island	-171.97918092500	25.96202067840

Maro Reef	-170.18133220600	25.69968866680
Maro Reef	-170.17958332600	25.21524888540
Maro Reef	-171.00505472200	25.21524888540
Maro Reef	-171.00505472200	25.69968866680
Gardner Pinnacles	-167.74832319300	25.26070709440
Gardner Pinnacles	-167.75087047400	24.34878019150
Gardner Pinnacles	-168.36221811900	24.35132747340
Gardner Pinnacles	-168.36476540100	25.26070709440
French Frigate Shoals	-165.93465851400	23.94630965900
French Frigate Shoals	-165.93465851400	23.56421738120
French Frigate Shoals	-166.45685129400	23.56421738120
French Frigate Shoals	-166.45685129400	23.94630965900
Necker Island	-164.13627752700	23.71705429230
Necker Island	-164.13373024500	23.20505064020
Necker Island	-164.92084033700	23.20505064020
Necker Island	-164.92338761900	23.71960157420
Nihoa Island	-161.66031956700	23.23816530420
Nihoa Island	-161.66286684900	22.94013332760
Nihoa Island	-162.05005369100	22.94268060940
Nihoa Island	-162.05260097200	23.23561802240

5b. Check all applicable regulated activities proposed to be conducted in the Monument:

☒ Removing, moving, taking, harvesting, possessing, injuring, disturbing, or damaging any living or nonliving Monument resource

☒ Drilling into, dredging, or otherwise altering the submerged lands other than by anchoring a vessel; or constructing, placing, or abandoning any structure, material, or other matter on the submerged lands

☐ Anchoring a vessel

☐ Deserting a vessel aground, at anchor, or adrift

☐ Discharging or depositing any material or matter into the Monument

☒ Touching coral, living or dead

☐ Possessing fishing gear except when stowed and not available for immediate use during passage without interruption through the Monument

☐ Attracting any living Monument resource

☐ Sustenance fishing (Federal waters only, outside of Special Preservation Areas, Ecological Reserves and Special Management Areas)

☐ Subsistence fishing (State waters only)

☒ Swimming, snorkeling, or closed or open circuit SCUBA diving within any Special Preservation Area or Midway Atoll Special Management Area

6 Purpose/Need/Scope ***State purpose of proposed activities:***

1) Alterations in the frequency, intensity and duration of meteorological and hydrological events have been observed and predicted in the context of global climate change. Developing a baseline for variation of physical parameters is essential to understanding how the NWHI will be affected by global climate change. We have developed new techniques to analyze high frequency physical data and these techniques may offer a new way to set a framework for analyzing the effects of global climate change on the ecosystems of the NWHI's.
We are proposing a novel approach that may offer a new way to set a framework for analyzing

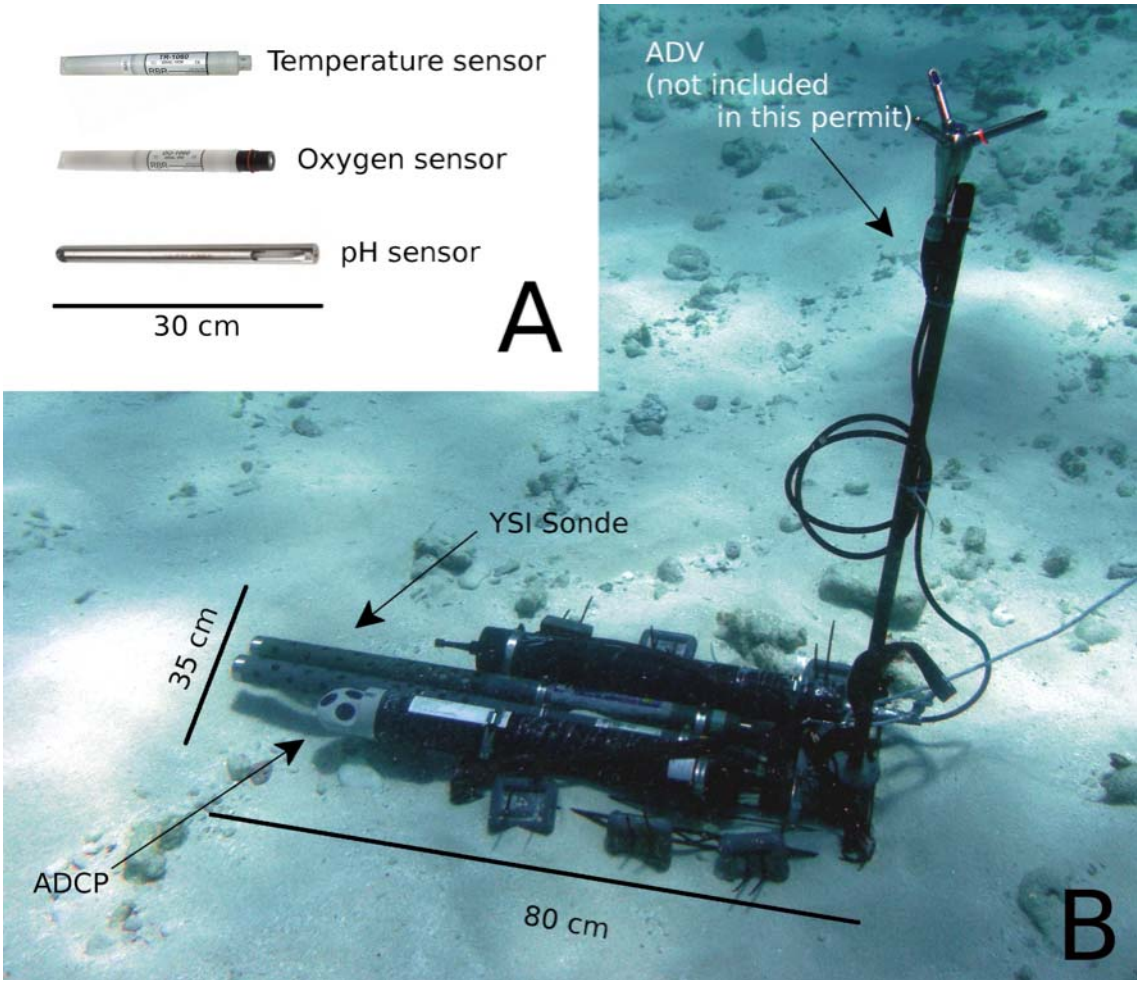

Figure 1: Sensors to be used in this study. A) standalone sensors for temperature (RBR TR-1060), dissolved oxygen (RBR DO-1060) and pH (WQL-pH Logger). B picture of the sensor array as used in the previous year, showing the ADCP (Aquadop Profiler, Nortek A.S.), 2 multiparametric probes (YSI 600XLM Sonde) and an acoustic Doppler velocimeter (Vector Profiler, Nortek A.S.). Note that no ADV would be used this year.

the effects of global climate change on the ecosystems of the NWHI's. We would obtain high frequency time series (i.e. sampling rates of ~minutes) at different locations in the reef. These series would include temperature, salinity, pH and dissolved oxygen. Then we would perform cross-spectrum analyses among the different high frequency series and with available datasets from NOAA stations in the monument (available online). We would identify the relevant scales of variability in each site, and would relate changes in the slopes of these spectra with site characteristics and distance between stations. This would allow us to ascertain: 1) to which extent spaced sites are correlated, and 2) what are the frequencies at which these correlations are lost. This approach will improve our understanding of how regional changes in the frequency of storms may translate into changes in what individual organisms and reefs actually experience in different locations, and will help us design an improved environmental monitoring scheme. The data will also provide a means to determine which reefs are more resilient in terms of physical environment -- which reefs have more stable responses to lager scale fluctuations, which will provide managers with information about which reefs may be most likely to survive climate fluctuations.
The specific objectives identified for this project are:
A) Collect high frequency data over a 1-2 month period:
a) Analyze this data to determine ranges of environmental variability and the correlation of variables along a reef.
B) Compare these reef scale variations to those occurring at larger scales (buoy data and monitoring station data within the monument.
C) Develop a model linking the two scales of data - that can be applied with further sensor data across the whole reef system.

7. Answer the Findings below by providing information that you believe will assist the Co-Trustees in determining how your proposed activities are compatible with the conservation and management of the natural, historic, and cultural resources of the Monument:

The findings are as follows:

a. How can the activity be conducted with adequate safeguards for the cultural, natural and historic resources and ecological integrity of the Monument?

We would only be deploying sensors in off shore sites that are used by other teams - either CRED and or Donahue labs. Sensors would be deployed on existing structures (CRED) sites or on sand patches within the reef. The instruments to be deployed are small and only slightly negatively buoyant. To eliminate the risk of dislodging several weights would be attached independently to each probe, so that even if one were dislodged, the others would still be securing down the instruments. In case no existing structure is suitable for the attachment of the suite of sensors (i.e. the YSI sonde + the ADCP), these would be attached to a small rectangular wire platform and placed over a sandy spot (see figure 1B). Weights would be tied using stainless steel hose clamps. All sensors to be used in this study were successfully deployed last year for periods of up to 3 days using the exact same procedures outlined here.
Divers would use proper technique so that they do not come in contact with the reef. As outlined in detail below, our sample size and methodologies have all been selected to provide robust and

scientifically rigorous information to managers with the least possible impact to the natural resources of the Monument.

Our work will not impact historic resources: we do not set foot on land within the Monument, and we report but do not touch any submerged artifacts discovered during our diving activities. My team and I work closely with two community based groups on Oahu that are interested in restoring taro fields to sustainable taro production and the He‘eia fishpond to a functioning fish pond for education and sustainable fish production. Through our work with these groups we have developed strong ties to social scientists working with these groups as well as some of the kapuna involved as leaders of the groups. We strive to work within the context of the groups who have the restoration vision and focus our research topics on those deemed important to the community. In our work in Papahānaumokuākea we will not disturb any archaeological sites on land or in the sea. We will not go onto land at anytime. Locations will be chosen so that no historical sites are disturbed. Also each participant will be required to participate in a Cultural Briefing prior to departure on the Hi'ialakai. Further each member of my team will be asked to reflect on the importance of the site they are being given the privilege to enter and will be asked to develop their own offering and spiritual reflection on the importance of Papahānaumokuākea. In respect for the importance of ritual we will gather on the ship deck for each person to offer his or her own vision for reflection.

b. How will the activity be conducted in a manner compatible with the management direction of this proclamation, considering the extent to which the conduct of the activity may diminish or enhance Monument cultural, natural and historic resources, qualities, and ecological integrity, any indirect, secondary, or cumulative effects of the activity, and the duration of such effects?

This type of research is directly mandated by the Proclamation, and is necessary to both maintain ecosystem integrity and provide for adaptive ecosystem management in the face of natural or anthropogenic disasters and global climate change.

1) There is limited information about natural high frequency variation in the physical environment. Variance in environmental parameters at frequencies between one day and several seconds, associated to important physical phenomena such as daily radiation patterns, tides, waves or turbulence, are not adequately resolved by current sampling strategy. This project will generate baseline information at such scales and provide new techniques to establish variability. Baseline information will allow us to develop information on present variability as a function of larger scale measures of variation so that the physical environment on different reefs can be predicted in the face of changing climate. This will allow managers to better predict outcomes of climate change and identify reefs or reef systems that are less likely to be affected and thus may be identified as special regions for protection.

As outlined above and below, our activities have no detectable effects that will diminish Monument resources, nor have any known indirect, secondary or cumulative effects on the ecosystem or resources therein. We will use existing structures or sand patches and will leave nothing behind after collection of our equipment by the Donahue lab on a subsequent cruise.

c. Is there a practicable alternative to conducting the activity within the Monument? If not, explain why your activities must be conducted in the Monument.

1) To establish baseline information about the NWHI and models that will predict variability as a function of climate change it is essential that measurement be made within the monument. Research to understand physical variability among islands driven by larger scale processes must be done in the NWHI.

d. How does the end value of the activity outweigh its adverse impacts on Monument cultural, natural and historic resources, qualities, and ecological integrity?

1) Given that our research requires very little interaction with the reef and uses either sand or existing structures for sensor attachment, it should have no adverse effects on the resources of the Monument, we believe that the end value of this research clearly outweighs that impact. It is essential that we begin to understand the range of physical variation that individual reefs systems experience as a function of larger spatial scale measures to make management decisions about impacts of global climate change on coral reefs within the monument.

e. Explain how the duration of the activity is no longer than necessary to achieve its stated purpose.

The cruise length is shorter than ideal, and is certainly no longer than is necessary to accomplish the research goals outlined in this permit application. Ideally one could sample monthly to get a time-integrated signal of baseline physical parameters. However, deploying the sensor arrays for 1- 2 months will provide enough data to demonstrate the usefulness and importance of these types of measures to understanding the range of natural variability of reefs. This data will not only provide information on variability but also serve as a present day baseline on which to compare future environmental changes.

f. Provide information demonstrating that you are qualified to conduct and complete the activity and mitigate any potential impacts resulting from its conduct.

I have a PhD in Integrative Biology, and have published more than 40 research papers in peer-reviewed journals dealing specifically with the subject of nutrient dynamics and transport in systems. I also have extensive experience analyzing physical data in shallow reef systems. I will be responsible for the conduct of my team and the field PI on this project will be Oscar Guadayol, who has a Ph.D. in marine sciences and has been involved in a number of research cruises. He has extensive experience analyzing time series data and has published in this research area. Last year he led a team in the NWHI, and has been team lead for cruises in the Mediterranean. He is a research diver and has worked to develop the analysis for the variation in environments across reefs. Sherril Leon Soon will also work on the cruise. She is a Ph.D. candidate in oceanography and a certified research diver. She will be under the supervision of Dr. Guadayol.

g. Provide information demonstrating that you have adequate financial resources available to conduct and complete the activity and mitigate any potential impacts resulting from its conduct.

There are adequate finances in the Thomas lab and the PMNM-HIMB partnership to conduct and complete all the research outlined herein. We have additional funding through a start-up grant to Thomas. We have an established track record of completing and publishing the research.

h. Explain how your methods and procedures are appropriate to achieve the proposed activity's goals in relation to their impacts to Monument cultural, natural and historic resources, qualities, and ecological integrity.

1) To achieve our goals of developing high frequency analysis of the physical environment on NWHI reefs for comparison to larger scale measures (buoys and other physical data available on the NWHI) we would deploy sensors for 1- 2 months in the same locations of other undergoing ecological monitoring projects, which will make retrieving easier and safer. The exact location and depth of the deployments would very much depend of the cruise plans for both the deploying and the subsequent retrieving cruise. The most likely site would be French Frigate Shoals, as it is the one where we expect to spend more time. We would deploy several small standalone sensors, at depths <60feet either attaching them to existing structures of the ongoing monitoring projects, or, if these structures are considered as unsteady, we would tie them to weights and leave them on sandy spots near the ongoing monitoring sites where they would be easy to be found but one of our team or anyone else. The ADCP and the multiparametric sonde would be placed on top of a heavy metallic frame (60X35X3cm), weighted with small diving weights (see figure 1B), and placed on a suitable spot on a bottom with no live cover. The instruments would be in place for just one to 2 months, but in the event that during the second cruise conditions do not allow their recovery by the Donahue lab team, they could be easily found and recovered during other cruises. Thus, the possibility of leaving any object for a longer period of time is minimal.

Data would be collected at frequencies on the scale of minutes. The use of small sensors is a safe and relatively cheap way to obtain measurements at frequencies otherwise unattainable. Furthermore, using *in situ* sensors have minimal impact and avoids the necessity of taking samples from the Monument. We will then compare these data with low frequency data obtained from meteorological and oceanographic buoys by using cross-spectral and cross correlation analyses to determine how local variability is represented by larger spatial and temporal scale measures.

The importance of this work is to provide a measure of present variability in environmental parameters and develop a predictive model of them based on larger scale measures. This work will provide managers information about how the physical environment at specific reefs will respond to long-term climate change. Deploying sensors at different spatial scales is the only way to develop these predictive models.

The vessel and Monument staff, aboard the NOAA vessel Hi'ialakai, will guide our choices of sites. We will avoid any sites that are identified as culturally significant, and focus our activities in regions that maximize the safety of the crew while ensuring that the proposed work will be

completed. All work will be conducted in shallow coastal sites. No access to land is necessary. The methods outlined herein are employed routinely in the Thomas lab and are appropriate to the proposed activities.

i. Has your vessel has been outfitted with a mobile transceiver unit approved by OLE and complies with the requirements of Presidential Proclamation 8031?

We will be using the NOAA vessel Hi'ialakai.

j. Demonstrate that there are no other factors that would make the issuance of a permit for the activity inappropriate.

There are no other factors that would make the issuance of the permit inappropriate.

8. Procedures/Methods:

1) Sensors will be deployed using SCUBA on the reef system by attaching them to or near CRED sites. If attachment to the CRED structure is not possible we will deploy the sensors at sandy areas within the reef matrix. We have done this successfully in a reef system within Kaneohe Bay. Our deployment does not impact the reef as we do not attach anything to live reef. Our plan is to deploy sensors near at least one of the locations used by Dr. Megan Donahue for her research so that we can provide a collaborative framework for the data analysis. Sensors will be deployed, and then collected on the next cruise. Data will be analyzed using cross-correlation and cross-spectrum analyses and will be compared to off shore buoy data. Our work in the MHI and in the NWHI has resulted in 3 presentations at national meetings and is the core of three papers under development.

A sensor array will be deployed over one reef system to measure habitat variability (30 x 30 meters). Also a suite of sensors will measure variations in temperature, pH, dissolved oxygen, and water flow. The sensor array will be composed of small (<300mm x <25mm Ø) standalone sensors for oxygen (DO-1060, RBR), temperature (TR-1060P, RBR) and pH (WQL-pH pH Datalogger). The suite will 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 2 instruments will be fixed to small weights that will be recovered along with the instrument, and will not be directly attached to the bottom. Sandy areas will be selected to deploy the instruments. The multiparametric sonde is 541mm x 49mm Ø. The ADCP is 628mm x 75mm Ø. These sensors will be deployed on the earliest cruise and collected on the following cruise by Donahue lab members.

NOTE: If land or marine archeological activities are involved, contact the Monument Permit Coordinator at the address on the general application form before proceeding, as a customized application will be needed. For more information, contact the Monument office on the first page of this application.

9a. Collection of specimens - collecting activities (would apply to any activity): organisms or objects (List of species, if applicable, attach additional sheets if necessary):

☐ Whole Organism ☐ Partial Organism

9b. What will be done with the specimens after the project has ended?

No samples will be taken

9c. Will the organisms be kept alive after collection? ☐ Yes ☐ No

• General site/location for collections:

• Is it an open or closed system? ☐ Open ☐ Closed

• Is there an outfall? ☐ Yes ☐ No

• Will these organisms be housed with other organisms? If so, what are the other organisms?

• Will organisms be released?

10. If applicable, how will the collected samples or specimens be transported out of the Monument?

11. Describe collaborative activities to share samples, reduce duplicative sampling, or duplicative research:

12a. List all specialized gear and materials to be used in this activity:

Scuba, sensors as outlined above.

12b. List all Hazardous Materials you propose to take to and use within the Monument:

None.

13. Describe any fixed installations and instrumentation proposed to be set in the Monument:

An array of sensors and a suite of sensors to measure variations in temperature, pH, dissolved oxygen, and water flow (Fig. 1). The sensor array will be composed of small (<300mm x <25mm Ø) standalone sensors for oxygen (DO-1060, RBR), temperature (TR-1060P, RBR) and pH (WQL-pH pH Datalogger). The suite will 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.). These sensors will be attached to blocks placed in the sand near reefs, not on reefs (see figure above).

14. Provide a time line for sample analysis, data analysis, write-up and publication of information:

Time series data will be analyzed as soon as sensors are collected. Guadayol has already developed analytical methods so we expect that analysis will be done within 6 months of the second cruise when the Donahue lab retrieves the sensors.

Regardless of the time to publication, the results from these studies are made available to Monument managers as quickly as possible through the brown-bag luncheons, semi-annual reports, and semi-annual mini symposium during which all researchers involved in this project present the most current findings from their ongoing research to the broader management community. We also reach the NGO community and general public each year with presentations at the Hawaii Conservation Conference, Hanauma Bay seminar series, and other education and outreach venues. In sum, these efforts ensure that research results are provided to the Monument co-trustees almost as quickly as they become available, and made available to the greater management community within no more than 6 months of the data being collected.

15. List all Applicants' publications directly related to the proposed project:

Badgley B.D., Thomas F.I.M. and V.J. Harwood 2010 The Effects of Submerged Aquatic Vegetation on the Persistence of Environmental Populations of Enterococcus spp. in Outdoor Mesocosms. Environmental Microbiology 12: 1271-1281.

Berdalet, E., Peters, F., Koumandou, V., Roldán, C., Guadayol, Ò., Estrada, M. 2007. Species-specific physiological response of dinoflagellates to quantified small-scale turbulence. Journal of Phycology 43 (5), 965–977.

Bolli, L., Llaveria, G., Garcés, E., Guadayol, Ò., van Lenning, K., Peters, F., Berdalet, E. 2007. Modulation of ecdysal cyst and toxin dynamics of two Alexandrium (Dinophyceae) species under small-scale turbulence. Biogeosciences 4: 559-567.

Guadayol, Ò., Peters, F., Marrasé, C., Gasol, J.M., Roldán, C., Berdalet, E., Massana, R., Sabata, A. 2009. Episodic meteorological and nutrient load events as drivers of coastal ecosystem dynamics: a time series analysis. Marine Ecology Progress Series 381: 139-151.

Guadayol, Ò., Peters, F., Stiansen, J.E., Marrasé, C., Lohrmann, A. 2009. Evaluation of oscillating grids and orbital shakers as means to generate isotropic and homogeneous small-scale turbulence in laboratory enclosures commonly used in plankton studies. Limnology and Oceanography: Methods 7:287-303.

Guadayol, Ò., Peters, F. 2006. Analysis of wind events in a coastal area: a tool for assessing turbulence variability for studies on plankton. Scientia Marina 70: 9-20.

Masaló, I., Guadayol, Ò., Peters, F., Oca, J. 2008. Analysis of sedimentation and resuspension processes of aquaculture biosolids using an oscillating grid. Aquacultural Engineering. Aquacultural Engineering. 38: 135-144. 2010 Honorable Mention Paper Award of the 2010 Aquaculture Engineering Society Awards.

With knowledge of the penalties for false or incomplete statements, as provided by 18 U.S.C. 1001, and for perjury, as provided by 18 U.S.C. 1621, I hereby certify to the best of my abilities under penalty of perjury of that the information I have provided on this application form is true and correct. I agree that the Co-Trustees may post this application in its entirety on the Internet. I understand that the Co-Trustees will consider deleting all information that I have identified as "confidential" prior to posting the application.

_____ _____

Signature Date

SEND ONE SIGNED APPLICATION VIA MAIL TO THE MONUMENT OFFICE BELOW:

Papahānaumokuākea Marine National Monument Permit Coordinator
6600 Kalaniana'ole Hwy. # 300
Honolulu, HI 96825
FAX: (808) 397-2662

DID YOU INCLUDE THESE?

☒ Applicant CV/Resume/Biography
☒ Intended field Principal Investigator CV/Resume/Biography
☒ Electronic and Hard Copy of Application with Signature
☒ Statement of information you wish to be kept confidential
☒ Material Safety Data Sheets for Hazardous Materials