

**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:  
NOAA/Inouye Regional Center  
NOS/ONMS/PMNM/Attn: Permit Coordinator  
1845 Wasp Blvd, Building 176  
Honolulu, HI 96818  
nwhipermit@noaa.gov  
PHONE: (808) 725-5800    FAX: (808) 455-3093

**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:** Carl G. Meyer

**Affiliation:** Hawaii Institute of Marine Biology

**Permit Category:** Research

**Proposed Activity Dates:** May 1st-Oct 30 2015

**Proposed Method of Entry (Vessel/Plane):** Vessel Hi'ialakai

**Proposed Locations:** Necker, Nihoa, French Frigate Shoals, Gardner Pinnacles, Maro Reef, Lisianski, Laysan, Pearl & Hermes Reef, Midway, Kure

**Estimated number of individuals (including Applicant) to be covered under this permit:** 8

**Estimated number of days in the Monument:** 70

**Description of proposed activities:** (complete these sentences):

a.) The proposed activity would...

Quantify the movements and trophic ecology of top predators (sharks and large fishes) in the Monument to: (1) improve our broad understanding of Monument ecology, (2) further elucidate the role of deep reefs in the ecology of Monument predators, and (3) enhance our understanding of food web dynamics in the Monument (4) enhance our understanding of the drivers of marine herbivory in the Monument and elsewhere.

b.) To accomplish this activity we would ....

Capture and equip top predators with electronic tags and small video cameras, and monitor their movements using acoustic receivers (deployed on the sea floor). Collect small, non-lethal tissue samples from top predators for chemical analysis to determine feeding habits. Collect reference isotopic samples from deep and shallow reefs by: (1) lethal sampling of up to 240 reef fishes (collected via 3-prong pole spear). These reference samples will be used to determine the trophic position and feeding location of predators, and clarify the foodweb baseline in Monument locations. (2) quantify digestive enzyme activity in herbivorous fishes along a latitudinal and vertical gradient. (3) assess digestability of algae between shallow and mesophotic reefs

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

Our research will provide Monument managers with information on the movements patterns and feeding habitats of culturally and ecologically important top predators, and clarify the relative contributions of herbivory and planktivory to Monument food webs supporting these predators. Our most recent published research suggests individual dietary specialization among predators, with individuals from the same species feeding on different prey types. We will be further investigating individual specialization in diet for sharks and ulua to provide managers with a more in-depth understanding of how top predators influence Monument food webs. We will also continue to provide new information on the importance of a poorly-understood habitat type (mesophotic deep reefs) in the Monument, to the ecology of top predators. Our research will also provide insight as to potential drivers of the presence of herbivorous fishes in the monument. Herbivores are abundant on some mesophotic reefs (e.g. FFS) but virtually absent on others (PHR), yet the reasons for these differences are unknown.

**Other information or background:**

Our research has minimal impact on monument resources. Sharks and other predators are captured, tagged and released at their capture locations. Our listening stations (acoustic receiver + moorings) are designed to have minimal substrate impact and leave nothing behind when they are removed. We are requesting to lethally sample no more than 240 individuals from the most common species of reef fishes.

## **Section A - Applicant Information**

### **1. Applicant**

Name (last, first, middle initial): Meyer, Carl, G.

Title: Assistant Researcher

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

Carl Meyer

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

[REDACTED]  
[REDACTED]  
[REDACTED]  
[REDACTED]

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

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

University of Hawaii, Hawaii Institute of Marine Biology

#### **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):**

Yannis Papastamatiou, Co-collaborator, Research Diver, Field Biologist

Mark Royer, Co-collaborator, Research Diver, Field Biologist

Danny Coffey, Co-collaborator, Research Diver, Field Biologist

James Anderson, Co-collaborator, Research Diver, Field Biologist

TBD

TBD

TBD

**Section B: Project Information**

**5a. Project location(s):**

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

Remaining ashore on any island or atoll (with the exception of Midway & Kure Atolls and Field Camp staff on other islands/atolls) between sunset and sunrise.

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

Location Description:

Fishing/Tagging

Fish capture and tagging will be carried out from small vessels (launched from a mother ship) and will occur in the shallow waters around the Monument locations listed above.

Receiver Deployment and Recovery

A total of 24 receivers are currently deployed at 3 islands/atolls in the Monument (Appendix 1). Our goal is to service and redeploy these existing receivers to provide continued monitoring coverage within the Monument.

Reef fish collection

Up to 240 reef fishes will be collected using pole spears in shallow waters and on mesophotic reefs (depth 150-300ft) at FFS, PHR, MID, KUR.

Algal Collection

We will collect algal samples from mesophotic and shallow reefs at FFS, PHR, MID, KUR. We will fill one ziplock bag (1 gallon) on shallow and mesophotic reefs at each of those locations

**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:***

(a) Purpose of proposed activities

The purpose of this research is to provide managers with empirical data on top predator movement patterns and feeding habitats in Monument waters. This information will provide managers with a clearer understanding of the role top predators play in food web dynamics in Monument waters. We have the following specific goals and objectives;

1. Download 24 underwater receivers currently stationed in the Monument to retrieve stored movement data from 267 top predators tagged with acoustic transmitters from 2008 to 2014.
2. Determine how widely these animals have ranged since Fall 2014 and identify their patterns of movement.
3. Equip up to 160 additional ulua and Galapagos sharks (20 of each species at FFS, PHR, MID, and KUR) with pressure-sensor acoustic transmitters detectable by our listening array. These tag deployments will enable us to further clarify ‘upslope-downslope’ movements between shallow and mesophotic habitats by abundant monument predators.
4. Equip up to 5 ulua and 5 Galapagos sharks at FFS/PHR/MID/KUR with tri-axial accelerometers and digital camera data loggers to provide high resolution information on swimming patterns, habitat use and feeding.
5. Collect small samples of muscle tissue from predators (ulua, galapagos sharks) for chemical analyses (stable isotopes), from FFS and PHR to provide insight into predator feeding habits and reproductive status (up to 160 predators in total will be sampled). A small, non-lethal biopsy will be taken from each predator during tagging activities. To establish the chemical composition of prey species, tissue samples will be collected from 240 reef fishes collected at shallow and deep locations at FFS, PHR, MID and KUR (see lethal collections below).
6. Lethally sample reef fishes from shallow and mesophotic reefs for four locations: FFS, PHR, MID, KUR (240 total). Digestive enzyme activity of 80 herbivorous individuals from among these 240 fishes will be quantified.
7. Algal collection: Algae will be sampled from shallow and mesophotic reefs at FFS, PHR, MID and KUR and analyzed for digestibility. Collections would consist of a gallon ziplock bag of the most common algal species present per site. We will quantify the levels of toxic chemicals in algae as well as nutrient/starch content.

(b) Need for proposed activities

Top predators play an important role in many ecosystems and in Monument waters this role is filled by sharks (primarily tiger, galapagos, gray reef and whitetip reef sharks) and large teleost fishes (primarily ulua) (DeCrosta, Wetherbee et al. 1997, Friedlander & DeMartini 2002, Holzwarth et al. 2006, Papastamatiou et al., 2006). Science-based management of the marine top predators of the Hawaiian archipelago requires that we know whether key species are site-

attached to specific areas or, if not, how frequent and extensive are their movements. Since 2005 we have been using a combination of acoustic and satellite tags to quantify top predator movements in the Monument, and address three broad questions relevant to management zoning; (1) Do top predators move across open ocean between atolls?, (2) How extensive are their intra-atoll movements?, and (3) Do top predators exhibit predictable patterns of movement and habitat use? (4) Do predators influence the presence of herbivores on mesophotic reefs?

Using these technologies we have already made substantial progress in quantifying predator movement patterns in Monument waters and beyond (see Meyer et al. 2007a,b, Meyer et al. 2009, 2010, Papastamatiou et al. 2013, Papastamatiou et al. In Press). For example, we have shown that tiger sharks routinely swim between atolls, range along the entire Hawaiian archipelago and venture hundreds of miles beyond Monument boundaries into open-ocean. Mature female tiger sharks may travel from monument waters to the Main Hawaiian Islands for pupping during the fall (Papastamatiou et al. 2013). We also obtained the first empirical evidence that gray reef sharks swim across open-ocean between atolls. We have found other top predators (e.g. ulua, Galapagos sharks) are site-attached to individual atolls, but wide-ranging within their 'home' atoll (e.g., Meyer et al., 2007a,b, 2010). We discovered that ulua & uku have predictable patterns of movement, including diel habitat shifts and tidal & lunar rhythmicity (Meyer et al., 2007a,b). We also found that during summer full moons, ulua from all over French Frigate Shoals atoll converge on one particular location where they form large spawning aggregations (Meyer et al., 2007a).

Although we have already made substantial progress in quantifying predator movement patterns in Monument waters, important questions remain unanswered. We have gained considerable insight into the horizontal movements of Monument predators but are still in the process of elucidating their vertical movements. For example, our most recent research has revealed that both ulua and Galapagos sharks range between shallow and mesophotic habitats, but patterns of vertical behavior are highly variable between individuals of the same species. This variability in vertical movements is also reflected in the isotopic composition of predator tissues (Papastamatiou et al. In Press), suggesting possible individual specialization in diet and different foraging strategies and habitats within the same species at a single Monument location. These questions have important implications for understanding ecosystem function and resolving important management questions such as whether ulua are competing for food with critically endangered monk seals. Recent surveys of mesophotic reefs in the Monument suggest that these areas maybe important habitat for several life stages of reef fishes and invertebrates, highlighting the importance of understanding the links between mesophotic and shallow reefs. Our initial data from PHR suggest that predators utilize mesophotic reefs and may in fact be important vectors, transferring nutrients from shallow to deeper reefs (Papastamatiou et al. In Press). To expand on this work we need to see whether similar patterns exist at other islands and atolls of the NWHI. Our previous work has also suggested that predators only obtain 35% of their prey from mesophotic reefs. However, it has also been noticed that herbivorous fishes are found on mesophotic reefs of some atolls (e.g. FFS) but absent from others (PHR). It is unknown if this is due to the presence of predators and reduced shelter on mesophotic reefs or potentially physiological constraints on the herbivores. The drivers of herbivory are one of the pivotal

questions in ecology and we will take a unique perspective by studying the fishes along a latitudinal and more importantly, vertical, gradient.

(c) Scope of proposed activities

We propose to recover, download and redeploy up to 24 receivers already stationed in Monument waters (see Appendix 1). This will enable us to recover another 12 months of predator movement data (Fall 2014-Summer 2015) and to continue monitoring our transmitter-equipped predators in order to determine how their movement patterns vary over multi year time-scales. In order to quantify the vertical (depth) movements of ulua and Galapagos sharks, we propose implanting pressure-sensor acoustic transmitters (to quantify swimming depth) into 20 individuals from each species at PHR, FFS, MID & KUR (i.e. 80 total ulua & 80 total Galapagos sharks). To provide additional, high-resolution data on movement patterns, habitat use and feeding, we are also proposing to equip 5 Galapagos sharks and 5 ulua at FFS and/or PHR and/or MID and/or KUR with accelerometer-digital camera data loggers.

To quantify trophic ecology of predators, we will obtain muscle biopsies from all galapagos sharks and uluas captured (up to 160 total). We will analyze the isotopic content of muscle tissue to determine carbon:nitrogen ratios, which will provide insight into the trophic levels of these animals and where they are foraging. To ground truth carbon values, we will also collect a total of up to 240 reef fishes from among the most common species at 4 Monument atolls. At FFS, PHR, MID and KUR we will collect fishes from a mesophotic reef and a shallow water (30-60ft) comparison site. We will select shallow water collection sites that are directly inshore from the mesophotic collection sites. Experienced collectors will use three-prong spears to capture reef fishes at both shallow and mesophotic sites;

Mesophotic fish collectors

Randy Kosaki  
Yannis Papastamatiou  
TBD  
TBD

Shallow fish collectors

Randy Kosaki  
Yannis Papastamatiou  
Mark Royer  
Carl Meyer  
TBD  
TBD

For each atoll, we aim to collect the same species at both deep and shallow reefs. Note that to minimize temporal variation in isotope signatures, tissue samples from predators/reef fish need to be collected at the same time (i.e. we cannot use tissues from frozen specimens collected in previous years).

\*Considering the purpose of the proposed activities, do you intend to film / photograph federally protected species?    Yes  No

For a list of terrestrial species protected under the Endangered Species Act visit:

<http://www.fws.gov/endangered/>

For a list of marine species protected under the Endangered Species Act visit:

<http://www.nmfs.noaa.gov/pr/species/esa/>

For information about species protected under the Marine Mammal Protection Act visit:

<http://www.nmfs.noaa.gov/pr/laws/mmpa/>

**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?

The activity will be conducted with adequate safeguards for the resources and ecological integrity of the Monument. For top predators we use non-lethal catch and release, and telemetry techniques that have minimal impact on the resources and ecological integrity of the Monument. Some reef fishes will be lethally sampled, but only at very low numbers per site (no more than 10 individuals per species), and overall (240 fish total from 8 sites at 4 atolls). We will also share specimens with other researchers for genetic analysis and life history characterization so that lethally-sampled fishes are fully utilized. This project is a continuing effort to quantify top predator movements and feeding ecology throughout the NWHI for the purpose of informing management. Principal Investigator Carl Meyer has previously consulted with William Aila about the cultural implications of this research. Mr Aila is very familiar with our research, having both observed and assisted us during shark tagging activities conducted at French Frigate Shoals in June 2010. This provided a valuable opportunity for Carl Meyer to discuss at length with Mr Aila the challenges associated with balancing cultural concerns against the need for directed management of Monument resources, including the gathering of scientific knowledge.

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 proposed activities will have minimal impact on the resources of the region. The top predator tracking & sampling research consists of non-lethal catch and release, telemetry monitoring, autonomous data-logging and tissue sampling. A limited amount of lethal sampling (240 reef fishes total, 10 per species per sample site) will be conducted at four atolls. This research is being conducted in concert with the priorities listed in Monument research plan for

the Monument. The scientific knowledge provided by these activities will help managers to better understand the role of sharks and other top predators in Monument ecology

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 is no practicable alternative to conducting activities in the Monument. We are addressing questions that are directly relevant to management of Monument resources (we are quantifying movement patterns & feeding ecology of top predators throughout the Monument), hence the study must be carried out within 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?

The management value of data produced by our research activities outweighs the minor, transient impacts on Monument resources. The methods and procedures that we are proposing will have minimal impacts on Monument resources, qualities, and ecological integrity. No predators will be removed from the Monument and we have empirical data showing that tagged predators resume normal patterns of behavior soon after release (e.g., Meyer et. al. 2007a,b, 2009, 2010). Up to 240 reef fishes will be removed from the monument, but these will provide valuable data on a little-studied habitat (mesophotic reefs) that is an important component of the Monument ecosystem. Our receivers are stationed on uncolonized habitats, and removal will leave no evidence of their presence in shallow habitats (see Appendix 2), and leave only a small end weight in mesophotic habitats. The scientific knowledge provided by these activities will help managers to better understand the role of sharks and other top predators in the Monument ecosystem.

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

The actual fieldwork component of this research involves the minimum time required to reach the desired sample size of sharks and fishes based on historical catch rates. The monitoring of long-term predator movements is done remotely using small receivers left in situ year-round. The multi-year overall time frame of our proposed activities is consistent with our objectives of quantifying long-term movement patterns of predators in Monument waters. Long-term studies are essential for identifying seasonal movements and determining how movement patterns vary over multi year time-scales.

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

The principle investigator has more than 20 years of experience conducting this type of research (see attached CV for details) and is well qualified to conduct and complete the activity and mitigate any potential impacts resulting from its conduct. All personnel included in this permit application have extensive experience conducting research in wildlife refuges, and in the proposed research techniques. Yannis Papastamatiou has extensive experience performing stable isotope analysis on fish tissues. The Stable Isotope Laboratory at the University of Hawaii Manoa will assist in analysis of samples, under the guidance of Dr Brian Popp. Digestive

enzyme assays and algae digestibility analysis will be performed by Dr Donovan German at University California Irvine. This is a continuance of a multi-year project.

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. Our research will be supported by resources from University of Hawaii, and University of St. Andrews (Scotland). These resources will be adequate to conduct and complete the proposed activities and mitigate any potential impacts resulting from its conduct.

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.

The methods and procedures that we are proposing are ideal for achieving our goals with minimal impacts to Monument resources, qualities, and ecological integrity. The use of passive monitoring techniques (self-contained acoustic receivers) means that we need relatively little human access to the Monument in order to achieve continuous, year-round monitoring of predator movements. Our shallow site receivers are stationed on uncolonized habitats, and removal will leave no evidence of their presence (see Appendix 2). Mesophotic receivers leave a small end-weight behind on recovery. No top predators will be removed from the Monument as a result of our research, and we have empirical data showing that tagged predators resume normal patterns of behavior soon after release (e.g., Meyer et. al. 2007a,b, 2010). Our datalogging (accelerometer-camera) techniques will provide novel insight into predator behavior via brief (days), temporary attachment of datalogging packages that release from predators automatically, float to the surface and are recovered via a homing beacon. A very limited amount of lethal sampling (240 reef fishes total, maximum 10 fish per species per sample site) will be conducted at four atolls

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

We will use a combination of NOAA and private charter vessels equipped with appropriate mobile transceiver units

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

We have met all requirements of previously issued permits for research work in PMNM. There are no other factors that would make the issuance of a permit for our proposed activities inappropriate.

### **8. Procedures/Methods:**

Activities will be carried out from small boats launched from a mother ship. Servicing of receivers will be done by snorkelers and SCUBA divers, and from small boats via an acoustic release system. Our chosen long-term monitoring method (remote acoustic monitoring) is ideal for quantifying animal movements in remote, environmentally-sensitive locations because it has minimal environmental impact and requires only occasional, brief access by researchers to individual study sites, yet provides continuous monitoring of animal movements at those sites.

Shorter term datalogging involves temporary attachment of small devices to study species. The devices release automatically at a pre-determined time and are found and recovered via a homing beacon. We have previously used this datalogging technique successfully in Monument waters.

(a) Recovery and redeployment of underwater receivers

Shallow (<30 m) deployments: We will continue to use a temporary receiver mooring system that has previously been empirically demonstrated to successfully withstand seasonal high surf. Moorings, installed by snorkelers or SCUBA divers will consist of sand screws in areas of soft sediment, and chain around uncolonized substrate in hard bottom areas (live substrates will be avoided). We will completely remove these moorings when acoustic monitoring is completed (receivers will be in place for at least 2 years). The receivers will be anchored to the moorings and suspended 1-4 m above the ocean floor. The receivers will identify and record the presence of any acoustic transmitters within range (up to 500 m). The transmitter number, time of arrival and departure and the date will be recorded and stored until the data are downloaded from the receivers to a computer. The receivers have a battery life of approximately 15 months and will be serviced at 12 month intervals.

Deep (mesophotic >50m) deployments: We will recover and redeploy 6 underwater receivers at existing mesophotic sites at Pearl and Hermes Reef and French Frigate Shoals atoll. Receivers will be attached to weighted (with concrete block) moorings, and dropped to the sea floor so that they land on flat, uncolonized habitat (determined via echosounding). The moorings will incorporate an acoustic release to allow for surface recovery. Use of an acoustic release means the end weights and lower 30cm of the mooring (chain, polypro and twine) are sacrificial and will be left in situ when the receivers are recovered. As with shallow units, the mesophotic zone receivers will be suspended 4 m above the ocean floor and will be serviced at 12 month intervals.

(b) Data retrieval, reduction and analysis.

We will download receivers currently deployed in Monument waters (Appendix 1). Data downloading consists of interfacing the receiver to a computer via a wireless 'bluetooth' connection, and can be accomplished in the field. Preliminary data reduction and analyses will commence after downloading.

(c) Deployment of acoustic transmitters

We will implant acoustic transmitters into up to 160 sharks and fishes captured in monument waters. Our predator handling & tagging activities will be carried out in accordance with the animal use protocols of the University of Hawaii (protocol #05-053). Ulua will be captured by trolling (using an artificial lure) and handlining (using a single baited hook) from a small skiff. Sharks will be captured by handlining (using a single baited hook) from a small skiff and using a bottom-set, 10 hook shark line. Captured sharks and ulua will be brought alongside the skiff, tail-rope and inverted to initiate tonic immobility for transmitter implantation. We will implant coded acoustic transmitters (V16 & V16P, 16 mm diameter, 90 mm long, Vemco, Halifax, Nova Scotia) into the body cavities of each predator through a small incision in the abdominal wall (Holland et al., 1999; Meyer & Honebrink 2005, Meyer et al. 2007a,b, 2010). The incision will then be sutured closed, blood will be drawn from the caudal vein, a small tissue sample will be

taken from the dorsal musculature (see also below), the hook removed and the predator released. This entire handling process can be completed in less than 10 minutes. Every fish captured and equipped with an acoustic tag will also receive an external dart tag.

Previous reviews of the above capture procedures have prompted a series of questions about potential impacts on other species. To provide additional information we have included these questions and our responses;

1. What kind of by-catch is likely to occur?

Trolling by-catch includes reef-associated piscivores attracted to artificial lures, primarily uku (*Aprion virescens*). Baited handlines and sharklines very rarely catch anything other than target species. Any non-target species are released.

2. How can by-catch be minimized or mitigated?

Non-target fishes captured by trolling are immediately released. If by-catch becomes more than occasional then trolling is ceased in that area.

3. Are lines an entanglement hazard for seals? What mitigation measures are taken?

No. Handlines (baited and trolled) are manned constantly. We have not been approached by seals while using these methods. We have never had any seal interactions with bottom-set shark lines. These are heavy gauge lines with heavy end-weights and large surface floats, resulting in a 'taut' deployment, greatly reducing entanglement risks. As an added precaution we constantly monitor any such lines set within 1 km of seal haul-out sites.

4. Has there been any seabird interaction with the fishing gear?

Seabirds are sporadically attracted by trolling activities. Fishing is ceased and lines retrieved whenever birds show interest in the fishing gear. By taking these precautions we have avoided any physical interactions between birds and trolling gear.

#### (d) Deployment and recovery of accelerometer-digital camera dataloggers

Shark and ulua capture methods for accelerometer deployment methods are identical to those described in item (c) above. Each datalogger package will consist of a tri-axial accelerometer (W1000L-PD3GT, 22 mm in diameter, 123 mm in length, 90 g in air; Little Leonardo Co., Tokyo, Japan) and a digital camera (DSL380-VDT, 22 mm in diameter, 132 mm in length, 83 g in air; Little Leonardo Co., Tokyo, Japan), attached to a float equipped with a VHF transmitter and timed release mechanism (see picture - Appendix 3).

Accelerometers record swimming speed, depth, temperature (at 1 s intervals), and tri-axial acceleration (at 1/32 s intervals, 32 Hz). Digital video cameras capture 8h hours of duty-cycled

footage (i.e. the 8h can be spread across several days of deployment), and record depth and temperature at 1 sec intervals. Total device weights in air are 311g, and their buoyancies are offset by 76 g in sea water. The accelerometer package will be attached to the left or right pectoral fin of each shark by cable ties secured through two small holes drilled through the fin (see picture - Appendix 3). The devices will be attached to the second dorsal fin of each ulua using cable ties secured through small holes through the superficial dorsal musculature below the dorsal fins. After 24-48 h, a pre-programmed release timer will release the cable tie and allow the instruments to detach and float to the surface, where they will be located using the VHF transmitter and retrieved. Nothing is left attached to the animal.

(e) Collection of tissue biopsies from predators

Predator capture methods for tissue biopsy collections are identical to those described in item (c) above. We will collect small muscle biopsies from all predators captured. This involves making a small incision in the skin and using a biopsy tip to remove approximately 0.5 cc of muscle. These samples will be collected while predators are restrained for tagging. Tissue samples will be transferred to small plastic vials, frozen and transported back to Honolulu for laboratory analyses (stable isotope content).

(f) Collection of tissue biopsies from prey species

To obtain reference 'signatures' of chemical composition of potential prey (smaller reef fishes), we will lethally collect a total of 240 reef fishes from FFS, PHR, MID and KUR (1 shallow and 1 mesophotic site per atoll). We will sample up to 10 individuals per target species at each site. At each atoll, one site will consist of a mesophotic reef and the other an adjacent shallow reef (30-60ft range). Muscle tissue will be obtained from each species for stable isotope analysis. Digestive tracts will be sent to Dr Donovan German at UC Irvine. We will also send the remains of specimens to Drs. Brian Bowen and Eric Franklin for genetic and life history analysis. The latter are collecting specimens to quantify genetic connectivity between Monument locations and between mesophotic and shallow reef sites. Note that to minimize temporal variation in isotope signatures, tissue samples from predators/reef fish/algae need to be collected at the same time (i.e. we cannot use tissues from frozen specimens collected in previous years).

(g) Chemical analyses of tissue samples

Stable isotopes: The composition of heavy isotopes in an animal's tissues reflects that of its food, and the isotopic signature of the primary producers in the ecosystem. The  $^{15}\text{N} : ^{14}\text{N}$  ratio is an indicator of a predator's trophic position in the food web, while the  $^{13}\text{C} : ^{12}\text{C}$  ratio highlights the source of carbon for the primary producers at the base of the food chain from which the predator is feeding (e.g. coastal or pelagic, France 1995, Post 2002). Samples will be frozen until they are processed at the stable isotope laboratory at the University of Hawaii at Manoa. Samples are dried in a 60 °C drying oven for at least 48 h or until the sample are completely dried out, and then ground into a fine powder and weighed out into micro sampling dishes. We will use a carbon-nitrogen analyzer (Finnigan ConFlo II/Delta-Plus, Bremen, Germany) to determine the relative concentration of heavy  $^{15}\text{N}$  and  $^{13}\text{C}$  in each sample. Values are presented as ‰, relative to standards of V-PDB and atmospheric  $\text{N}_2$  for  $^{13}\text{C}$  and  $^{15}\text{N}$  respectively.

(f) algal samples will be sent to Dr Donovan German at UC Irvine where they will be analyzed for natural toxins and starch content (as indicator of nutrient value).

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**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:

Please refer to Appendix 4

Scientific name:

Please refer to Appendix 4

# & size of specimens:

Please refer to Appendix 4

Collection location:

Shallow and mesophotic reefs around FFS, PHR, MID, KUR

Whole Organism  Partial Organism

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

Fish tissue samples will be utilized for stable isotope analysis. Remains of reef fishes will be passed on to researchers studying genetic conductivity and life history characteristics in the monument.

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

• General site/location for collections:

Shallow and mesophotic reefs at FFS and PHR, MID and KUR

• Is it an open or closed system?  Open  Closed

N/A

• Is there an outfall?  Yes  No

N/A

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

N/A

• Will organisms be released?

Predators = yes - see procedures section above.

Prey items = no. Reef fishes will be sacrificed.

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

Muscle tissue and whole reef fishes will be stored frozen for transport out of the Monument.

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

We will share all reef fish specimens with researchers studying genetic conductivity in the monument (Dr Brian Bowen) and life history characteristics of reef fishes (Eric Franklin). These data will be used in collaboration with other proposed projects. Brian Popp (UH-SOEST) will be

using stable isotopes to determine if there is a difference in signal between shallow and deep counterparts, which will be required if we are to determine if predators are foraging on deep reefs. Fish digestive tracts, and algae samples will be sent to Dr Donovan German at UC Irvine

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

Please refer to Appendices 2 and 3

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

N/A

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

Please refer to Appendix 2

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

Analyses, interpretation and publication of data are ongoing. We already have ten papers derived from our PMNM studies published in international peer-reviewed journals.

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

Meyer CG, Papastamatiou YP, Holland KN. 2007. Seasonal, diel and tidal movements of green jobfish (*Aprion virescens*, Lutjanidae) at remote Hawaiian atolls: Implications for Marine Protected Area design. *Marine Biology*. 151: 2133-2143.

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Meyer C.G., T.B. Clark, Y.P. Papastamatiou, N.M. Whitney, & K.N. Holland. (2009). Long-term movements of tiger sharks (*Galeocerdo cuvier*) in Hawaii. *Marine Ecology Progress Series*. 381: 223-235.

Meyer CG, Papastamatiou YP, Holland KN (2010). A multiple instrument approach to quantifying the movement patterns and habitat use of tiger and Galapagos sharks at French Frigate Shoals, Hawaii. *Marine Biology* 157: 1857-1868

Papastamatiou YP, Friedlander AM, Caselle JE, Lowe CG. 2010. Long term movement patterns and trophic ecology of blacktip reef sharks (*Carcharhinus melanopterus*) at Palmyra Atoll. *Journal of Experimental Marine Biology and Ecology* 386: 94-102

Papastamatiou YP, Cartamil DP, Lowe CG, Meyer CG, Wetherbee, BM, Holland KN. 2011. Scales of orientation, directed walks, and movement path structure in sharks. *Journal of Animal Ecology*. In Press.

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doi:10.1242/jeb.075432.

Meyer C, O'Malley J, Papastamatiou Y, Dale J, Hutchinson M, Anderson J, Royer M, Holland K. 2014. Growth and maximum size of tiger sharks (*Galeocerdo cuvier*) in Hawaii. PLoS One 9:e84799

Papastamatiou YP, Meyer C., Carlvaho F., Dale J., Hutchinson M., Holland K. 2013. Telemetry and random walk models reveal complex patterns of partial migration in a marine predator. Ecology. 94: 2595-2606

Papastamatiou YP, Meyer CG, Kosaki RK, Natalie J. Wallsgrove NJ, Popp BN. In Press. Movements and foraging of predators associated with mesophotic reefs and their potential for linking ecological habitats. Marine Ecology Progress Series.

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.

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Signature

Date

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

NOAA/Inouye Regional Center  
NOS/ONMS/PMNM/Attn: Permit Coordinator  
1845 Wasp Blvd, Building 176  
Honolulu, HI 96818  
FAX: (808) 455-3093

**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