

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: DONALD C. POTTS

Affiliation: Institute of Marine Sciences, University of California, Santa Cruz

Permit Category: Research

Proposed Activity Dates: 1 June 2010 - 31 December 2015

Proposed Method of Entry (Vessel/Plane): USFWS Charter flights from/to Honolulu

Proposed Locations: Multiple shallow sites (<35 m) on and around Midway Atoll

Estimated number of individuals (including Applicant) to be covered under this permit:

Variable: 2-8 people at any one time

Estimated number of days in the Monument:

Up to 300 person days per year

Description of proposed activities: (complete these sentences):

a.) The proposed activity would...

... continue an integrated, multi-disciplinary, 6-year program of biological, geological, oceanographic and hydrological studies that began in 2005 involving: surveys, coral ecology, community dynamics, habitat monitoring, reef growth, sediments, reef history, cyanobacteria monitoring, large bivalve monitoring, groundwater discharge.

b.) To accomplish this activity we would

... conduct 9 specific activities involving direct field observations; habitat monitoring by regular field observations and instruments; experiments to quantify key rates of processes affecting reef growth and reef degradation; identification and monitoring of bio-indicators; collection of biological and geological samples necessary for identification, classification, or physical and chemical analyses; and assessment of changes since human contact began in the 19th century. The specific rationale, methods and equipment of the studies are described in the attached Detail sheets.

c.) This activity would help the Monument by ...

... Creating and then building on detailed baseline knowledge of Midway's physical structure and its ecosystem processes, and of variation among and within critical habitats. Our monitoring includes potential "early warning" bio-indicators of environmental change or physiological stress (e.g. coral bleaching, cyanobacterial blooms, diseases, and algal blooms). The experiments will quantify the rates of responses when particular factors are altered, while also giving better understanding of key interactions shaping reef communities and ecosystems. These studies will assist the Monument managers in determining causes of reef deterioration, study strategies to protect the resource from further damage, and explore ways to enhance long-term sustainability of the Midway Atoll National Wildlife Refuge.

Other information or background:

NEW This application is for renewal of nine activities conducted previously as parts of permit PMNM-2008-065 that expired on 31 December 2009. Most of the text is identical to that in our 2008 permit application, with two main exceptions: we have deleted text about some activities that will not be continued under this permit; and we have updated some factual details to reflect 2010 conditions. We have also made some minor editorial changes for clarity and consistency.

NEW Paragraphs beginning with "NEW" indicate material that was not in the 2008 application.

NEW No work was done under permit PMNM-2008-065 in 2008 because it was issued late in the year (October), after we had left Midway. The nine activities were all severely curtailed or cancelled in 2009, due to massive cost increases caused by the global, national, state and university financial crises which forced us to abandon our field season nearly two months earlier than planned. We have made substantial changes in budget allocations for 2010 and beyond to alleviate this problem. The following table lists the nine activities, with their item numbers from PMNM-2008-065 (in parentheses), and with new numbers that give the sequence of treatment in this application.

ITEM		
New#	2008(#)	ACTIVITY
1	(4)	Monitoring: Permanent Transects
2	(5)	Sampling: Coral Reproductive Tissues
3	(6)	Monitoring: Settlement Tiles
4	(8)	Monitoring: Underwater Video
5	(9)	Monitoring: Reef Growth
6	(10)	Sampling: Urchin and Starfish Skeletons
7	(11)	Experiment: RubbleTransport
8	(12)	Sampling: Short Reef Cores
9	(13)	Sampling: Long Coral Cores

The overall project began in 2005 to provide a sound scientific basis for management of Midway Atoll within the PMNM. In 2005, the Mitsubishi Corporation (Tokyo) agreed to

provide stable funding of \$100,000 per year for 5 years. Among PMNM reefs, Midway Atoll is particularly vulnerable to environmental change for several reasons:

1. It lies at or near Grigg's (1982) "Darwin Point" (28-29 N). This is the latitude north of which rates of erosion, sediment export and subsidence exceed rates of carbonate accretion, sediment deposition and reef growth, and reefs are expected to degrade into submerged banks.

2. It is ecologically as well as latitudinally marginal. Many reef-building species (e.g. corals, coralline algae) appear to have poor recruitment, slow growth, poor survival, small populations and limited distributions among habitats. Conversely, bio-eroding species (e.g. fish, sea urchins) are abundant, widely distributed, and appear to have good recruitment.

3. It has been greatly modified by dredging, cutting a shipping channel through the reef margin, island expansion and construction of many kinds. These have almost certainly altered lagoon water levels and residence times; increased current strengths and wave energy in some habitats; increased sediment movement, scouring, and export from the reef; and probably continue to contribute directly or indirectly to habitat degradation (e.g. compared to the largely unmodified Kure Atoll) over much of the lagoon and backreef habitats.

4. It is exposed to major seasonal and other habitat variations because it lies in the steep climatic and oceanographic gradients between the warm equatorial systems (i.e. tradewind zone) and the cooler North Pacific gyral system (NW winds and storms).

5. Imposed on all of these stressors, are the multiple effects of increasing atmospheric and dissolved CO₂ being expressed as sea-level rise, climate changes (temperature, precipitation, winds, storms), oceanographic changes (currents, upwelling), and ocean acidification. Existing climatic models lack the regional resolution to predict probable future climatic and oceanographic conditions at Midway Atoll, but transition zones are likely to become relatively unstable with strong impacts. In addition, rates of CO₂ increase, sea-level rise, and ocean acidification already are exceeding those assumed for many of the IPCC (2007) projections, suggesting that consequences of climate change will affect Midway earlier rather than later.

This application builds on work begun in 2005 under USFWS permits and continued under permits PMNM-2007-013, PMNM-2008-056a, PMNM-2008-056b, PMNM-2008-065 and PMNM-2009-040.

Section A - Applicant Information

1. Applicant

Name (last, first, middle initial): Potts, Donald, C.

Title: Professor of Biology

1a. Intended field Principal Investigator (See instructions for more information):

Potts, Donald C. (Applicant)

Cover, Wendy, Ph.D. student, University of California, Santa Cruz

McCully, Kristin Ph.D. student, University of California, Santa Cruz

Warner, Anne B. Ph.D. student, University of California, Santa Cruz

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

Institute of Marine Sciences

Phone: Office: [redacted] Lab: [redacted] Cell: [redacted]

Fax: [redacted]

Email: [redacted]

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

3. Affiliation (institution/agency/organization directly related to the proposed project):

Institute of Marine Sciences (IMS), and
Center for the Development and Evolution of the Land-Sea Interface (CDELSI)
University of California, Santa Cruz

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):

Participants will be drawn from the following pool. All UCSC personnel are AAUS certified research divers and DOI-qualified motor boat operators:

Wendy Cover	UCSC Ph.D. student (Ecology & Evolutionary Biology)	[REDACTED]
Helen O'Brien	UCSC Ph.D. student (Ecology & Evolutionary Biology)	[REDACTED]
Kristin McCully	UCSC Ph.D. student (Ecology & Evolutionary Biology)	[REDACTED]
Rachel Fabian	UCSC Ph.D. student (Ocean Sciences)	[REDACTED]
Warner, Anne B.	UCSC Ph.D. student (Ocean Sciences)	[REDACTED]
Dennis Hubbard	Professor of Geology, Oberlin College OH (sedimentologist)	[REDACTED]

Up to 5 Volunteers per year (from Mitsubishi International Corporation) - to be named

Section B: Project Information

5a. Project location(s):

- | | | | |
|---|--|---|-------------------------------------|
| <input type="checkbox"/> Nihoa Island | <input type="checkbox"/> Land-based | <input type="checkbox"/> Shallow water | <input type="checkbox"/> Deep water |
| <input type="checkbox"/> Necker Island (Mokumanamana) | <input type="checkbox"/> Land-based | <input type="checkbox"/> Shallow water | <input type="checkbox"/> Deep water |
| <input type="checkbox"/> French Frigate Shoals | <input type="checkbox"/> Land-based | <input type="checkbox"/> Shallow water | <input type="checkbox"/> Deep water |
| <input type="checkbox"/> Gardner Pinnacles | <input type="checkbox"/> Land-based | <input type="checkbox"/> Shallow water | <input type="checkbox"/> Deep water |
| <input type="checkbox"/> Maro Reef | | | |
| <input type="checkbox"/> Laysan Island | <input type="checkbox"/> Land-based | <input type="checkbox"/> Shallow water | <input type="checkbox"/> Deep water |
| <input type="checkbox"/> Lisianski Island, Neva Shoal | <input type="checkbox"/> Land-based | <input type="checkbox"/> Shallow water | <input type="checkbox"/> Deep water |
| <input type="checkbox"/> Pearl and Hermes Atoll | <input type="checkbox"/> Land-based | <input type="checkbox"/> Shallow water | <input type="checkbox"/> Deep water |
| <input checked="" type="checkbox"/> Midway Atoll | <input checked="" type="checkbox"/> Land-based | <input checked="" type="checkbox"/> Shallow water | <input type="checkbox"/> Deep water |
| <input type="checkbox"/> Kure Atoll | <input type="checkbox"/> Land-based | <input type="checkbox"/> Shallow water | <input type="checkbox"/> Deep water |
| <input type="checkbox"/> Other | | | |

Ocean Based

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

Location Description:

Multiple sites spanning the main habitats (reef margins, forereef, backreef, lagoon, harbors, beaches) in water depths of 0 - 35 m. strategically positioned to give statistically valid representation of all major habitats. Specific locations of individual activities are given in maps included in the attached Detail sheets for each activity.

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:*

The central goal of all of our activities is to provide a sound scientific basis for management of Midway Atoll as a PMNM unit by:

1. Testing the hypothesis that Midway Atoll can persist as a sustainable physical and biological system during global and regional environmental changes over the next century, and despite its history of severe disturbance and modification.
2. Developing and testing management procedures to enhance sustainability by reducing some adverse impacts of past and future environmental changes or by stimulating positive effects.

The sustainability of Midway Atoll depends on maintaining the long-term physical and biological health of its marine ecosystems, and enhancing its sustainability is essential for the future development, management, public access and supervision of the entire PMNM.

Collectively, our activities form a multi-disciplinary approach that addresses the most immediate issues likely to affect corals, coralline algae, and reefs today, or in the near future. Our main goals are to:

1. Describe "baselines" for present patterns and processes (biological and physical) affecting the balance between reef growth and reef destruction in each major habitat at Midway Atoll.
2. Identify continuing physical and ecological consequences of previous anthropogenic modifications (e.g. dredging, channeling, construction, metallic debris).
3. Detect climatic and oceanographic changes, and explore likely consequences in each habitat.
4. Model each habitat over the next 10, 25, 50, 100 years as a biological, geological, physical and chemical system, while incorporating IPCC (2007) and similar projections.
5. Advise the USFWS and PMNM about management practices that may enhance the sustainability of Midway Atoll as a viable coral reef ecosystem.

All of our activities address responses to the major environmental changes identified in the recent Inter-Governmental Panel on Climate Change report (IPCC 2007) as most likely to affect coral reefs in coming decades (i.e. sea-level rise, increasing water temperature, altered prevailing wind and storm patterns, modified surface circulations and upwelling, declining ocean pH, changing ecological relationships among species).

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?

All work will be done in conformity with PMNM, USFWS, Midway Atoll NWR, UCSC, and OSHA regulations and standards, and with continuing discussions with Midway NWR and PMNM staff.

We will avoid known historical and archeological sites, and locations of special conservation significance. When collecting sediment samples, we try to avoid sites with visible or suspected anthropogenic materials. All participants have been briefed formally about archeological or historical artifacts and are very sensitive to the issue. No artifacts are disturbed. Numbers and sizes of samples are the minimum necessary to be scientifically and statistically valid, and they will be located to avoid adverse impacts on other aspects of the site. Research is conducted with materials constructed of non-corrosable materials (e.g. plastics, marine grade stainless steel) and will be located on non-living surfaces, or on sand or rubble bottoms, and anchored securely to prevent entanglement or movement by wind, waves or currents. All markers are as small as technically possible. All markers are removed at the conclusion of the research.

A minimum number of cores will be taken and all holes will be plugged to prevent erosion and allow for coral regrowth over the small area removed. Tissue samples taken from corals will be small, and the knowledge gained about coral reproductive timing will make monitoring future coral recruitment and evaluating the population status of corals much easier and less invasive, and will be essential to coral restoration efforts. This far outweighs the small samples of coral tissue that will be necessary for evaluating reproductive state.

The findings from this research will all serve to protect the ecological integrity of the Monument.

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 ultimate goal is to provide information directly relevant to the management of marine environments at Midway Atoll, and all activities are designed with this in mind. Any impacts will be small and very localized compared to ongoing anthropogenic disturbances; but every site will be monitored for unanticipated impacts. All markers and experimental materials will be removed as soon as they are no longer needed.

Midway Atoll is an ecologically and latitudinally marginal reef in which many habitats (e.g. much of the lagoon and backreef) appear to be degrading under intense bio-erosion (by urchins and fish) and high sediment movement - at least the latter is probably associated with the mid-20th century modifications. It is not obvious whether the reef as a whole will continue to

degrade or will be rejuvenated by projected changes in sea level, climate, oceanography and ocean chemistry. Our work is directed at understanding key ecological and physical processes acting on the reef today, and then exploring how they are likely to respond to future changes. Management options that may enhance sustainability will be assessed by integrating information from each habitat into models of the entire atoll. Our results will be relevant to changes affecting other NWHI atolls, as well as to reefs in other parts of the Pacific. This research will enhance the knowledge and understanding of current and past climatic, oceanographic and human impacts on the reef system. It will also provide early warning indicators of environmental stress, identify impacts and locations of pollutants, and provide advanced techniques for monitoring concentrations of cyanobacteria and other organisms on reefs through satellite imagery.

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.

No other site in the world has similar high latitude reefs with relatively intact food chains. While Kure Atoll is the most similar in terms of setting, it lacks the infrastructure and access of Midway, and was outside NWR jurisdiction when our program began. Because of Midway's unique history of isolation, high endemism, and history of intense anthropogenic disturbance, extrapolations to Midway from reefs outside the PMNM are likely to have limited usefulness. Therefore, work must be done in the NWHI, and the infrastructure available at Midway means that activities can be done efficiently and with minimal additional impacts.

No other site in the world has the same water chemistry, oceanography, organism densities and history of anthropogenic disturbance as Midway. These studies must be conducted in this location due to the probable persistent effects of such disturbances as blasting and dredging on the reef, local nutrient inputs, and the high urchin densities in this particular reef system.

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

Our core questions are: Can Midway Atoll persist as a viable coral reef ecosystem? And if so, can some processes be managed to maximize its sustainability? Any adverse impacts of these studies will be very small and ephemeral compared to the changes that will undoubtedly occur if no attempt is made to ameliorate them. Our findings will be also be relevant to other reefs in the PMNM and beyond, and knowledge probably can be transferred to other reefs without having to repeat such extensive studies elsewhere.

The findings from these studies will provide essential data to the continued health of the reef at Midway. Questions about the overall health and long-term sustainability of this system are all ones that this study will help to answer.

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

Regional to global changes will continue for decades, if not centuries, and multi-year projects are essential to measure rates of change, understand their dynamics and consequences, and document patterns of variation within and between sites and years. We will continually re-evaluate data and circumstances; and may terminate some projects, extend others, or initiate new ones as we learn about the system.

NEW We originally planned 6 years of activities (2005-2011). We always expected to continue some activities into 2010 and 2011, and we were unable to complete many activities in 2009 for three reasons:

1. Permit 2008-065 was issued too late in the year (October) for us to conduct any of its activities during the 2008 field program.
2. The financial crises beginning in late 2008 led to massive cost increases (from 50% to over 110%) in all parts of our budget. Collectively they forced us to truncate the field season in early August 2009, instead of its planned ending in late September. This forced us to greatly curtail, or defer entirely, many activities.
3. Our findings so far have led us to shift some effort to new activities, and to seek other permits for them: e.g. pearl oyster growth experiments (2009-040); long sediment cores and atoll disturbance history (2010-035); and restoration of *Porites compressa* patch reefs (2010-036).

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

Dr. Potts has studied the ecology and evolution of corals and reefs for over 30 years (mainly in Australia, Papua New Guinea, Hawaii), and various aspects of reef paleo-ecology, past climates and geological processes for about 15 years (in Papua New Guinea, Hawaii). He has worked on Midway Atoll in every year since 2002 (except 2004). He has been active in national and international marine science and biodiversity policy for ca. 15 years (see CV).

Graduate student Wendy Cover worked on Niue in the South Pacific for two years before becoming a Ph.D. student in marine ecology; she is now in her sixth year of research at Midway.

Graduate student Kristin McCully is now in her fourth year of Ph.D. research at Midway Atoll. She has also worked on reefs in Australia, French Polynesia and Hawaii.

Graduate student Anne Warner is starting her third year of work on Midway Atoll, has training in both biology and geology, and has a strong background in reef sedimentology.

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.

Core funding comes from the Mitsubishi Corporation (Tokyo) under their Social Responsibility Program. These funds are committed for 5 years (2006-2011) at \$100,000 a year. Our Midway work is one of three complementary projects forming the Mitsubishi Corporation's Global Coral Reef Conservation Project (other sites are in the Seychelles and the Ryukus). Refunding the program will be discussed during 2010.

. The Regents of the University of California maintain programs of self-insurance for liability of the Regents and claims of bodily injury, property damage, or personal injury resulting from the acts or omissions of its employees acting within the course and scope of their employment as defined by the California Tort Claims Act.

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.

All methods are either standard ecological and geological techniques widely used by reef scientists, or are small-scale, largely non-invasive, technological advances designed to provide maximum information with minimum disturbance. All methods have been discussed with USFWS scientists (e.g. John Klavitter and Jim Maragos) and discussions will continue throughout the work. Some experiments are necessary because experiments are the only way to dissect out and quantify interacting processes, such as concurrent coral growth and reef bioerosion. These experiments use common species at sites where they are abundant, and individual samples will be as small as possible to minimize impacts on surrounding organisms. We avoid rare species or unusual locations, and use mitigation methods wherever possible (e.g. concrete plugs to fill core holes). We take the minimum number of samples consistent with sound statistical analysis, and we discuss locations and details of each activity with Midway NWR management before beginning field work.

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 use Midway Atoll NWR's small boats, and we follow both USFWS and UCSC boating regulations and procedures.

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

None known

8. Procedures/Methods:

NEW We are requesting approval to continue nine activities previously approved but not completed under permit PMNM-2008-065.

New#	ACTIVITY
1	Monitoring: Permanent Transects
2	Sampling: Coral Reproductive Tissues
3	Monitoring: Settlement Tiles
4	Monitoring: Underwater Video

- 5 Monitoring: Reef growth
- 6 Sampling: Urchin and Starfish Skeletons
- 7 Experiment: Rubble Transport
- 8 Sampling: Short Reef Cores
- 9 Sampling: Long Coral Cores

See attached Detail sheets for procedures and methods specific to each activity. The following general notes apply to all nine activities.

A. All numbers of samples, objects or installations are estimated maximum numbers; actual numbers may be lower, depending on field priorities, weather and water conditions, schedules, and availability of people, boats or additional funds.

1

B. We use USFWS boats (usually an 18' whaler), diving support, and workspace, but do not require participation by USFWS or PMNM staff. Most existing sites are on or near shallow or emergent reef margins, reef crests, backreef flats or in the shallow lagoon. We work from small boats, and anchor on sand or rubble near the sites. Most work is at shallow sites and is completed by snorkel, or sometimes by walking on the exposed reef margin (we do not step on or damage any living organisms while walking). Sites on the forereef and in deeper parts of the lagoon and harbor require SCUBA. A few sites close to the island may be reached by snorkeling from the beach.

C. Sites are selected and field methods designed and deployed in consultation with the Resident Biologist and other Midway NWR staff, while paying particular attention to avoid sites, activities, or designs that might adversely impact monk seals, green turtles or other species of concern.

D. All markers (e.g. stakes, pins, tags, buoys), experimental materials (e.g. tiles, cages, fences, ropes, lines) and fastenings (e.g. nails, bolts, screws, epoxy putty, cable ties) are of the smallest practical size, are composed of non-toxic and non-corroding materials (e.g. plastics, 316 stainless steel, epoxies), and will be removed as soon as they are no longer needed.

E. Stainless steel nails, screws, bolts and stakes are set into holes drilled into bare rock with a hand-held air drill powered from a Scuba tank. Plastic anchors or epoxy putty are used in the holes for greater security.

F. The location of every site, and of every activity, sample or data collection point is recorded by a hand-held GPS unit and will be plotted on maps or images of the reef.

G. Wherever possible, every sampling or data collection point is photographed by digital camera.

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:

1. Corals: Lace coral
Antler coral
Lobed coral
Finger coral
Rice coral
Blue rice coral
2. Sea urchins (up to 15 species)
Starfish (up to 15 species)
3. Short reef cores
4. Long coral cores - Lobed coral/Evermann's coral/Duerden's coral

Scientific name:

1. Corals: Pocillopora damicornis
Pocillopora ligulata/meandrina
Porites lobata
Porites compressa
Montipora capitata
Montipora flabellata
2. Sea urchins TBD - up to 15 species
Starfish TBD - up to 15 species
3. Short cores N/A
4. Long cores , Porites lobata, P. evermanni, P. duerdeni).

& size of specimens:

1. Corals Up to 90 every 2 weeks; 1-2 cm of skeleton + tissue
2. Sea urchins 2 adults per species - up to 15 species
Starfish 2 adults per species - up to 15 species
3. Short cores up to 100; ~3 cm diameter x ~10 cm long

4. Long cores up to 3 cores; 5-10 cm diameter x ~1 m long

Collection location:

See maps in attached Detail sheets

Whole Organism Partial Organism

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

1. The main collections will be deposited in the Bishop Museum in Honolulu.
2. Duplicate material will be offered to other museums with strong central Pacific collections (e.g. California Academy of Sciences, Smithsonian Institution).
3. Unused material and working samples unsuitable for museum deposition will be retained at UCSC for future research and teaching, and will be available to other researchers.

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

Some individuals may be brought alive to aquaria in the Boat House, for short periods for observation, photographing, or processing as specimens.

- General site/location for collections:

Boat House

- Is it an open or closed system? Open Closed

- Is there an outfall? Yes No

Water and remaining organisms will be disposed of on land in a place exposed to direct sunlight to sterilize them and prevent return of possible pathogens to the sea.

- Will these organisms be housed with other organisms? If so, what are the other organisms?
NO

- Will organisms be released?
Whenever possible

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

USFWS charter flights to Honolulu. Most material will be dried (corals, sediments, coralline algae). Tissue samples will be preserved in alcohol or formalin. These specimens will be shipped in a damp state in sealed containers or plastic bags, after most fluids have been drained from the containers and disposed of following USFWS requirements at Midway. Some samples may be shipped to Honolulu on cargo flights or barges, following FAA, UCSC and any other relevant regulations.

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

We are very interested in complementary or collaborative work with other researchers and agencies to provide the best collective information and advice to the PMNM and USFWS about the feasibility of field-tested management options. We have frequently discussed possible new collaborations with John Klavitter and Matthew Brown at Midway Atoll NWR.

My students and I have collaborated with Dr. J.E. Maragos (USFWS, Honolulu) on a number of reef projects in the NWHI and Remote Island NWRs in other parts of the Pacific over the last 10 years, and he helps us remain aware of potential collaborations in the region.

Within the last 12 months, we have been in active communication with:

1. Dr. R. Toonen (University of Hawaii, Manoa) about sharing or joint collection of coral samples at Midway.
2. Dr. R. Brainard, Dr. R.K. Hoeke, Dr. K. Wong and Dr. O. Vetter (all NOAA/CRED) about sharing responsibility for maintaining data loggers and experiments in complementary sites.
3. Dr. J. Maragos (USFWS, Honolulu) about complementing his sites and monitoring programs concentrating on corals at Midway and elsewhere.
4. Dr. Lee Ann Woodward (USFWS, Honolulu) about complementary groundwater studies.
5. Dr. E. DeMartini (NOAA Fisheries Pacific Islands Fisheries Science Center) and Dr. A. Friedlander (Oceanic Institute) about linking their fish monitoring data and our data on bio-erosion and other ecological processes.
6. Dr. G. Aeby (Hawai'i Institute Marine Biology) about standardizing our bio-indicator surveys to use similar methods so that our data will complement other work on coral diseases in the PMNM.
7. Over the last year we have also talked to other individuals in the University of Hawaii, USGS, NOAA and HURL about possible areas of overlapping interest.
8. We plan to place all data in public, online depositories, presumably at NOAA sites, after taking advice from the PMNM about the most appropriate depositories.

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

1. All team members will use snorkeling equipment (mask, snorkel, fins, wetsuit), and the UCSC personnel will also have a full set of SCUBA gear (BC, dive computer, safety equipment). Tanks and weight-belts will be supplied by the USFWS at Midway.

2. We will be working primarily from small boats; with some beach entries from beaches open to the public.

3. Most organisms and samples will be collected by hand. Where necessary we will use a hammer and chisel on hard substrates.

4. Small cores (3 cm diameter; up to 10 cm long) of limestone, coralline algae, or coral will be taken with hand-held corers mounted in pneumatic drills and powered from a SCUBA tank.

5. Three long cores (3 -10 cm diameter; 10-100 cm long) will be taken from live corals in three habitats to determine their ages and past growth rates (X-rays) and to analyze for isotopic proxies of environmental variables (e.g. temperature, productivity, pH, N-fixation), and for residues of possible organic and inorganic pollutants.

6. Other equipment includes an underwater video system with 2 infrared lamps; assorted hand tools; electronic balances; small laboratory items; laptop computers; cameras, etc.

7. Field supplies and equipment for marking monitoring sites and attaching experimental items (e.g. metal stakes, nails, screws, bolts, nuts, washers) will usually be marine-grade stainless steel (SS316). Cages will be made of plastic or steel mesh on plastic or steel frames. Various epoxy cements will be used for attachments in experiments. Field equipment also includes: buckets, hammers, chisels, pneumatic drills and corers, etc.

When not in use, all material will be stored on Midway Atoll in the USFWS offices or the Boat House.

Field items will be recovered as soon as they are no longer needed, and cleaned and stored for re-use (wherever possible).

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

Small amounts of the following are already on Midway Atoll, stored in USFWS chemical cabinets. An MSDS for each was submitted with the application for Permit PMNM-2007-013. Small quantities of formalin and ethanol will be used for preservation of tissue samples. Chemicals remaining at the end of the project will be removed, disposed of, or donated to the USFWS - following consultation with USFWS staff.

Formaldehyde

Ethanol

Nitric acid

Hydrochloric acid

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

Stainless steel screws, bolts and stakes for marking sites, establishing reef growth station, and attaching coral settlement tiles.

All items will be installed, maintained and removed when no longer needed by UCSC personnel. A global positioning system (GPS) inventory is being maintained for all items and

materials placed on the reef, including such information as latitude and longitude, depth, type of material, site number, date installed, date removed, dates checked, and other notes. Images are also available for most items.

Installations and their locations described in the Detail sheets (attached).

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

We are continuing analyses of 2007-2009 data and samples. Laboratory chemical and morphological analyses of water and sediment samples should be completed by mid 2010. We anticipate that each year's samples will be analyzed by the spring of the following year, in time to inform the next summer's field work.

We will prepare annual reports as required for PMNM, USFWS, UCSC and the Mitsubishi Corporation. We expect to submit at least four manuscripts papers to peer-reviewed scientific journals during 2010, followed by 2-4 papers annually after that. We typically give papers at several conferences each year, with a major set of presentations scheduled for the 12th International Coral Reef Symposium in Australia in 2012

We maintain a webpage and a blog, and also expect to produce several kinds of material suitable for public outreach and K-12 educational programs in collaboration with the USFWS and UCSC's Marine Laboratory.

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

Arledge, R.K., Hatcher, E.B. (2008). Investigating the effects of higher spatial resolution on benthic classification accuracy at Midway Atoll. M.S. Thesis. Naval Postgraduate School, Monterey, CA. iv + 125 pp.

Blankenship, J.R. (2006). Assessing the ability of hyperspectral data to detect *Lyngbya* spp.: a potential biological indicator for presence of metal objects in the littoral environment. M.S. Thesis. Naval Postgraduate School, Monterey CA. xviii + 241 pp.

Camacho, M.A. (2006). Depth analysis of Midway Atoll using QuickBird multi-spectral imaging over variable substrates. M.S. Thesis. Naval Postgraduate School. Monterey CA.

Cover, W.A. (2010). Direct negative impacts of sea urchins, *Echinometra mathaei*, on live corals. MS in preparation.

Maragos, J. E., Potts, D.C., Aeby, G., Gulko, D., Kenyon, J., Siciliano, D., VanRavenswaay, D. (2004). 2000-2002 rapid ecological assessment of corals Anthozoa on shallow reefs of the Northwestern Hawaiian Islands. Part 1: Species and distribution. *Pacific Science* 58: 21230.

Siciliano, D. (2005). Latitudinal limits to coral reef accretion: testing the Darwin point hypothesis at Kure Atoll, Northwestern Hawaiian Islands, using new evidence from high resolution remote sensing and in situ data., Ph.D. Dissertation, University California, Santa Cruz.

Vroom, P.S., Asher, J., Braun, C.L., Coccagna, E., Vetter, O.J., Cover, W.A., McCully, K.M., Potts, D.C., Vanderlip, A.M., Vanderlip, C. (2009). Macroalgal *Boodlea composita* bloom at Kure and Midway Atolls, Northwestern Hawaiian Islands. *Botanica Marina* 52: 36363.

Warner, A. (2009). Sediment production and distribution at Midway Atoll. Undergraduate Honors Thesis, Oberlin College.

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