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: Megan Donahue
Affiliation: Hawai‘i Institute of Marine Biology

Permit Category: Research
Proposed Activity Dates: 06/01/14-11/15/14
Proposed Method of Entry (Vessel/Plane): R/V Hiialakai
Proposed Locations: Shallow water reef (<100 ft depth) focused on bioeroder communities in forereef and lagoon habitats. Specific locations for the study will depend on cruise logistics but will include forereef sites at FFS, LIS, PHR, and KUR and lagoon sites at MID.

Estimated number of individuals (including Applicant) to be covered under this permit: 6
Estimated number of days in the Monument: 50

Description of proposed activities: (complete these sentences):

a.) The proposed activity would…
measure bioerosion rates and bioeroder community composition on reefs in the NWHI. We will characterize differences in bioeroder communities between the MHI and NWHI, compare bioerosion rates throughout the archipelago, identify environmental drivers of bioerosion rates and bioeroder community structure, and evaluate whether internal bioeroders can serve as indicators of community response to ocean acidification on coral reefs.

b.) To accomplish this activity we would ….
(i) retrieve 10 bioerosion blocks remaining at MID (see explanation below).
(ii) measure variation in bioeroder community composition by collecting thirty small pieces (5x5x5cm) of dead coral skeleton at each of 21 sites (FFS, LIS, PHR, KUR, MID). These pieces of reef substrate will be sampled for bioeroding fauna using mass sequencing in collaboration with the Toonen lab.

Explanation: Bioerosion rates are measured using microCT scans of coral blocks to get a 3D image of the eroded material; this method gives a better estimate of bioerosion rate than the

traditional buoyant weight technique and allows characterization of distinct bioeroder groups. In July 2011, we deployed five calcium carbonate blocks at each of 15 forereef sites (5 sites each at FFS, LIS, PHR) and 20 blocks in a lagoon site at MID. In July 2012, we retrieved all the blocks from FFS, LIS, and PHR, and 10 of the blocks at MID, and deployed blocks at 5 sites on KUR. In July 2013, the KUR blocks were retrieved. For our 2014 permit, we plan to retrieve the final 10 blocks from MID.

c.) This activity would help the Monument by …
evaluating whether internal bioeroders can serve as indicators of community response to ocean acidification on coral reefs. The community structure and function of bioeroding organisms may have a major effect on coral reef resilience: the sponges, polychaete worms, and tiny mollusks that comprise bioeroder communities control the strength and complexity of the coral reef framework, which is the habitat for more charismatic coral reef organisms. Shifts in the composition and functioning of these out-of-sight, but fundamental members of coral reef ecosystems may change the accretion-erosion balance of coral reefs. The methods developed here will help managers anticipate the likely effects of ocean acidification on bioeroder communities and bioerosion rates.

Other information or background: All forereef sites are co-located with NOAA-CRED permanent sites. This minimizes the impact to the reefs and faciliates sharing of information

Section A - Applicant Information

1. Applicant

Name (last, first, middle initial): Donahue, Megan J.

Title: Associate Researcher, Hawai'i Institute of Marine Biology

1a. Intended field Principal Investigator (See instructions for more information):
Nyssa Silbiger, graduate student

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

For students, major professor's name, telephone and email address:

3. Affiliation (institution/agency/organization directly related to the proposed project):
Hawaii Institute of Marine Biology (HIMB), 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):
Megan Donahue, Applicant, research diver
Nyssa Silbiger, Field PI, research diver
Chelsie Counsell, research diver
Scott Godwin, research diver
Holly Bolick, research diver
Un-named Individual, 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:
Specific locations for the study will depend on cruise logistics, but out target sites are:

Island/Atoll	Site Name	Latitude	Longitude
French Frigate Shoals	FFS -34	23.62792	-166.13538
French Frigate Shoals	FFS -12	23.63835	-166.18005
French Frigate Shoals	FFS-H6	23.88046	-166.27306
French Frigate Shoals	FFS-21	23.84695	-166.32695
French Frigate Shoals	FFS-33	23.83651	-166.26669
Midway Atoll	MID-H11A	28.217667	-177.403217
Midway Atoll	MID-H11B	28.2175	-177.40305
Pearl and Hermes Atoll	PHR-39	27.94045941	-175.8613056
Pearl and Hermes Atoll	PHR-44	27.91026	-175.90483
Pearl and Hermes Atoll	PHR-42	27.75312882	-175.9489414
Pearl and Hermes Atoll	PHR-R26	27.78583	-175.78028
Pearl and Hermes Atoll	PHR-R33	27.78546679	-175.82355
Lisianski Island Marine Area	LIS-09	25.9580487	-173.8823619
Lisianski Island Marine Area	LIS-R10	25.94461746	-173.9536197
Lisianski Island Marine Area	LIS-18	26.00425931	-173.99409
Lisianski Island Marine Area	LIS-R14	26.07838458	-173.9970317
Lisianski Island Marine Area	LIS-R9	26.03954921	-174.0124643
Kure Atoll	KUR-12	28.382308	–178.324479
Kure Atoll	KUR-33	28.416767	–178.378433
Kure Atoll	KUR-02	28.453633	–178.344017
Kure Atoll	KUR-04	28.426650	–178.285870
Kure Atoll	KUR-06	28.386780	–178.347920

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 will 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

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:***

Bioerosion, the removal of CaCO3 reef structure by biological agents (Neumann 1966), is a natural process that influences the mechanical stability, structural complexity, and net accretion rate of coral reefs. Extensive bioerosion can compromise the mechanical stability and structural complexity of reefs, thereby increasing susceptibility to storm damage (Hutchings 1986) and decreasing habitat availability for other reef organisms (Hoegh-Guldberg et al. 2007), and organisms that rely on emergent land, including Hawaiian monk seals, sea turtles, and sea birds. Bioeroders may be classified into three functional groups: microborers (e.g., euendoliths), macroborers (e.g., sponges, polychaetes, and bivalves), and grazers (e.g., urchins and fish). Micro- and macroborers erode the interior of reef substrate and are typically more abundant in dead coral substrate than live coral (Highsmith 1981). In the PMNM, micro- and macro-borers communities have remained largely unstudied and, although grazer density has been estimated on a few reefs, erosion rates due to bioeroders of any group have never been measured directly.

The community of bioeroders are a good target for detecting community changes in response to ocean acidification: (i) bioerosion is integral to long-term reef sustainability (Grigg 1982), (ii) bioerosion rates are sensitive to pH (Tribollet et al 2009, Silbiger et al in review), (iii) bioeroder community composition may shift in response to changes in pH, and (iv) applying new technologies will allow the efficient measurement of bioerosion rates and community composition that is critical for managers. The effective use of bioerosion rates as a monitoring and management tool requires distinguishing the effects of ocean acidification from other environmental parameters; this is the challenge that motivates this project.

Available predictions of pH in the coastal zones (Orr et al 2005, IPCC 2007) are based on models of open ocean values. Applying these predictions to coral reef ecosystems is complicated by the temporal and spatial variability of pH in coastal waters (Gagliano et al 2010, Guadayol et al 2014). These new studies show substantial small scale variation in pH within and between reef habitats, including a range of natural variation that can be as large as predicted changes in ocean acidification at the global scale This is not unexpected: studies of reef metabolism indicate that these differences in pH may be influenced by relative abundance of respiring and photosynthesizing organisms, flushing rate of the overlying water mass (and, therefore, the presence and thickness of boundary layers), and the history of the water mass. While this variation in pH complicates our predictions of coral reef response to ocean acidification, it also provides an opportunity to examine community-level responses to pH variation and, further, how communities may respond to future change.

In this ongoing project, we take advantage of natural variation in the pH over small spatial scales in lagoonal reefs and at large scales over the Hawaiian Archipelago to examine how bioeroding communities may respond to ocean acidification and to test the effectiveness of using bioerosion rates and bioeroder communities as indicators of climate change in remote coral reef systems. We include forereef sites to decrease the within-site variation and examine Archipelago-wide patterns. Bioeroder community composition is being assessed using a

combination of taxonomic and molecular techniques in collaboration with the Bishop Museum and Dr. Rob Toonen's laboratory. We are using mass sequencing of communtiy samples ground-truthed by sequences from taxonomically identified organisms.
The specific objectives identified for this project are:
1) Characterize variation in bioeroder community composition within reefs and across the Archipelago using taxonomincally-identified samples and mass sequencing
2) Measure bioerosion rates using microCT technology
a) Compare CaCO3 loss within and between reefs across the Archipelago
b) Measure CaCO3 accretion
3) Evaluate the relationship between pH, bioerosion rate, and bioeroder community composition, controlling for other environmental parameters

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 are a team of conservation biologists, teaching and studying the science of how best to manage and conserve the ecological integrity of marine ecosystems. Therefore, minimizing our impact to the ecosystem we are trying to conserve is a natural and inherent part of any research we conduct within the Monument. It is my goal to inculcate in students and trainees that work with me a respect for the resources that we study. This respect requires that we carefully consider the impact of our study design, that our study design is robust and will produce useful results, and that our work is disseminated to scientists and managers to improve the conservation efforts in these systems. In developing our research methods, we have taken care to minimize any potential negative impacts to the system as outlined in the methods section below. We believe that we have implemented every reasonable safeguard for the natural resources and ecological integrity of the Monument in our research, and we do not expect any detectable impact from our research sampling. 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. As in previous years, each participant is required to participate in a Cultural Briefing prior to departure on the Hi'ialakai. Each member of my team is aware of the unique ecological status of the Monument, and this briefing reminds all team members of the cultural significance of the place. However, this separation of natural, cultural, and historic resources is itself a western construct. Stewardship of natural resources is a central theme in the relationship that Hawaiians have with the natural world and, thus, there is no difference between a natural and cultural resource.

Papahanaumokuakea is a sacred place to native Hawaiians; a place that is included in the oral history of chants and meles; a place where native Hawaiians have travelled for hundreds of years. We strive to approach our work in the Monument with the same humility, wonder, and regard for the natural world as these travelers. We intend that our research in the Monument will give a strong foundation to stewardship practices that best manage and protect the coral reefs ecosystems of Papahanaumokuakea. Native Hawaiians learned when and where important food fish were spawning and, understanding their potential impact on fish populations, protected these times and areas. In a similar way, we will be learning about the bioeroding communities of the Monument and trying to understand and mitigate the impacts of anthropogenic climate change

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?
The research we propose here is the type of research directly mandated by the Proclamation: it is "research designed to further understanding of monument resources and qualities… [and] will assist in the conservation and management of the monument". The research we propose is necessary to both maintain ecosystem integrity and provide for adaptive ecosystem management in the face global climate change. As outlined above and below, our activities have no detectable effect to diminish Monument resources, nor have any known indirect, secondary or cumulative effects on the ecosystem or resources therein. Because of concerns about cumulative impacts, a threat assessment of the activities in the Monument have been conducted (Selkoe et al. 2008), and a compiled cumulative impact threat map of the Monument (Selkoe et al. 2009) has been provided to the co-trustees for use in future management decisions.
Our proposed activities are minimally invasive. On forereefs, coral blocks were attached to permanent transect stakes and CAUs (artificial units that measure accretion rates) with cable ties that were previously installed by NOAA's Coral Reef Ecosystem Division (CRED). On lagoon reefs, coral blocks were attached to dead substrate with marine epoxy, carefully avoiding live coral. Under this permit, the last remaining 10 blocks deployed in Midway would be removed. The small samples of dead coral skeleton (no more than thirty 5x5x5cm samples from each of 21 sites) that we plan to collect from reefs are a tiny fraction of the reef substrate removed naturally by external bioeroders (e.g., urchins, parrotfish). Negative impacts on the reefs, atoll, and Monument are exceedingly small, while the positive impacts of the results of our research are Monument-wide.
Our overriding goal is to provide scientific information to managers so that the Papahanaumokuakea Marine National Monument can be managed and protected based on policy grounded in sound science. Our divers are experienced in moving in and around coral and coral reefs so as to not cause damage. Each diver has been through intensive dive training and is a certified scientific diver with the American Association of Underwater Scientists. We are conducting these activities already in Kane'ohe Bay, allowing us to hone our methods to minimize impacts on the Monument.

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.

There are no alternatives to conducting this activity within the monument. Our research is aimed at understanding how bioerosion processes shift along the Hawaiian Archipelago and it is the reefs in the Monument that will need to be managed. For example, the same information from reefs in the main Hawaiian Islands is interesting – indeed, we are pursuing a similar study in Kaneohe Bay-- but there is no basis upon which to say that the reefs in the Monument are like the Main Hawaiian Island reefs. In fact, we know they are not the same -- Kaneohe Bay has many introduced species that are not present in the Monument.

d. How does the end value of the activity outweigh its adverse impacts on Monument cultural, natural and historic resources, qualities, and ecological integrity?
We anticipate truly negligible impact of our study on the resources of the Monument and, therefore, believe that the end value of this research clearly outweighs that imperceptible impact. Further, an understanding of bioerosion rates across this region will greatly increase the decision making capacity of the co-trustees in dealing with the potential impacts of global climate change within the Monument

e. Explain how the duration of the activity is no longer than necessary to achieve its stated purpose.
It is anticipated that retrieving the remaining coral blocks at Midway will take a half day and that collecting pieces of dead coral skeleton at the FFS, LIS, PHR, and KUR will take 2-3 days per atoll with 2-4 divers. Depending on cruise itineraries, we may need to participate on two cruises to access all of our target sites. As such, the estimated number of days in the monument (50 days) is necessary to accomplish the research goals outlined in this permit application.

f. Provide information demonstrating that you are qualified to conduct and complete the activity and mitigate any potential impacts resulting from its conduct.
Donahue has been an AAUS certified scuba diver and NAUI instructor for 19 years. I have used diving for research and trained others to dive on projects in the Gulf of Maine, California, and Hawaii, including research in other protected areas like the Channel Islands National Park. I have a PhD in Ecology from the University of California, Davis and have publications on marine ecology and spatial population dynamics relevant to this study. This is my fourth permit application for work in the Monument. I was privileged to enter the Monument on the July-August 2011 cruise to deploy/retrieve calcium carbonate blocks for the project outlined in this application and on the May 2010 cruise to support other projects, including Scott Godwin's (PMNM) surveys of invasive species and Rob Toonen's connectivity sampling.
The field PI for the July cruise (anticipating collection at MID, PHR, LIS, FFS, and KUR) is Nyssa Silbiger. She was a field PI on the July-August 2011 and 2012 cruise and also assisted Derek Smith on the May 2010 cruise. Nyssa is a graduate student in my laboratory and an experienced coral reef diver; her masters research was performed at Aquarius, an underwater ocean laboratory located in the Florida Keys National Marine Sanctuary.

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.

The project proposed here is a collaboration between the Donahue (sampling of bioeroders) and Toonen (molecular) laboratories at the Hawaii Institute of Marine Biology, and NOAA CRED (site coordination and environmental data). We have funding through Hawaii SeaGrant for this project.

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.
Our choice of sites will be guided by the vessel and Monument staff while aboard the NOAA vessel Hi'ialakai. We generally 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. The questions we are addressing are central to understanding reef erosion processes and the Monument's response to global climate change. Any negative impacts of our study are minimal and temporary and should not alter the Monument's cultural, natural and historic resources, qualities or ecological integrity. The positive impacts of our study will help guide appropriate stewardship practices to preserve and manage the qualities and integrity of the Monument's cultural and natural and historic resources. Our data is necessary to provide a strong scientific understanding of coral reef ecosystem processes by which proper management protocols can be designed. These data also are invaluable in providing a baseline with which to monitor the success of management efforts.

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 on board NOAA vessel Hi'ialakai

j. Demonstrate that there are no other factors that would make the issuance of a permit for the activity inappropriate.
We will only be doing activities listed on this permit application

8. Procedures/Methods:
There are two aspects to the study(i) measuring bioerosion rates using experimental coral blocks (microCT) and (ii) characterizing the bioeroding community in dead coral substrate (molecular ID).

(i) Measuring Bioerosion rates:
Under this permit, we will complete the bioerosion rate study by retrieving the ten remaining bioerosion blocks deployed at MID in 2011. The bioerosion rates on these blocks will be compared with bioerosion rates from blocks at the same site deployed for just 1 year. We expect to spend a half day at the Midway lagoon site retrieving these remaining 10 blocks.

These blocks act as settling substrate for bioeroders. Prior to deployment, calcium carbonate blocks were scanned using an eXplore CT120 uCT scanner at Cornell University. Micro computer-aided tomography is a powerful technology for visualizing the internal structure of

solid objects. The exceptional resolution of this technology allows for precise examination of coral skeletal density and the size, shape, and location of each bore hole in a given coral block. By performing pre- and post-deployment scans of the coral blocks, we can accurately measure of the amount of CaCO3 removed to calculate bioerosion rate, as well as any accretion of CaCO3 by crustose coralline algae. Pre and post-deployment scans will be aligned and subtracted to show the total volume of lost substrate and the size, shape, and location of excavation sites. Using the blocks retrieved under this permit, we will be able to compare 1-year vs 3-year bioerosion rates at the same site (Midway Lagoon).

(ii) Characterization of the bioeroding community by mass sequencing.
Under this permit, we propose to sample up to 30 small pieces (5x5x5cm) of dead coral skeleton at each of 21 sites (5 each at FFS, LIS, PHR, KUR, and 1 at MID) for a total of 630 small pieces of dead coral skeleton. We expect to take 2-3 days each at FFS, LIS, PHR, and KUR to complete the sampling. These are our planned sampling locations, but we request the flexibility to sample at other locations depending on cruise logistics (total take will not exceed 630 small pieces of dead coral skeleton = 0.079 cubic meters total take). These samples of dead Porites sp. skeleton will be taken using a rock hammer and chisel, taking care to avoid live coral. Shipboard, in the Monument, samples will be stored in vials of >70% ethanol or saturated salt buffer at room temperature and given a unique sample number. Upon return to HIMB, samples will be homogenized to form a slurry and mass sequenced to characterize within and between atoll community diversity for the cyptic bioeroding fauna. The DNA sequences extracted from this slurry will be compared to samples collected under our 2012 permit. These previous samples were sorted and identified taxonomically by Scott Godwin (PMNM) and Holly Bolick (Bishop Museum), and sequenced by Eric Tong in the Toonen lab. These sequences will allow us to identify particular organisms from samples taken for mass sequencing on this permit.

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):

Common name:
We will be collecting pieces of dead Porites spp. skeleton. Dead coral skeleton harbors a diverse community of bioeroding organisms that has not been systematically targeted for study previously in the PMNM. One of the goals of this project is to more thoroughly document the composition of the bioeroding community in the PMNM. Based on studies in the MHI and previous work of the Census of Marine Life, we anticipate a wide variety of sponges and marine

worms, as well as hydrozoans, bryozoans, barnacles, tiny mollusks, and turf algae. We expect a subset of these organisms will settle on our deployed blocks of calcium carbonate. Although we cannot give a specific list of the numbers of individual species we will find in samples, we have attached a list of bioeroders and and other organisms that commonly settle on coral skeleton in Kaneohe Bay, Oahu (based on White 1980 and our own observations) and that we identified from the 2012 PMNM collections.

Scientific name:
dead Porites spp skeleton

& size of specimens:
up to 630 pieces, 5x5x5 cm each (total: 0.079 cubic meters)

Collection location:
30 pieces per site at up to 21 sites

☒ Whole Organism ☒ Partial Organism

9b. What will be done with the specimens after the project has ended?
Preserved samples remain the property of the Monument and will be made available to others requesting access to these materials through the appropriate permit process. PI Donahue will maintain a database of samples and provide for the storage of all samples collected at HIMB until they are consumed by the study or such time as the Monument co-trustees request that they be returned to them. Taxonomic voucher specimens will be submitted for permanent inclusion in the Bishop or Smithsonian museum collections as per the terms of material transfer agreement

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?
Calcium carbonate blocks and samples of dead coral tissue will be preserved for genetic analyses (in ethanol or saturated salt buffer) and transported back to HIMB aboard the R/V Hi'ialakai. See attached MSDS sheets

11. Describe collaborative activities to share samples, reduce duplicative sampling, or duplicative research:
All HIMB researchers working on similar species have coordinated to share samples and avoid duplicate sampling. This project reflects this coordination, as a joint effort between the Donahue and Toonen laboratories at HIMB, and NOAA CRED. HIMB and NOAA monument staff hold semiannual meeting and annual meetings with other agencies working in the monument so that research projects and resources available are widely known. To my knowledge, no other systematic collections of internal bioeroders and measures of bioerosion rates have been made in the Monument.
Anticipated sharing of collections:
Samples of bioeroders in dead Porites spp. skeleton: We anticipate doing most of the sample processing at HIMB, including extracting bioeroding organisms from the samples, most morphological inspection, DNA extraction, and sequencing. We anticipate sharing samples with Holly Bolick at the Bishop Museum[redacted]

12a. List all specialized gear and materials to be used in this activity:
• Divers will use standard open-circuit SCUBA and snorkling equipment.
• We will retrieve calcium carbonate blocks by cutting cable-ties with clippers or a dive knife
• On the ship, samples of dead coral skeleton and calcium carbonate blocks will be placed in plastic containers filled with ethyl alcohol or salt-saturated dimethyl sulfate.

12b. List all Hazardous Materials you propose to take to and use within the Monument:
Tissue preservative solutions for DNA analyses include: 95% ethanol (EtOH) and saturated salt buffer with dimethylsulfoxide (DMSO). MSDS sheets attached

13. Describe any fixed installations and instrumentation proposed to be set in the Monument:
In 2011, a total of 95 calcium carbonate blocks were attached to CAUs with cable ties or to bare rock with marine epoxy. In 2012, we removed all but 10 blocks deployed in 2011. In 2012 we also deployed 25 blocks at Kure Atoll, which were removed in 2013. We are requesting to remove the last 10 blocks that were fixed onto bare substrate at Midway atoll.

14. Provide a time line for sample analysis, data analysis, write-up and publication of information:
Analysis of bioeroders in the pieces of dead coral skeleton will take up to a year, as it requires

DNA extraction and sequencing and running the entire sample using a bioinformatics approach. We anticipate that extraction of organisms, and DNA extraction and sequencing will take place within one year of returning from the cruise. Once the calcium carbonate blocks are retrieved in August, 2014, we will immediately send them to the microCT laboratory at Cornell University to be scanned. All blocks collected from previous cruises have already been scanned and are currently being analyzed for bioerosion rates.
The molecular analysis of bioeroder communities in environmental samples of dead coral skeleton will be completed and submitted for publication within two years of the cruise. Analysis of bioerosion rates and community composition based on taxonomy is underway from prior collections and will be completed within 1 years of this cruise. Regardless of the time to publication, the results from these studies are made available to Monument managers as quickly as possible through semi-annual reports and ongoing coorperation with 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 one year of the data being collected

15. List all Applicants' publications directly related to the proposed project:
Guadayol O, NJ Silbiger, MJ Donahue, FI Thomas. 2014. Patterns in temporal variability of pH, temperature and oxygen along an environmental gradient across a coral reef. PLOS One 9.1: e85213.
Silbiger NJ, O Guadayol, FI Thomas, MJ Donahue. Submitted. Reefs shift from net accretion to erosion with rising ocean acidity.

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