

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 Insitute of Marine Biology

Permit Category: Research

Proposed Activity Dates: April 1 2009 - September 30 2009

Proposed Method of Entry (Vessel/Plane): Vessel/Plane.

Proposed Locations: Shallow water habitat (<100m) around French Frigate Shoals

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

5

Estimated number of days in the Monument: 90

Description of proposed activities: (complete these sentences):

a.) The proposed activity would...

Quantify the movements of sharks at French Frigate Shoals Atoll to improve our understanding of shark predation on Hawaiian monk seals.

b.) To accomplish this activity we would

Equip large sharks with electronic tags, and monitor their movements using acoustic receivers (deployed on the sea floor) and satellites. Sharks are captured using handlines and 10 hook bottom-set lines, restrained alongside a small boat during transmitter attachment and then released. 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 ...

The purpose of our research is to provide Monument managers with empirical data on shark movement patterns 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 are working with the Office of Hawaiian Affairs to seek 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):

TBD

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

[REDACTED]

Phone:

[REDACTED]

Fax:

[REDACTED]

Email:

[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):

Jon Dale, Research Diver & Field Technician

Yannis Papastamatiou, Research Diver & Field Technician

Tim Clark, Research Diver & Field Technician

TBD, Research Diver & Field Technician

TBD, Research Diver & Field Technician

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 checked="" type="checkbox"/> Land-based	<input checked="" type="checkbox"/> Shallow water	<input type="checkbox"/> Deep water
<input type="checkbox"/> Gardner Pinnacles	<input type="checkbox"/> Land-based	<input type="checkbox"/> Shallow water	<input type="checkbox"/> Deep water
<input type="checkbox"/> Maro Reef			
<input type="checkbox"/> Laysan Island	<input type="checkbox"/> Land-based	<input type="checkbox"/> Shallow water	<input type="checkbox"/> Deep water
<input type="checkbox"/> Lisianski Island, Neva Shoal	<input type="checkbox"/> Land-based	<input type="checkbox"/> Shallow water	<input type="checkbox"/> Deep water
<input type="checkbox"/> Pearl and Hermes Atoll	<input type="checkbox"/> Land-based	<input type="checkbox"/> Shallow water	<input type="checkbox"/> Deep water
<input type="checkbox"/> Midway Atoll	<input type="checkbox"/> Land-based	<input type="checkbox"/> Shallow water	<input type="checkbox"/> Deep water
<input type="checkbox"/> Kure Atoll	<input type="checkbox"/> Land-based	<input type="checkbox"/> Shallow water	<input type="checkbox"/> Deep water
<input type="checkbox"/> Other			

Ocean Based

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

Location Description:

Fishing/Tagging

Field personnel will be based primarily at Tern Island field station (FFS) with supplemental ship-based activities. Shark tagging will occur in the shallow waters (<100m) around French Frigate Shoals. The exact locations of all shark captures will be recorded using a handheld GPS.

Receiver Deployment and Recovery

Eight receivers are currently stationed in the shallow waters around FFS. The specific positions (latitude and longitude) of these units are given in Appendix 1, together with deployment depth and habitat characteristics. Up to thirty additional receivers will be deployed to increase monitoring coverage at French Frigate Shoals.

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 our research is to provide Monument managers with empirical data on shark movement patterns and population sizes at French Frigate Shoals atoll. This information is vital for a better understanding of shark predation on Hawaiian monk seals and for selecting appropriate management strategies for mitigating predation impacts on monk seals. We have the following specific goals and objectives;

- (1) Download 8 underwater receivers currently stationed at FFS to retrieve stored movement data from sharks tagged with acoustic transmitters in 2008.
- (2) Determine the movement and habitat utilization patterns of these sharks, with specific emphasis on the frequency and timing of visits by Galapagos and tiger sharks to monk seal pupping sites inside the atoll lagoon.
- (3) Improve our receiver coverage by deploying up to thirty additional underwater receivers at French Frigate Shoals (Appendix 1).
- (4) Equip up to 100 additional galapagos sharks and 50 tiger sharks with acoustic tags detectable by our listening array. These tag deployments will enable us to reach adequate sample sizes to answer key questions about shark movements at FFS that will best inform seal predation mitigation strategies.

(b) Need for proposed activities

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). These suspicions led to culling of 12 Galapagos sharks around a major monk seal pupping site (Trig Island, FFS) during 2000-2006 in an attempt to reduce pup predation. Despite shark culling and an overall decline in sightings of Galapagos sharks in shallow waters around pupping sites, pup losses continue. In 2008 a variety of potential shark deterrent devices were placed around Trig Island in a new attempt to reduce pup mortalities.

Anti-predation strategies implemented to date have been based on untested assumptions about shark behavior at FFS. We need a better understanding of shark movement patterns at FFS to identify the most effective anti-predation strategies. Several key questions must be addressed;

- (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 much do shark movement patterns vary naturally over time?

(6) Do shark deterrents produce quantifiable changes in shark behavior around pupping sites?

(c) Scope of proposed activities

We propose to continue monitoring our existing transmitter-equipped sharks in order to determine how their movement patterns vary over multi year time-scales at FFS. This will require servicing and redeploying 8 existing receivers currently deployed at FFS (see Appendix 1). We also propose augmenting our monitoring coverage by deploying up to 30 additional underwater receivers at FFS to obtain higher resolution shark movement data from around monk seal pupping sites. We propose implanting acoustic transmitters into up to 100 additional galapagos sharks and 50 additional tiger sharks to address key questions listed in section b above (see also procedures, section c).

Cited References - see section 15

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 acoustic monitoring 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 are working with the Office of Hawaiian Affairs to seek 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 the current draft NOAA research plan for the Monument. We are working with the Office of Hawaiian Affairs to seek 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 sharks at FFS atoll), 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 within hours of 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). We are working with the Office of Hawaiian Affairs to seek 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 sharks based on historical catch rates. The monitoring of shark 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 sharks 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 a decade 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. We are working with the Office of Hawaiian Affairs to seek guidance on how to mitigate potential cultural impacts associated with our research.

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 (MOA 2005-008/6882), and we are provided access to the Monument on NOAA research vessels. We are also exploring the possibility of transporting personnel to Tern Island by aircraft. 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) means that we need relatively little human access to the Monument in order to achieve continuous, year-round monitoring of predator movements. No sharks 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 within hours of 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). We are working with the Office of Hawaiian Affairs to seek guidance on how to mitigate potential cultural impacts associated with our research.

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.

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

8. Procedures/Methods:

We will access sites within FFS using small boats launched from Tern Island. Predator capture and tagging will be conducted from these boats. Servicing of receivers will be done by snorkelers and SCUBA divers. We will require terrestrial access to Tern Island only, and will not be conducting night operations. 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 (see also Appendix 2)

We will create temporary receiver moorings using a system that has previously been empirically demonstrated to successfully withstand seasonal high surf. Moorings 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 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.

(b) Data retrieval, reduction and analysis.

We will download receivers currently deployed at FFS (Appendix 1). Data downloading consists of interfacing the receiver to a computer via a magnetically coupled probe and the serial port of the computer, and can be accomplished in the field. Preliminary data reduction and analyses will commence after downloading.

(c) Deployment of transmitters

We will implant acoustic transmitters into up to 100 galapagos sharks and up to 50 tiger sharks captured at FFS. Our predator handling & tagging activities will be carried out in accordance with the animal use protocols of the University of Hawaii (protocol #05-053). We will capture target species by handlining (using a single baited hook) from a small skiff and using a bottom-set, 10 hook shark line. Captured sharks will be brought alongside the skiff, tail-rope and inverted to initiate tonic immobility. In this trance-like condition, sharks remain docile while transmitters are surgically implanted. We will implant coded acoustic transmitters (V16, 9 mm diameter, 90 mm long, Vemco, Halifax, Nova Scotia) into the body cavities of each shark 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, the hook removed and the shark released. This entire handling process can be completed in less than 10 minutes. Our acoustic transmitters have expected life spans of 2-10 years, thereby offering the possibility of detecting annual or seasonal patterns of movement and habitat use (Meyer et al. 2007a,b).

Cited References

Antonelis, G. A., J. D. Baker, T. C. Johanos, A. L. Harting, 2006. Abundance of the Hawaiian Monk Seal (*Monachus schauinslandi*): status and conservation issues. Atoll Research Bulletin 543:75-101.

Caretta, J. V., K. A. Forney, M. M. Muto, J. Barlow, J. Baker, B. Hanson, and M. Lowry. 2007. U.S. Pacific Marine Mammal Stock Assessment: 2006 NOAA-TMNMFS-SWFSC-398.

Harting, A. L., J. D. Baker, and T. C. Johanos. 2007. Reproductive patterns of the Hawaiian monk seal. *Marine Mammal Science* 23:553-573.

Holland KN, Wetherbee BM, Lowe CG and CG Meyer (1999) Movements of tiger sharks (*Galeocerdo cuvier*) in coastal Hawaiian waters. *Marine Biology* 134: 665-673.

Meyer CG and R Honebrink (2005) Retention of surgically implanted transmitters by bluefin trevally (*Caranx melampygus*). Implications for long-term movement studies. *Transactions of the American Fisheries Society*. 134:602-606.

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.

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:

N/A

Scientific name:

N/A

& size of specimens:

N/A

Collection location:

N/A

Whole Organism Partial Organism

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

N/A

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

N/A

• General site/location for collections:

N/A

• 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?

N/A

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

N/A

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

N/A

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. We already have two manuscripts published in international peer-reviewed journals. We have a 3rd manuscript 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.

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 9/1/08

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

Carl Meyer – Papahānaumokuākea FFS Shark Tagging

Appendix 1 Activity Locations

(1) We will recover, download and redeploy 8 receivers deployed at the following locations;

Location	Latitude	Longitude	Habitat
Rapture Reef	23.635090	-166.185700	Sand
Gins	23.726150	-166.189633	Sand
La Perouse	23.769450	-166.262083	Uncolonized hard bottom
East Island	23.786860	-166.207090	Sand
Round I	23.827467	-166.228567	Sand
Tern Island	23.866640	-166.288200	Sand
Trig Island	23.869453	-166.241583	Sand
N of Atoll	23.881833	-166.292233	Sand

Carl Meyer – Papahānaumokuākea MNM Top Predator Tagging

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.

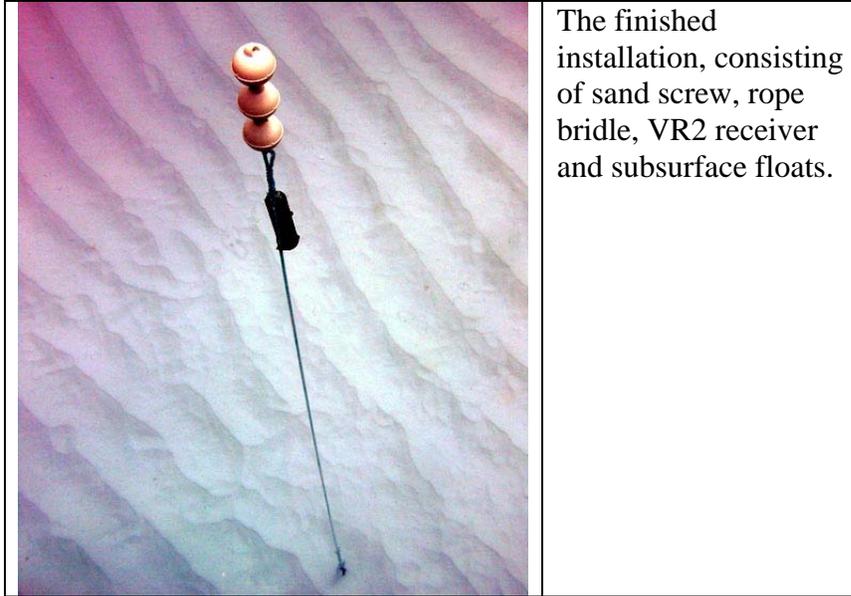


Vemco VR2 Receiver

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.

	<p>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.</p>
	<p>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 <i>in situ</i>.</p>

Carl Meyer – Papahānaumokuākea MNM Top 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.