

Papahānaumokuākea Marine National Monument
Permit Application - Research
OMB Control # 0648-0548
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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: Carl G. Meyer

Affiliation: Hawaii Institute of Marine Biology

Permit Category: Research

Proposed Activity Dates: May 1st-Oct 30 2014

Proposed Method of Entry (Vessel/Plane): NOAA Vessel Hialaki

Proposed Locations: French Frigate Shoals, Pearl & Hermes Reef, Midway

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) provide further specific insight into shark predation on endangered species (Hawaiian monk seals and blackfoot albatross) at French Frigate Shoals Atoll, and (3) elucidate the role of deep reefs in the ecology of Monument predators.

b.) To accomplish this activity we would

Capture and equip top predators with electronic tags, 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 200 reef fishes (collected via 3-prong pole spear). These reference samples will be used to determine the trophic position and feeding location of predators.

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. We will continue to quantify the depths at which sharks and other large predators, such as ulua, routinely forage to determine where competitive overlap may exist between these species and Hawaiian monk seals. We will also be investigating individual specialization in diet for sharks at FFS, which may enable us to determine if there are some true 'monk seal' specialists. 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.

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 200 of the most common reef fishes. 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.

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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
James Anderson, Co-collaborator, Research Diver, Field Biologist
Itsumi Nakamura, Co-collaborator, Research Diver, Field Biologist
Mark Royer, Co-collaborator, Research Diver, Field Biologist
Danny Coffey, Co-collaborator, Research Diver, Field Biologist
TBD
TBD
TBD

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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 checked="" type="checkbox"/> French Frigate Shoals	<input type="checkbox"/> Land-based	<input checked="" type="checkbox"/> Shallow water	<input checked="" 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 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 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:

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 20 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, and to extend mesophotic coverage by deploying two new receivers on reefs at 200-250 ft at FFS and Pearl & Hermes Reef (PHR).

Reef fish collection

Reef fishes will be collected using pole spears in shallow waters and on mesophotic reefs (depth 150-300ft) at FFS and PHR.

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

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- 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. A major component of this work involves quantifying shark movements and feeding ecology at FFS to provide insight into predation on endangered species such as Hawaiian monk seals and albatross. This information will provide managers with a clearer understanding of the role of shark predation in population dynamics of endangered species in Monument waters. We have the following specific goals and objectives;

1. Download 20 underwater receivers currently stationed in the Monument to retrieve stored movement data from 240 top predators tagged with acoustic transmitters from 2008 to 2012.
2. Determine how widely these animals have ranged since Summer 2013 and identify their patterns of movement.
3. Deploy an additional four underwater receivers on mesophotic reefs (depth 200-250 ft). Two of these will be placed at FFS and two at P&H. Receivers will be attached to heavy weights and acoustic releases.
3. Equip up to 80 additional ulua and Galapagos sharks (20 of each species at FFS and PHR) with pressure-sensor acoustic transmitters detectable by our listening array. These tag deployments will enable us to obtain the first insights into 'upslope-downslope' movements between shallow and mesophotic habitats by abundant monument predators.
4. Equip up to 10 sandbar sharks, 10 whitetip reef sharks, 10 grey reef sharks and 10 blacktip sharks with surgically-implanted conventional coded acoustic transmitters at FFS. We already have preliminary movement data for these shark species in Monument waters, and these deployments will help to build a clearer understanding of their basic patterns of movement and habitat use at FFS.
5. Collect small samples of muscle and blood tissue from predators (ulua, galapagos sharks, tiger sharks) for chemical analyses (stable isotopes, hormones), from FFS and PHR to provide insight into predator feeding habits and reproductive status (up to 150 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 200 reef fishes collected at shallow and deep locations at FFS & PHR.

(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, grey 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?

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). 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 we still know very little about their vertical movements. For example, we don't know to what depths abundant Monument predators such as ulua typically range, or whether they forage at both shallow and meso-photic depths, thus the trophic links between shallow and deep mesophotic reefs are poorly understood. 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 will utilize mesophotic reefs and may in fact be important vectors, transferring nutrients from shallow to deeper reefs. To expand on this work we need to a) expand our acoustic coverage of mesophotic reefs and b) see if these patterns are consistent at other islands and atolls of the NWHI.

In addition to providing a broad understanding of predator movements in Monument waters, we have also been quantifying movements of Galapagos and tiger sharks at FFS to provide specific insight into shark predation on Hawaiian monk seal pups at this location. The Hawaiian monk seal (*Monachus schauinslandi*) is critically endangered with approximately 1,200 seals remaining and the total population size projected to fall below 1000 within the next five years. Among the six primary breeding sites in the NWHI, French Frigate Shoals (FFS) has experienced the most dramatic decline, with beach counts at FFS declining 70% from 1989-2004 (Antonelis et al. 2006, Caretta et al., 2007). The main demographic factors in the decline have been poor juvenile survival (pup mortalities at FFS range from 15-69% of each annual cohort), exacerbated by lower reproductive rates as compared to other breeding sites in the NWHI (Harting et al. 2007). Shark predation is suspected to be the single greatest cause of mortality for pre-weaned Hawaiian monk seal pups at FFS, with a small number of persistent Galapagos sharks thought to be the primary culprits (although historically tiger sharks were considered the main predator of monk seals). However, most pup predation is not seen and questions remain about the numbers and species of sharks involved. To resolve these important questions we equipped Galapagos (N=89) and tiger sharks (N=54) at FFS with acoustic transmitters in 2008 and 2009, and deployed acoustic 'fences' of underwater receivers around monk seal pupping sites. We have subsequently shown that almost half of all tagged tiger sharks visited shallow habitats adjacent to monk seal sites compared to around 13 percent of Galapagos sharks. We also generated the first mark-recapture estimate of Galapagos shark population size at FFS (Dale et al. 2011), suggesting that around 668 individuals were present at FFS in summer 2009. Combining this population size estimate with our telemetry data, suggests some 88 individual Galapagos sharks visited shallow habitats adjacent to monk seal pupping sites at FFS between 2009 & 2011. We are currently analyzing these data to further determine whether Galapagos shark visits to monk seal pupping sites have predictable patterns.

An increasing amount of data is showing individual specialization in diet by top predators, where each individual may specialize on a particular prey item (e.g. Matich et al., 2011). This may be particularly important at FFS where it is hypothesized that a subset of Galapagos sharks have become monk seal pup specialists. We will investigate specialization by collecting muscle and blood samples from each predator and using them for stable isotope analysis. Blood (fast) and muscle (slow) have different tissue turn-over times and therefore represent diet over different time scales. Essentially muscle tissue provides an indication of what the predator has been eating over many months to years, while blood will be more indicative of diet from weeks to a few months. Combined, we can use these results to estimate the degree of specialization in diet (see Matich et al., 2011).

(c) Scope of proposed activities

We propose to recover, download and redeploy up to 20 receivers already stationed in Monument waters (see Appendix 1). This will enable us to recover another 12 months of predator movement data (summer 2013-summer 2014) 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 both PHR & FFS (i.e. 40 total ulua & 40 total Galapagos sharks). To detect these animals on deeper reefs we will deploy two underwater listening stations on mesophotic reefs at FFS and an additional two receivers on mesophotic reefs at PHR.

To quantify trophic ecology of predators, we will obtain muscle biopsies from all galapagos sharks and uluas captured (up to 90 total). We will obtain 4mL of blood from each predator. 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 200 reef fishes from among the most common species at 4 Monument sites. At FFS and PHR we will collect fishes from a mesophotic reef and a shallow water (30-60ft) comparison site. Forty individuals will be collected from each shallow site, and 60 individuals from each mesophotic site. Up to 10 individuals of each of the 4 most common reef fish species will be collected from shallow sites, and up to 10 individuals of each of the 6 most common reef fish species will be collected from mesophotic sites. Selecting samples from only the most abundant reef fish species reduces biological impact and is also scientifically valid as we aim to sample "prey species" that are likely to be the most abundant species present.

Based on records from previous mesophotic dives, we have identified shortlists of fish species most commonly seen on mesophotic reefs at FFS (N=6) & PHR (N=6). We cannot be certain of the identity of the three most abundant species until divers are in situ on mesophotic reefs but they will be drawn from the following list;

FFS - Mesophotic fishes

Chromis verater
Parupeneus multifasciatus
Chaetodon miliaris
Chaetodon fremblyi
Myripristis chryseres
Acanthurus olivaceous

PHR - Mesophotic fishes

Chromis verater
Parupeneus multifasciatus
Chaetodon miliaris
Chaetodon fremblyi
Myripristis chryseres
Acanthurus olivaceous

We will collect the following species at shallow water sites;

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Parupeneus multifasciatus
Chaetodon miliaris
Chaetodon fremblii
Acanthurus olivaceus

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).

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 (200 fish total from 4 sites at 2 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, ultrasonic imaging and blood sampling. 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 200 reef fishes will be removed from the monument, but these will provide valuable data on a little-studied habitat that is an important component of the monument (mesophotic reefs). 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 rig 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 in sampling blood from sharks and 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. 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 rig 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). A very limited amount of lethal sampling (200 reef fishes total, maximum 10 fish per species per sample site) will be conducted at two atolls

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 use NOAA 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.

(a) Recovery and redeployment of underwater receivers

Shallow (<30 m) deployments (see Appendix 2): 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 6 to 12 month intervals.

Deep (mesophotic >50m) deployments: We will deploy 4 underwater receivers at mesophotic sites at Pearl and Hermes Reef and French Frigate Shoals atoll. Side scan sonar mapping and depth sounders will be utilized to select flat, uncolonized habitat adjacent to ledges at depths of between 200-300ft. Receivers will be attached to weighted (with concrete block) moorings, and dropped to the sea floor so that they land on the flat habitat. 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 80 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-roped 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 (other sharks, very occasional large ulua) 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) 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). We will use an 18 gauge needle to collect 4 mL of blood from the caudal vein of each animal. Of this, 3mL will be placed in a BD vacutainer vial and spun down in a field centrifuge to separate plasma from the other cellular material. The other 1 mL will be kept as a 'whole blood' sample. All samples will then be frozen.

(e) 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 200 reef fishes from FFS and PHR (1 shallow and 1 mesophotic site per atoll, 60 fish per mesophotic site, 40 fish per shallow site). We will sample up to 10 individuals from each of three 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. 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).

(f) 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}N and ^{13}C in each sample. Values are presented as ‰, relative to standards of V-PDB and atmospheric N_2 for ^{13}C and ^{15}N respectively.

g) We are currently developing and refining protocols to determine reproductive status of female sharks from field ultrasound scans and blood hormone levels. Field ultrasound scans will be conducted while captured sharks are alongside the tagging boat and inverted in a state of tonic immobility. This provides easy access to the abdominal region containing the stomach and uteri. Scans are carried out using a portable veterinary ultrasound unit equipped with a convex probe. The probe is passed back and forth across the ventral surface of the shark in the area overlaying the stomach and uteri.

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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.

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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 3

Scientific name:

Please refer to Appendix 3

& size of specimens:

Please refer to Appendix 3

Collection location:

Please refer to Appendix 3

Whole Organism Partial Organism

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

The animal 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

• 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?

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Muscle tissue & blood samples, 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.

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

Please refer to Appendix 4

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 nine 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

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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

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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

Appendix 1 – Carl Meyer – Acoustic Receiver Locations

Atoll	Location Description	Latitude	Longitude	Depth (ft)
FFS	Rapture Reef	23.63509	-166.18570	85
FFS	Gins	23.72615	-166.16967	37
FFS	SE of La Perouse	23.74926	-166.21773	70
FFS	East Island	23.78686	-166.20709	10
FFS	NE of La Perouse	23.80545	-166.26106	72
FFS	Round & Mullet	23.82747	-166.22857	10
FFS	Tern Island	23.86664	-166.28820	10
FFS	Trig Island	23.86945	-166.24158	15
FFS	North of Trig	23.88609	-166.22641	150
FFS	South mesophotic reef	23.63882	-166.25135	165
Midway	Frigate Point	28.19117	-177.39450	30
Midway	Fish Hole	28.19742	-177.36272	40
Midway	North Barrier Reef	28.28610	-177.36212	90
PHR	SW Corner	27.75290	-175.94805	50
PHR	SE Channel	27.78702	-175.83623	30
PHR	Main Channel -West Side	27.79092	-175.86300	35
PHR	West Spur and Groove	27.80215	-176.01095	100
PHR	NE Side	27.90115	-175.72205	65
PHR	NW Side	27.91095	-175.90890	85
PHR	West side mesophotic reef	27.76206	-175.98315	200

Carl Meyer – Papahānaumokuākea Predator Tagging

Appendix 2 Shallow site (non-mesophotic) receiver installations in the Monument

We use Vemco VR2 underwater receivers for monitoring movements of transmitter-equipped predators. The VR2 consists of a hydrophone, receiver, ID detector, data logging memory, and battery all housed in a submersible plastic case.



Vemco VR2 Receiver

Each receiver is mounted on a mooring consisting of an anchor (either a sand screw, or chain around uncolonized hard substrate), rope bridle and subsurface floats.

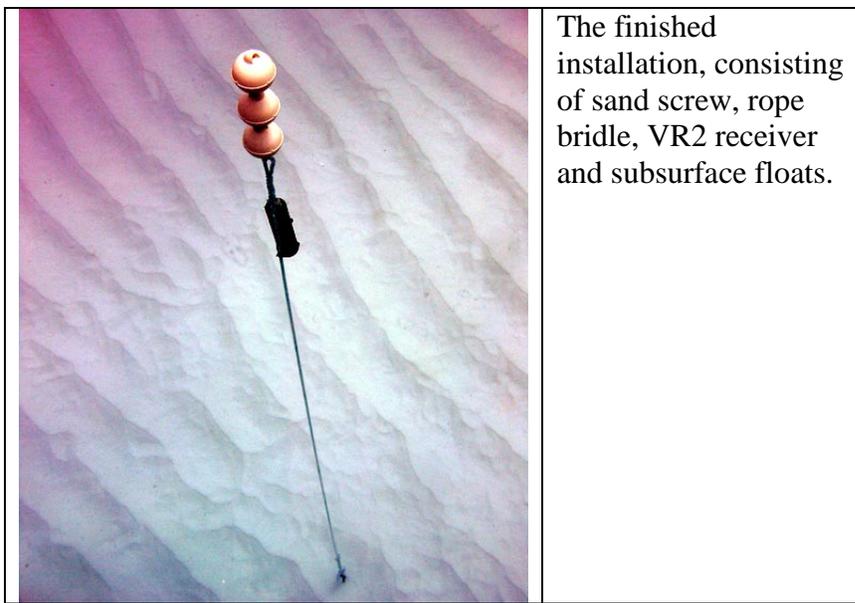


We use 4 ft steel sand screws which are literally screwed into the sand, leaving an eye loop exposed. This is the point of attachment for the rope bridle.



Anti-chafing gear (heavy duty hose) protects the rope bridle at point of contact with the sand screw eye loop. We splice the rope bridle to the sand screw *in situ*.

Carl Meyer – Papahānaumokuākea Predator Tagging



We use the sand screw installation whenever possible. In hard-bottom areas we use chain around natural arches in lieu of sand screws (the other components are identical).

We service these installations every 6-12 months, at which time we completely replace all mooring components (anchors, rope bridles, floats), and download and re-battery the receivers.

We plan to maintain these installations for the duration of the acoustic monitoring research (at least 2 years). We will remove these installations on completion of the research. Removal is straightforward, takes less than 10 minutes per installation and leaves nothing behind.

Appendix 3 Carl Meyer – Details of tissue sample collections

Common Name	Scientific Name	# & Size of specimens	Collection location
Tiger shark	<i>Galeocerdo cuvier</i>	20 x 4 ml blood	FFS
Galapagos shark	<i>Carcharhinus galapagensis</i>	45 x 0.5cc muscle tissue	FFS, PHR
Galapagos shark	<i>Carcharhinus galapagensis</i>	45 x 4 ml blood	FFS, PHR
Sandbar shark	<i>Carcharhinus plumbeus</i>	10 x 0.5cc muscle tissue	FFS
Sandbar shark	<i>Carcharhinus plumbeus</i>	10 x 4 ml blood	FFS
Grey reef shark	<i>Carcharhinus amblyrhincos</i>	10 x 0.5cc muscle tissue	FFS
Grey reef shark	<i>Carcharhinus plumbeus</i>	10 x 4 ml blood	FFS
Blacktip shark	<i>Carcharhinus limbatus</i>	10 x 0.5cc muscle tissue	FFS
Blacktip shark	<i>Carcharhinus limbatus</i>	10 x 4 ml blood	FFS
Whitetip reef shark	<i>Triaenodon obesus</i>	10 x 0.5cc muscle tissue	FFS
Whitetip reef shark	<i>Triaenodon obesus</i>	10 x 4 ml blood	FFS
Ulua	<i>Caranx ignobilis</i>	45 x 0.5cc muscle tissue	FFS, PHR
Manybar goatfish	<i>Parupeneus multifasciatus</i>	40 x entire fish*	FFS, PHR
Milletseed butterflyfish	<i>Chaetodon miliaris</i>	40 x entire fish*	FFS, PHR
Orange-cheek surgeonfish	<i>Acanthurus olivaceus</i>	40 x entire fish*	FFS, PHR
Bluestriped butterflyfish	<i>Chaetodon fremblii</i>	40 x entire fish*	FFS, PHR
Threespot Chromis	<i>Chromis verater</i>	20 x entire fish*	FFS, PHR
Yellowfin Soldierfish	<i>Myripristis chryseres</i>	20 x entire fish*	FFS, PHR

* To reduce impact, we will sample individuals of only the 3 most abundant species present at the FFS & PHR mesophotic sites. We cannot predict with certainty what these species will be until we reach specific dive sites, hence we include this list of 6 species derived from previous surveys of mesophotic reef fauna.