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 Meyer
Affiliation: Hawaii Institute of Marine Biology

Permit Category: Research
Proposed Activity Dates: May 1 - October 30 2010
Proposed Method of Entry (Vessel/Plane): Vessel
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: 6
Estimated number of days in the Monument: 70

Description of proposed activities: (complete these sentences):

a.) The proposed activity would…

Quantify the movements and feeding habits of top predators (sharks and large fishes) in the Monument to: (1) improve our broad understanding of Monument ecology, and (2) provide further specific insight into shark predation on Hawaiian monk seals at French Frigate Shoals Atoll.

b.) To accomplish this activity we would ….

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. Sharks are captured using 10 hook bottom-set lines, restrained alongside a small boat during transmitter attachment and then released. Fishes (ulua, hapu'upu'u) will be captured using handlines and either tagged alongside a small boat (ulua), or in situ on the sea floor by SCUBA divers (hapu'upu'u). Acoustic receivers are deployed and recovered by SCUBA divers, and listen year-round for predators equipped with acoustic tags.

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, one of which (hapu'upu'u) is also the only endemic Hawaiian grouper. We will quantify how deep sharks and large fishes such as ulua range, and begin to assess the depths at which these predators routinely forage to determine where competitive overlap may exist between these species and Hawaiian monk seals. We will provide Monument managers with empirical data on shark movement patterns and diet at French Frigate Shoals atoll. This information is vital for a better understanding of shark predation on Hawaiian monk seals and selecting appropriate management strategies for mitigating predation impacts on monk seals.

Other information or background: Our research has minimal impact on monument resources. Sharks 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 will seek appropriate guidance on how to mitigate potential cultural impacts associated with our research.

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: Not Applicable

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, Research Diver, Field Technician
Jon Dale, Research Diver, Field Technician
Christain Clark, Research Diver, Field Technician
Melanie Hutchinson, Research Diver, Field Technician
Yuuki Watanabe, Field Technician
Austin Stankus, Field Technician

Section B: Project Information

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

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

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

Location Description:
Fishing/Tagging
Fish capture and tagging will be ship-based and will occur in the shallow waters around the Monument locations listed above.

Receiver Deployment and Recovery
A total of 48 receivers are currently deployed at 9 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. We are also requesting 4 additional receiver deployments at FFS (2) and PHR (2) to extend our listening coverage at these atolls into deeper, mesophotic habitats. Exact locations of new deployments will be recorded using a handheld GPS. In addition we plan to swap out up to 8 Ecological Acoustic Recorder units (EARs) that are co-located with several of our acoustic receivers. EARs have been deployed in the Monument by Dr. Marc lammers (HIMB/NOAA) in order to monitor biological (e.g. whale song) and manmade (boat engine noise) sounds.

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. A major component of this work involves quantifying shark movements at FFS to provide insight into predation on critically-endangered Hawaiian monk seal pups. This information is needed for selecting appropriate management strategies for these culturally and ecologically important sharks and fishes. We have the following specific goals and objectives;

1. Download 48 underwater receivers currently stationed in the Monument to retrieve stored movement data from 186 top predators tagged with acoustic transmitters from 2007 to 2009.

2. Determine how widely these animals have ranged since August 2009 and identify their patterns of movement. Particular emphasis will be placed on determining the frequency and timing of visits by Galapagos and tiger sharks to monk seal pupping sites at FFS atoll.

3. Extend our receiver coverage to mesophotic habitat by deploying 4 additional underwater receivers at FFS (2) and PHR (2).

4. 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.

5. Enhance our overall understanding of shark spatial dynamics at FFS by quantifying the movements of four abundant shark species (sandbar, reef whitetip, grey reef, blacktip) which are not implicated in predation on monk seals. We aim to equip up to 20 individuals of each species with acoustic transmitters. This will take advantage of the listening array already in situ at FFS, and allow for simultaneous comparison with movement patterns of tiger (N=39) and Galapagos sharks (N=68) tagged at FFS in 2009.

6. Deploy tri-axial accelerometer + digital camera data loggers on up to 5 ulua and 5 Galapagos sharks at FFS to provide high resolution information on swimming patterns and habitat use.

7. Equip up to 20 Hapu'upu'u (10 each at Midway and Kure) with acoustic transmitters to obtain an adequate sample size to characterize movement patterns of this species.

8. Collect small samples of muscle tissue for chemical analyses (fatty acids + stable isotopes) to provide insight into predator feeding habits. 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 opportunistically from reef fishes and invertebrates collected by other researchers at various depths and 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, gray reef and whitetip reef sharks) and large teleost fishes (primarily ulua) (DeCrosta 1981, Wetherbee et al. 1997, Friedlander & DeMartini 2002, Holzwarth 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 (see Meyer et al. 2007a,b, Meyer et al. 2009). 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. 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). 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 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.

In addition to providing a broad understanding of predator movements in Monument water, 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. Our experimental design will allow us to address the following specific questions;

(1) How frequently do large sharks (tiger and galapagos) visit monk seal pupping sites?

(2) Do shark visits to monk seal pupping sites have predictable patterns?

(3) What proportion of all Galapagos and tiger sharks tagged at FFS visit pupping sites?

(4) Do individual sharks visit multiple pupping sites?

(5) How do shark movement patterns vary over time?

We need to return to FFS and download our receivers in order to recover data that will enable us to answer the above questions.

(c) Scope of proposed activities
We propose to recover, download and redeploy up to 48 receivers already stationed in Monument waters (see Appendix 1). This will enable us to recover another 12 months of predator movement data (summer 2009-summer 2010) and to continue monitoring our transmitter-equipped predators in order to determine how their movement patterns vary over multi year time-scales. We also aim to swap out up to 8 Ecological Acoustic Recorders (EARs) co-located with our receivers. These EAR units have been deployed as part of an ecosystem noise monitoring program conducted by Dr. Marc Lammers (HIMB/NOAA). We also propose deploying four additional underwater receivers in Monument waters in order to extend our monitoring coverage into mesophotic habitats at FFS (2 receivers) and PHR (2 receivers). 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 provide additional, high-resolution data on movement patterns and habitat use, we are also proposing to deploy accelerometer-digital camera data loggers on 5 ulua and 5 Galapagos sharks at FFS. At FFS, we propose implanting acoustic transmitters into up to 20 individuals from each of four shark species (grey reef, blacktip, sandbar, whitetip reef - up to 80 total sharks tagged) to provide movement and habitat use data for comparison with Galapagos and tiger sharks tagged in 2009. At Midway and Kure we propose to equip 20 Hapu'upu'u with acoustic transmitters. Thus we are requesting up to 190 new transmitter deployments & predator biopsy samples (all species combined).

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. We use non-lethal catch and release, and telemetry techniques that have minimal impact on the resources and ecological integrity of the Monument. This project is a continuing effort to quantify top predator movements throughout the NWHI for the purpose of informing management. We will seek appropriate guidance on how to mitigate potential cultural impacts associated with our research.

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 research consists of non-lethal catch and release, and acoustic monitoring. This research is being conducted in concert with the priorities listed in Monument research plan for the Monument. We will seek appropriate guidance on how to mitigate potential cultural impacts associated with our research.

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 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 animals 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). Our receivers are stationed on uncolonized habitats, and removal will leave no evidence of their presence (see Appendix 2). We will seek appropriate guidance on how to mitigate potential cultural impacts associated with our research.

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 tagged fishes based on historical catch rates. The monitoring of 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 15 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 the Monument, and in acoustic monitoring techniques. 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 is supported by an award to Hawaii Institute of Marine Biology from the National Marine Sanctuary Program, and we are provided access to the Monument on NOAA research vessels. These resources are 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 and satellite telemetry) means that we need relatively little human access to the Monument in order to achieve continuous, year-round monitoring of predator movements. 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). Our receivers are stationed on uncolonized habitats, and removal will leave no evidence of their presence (see Appendix 2).

i. Has your vessel has been outfitted with a mobile transceiver unit approved by OLE and complies with the requirements of Presidential Proclamation 8031?
NOAA vessels are equipped with the NOAA OLE Vessel Monitoring System

j. Demonstrate that there are no other factors that would make the issuance of a permit for the activity inappropriate.
We will seek appropriate guidance on how to mitigate potential cultural impacts associated with our research.

8. Procedures/Methods:
Activities will be carried out from small boats lauched from NOAA vessel Hi'ialakai and will not require any terrestrial access. Servicing of receivers will be done by snorkelers and SCUBA divers. Our chosen 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) Deployment of underwater receivers in mesophotic habitats
We will deploy 4 underwater receivers at two sites each at Pearl and Hermes and French Frigate Shoals atoll (4 sites total) in May 2010. 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 chain links) moorings , and lowered to the sea floor so that they land on the flat habitat. The receivers will be suspended 4 m above the ocean floor, and 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. These receivers will be initially recovered and re-deployed during deep technical dives in July 2010.

(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 180 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. SCUBA divers will capture hapu'upu'u by handlining (using a single baited hook) underwater. Captured hapu'upu'u will be restrained on the sea bed in a hand net during tagging procedures. We will implant coded acoustic transmitters (V16 & V16P, 9 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). The incision will then be sutured closed, 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), omilu (Caranx melampyus), kawa kawa (Euthynnus affinis) and kahala (Seriola dumerili). 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 alongside the boat without removing them from the water. 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

Galapagos 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 4).

Accelerometers record swimming speed, depth, temperature (at 1 s intervals), and tri-axial acceleration (at 1/32 s intervals, 32 Hz). Digital cameras capture still images (1MB pixels) at 4 sec intervals, 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 dorsal fin of each shark by plastic cable ties secured through two small holes drilled through the fin (see picture - Appendix 4). The devices will be attached to the second dorsal fin of each ulua using plastic 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 cause the instruments to detach and float to the surface, where they will be located using the VHF transmitter and retrieved.

(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 and fatty acid contect).

(f) Collection of tissue biopsies from prey species
To obtain reference 'signatures' of chemical composition of potential prey (smaller reef fishes and invertebrates), we will opportunistically collect tissue samples from reef fishes and invertebrates collected by Drs. Brian Bowen and Robert Toonen. The latter are collecting specimens to quantify genetic connectivity between Monument locations and elsewhere.

(g) Chemical analyses of tissue samples

Stable isotopes: The composition of heavy isotopes in an animal's tissues reflects the concentration in its food, and the isotopic signature of the primary producers in the ecosystem. The 15N: 14N ratio is an indicator of a predator's trophic position in the food web, while the 13C: 12C 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 ºC 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 15N and 13C in each sample. Values are presented as ‰, relative to standards of V-PDB and atmospheric N2 for 13C and 15N respectively.

Fatty acids: Each sample will be homogenized and lipids recovered using a modified Folch method (Budge et al 2006). Fatty acid methyl esters (FAME) will be prepared from each extracted lipid sample using an acidic catalyst. Identification of FAME will be performed using temperature programmed gas-liquid chromatography. Individual fatty acids will be expressed as a percentage of the total fatty acids.

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Meyer CG, Holland KN, Papastamatiou YP. 2007a. Seasonal and diel movements of giant trevally (Caranx ignobilis) at remote Hawaiian atolls: implications for the design of Marine Protected Areas. Marine Ecology Progress Series. 333: 13-25.

Meyer CG, Papastamatiou YP, Holland KN. 2007b. 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.

Meyer CG, Clark TB, Papastamatiou YP, Whitney NM, Holland KN. 2009. Long-term movements of tiger sharks (Galeocerdo cuvier) in Hawaii. Marine Ecology Progress Series. 381: 223–235.

Post D.M., 2002. Using stable isotopes to estimate trophic position: models, methods, and assumptions. Ecology 83(3): 703-718

Wetherbee BM, Crow GL and CG Lowe (1997). Distribution, reproduction and diet of the gray reef shark Carcharhinus amblyrhynchos in Hawaii. Marine Ecology Progress Series 151: 181-189.

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 5

Scientific name:
Please refer to Appendix 5

& size of specimens:
Please refer to Appendix 5

Collection location:
Please refer to Appendix 5

☐ Whole Organism ☒ Partial Organism

9b. What will be done with the specimens after the project has ended?
The small tissue samples collected will be fully utilized for chemical analyses

9c. Will the organisms be kept alive after collection? ☐ **Yes** ☐ **No**
N/A

• General site/location for collections:
Please refer to Appendix 5

• 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 8 c & e above.
Prey items = yes and no, depending on organism type. Reef fishes will be sacrificed, invertebrates may only be biopsied (refer to Bowen/Toonen permits)

10. If applicable, how will the collected samples or specimens be transported out of the Monument?
Muscle tissue samples will be stored frozen in plastic vials for transport out of the Monument.

11. Describe collaborative activities to share samples, reduce duplicative sampling, or duplicative research:
To reduce duplicative sampling, we propose obtaining tissue samples from specimens collected by Brian Bowen and Rob Toonen (UH-HIMB) for genetic connectivity analysis. 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. We will swap out EARs for Marc Lammers (UH-HIMB/NOAA) during our receiver recovery dives.

12a. List all specialized gear and materials to be used in this activity:
Please refer to Appendix 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 of data are ongoing. An update on shark spatial dynamics at FFS will be ready by December 2010. We already have three manuscripts published in international peer-reviewed journals. We have 4 additional manuscripts currently in review.

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.

Meyer CG, Holland KN, Papastamatiou YP. 2007. Seasonal and diel movements of giant trevally (Caranx ignobilis) at remote Hawaiian atolls: implications for the design of Marine Protected Areas. Marine Ecology Progress Series. 333: 13-25.

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.

Dale J.J., A.M. Stankus, M.S. Burns, & C.G. Meyer. (In Review). The shark assemblage at French Frigate Shoals atoll, Hawaii: species composition, abundance and habitat use. Marine Biology.

Meyer CG, Papastamatiou YP, Holland KN (In Review). A multiple instrument approach to quantifying the movement patterns and habitat use of tiger and Galapagos sharks at French Frigate Shoals, Hawaii. Marine Biology

Nakamura I, Watanabe Y, Papastamatiou YP, Sato K, Meyer CG (in review) Vertical movements in tiger sharks Galeocerdo cuvier: locomotory cost saving or foraging? Journal of Experimental Biology

Gil Iosilevskii G, Papastamatiou YP, Meyer CG, Holland KN (in review) Why do sharks perform vertical "Yo-Yo" dives? A reverse engineering approach to tiger shark Galeocerdo cuvier swimming. Journal of Experimental Biology

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?

- [x] 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	Big Gin Bay	23.73355	-166.16612	5
FFS	Big Gin Point	23.73542	-166.16696	9
FFS	SE of La Perouse	23.74926	-166.21773	70
FFS	La Perouse	23.76945	-166.26208	30
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	Outside Trig	23.86945	-166.24158	15
FFS	Trig Island	23.87117	-166.24220	4
FFS	Trig Island	23.87124	-166.24323	4
FFS	Trig Island	23.87127	-166.24102	3
FFS	Trig Island	23.87135	-166.24435	3
FFS	East Tern	23.87135	-166.28203	6
FFS	Trig Island	23.87194	-166.24138	13
FFS	Trig Island	23.87200	-166.24205	5
FFS	Trig Island	23.87205	-166.24297	3
FFS	Trig Island	23.87206	-166.24529	5
FFS	Trig Island	23.87220	-166.24353	4
FFS	Trig Island	23.87237	-166.24432	4
FFS	Northern Barrier Reef	23.88183	-166.29223	147
FFS	Northern Barrier Reef	23.88183	-166.29223	147
FFS	North of Trig	23.88609	-166.22641	150
Gardner	West Cove	24.99834	-167.99982	51
Kure	SE Channel	28.38183	-178.30860	60
Kure	West Channel East Side	28.38897	-178.36187	50
Kure	West Channel	28.40388	-178.37508	70
Kure	Eastern Barrier Reef	28.42502	-178.28172	80
Kure	North Barrier Reef	28.46045	-178.32629	90
Laysan	South End	25.75463	-171.71562	66
Laysan	West Cove Channel	25.77395	-171.74248	30
Lisianski	South Neva Shoals	25.88237	-173.91573	85
Lisianski	East Side of Island	26.05728	-173.95957	14
Maro	North Tip	25.45842	-170.67104	55
Maro	Shark Point	25.46057	-170.68168	65
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
Nihoa	West Side	23.05942	-161.93058	40
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

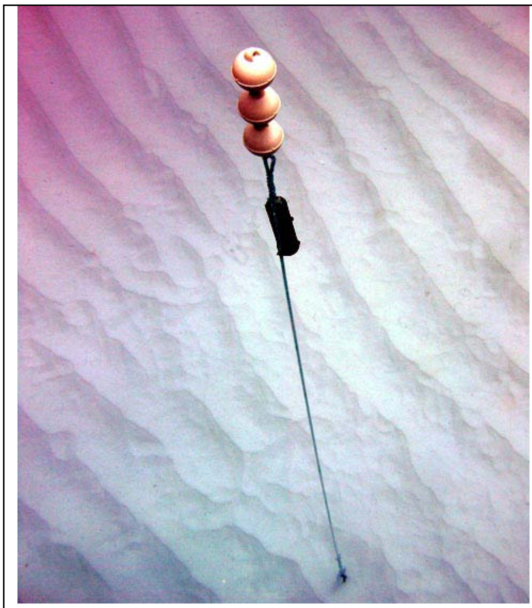
Appendix 2 Receiver installations in the Monument

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*.

	The finished installation, consisting of sand screw, rope bridle, VR2 receiver and subsurface floats.

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 Itemized list of gear and materials

Diving gear (will be transported in and out of Monument)

3 BCDs

3 Regulators

2 Weightbelts

6 Pairs of fins

8 Masks

4 Snorkels

2 Dive computers

2 Wetsuits

3 Dive knives

2 Surface floats and reels

2 Mesh bags

Fishing gear (will be transported in and out of Monument)

4 Handlines and lures

3 Ten hook shark lines

3 Bait knives

1 Chopping board

6 Large surface buoys

1 large hand net

Frozen bait (tuna heads)

Telemetry equipment (will be deployed in Monument waters)

190 V16 acoustic transmitters (will be surgically implanted in predators)

4 acoustic receivers (will be deployed on seabed)

Mooring supplies for acoustic receivers (see Appendix 2)

3 triaxial accelerometer-camera dataloggers

Miscellaneous items (will be transported in and out of Monument)

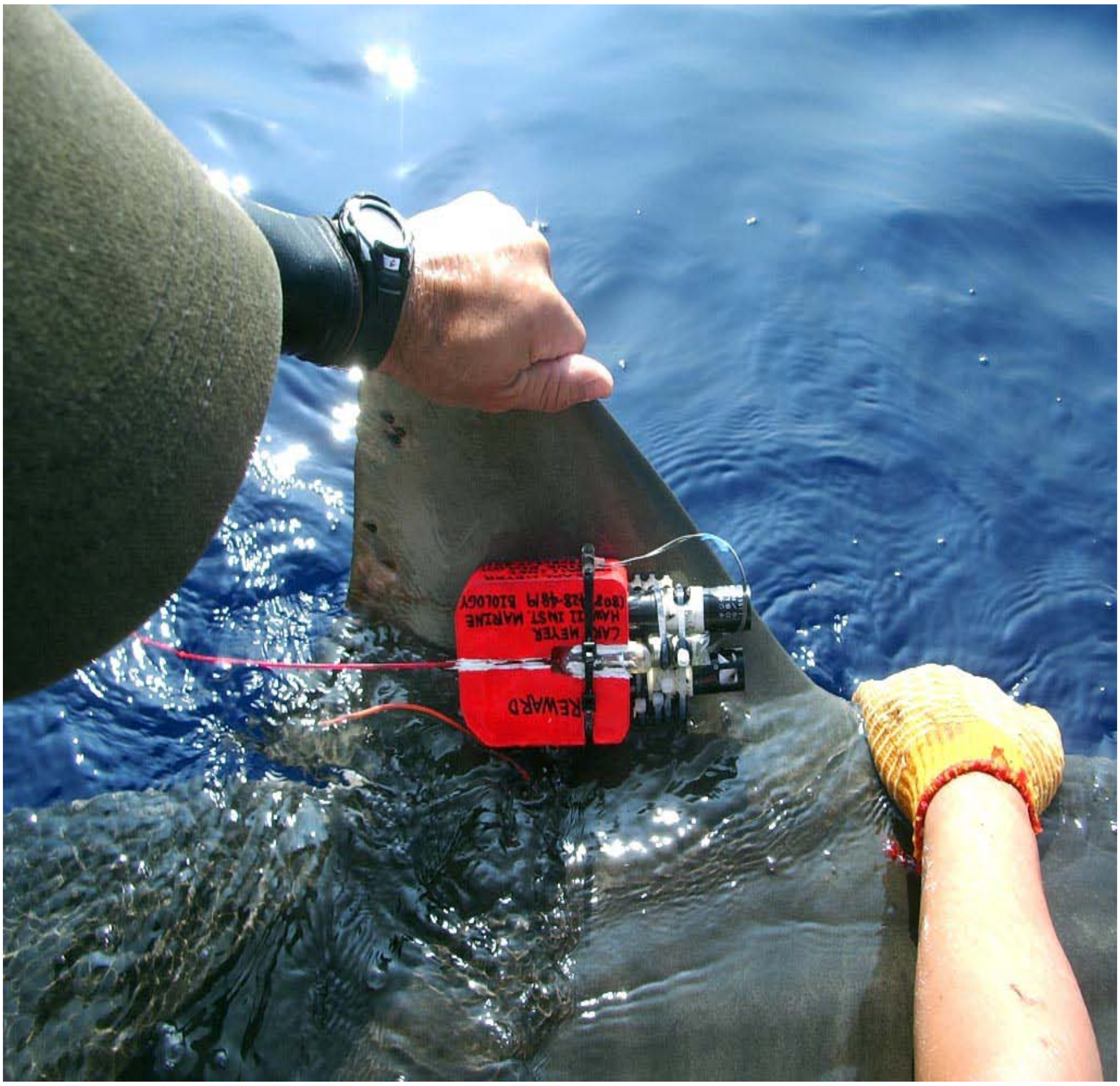
2 Laptop computers

2 Computer-receiver interfaces

Various rope working tools (fids, tape, rope cutter)

Receiver servicing supplies (batteries, electrical tape, scrubbing brushes)

Appendix 4 – Carl Meyer – PMNM Predator Tracking



Accelerometer-digital camera datalogger package deployed on a tiger shark

Appendix 5 Carl Meyer – Details of tissue sample collections

Common Name	Scientific Name	# & Size of specimens	Collection location
Galapagos shark	*Carcharhinus galapagensis*	45 x 5cc muscle tissue	FFS, PHR
Sandbar shark	*Carcharhinus plumbeus*	20 x 5cc muscle tissue	FFS
Grey reef shark	*Carcharhinus amblyrhincos*	20 x 5cc muscle tissue	FFS
Blacktip shark	*Carcharhinus limbatus*	20 x 5cc muscle tissue	FFS
Whitetip reef shark	*Triaenodon obesus*	20 x 5cc muscle tissue	FFS
Ulua	*Caranx ignobilis*	45 x 5cc muscle tissue	FFS, PHR
Hapu'upu'u	*Epinephelus quernus*	20 x 5cc muscle tissue	Midway, Kure