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: George A. Antonelis
Affiliation: National Marine Fishesies Service, Pacific Islands Fisheries Science Center

Permit Category: Research
Proposed Activity Dates: May 15, 2008 to September 30, 2008
Proposed Method of Entry (Vessel/Plane): Vessel and/or plane (based on availability)
Proposed Locations: FFS

Estimated number of individuals (including Applicant) to be covered under this permit:
Up to 10 but no more than 3 at any one time
Estimated number of days in the Monument: 135

Description of proposed activities: (complete these sentences):

a.) The proposed activity would…
monitor predation on Hawaiian monk seal pups by Galapagos sharks and deploy shark deterrent gear around selected FFS pupping sites.

b.) To accomplish this activity we would ….
observe shark activity at FFS (from ground and tower) and install visual, auditory, magnetic and electromagnetic deterrent devices on island, in small boats anchored offshore, or suspended in the water column using floating tubes or floats

c.) This activity would help the Monument by …
contributing to recovery of the Hawaiian monk seal, which is a keystone species within the Monument and is a protected species under provisions of both the ESA and MMPA. The Papahanaumokuakea Marine National Monument is home to approximately 94% of the entire population of endangered Hawaiian monk seals and is therefore critical to the future prospects of the species.

Other information or background: Predation on Hawaiian monk seals by Galapagos sharks has resulted in the loss of 15-21% of the annual cohort born at FFS in recent years. This behavior has not been observed at other breeding sites in the NWHI. This year, NMFS proposes to experiment with various non-lethal alternatives for mitigating this mortality source and salvaging of the reproductive potential of these pups.

Section A - Applicant Information

1. Applicant

Name (last, first, middle initial): Antonelis, George A.

Title: Chief, Protected Species Division

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

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

Phone:

Fax:

Email:

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

3. Affiliation (institution/agency/organization directly related to the proposed project):
NOAA, NMFS
Pacific Islands Fisheries Science Center (PIFSC)
Protected Species Division (PSD)

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):
Charles Littnan, PIFSC,
John Henderson, PIFSC,
Robert Dollar, PIFSC,
Shawn Farry, PIFSC
Mark Sullivan, PIFSC
Chad Yoshinaga, PIFSC,
Additional technicians (TBD) under the supervision of Shawn Farry

Section B: Project Information

5a. Project location(s):

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

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

Location Description:
Vicinity of Trig and the Gins Islands and/or other islets within FFS where predatory Galapagos shark activity is detected

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:***
Recent studies have shown that shark predation has been a significant factor contributing to early pup mortality at FFS, particularly at Trig Island. A significant number of pup deaths or disappearances related to shark predation have been either directly observed or inferred from previous events associated with shark predation on pups. Intense predation on preweaned pups and recently weaned pups was first detected at Trig and neighboring Whaleskate Island in the late 1990s, when 18-28 mortalities were documented each year from 1997-99. This equated to 38-69% of the annual cohort born at those sites. Atoll-wide, there have been 8-12 shark predation losses each of the last 7 years, equating to 15-21% of the annual cohort born at FFS. Last year (2007), 8 of the 43 pups born at FFS were believed lost due to shark predation. One other severely bitten pup was expected to die post season, and an additional weaned pup was reported missing prior to the start of the field season and may have been a shark predation mortality. This predation on pre-weaned pups is believed to involve a small number of persistent predators that first adopted the behavior after being attracted to the site by unusually high numbers of pup carcasses associated with two years of adult male seal aggression at Trig.

These high predation rates are incompatible with monk seal recovery at FFS, where a decrease in annual cohort size is predicted from an aging population. The proposed activities will include opportunistic monitoring of shark activity at sites where predation is detetected or suspected, and the use of several non-lethal, temporarily installed deterrents (sound, light, physical obstacles, and small work boats) to discourage predatory Galapagos sharks from sites where suckling and recently weaned pups are easily preyed upon.

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 PSD has assessed Hawaiian monk seal subpopulations in the NWHI annually since 1982. PSD has been monitoring shark predation on monk seal pups since 1997 and conducted shark removals from 2000 through 2007 (total of 12 Galapagos sharks removed). Through these investigations, PSD has acquired the necessary expertise for conducting research while also demonstrating a sensitivity to all other Refuge resources and procedures. There are no adverse effects anticipated for the proposed use of temporarily installed sound, light , visual, and magnetic deterrents near sites where young monk seal pups are most vulnerable to shark predaton. Regular monitoring of the deterrrent devices will occur to ensure and mitigate any unlikey negative effects to the ecosystem as a result of the actions proposed in the application.

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 Hawaiian monk seal is one of the keystone species within the Monument and activities that contribute to the monk seal's recovery are compatible with the objectives set forth in the Proclamation. Effects from deterring a limited number of the abundant Galapagos shark will be ephemeral and are not expected to have an effect on ecosystem functioning. Further, with the exception of the temporarily placed visual/magnetic deterrents placed in the near shore waters near monk seal mother/pup suckling sites pupping, all of the other proposed actions simulate ongoing human activities within the Atoll (e.g., engine noise from small work boats or actual small work boats at anchor). In contrast, failure to mitigate for the high predation rate (15-21% of the annual monk seal births) will have major effects on the likelihood of monk seal recovery at FFS. Mitigation for shark predation at FFS is also consistent with goal 6.b. of the U.S. Fish & Wildlife Service, National Wildlife Refuge System: "Conserve, restore where appropriate, and enhance all species of fish, wildlife, and plants that are endangered or threatened with becoming endangered."

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.
Intensive Galapagos shark predation on monk seal pups is a localized phenomenon at FFS. There are no comparable sites available outside the Monument where the proposed research on shark deterrents could be conducted. Further, it is essential that these activities be conducted at the location where they are most likely to benefit monk seal survival and recovery.

d. How does the end value of the activity outweigh its adverse impacts on Monument cultural, natural and historic resources, qualities, and ecological integrity?
As noted, the positive outcomes from enhanced monk seal recovery potential outweigh any adverse but highly unlikely impacts associated with the proposed non-lethal activities. We do not believe that other, secondary, impacts are likely to result from the deterrent experiments but all activities wil be monitored to ensure appropriate actions will be taken to mitigate any unexpected negative consequences of the proposed work.

e. Explain how the duration of the activity is no longer than necessary to achieve its stated purpose.
The activity will commence shortly before the start of the primary season so that the first sharks to begin patrolling pupping sites will encounter the deterrent devices. The activity will end at the conclusion of the pupping season.

f. Provide information demonstrating that you are qualified to conduct and complete the activity and mitigate any potential impacts resulting from its conduct.
The PSD at PIFSC has conducted field assessments of monk seals in the NWHI annually since 1982, and is recognized as being central to Hawaiian monk seal research. PSD has been engaged in shark monitoring and shark removals at FFS since 1998 and 2000, respectively. PSD has individuals on-staff with many years of experience and advanced expertise in monk seal ecology and marine ecosystems. We also have consulted, and will continue to consult, with other individuals, both in the scientific and private communities, having expertise in shark

behavior and potential deterrent methodology. To this end, NMFS convened a workshop on Shark Predation on Hawaiian Monk Seals in January 2008, to solicit input on shark behavior, shark deterrent technology, and other information pertinent to this situation. The workshop and our other ongoing consultations have also included contact with Native Hawaiian cultural practitioners.

g. Provide information demonstrating that you have adequate financial resources available to conduct and complete the activity and mitigate any potential impacts resulting from its conduct.
The PSD has annually received funding adequate to perform the activity, and anticipates that 2007 funding levels will continue to suffice. If additional funds are required to mitigate any unexpected impacts, resources would be available from PIFSC or NMFS Office of Protected Resources.

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.
As noted in item f, NMFS has solicited and received input from a broad spectrum of scientists and managers as we have developed plans for an effective shark deterrent system. Throughout development, we have sought low-impact methods that may be temporarily deployed and removed with minimal or no impact to the reef ecosystem. While some quasi-permanent structures (obstructions to shark movements) were discussed at the January predation workshop, no such structures or devices are proposed for use in 2008. The deterrent methods proposed herein will introduce some non-natural visual and auditory elements to the ecosystem, but those elements will be localized at focal predation sites, will be removed at the end of the monk seal pupping season, and are not expected to result in any permanent modification to the physical or biotic environment within the Monument.

i. Has your vessel has been outfitted with a mobile transceiver unit approved by OLE and complies with the requirements of Presidential Proclamation 8031?
The NOAA vessel R/V Oscar Elton Sette has been so equipped.

j. Demonstrate that there are no other factors that would make the issuance of a permit for the activity inappropriate.
This project is an extension of a previous project which was permitted by the Monument in 2007 and previously underwent extensive review in-house, by members of the Monk Seal Recovery Team, by the USFWS, and by the State of Hawaii. Unlike the shark mitigation activites permitted by the Monument in 2007, the current application does not seek authorization for lethal removal of Galapagos sharks and, in that light, may be less controversial than the previously permitted activities.

8. Procedures/Methods:
This project encompasses three main components: a) shark observation/monitoring, b) shark deterrents using visual stimuli (random low level lights and other) and/or magnetic field

deterrents (produced from metallic magnets or electromagnetic fields) and c) auditory shark deterrents using outboard random outboard motor sounds.

The types of deterrents proposed for use in 2008 are based on input received at the 2008 Shark Predation on Hawaiian Monk Seal Workshop or in private consultations. While there was consensus among the experts assembled at the Workshop that visual, auditory, magnetic, and electromagnetic deterrents held promise for deterring Galapagos sharks at FFS, realistic field trials have yet to be conducted with this species. Consequently, many aspects of this system can only be resolved during or after implementation, as field teams observe shark responses to each deterrent application and adapt the system for maximum effectiveness at each islet. This is likely to be an iterative process, and some flexibility will be necessary to ensure success.

A. Shark Observation/Monitoring

An effective monitoring system is required for documenting changes in shark activity at pupping sites, detecting instances of shark predation on monk seal pups, and assessing shark response to deterrent devices. In 2000, NMFS developed a standardized system for collecting and recording quantitative and behavioral data on sharks exhibiting predatory behavior toward monk seal pups. This system, called "time scan sampling" involved intensive, continuous observation of shark activity in the nearshore waters surrounding major pupping sites (a detailed description of the monitoring protocols are available in previous reports or upon request). Observations were historically conducted from both the ground and from an elevated tower on Trig Island. Continuous monitoring has proven less effective in recent years as sharks became increasingly wary of human presence and most patrolling and predation occurred at night. However, intensive monitoring may be reinvoked in 2008 because multiple deterrent systems will be deployed and it is essential that the effectiveness of each component be assessed. This will also enable us to progressively refine such aspects of the system as physical placement, timing, etc., and also to ascertain whether there are any undesirable effects associated with deterrent application We therefore propose to conduct intensive monitoring, including possible use of the observation tower, if the shark team concludes that the monitoring will help to assess the efficacy of each device.

Overnight camping: NMFS staff may request permission for overnight camping (1-3 nights at a time) in order to collect information during dawn/dusk periods. Overnight stays may be requested to evaluate the effectiveness and possible negative effects of the deterrents, or in response to an increase in shark activity or predation incidents. During overnight observations, the shark monitoring team may employ night-vision goggles to enable observations in low-light conditions (nocturnal and pre-dawn hours). No more than 2 people will overnight at study sites, campsites will involve minimum requirements typically used for backpacking (e.g., food, small, low profile tents and sleeping bags) and all waste material will be removed and transported to Tern Island for disposal in an appropriate manner. Such short camps have been successfully completed at Trig Island on numerous occasions in the past without causing harm to the environment or the wildlife.

Monk seal population assessment personnel will continue to visit Trig Island on a daily or near-daily basis so that missing pups, shark-injured pups, or elevated shark activity will be immediately detected. If sharks are observed, monitoring intensity will be immediately increased to evaluate the predation risk and to observe shark reaction to deterrent devices.

B. Visual deterrents and Combination (Visual + Magnetic or Visual + Electromagnetic) Deterrents
These deterrent types will be deployed at Trig Island (primary site) and possibly also at the Gins or East Island (at the latter only if no turtle biologists are present). They may also be combined with auditory deterrents (part C). All of these systems will be installed fron 200-500m of shore. The precise location, size (length, number of magnets, etc) of separate installations will be determined on-site based on inspection of the reef topology, prevailing currents and other site-specific considerations.

These systems will include the following primary elements:
1). Visual Array: this term refers to a generic class of visual deterents which may include one or several of the following devices: pvc tubing, closed-cell foam tubes ("swim noodles"), fishing floats, etc. These visual stimuli may also be attached to a magnetic array (item 4, below) to act as additional deterrent. All gear will be anchored on sand or rubble substrates where there will be no damage to coral or other Monument Resources. All attachment lines will be shielded with sections of 1/2" PVC pipe or foam tubes to ensure monk seal and other marine biota will not become entangled.

2). Boat deterrent: A small (18-20 ft) workboat will be left at Trig when personnel are not present on island. to give the impression humans are present. Motivation for this deterrent type is based on observation of a "boat effect" in previous years whereby patrolling sharks appeared to avoid small boats anchored offshore. The boat will be securely attached to both an offshoare and onshore mooring and satellite/VHF tracking of the boat will be possible in the unlikely event that it should break free.

3). Random lights: This deterrent type consists of a beacon or spotlight situated either onshore (1-2 high points on island) or in a small boat anchored near shore. The light(s) would be programmed to turn on/off at random or preselected times. If feasible, the light will be capable of rotating or changing orientation to minimize possible habituation to this stimulus. Portable solar panels and/or 12V battery arrays will be used to supply power for the lights.

4). Magnetic deterrents: Most in-water visual deterrents (item 1, above) will be coupled with magnetic deterrents. Design of these systems is based largely on the findings of Dr. Eric Stroud of Shark Defense Inc., whose research has demonstrated a measurable repellent effect of magnets on captive sharks of multiple species. Preliminary research and consultation indicate that Grade C8 Barium-Ferrite permanent magnets (~15.24 cm x 10.1 cm x 1.27 cm dimensions) are likely to be suitable for our purposes. The probable deployment method will be water column sets (magnets suspended at 40-50cm separations fixed between anchor and surface float). Spatial arrangment may involve double or multidimensional arrays to optimize the deterrent effect at each locale where a system is deployed.

6). Electromagnetic deterrents (e.g., "Shark Shields") may be deployed at primary access channels where patrolling sharks approach Trig Island. The main advantage of such a system (as compared to permanent magnets) is a more powerful deterrent effect at focal sites (up to 15m from the emitter for some commercial devices). However, electrical systems require continuous power which will necessitate a more powerful solar array to meet the power consumption needs. NMFS personnel are currently researching suitable options for electromagnetic devices and associated power systems. As with permanent magnet systems, electromagnetic systems may be coupled with visual deterrents to achieve maximum repellent effect.

C. Auditory Repellents

Auditory stimuli will be applied at Trig Island and possibly at other islets (Gin or East). The auditory repellents may be deployed either from the islet or from a small boat anchored offshore. Power will be supplied by a portable solar system. The stimuli will consist primarily of random boat sounds to mimic the sound of a small boat approaching the islet. NMFS personnel are currently investigating the best equipment for applying this stimulus, but a submersible system that administers random broadcasts is preferable.

D. Risks due to Deterrent Systems

When designing the deterrent systems to be deployed in 2008, the risk of negative impacts associated with each system will be a prime consideration. Such negative effects could include: entanglement (by monk seals or other species), undesired deterrent effects on non-target species, detachment and/or loss of the equipment, attraction to the islet from novel auditory or visual stimuli, and unintended damage to coral or other system resources. Each device will be evaluated according to each type of risk, and no device will be deployed unless the risks are determined to be negligible. Further, as noted in the section on Shark Monitoring/Observation (section A, above) both the effectiveness and risks associated with each device will be assessed by direct observation. Additionally, deployment of all deterrents will be incremental to allow assessment and evaluation, after which deployment may be suspended, modified, or expanded.

E. Native Hawaiian Practices and Participation

Prior to deployment, NMFS will consult with a Native Hawaiian cultural practitioner to determine if any miitigation efforts proposed for 2008 are deemed inappropriate or inconsistent with Native Hawaiian cultural considerations. All scientists participating in these activities will receive a Native Hawaiian cultural briefing before departure to the NWHI. In addition, the primary permittee, chief scientist, and other appropriate personnel look forward to consulting with the Office of Hawaiian Affairs (OHA) and the Monument's Native Hawaiian program coordinator on proper conduct while in the NWHI, on cultural sensitivities associated with the proposed activities and locations, and on the applicability of the results of this research to the role of OHA as one of the NWHI management agencies.

F. Activity reports

Periodically throughout the period covered by this permit, NMFS will submit progress reports describing preliminary findings on the success of the deterrent systems. These reports will also

describe any negative effects observed for each system, and will summarize shark activity at FFS:

- Number of pups born and currently present at each islet
- Date and location of shark related pup injuries, deaths and disappearances at all sites;
- Summary of observed shark activity at each site
- Any other information pertinent to the ongoing evaluation of this project

G, Project Evaluation

The ultimate goal of the project is a reduction in shark-related pup mortality at French Frigate Shoals, with particular emphasis at Trig Island. Given this goal, the number of pup mortalities will be the primary measure of project success (specifically, a decline in the number of losses as compared to 2000-2007 levels). In addition to this measure, other direct observations are key to evaluating project success. These include: the apparent deterrent effect of different types of devices, the manpower required to install and maintain each device, the cost of each device (both initial and ongoing), and any evidence of undesirable secondary effects associated with each class of device. These observations will be critical as we continue to refine the deterrent system for future application.

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:

Scientific name:

& size of specimens:

Collection location:

☐ Whole Organism ☐ Partial Organism

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

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

• General site/location for collections:

• Is it an open or closed system? ☐ Open ☐ Closed

• Is there an outfall? ☐ Yes ☐ No

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

• Will organisms be released?

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

11. Describe collaborative activities to share samples, reduce duplicative sampling, or duplicative research:
Representatives from PIFSC have been actively engaged in dialog with other labs and investigators to design field and laboratory research studies that specifically address our species and field situation. These researchers include: Eric Stroud of Shark Defense (private firm) who has studied the use of chemical agents and permanent magnetics to deter shark predation, and John Wang who has conducted field trials on the north shore of Oahu testing the efficacy of E+ metals (lanthanides) to deter shark feeding (including Galapagos sharks). In the former case, we provided Dr. Stroud with a Galapagos shark carcass to test the repellent effect associated with semiochemicals present in the carcass. We have also been actively involved with researchers at California State University (Lowe and Weatherby) and the Hawai‘i Inst. of Marine Biology (Meyers and Holland) to conduct behavioral studies of Galapagos sharks at FFS. We will continue to interact with these and other researchers to develop lab and field studies more specific to our situation with Galapagos shark predation at FFS.

12a. List all specialized gear and materials to be used in this activity:
The goal in 2008 will likely be to identify a deployment strategy and locations to test a trial deployment. This year is essentially a pilot year to evaluate the feasibility and efficacy of mitigating shark predation using non-lethal deterrents. Accordingly, several types of specialized deterrent devices will be deployed, and their effectiveness will be evaluated by direct observation and monitoring of pup losses.

The primary deterrent devices to be evaluated include an auditory system; multiple visual deterrents (a light source, anchored boat, and in-water visual deterrents used in combination with magnetic deterrents); and magnetic deterrents situated at primary shark access points around predation sites. A commercial electric deterrent system (Shark Shield) is also under

consideration for deployment in 2008, pending further evaluation, availability, and cost estimate. Each of these device types is described below and may be used in combination or separately as deemed appropriate by the field staff. The specific models mentioned below are contingent upon availability and additional research prior to deployment.

Auditory Deterrent:
Primary device: Lubell Labs Model LL919 – Diver recall system. 500m recall range, 1 mile under ideal conditions. Up to 180 db output. Omnidirectional, 12v battery operation. This device will be used to emit random sound broadcasts (i.e. boat motors, predators). Speakers and sound system/batteries will be secured in either a fixed boat or a fenced on- island location and will be removed at the end of the season or should any adverse non-target impacts be identified.
Additional Requirements - need 12v battery, solar panel, player, pelican case, timer, sound recordings, and preferred frequency requirements.
Locations: Trig and Gins

Visual Deterrents:
Type 1: Light Source:
Primary device: One to two single 12 volt light sources will be placed at high points on Trig or the Gins Islands and mounted on short metal poles 6-12 in off the ground or mounted to the anchored boat offshore. The light source will be shielded to prevent damage and programmed to turn on and off randomly during the night.
Additional Requirements: 12V battery, solar panel, player, pelican case, and timer.
Locations: Trig and Gins

Type 2: Boat Decoy
An unused boat will be left anchored at Trig and/or the Gins. The boat could be periodically moved about the island and in conjunction with sound emissions, may act as a deterrent. Visual deterrents will be immediately removed if entanglement or attraction potential is identified and the boat will be anchored securely with heavy duty moorings and anti chaffing gear.

Type 3: In-water visual deterrents
Objects such as PVC tubing or foam floats may be attached to magnet array (see Magnetic Deterrents, below) to act as additional visual deterrent.

Magnetic Deterrents:
Implementation of a “magnet fence” or densely spaced arrays would likely be an excessive amount of material to place around Trig Island, especially for a largely untested technique. However, utilizing single water column sets, higher density deployments could be set outside the primary mother pup swimming area with lower density deployments set in closer proximity to the island. Observations will be conducted to ensure seals are not attracted to lines or floats and will be remove or modified if entanglement or attraction potential is identified.

Of these apparatuses, the only component that might be considered highly specialized is the magnets. The recommended magnet type is: Grade C8 Barium-Ferrite permanent magnets

(15.24 cm x 10.1 cm x 1.27 cm). The cost, size, and handling safety make the use of this type of magnet very desirable over rare-Earth magnets of the same size. The strength of flux is sacrificed with a flux per unit area of at least one order of magnitude weaker at a Barium-Ferrite's magnet's surface than a rare-Earth magnet. However, despite this limitation, the wide-area flux created by these magnets may, especially at distances less than 20cm, orient the sharks away from the magnets.

Magnetic deterrents may be applied in several different fashions or "sets":
Water column sets - Magnets suspended at 40-50cm separations fixed between anchor and surface or subsurface float. This deployment could be used at various water depths and would have less entanglement potential than deployment strategies utilizing floating or subsurface horizontal lines. Anchors would be small (5-10lbs) and would only be placed on sand or rubble substrates. While a single vertical floating magnet set has low entangle potential, it may be further reduced by affixing ridged spacers such as PVC tubing or foam floatation tubes in between magnets. These spacers may also act as additional visual deterrents.

Bottom individual sets – This strategy may be useful in very shallow water. To facilitate recovery of the magnet as well as maximizing its zone of impact, the magnet could be affixed to a base such as a cinder block. Placement of these sets would only occur on sand or ruble substrates and would not be place on coral.

Random single water column sets – Single water column sets as described above, however deployed randomly about the lagoon for the purpose of disrupting shark movement within the suspected take zone.
For all types of set, the orientation at which the magnets are mounted will affect the resulting field. Mounting with the side containing the least surface area oriented towards the surface of the water, would create one polar flux lobe, at approximately 180G. Conversely, when placing the magnets flat with the side containing the most surface area oriented towards the surface of the water, two lobes are measured at approximately 100G, corresponding to the field lines from each pole. Positioning the magnets to create two 100G maxima in magnetic flux was hypothesized to be the most effective because having two electric field barriers instead of one would increase the exposure of the fields towards our subjects. With one barrier, the shark could encounter the 180G field and accelerate through it. But, with two barriers, the shark could encounter the first and detect that there was another electric field directly behind it. This could cause the shark to slow down while encountering the first field and then turn around after detecting the second field.
Commercial Electric Deterrents (Shark Shield)
Plans for application of an electric deterrent system are preliminary pending availability and cost estimate for designing a custom, externally powered system suitable for deployment at FFS.
Primary Device: 1-2 Shark Shield units. Model options are:
Mariner: 15m exclusion zone from emitter (30 diameter), 4 hour battery life limits usefulness, however, if battery life could be extended it may be worth testing. Power output not listed in product specifications.

Custom Units – may be operated by external sources and have been used on fish pens. A custom externally powered unit would allow for a larger on-island battery source with solar recharge. Its greater power would also be superior to magnets and remove the need for gear intensive magnet deployment.

Should a Shark Shield device prove practical, deployment would follow that of the magnet deterrents. The voltage associated with these systems is so low that there is no anticipated risk to outer monument resources.

The following information is extracted from the Shark Shield web site (http://www.sharkshield.com) and provides an overview of the device and how it functions:

The field generated by the Shark Shield poses no danger to the user, to sharks or to the environment. The field can be detected if the electrodes come into very close contact with the skin.

Direct contact with, or very close proximity to the antenna, may cause twitching of the surface muscles of the skin, in time with the slow pulsing of the signal. The conductive field readily travels through seawater, it being a better conductor than the human body. Thus the field tends to surround the body rather than penetrate it. Tests show that the type of signal generated by the Shark Shield is unable to pass through body tissues, unlike radio waves or microwaves that readily penetrate the body, and therefore it poses no health problems for users.

From the tests conducted to date, the Shark Shield does not harm the shark. The majority of initial testing was carried out by a team of marine biologists at the Natal Sharks Board of South Africa.

Scientific tests, as well as observations, show the field emitted by the Shark Shield causes discomfort to the shark, which can eventually lead to muscular spasms. However once the shark leaves the area, there is no lasting detrimental effect to the shark.

One of the distinct advantages of this unique electronic wave-form is that it only repels sharks and members of the Elasmobranch family that have have Ampullae of Lorenzini.

12b. List all Hazardous Materials you propose to take to and use within the Monument:
The only components of the deterrent system that might be considered hazardous are a) the 12V batteries that will power the audio and light deterrents, and b) the Shark Shield system. Please refer to the preceding question (item 12a) for material pertaining to the safety of the Shark Shield system. The batteries will be sealed and secured so that there is negligible chance of leaking any hazardous materials (i.e., battery acid) into the environment.

13. Describe any fixed installations and instrumentation proposed to be set in the Monument:
All devices (including light deterrents, auditory deterrents, visual deterrents, magnetic deterrents, and electric deterrents) will be temporary and removed at the end of the season or at any point

when they cannot be regularly monitored (daily when first deployed, and a minimum of every 2 days thereafter).

14. Provide a time line for sample analysis, data analysis, write-up and publication of information:
As noted in item 8 (Procedures and Methods), during the field season, NMFS will submit periodic progress reports describing preliminary findings on the success of the deterrent systems. At the conclusion of the study (on or before Nov 15, 2008), NMFS will prepare a report summarizing all findings from the season, including number of observed predation incidents, predation trends as compared to previous years, observed numbers of sharks at each site, observed reaction to deterrent devices of each type, problems encountered, preliminary conclusions about the efficacy of the deterrent system, and recommendations for future mitigation using the same deterrents or other methods.

15. List all Applicants' publications directly related to the proposed project:
Annual progress reports have been prepared by NMFS during each year of the shark predation mitigation project, 2000-2007. Also, a manuscript describing the predation situation and prior mitigation efforts has been submitted for publication to the journal Ecology and Society: Galapagos Sharks And Monk Seals: A Conservation Conundrum (A. Harting, G. Antonelis, B. Becker, S. Canja, D. Luers, and A. Dietrich).

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