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: Dr. Scott Shaffer
Affiliation: San Jose State University

Permit Category: Research
Proposed Activity Dates: 01 January 2021 - 31 December 2025
Proposed Method of Entry (Vessel/Plane): Plane or vessel
Proposed Locations: Midway Atoll NWR

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

Estimated number of days in the Monument: Approximately 75 days per year. The bulk of research will be conducted during a 2-6 week long period on site, starting in early December through April. This time frame coincides with the first half of the albatross breeding season and the first few months of breeding for boobies and frigatebirds. I am also requesting a 2-3 week window in June/July to deploy tracking devices on albatross fledglings. The timing and freqency of visits will depend on availability of flights or ship transport to the islands, USFWS schedules, and weather. Note that the number of days in the Monument is likely to be an overestimate depending on funding levels and personnel availability.

Description of proposed activities: (complete these sentences):

a.) The proposed activity would…

Research on albatrosses:

1) Characterize the interactions (frequency, duration, and at sea location) of albatrosses with fishing vessels based upon our ability to obtain vessel radar signals from foraging albatrosses equipped with high resolution GPS tracking devices, 2) add to our long-term monitoring of Laysan and black-footed albatrosses at sea behavior by the addition of five more years of data, 3) obtain feather or blood samples for analysis of stable isotope (Carbon & Nitrogen) signatures to infer proximate diet, and 4) to study fledgling albatross dispersal from the Northwest Hawaiian Islands.

Research on boobies and frigatebirds:

Continue research previously approved in PMNM-2016-003. I will continue to study the foraging ecology of Red-footed, Brown, and Masked boobies as well as Great Frigatebirds by monitoring 1) the movement patterns, at-sea distribution, and habitat use of breeding birds from Midway Atoll using GPS data loggers, 2) the diet of boobies and frigatebirds by collecting opportunistic samples when/if birds regurgitate when handled, 3) long term diet signals based on stable isotope analysis of feathers, and 4) stress levels as indicated by corticosterone levels in blood samples collected when the bird is captured for tag deployment AND removal. The foraging ecology of the birds would be studied in relation to environmental conditions that can be monitored with remotely sensed data (e.g. wind patterns, sea surface temperature, chlorophyll-a concentration). Because we already conduct similar studies on Laysan and black-footed albatrosses at these locations, this work would be an extension of our research program on albatrosses. The study would also take a comparative approach to examine species and/sex differences in foraging ecology which are commensurate with differences in life history patterns of each booby species. I have been involved in comparative studies of these species elsewhere (e.g. Lehua Island, Palmyra Atoll, and Baja California) so these data would be compare to behavior of birds in these regions.

b.) To accomplish this activity we would ….

Research on albatrosses:
We would deploy GPS tracking tags (including purpose built radar-detecting tags) in combination with activity loggers and geolocating archival loggers on up to 60 breeding Laysan albatrosses AND on up to 60 breeding black-footed albatrosses during the incubation phase AND up to 60 of EACH albatross species during the brooding phase in EACH breeding season (see Collection Table). In summary, we propose to study up to 120 adult individuals of each species in each breeding season. In all likelihood, our numbers of individuals will be much lower because of limitations on tracking tags, funding, number of personnel in the field, etc.

When possible, albatross trip durations will be measured on both equipped and non-equipped birds to test for gear-effects (we have done this in previous seasons as well and have not found any affects). When possiable, EACH bird will be weighed and up to 1 mL of blood sampled for isotopic analysis and genetic profiling. We will conduct post-hoc analyses to compare isotopic signatures from feathers to estimate trophic structure of diet between species. In June/July we would deploy tracking tags on up to 60 albatross fledglings (30 on each species) in each year.

Research on boobies and frigatebirds:
We would deploy 20 g GPS loggers on up to 30 breeding individuals of each species (less of Brown boobies) during the incubation, chick-brooding, OR chick-rearing phases. Each bird would be studied once but handled twice: 1) to attach the data loggers, collect 0.5 mL of blood, and to weigh the bird during logger deployment, and 2) to remove the GPS loggers, collect 1 mL of blood, weigh the bird, and collect up to 4 body feathers during recovery. In addition, we would opportunistically collect any diet samples regurgitated by the bird during handling. In all likelihood, our numbers of tag deployments would be much lower because of limitations on tracking tags, funding, number of personnel in the field, etc. Trip durations will be measured on both equipped and non-equipped birds to test for gear-effects (we have done this in previous seasons as well and have not found any affects)

c.) This activity would help the Monument by …

Research on albatrosses:

This research provides the PMNM specific and useful information on the occurrence of fishing activity within the PMNM, describe drivers of albatross-fisheries interactions, and assess and develop recommendations for enhancing bycatch mitigation in the region. Specifically, our goals for this research include 1) surveillance of potential illegal fishing activities within PMNM waters and the adjacent high seas regions from an albatrosses perspective; 2) targeted assessment of mechanisms that create or drive fine-scale albatross-vessel interactions of breeding black-footed and Laysan albatross during periods of highest overlap in distribution with tuna longline fleets (Nov.-May); 3) assessing the effectiveness of long-line night setting as a preventative measure for albatross bycatch through analysis of albatross movements and vessel activity during day and nighttime periods; 4) quantifying fishing pressure along the PMNM boundary and determine if there is a PMNM 'edge effect' that influences albatross interactions; and 5) propose dynamic bycatch mitigation schemes informed by this fine-scale analysis, and evaluate their implementation feasibility and effectiveness. Finally, the continuation of the long-term tracking dataset will be a critical asset for answering pressing questions about albatross ecology and conservation needs, a key component of ecosystem-based management.

Research on boobies and frigatebirds:

This research provides the Refuge/Monument managers with a greater understanding of the habitat use by boobies and frigatebirds within the Monument, because the foraging ranges of all three booby species' are within Monument waters (~50-200 km from the colony; Young et al. 2015; Gilmour et al. 2018), in contrast to our study on albatross which forage predominantly outside of the Monument. Frigatebirds are known to forage within and outside Monument waters (Gilmour et al. 2012). Thus, these studies would enhance our understanding of resources utilization by species that breed and predominately feed within the Papahanaumokuakea Marine National Monument. We may find that certain sectors of the Monument are more important to the boobies and frigatebirds than others, which could dictate further management, protection, or study. The boobies and frigatebirds are also unique in that they relay heavily on sub-surface predators like tuna and sharks that drive prey like flying fish or squid to the surface. Thus, studies that focus on the foraging ecology and subsequent breeding performance of boobies and frigatebirds could also provide information about the abundance of sub-surface predators within Monument waters. Finally, like the albatrosses, boobies and frigatebirds are abundant within the Monument, numbering several thousands pairs (specifically Red-footed boobies). As such, they act as a conduit between the marine and terrestrial environements by transfering nutrients between ecosystems. Therefore, Red-footed boobies and Great frigatebirds, which are tree nesters, could be a key species that provides nutrients to the limited tree species that exist within the Monument.

Other information or background:

Background for albatross research:

Understanding what drives the interactions between albatross and fisheries operations can offer resource managers new perspectives on strategies to reduce negative encounters, thereby promoting ocean management and albatross conservation. Albatross populations worldwide have been severely impacted by mortalities from long-line fisheries interactions where birds consume bait, become hooked, and then drown. Although albatross can be attracted to fishing vessels, simple overlap between albatross and fisheries distributions does not specifically equate to negative interactions for all individuals. Thus, individual-based perspectives can offer insights into the conditions under which albatross approach fishing vessels, and hence reveal intrinsic bird characteristics and/or situational behavior that can be applied in a management context. A fine-scale, individual-based approach is particularly relevant for the large populations of black-footed and Laysan albatross breeding within the Papahānaumokuākea Marine National Monument (PMNM) to help mitigate population impacts from this environmental stressor. These species often forage on fisheries derived resources and are thus susceptible to bycatch mortality from longline vessels. Bycatch of black-footed albatross by US fishing fleets in both Alaska and Hawai'i has increased in recent years, but it is unknown to what extent bycatch by the international fleets is impacting these populations.

Where and when fishing vessels operate is traditionally considered confidential information. However, using vessel monitoring systems (i.e., Automatic Identification System; AIS), Global Fishing Watch (GFW, https://globalfishingwatch.org/) has shed light on the distribution and movement patterns of fishing fleets in near-real time. Moreover, GFW uses proprietary algorithms to identify gear-specific fishing activities based on vessel speed, direction, distribution, and fishing time. Paired with albatross GPS tracks this dataset offers a powerful oppurtunity to understand alabtross encounters with legal (AIS active) vessels. Unfortunately, some operators disable AIS. Hence, the deployment of radar detecting biologging tags on albatross can fill this critical information gap. We aim to combine radar detections from the back of an albatross and GFW data to estimate the number of "dark" vessels and thus characterize the prevalence of illegal fishers inside or near monument boundaries. Illegal fisheries have negative impacts across multiple trophic levels, including target (e.g. tuna) and non-target (e.g., seabirds, turtles) species. Some fishers also may 'ride the line' by setting along the boundaries of marine protected areas or national exclusive economic boundaries, creating an 'edge effect' that can influence the distribution of mobile species like albatross, thereby increasing exposure to bycatch risk. This next phase of research will provide critical information on the prevalence of illegal fishing activity within and near the PMNM that managers can use to ensure protection of PMNM waters, and inform drivers of albatross-fisheries dynamics to support management of breeding populations within the PMNM.

Background on studies of boobies and frigatebirds:
As top marine predators, seabirds are known to intensify their foraging effort in oceanic habitats where biological productivity concentrates their prey along upwelling regions, eddies, and frontal zones (Kappes et al. 2010). Numerous studies recognize the potential to use seabirds as bioindicators of marine habitats and biological productivity, thus allowing researchers to determine "hot spots" for the conservation of marine ecosystems. Seabirds are probably the only component of marine ecosystems that are easy to study because they are fundamentally constrained by the fact that they commute between colonies where they breed and marine habitats where they feed. As a result, breeding success is closely coupled with the temporal and

spatial variability of food in the marine environment (Thorne et al. 205 & 2016). One of the keys to understand how seabirds integrate environmental variability is to couple information on where birds find food with indices of the physical environment in which they inhabit (Weimerskirch 2007). The present study investigates this by remotely tracking boobies and frigatebirds at sea and comparing bird locations and behaviour to oceanic conditions to determine and/or evaluate "hotspot" regions around the Monument and surrounding seascape (e.g. Young et al. 2015).

Biological productivity is known to be low in tropical/subtropical seas; however, many seabird species breed prolifically on islands throughout tropical and subtropical latitudes (Gilmour et al. 2019). For example, there are large colonies of boobies and frigatebirds on several islands within the Northwest Hawaiian Island chain (Harrison 1990). Recent studies on boobies (Young et al. 2010, 2015; Gilmour et al. 2018) show that foraging ranges from breeding colonies can be extensive (up to a few hundred km). Previous research also shows that spatial segregation exists among booby species that breed in other locations, with red-footed boobies travelling furthest offshore compared to Masked or Brown boobies (Weimerskirch et al. 2005, 2009). Hence, there are fascinating ecological/evolutionary implications that influence the foraging ecology of these seabirds, yet this has not been rigorously examined. Lastly, boobies are known to rely extensively on their associations with sub-surface predators like tunas, sharks, and marine mammals to find food (Ballance et al. 1997, Weimerskirch et al. 2005). This trophic interaction makes boobies even more interesting bio-indicators of marine ecosystems because fisheries can influence this relationship but many questions about the nature this relationship remain. The time to conduct such a study is more important than ever because the conservation of marine habitats around the globe has become a priority due to the numerous threats such as the development of fisheries and putative long-term changes in climate.

In the present study, we seek to examine the foraging ecology of boobies (Red-footed, Masked, and Brown) and Great frigatebirds using GPS loggers and remotely sensed oceanographic data, to elucidate whether these seabirds use specific oceanographic features or "hotspots" to find food within the Monument and surrounding seascape. The fine resolution (in space and time) of the GPS tags will also allow us to evaluate whether boobies and frigatebirds exhibit foraging behavior that is consistent with associations of subsurface predators like marine mammals, sharks, and tunas. Previous research conducted elsewhere using the same tracking devices suggests that specific flight patterns (straight line trajectories, slow flight speeds, frequent landings or dives) of boobies measured with tracking devices are consistent with visual observations of birds feeding amongst dolphins and tunas. The tracking devices will also allow us test the hypothesis that each booby species partitions their prey resources by segregating at sea, which has been suggested as a mechanism to reduce competition between different species. Overall, the results of this research will shed new light on the ecological and environmental factors that affect the abundance and diversity of tropical seabirds in the Monument. More importantly, these results will provide a basis with which to more fully manage the natural resources of the Monument.

The only tracking studies conducted on boobies or frigatebirds in the NWHI have occurred at Tern Island, French Frigate Shoals (Gilmour et al. 2012 & 2018; Young et al. 2015). Our work shows that red-footed (33%) and masked boobies (17%) travel and forage outside Monument waters (see Table 2 in Young et al. 2015). Overall, both booby species spent about the same proportion of time (ca. 45%) and activity (ca. 31%) outside the Monument (Young et al. 2015). In contrast, the same species studied at another Marine National Monument (Palmyra

Atoll) foraged almost exclusively within Monument waters. This was especially true of masked boobies where foraging ranges were considerably shorter (34 km vs. 84 km; Palmyra vs. Tern respectively) and all birds remained within the Monument. This suggest that population level differences in foraging ecology vary by island (Young et al. 2015). Despite our previous effort, only one island population within the NWHI have been studied so we have no idea whether population level differences occur in colonies that are closer in geographic proximity and that share similar marine habitats (e.g. Tern vs. Midway Atoll). Finally, we were able to identify important marine habitats based upon the frequency of visitations by the boobies. For example, Brooks Banks (northwest of Tern Island) are a series of shoals that both red-footed and masked boobies visited repeatedly by several individuals (Young et al. 2015). These shallow shoals likely faciliate the aggregation of predatory fish, sharks, and dolphins that boobies sometimes rely to enhance foraging opportunities.

Data sharing:
All tracking and associated metadata for each seabird species studied will be deposited in the Global Seabird Tracking Database, hosted by BirdLife International in the UK. We have already deposited the majority of our previous data in this database, which has been used in numerous reports, outreach activities, governmental assessment, and scientific publications. Tracking data will also be deposited in the Animal Telemetry Network (ATN). The ATN is part of the Integrated Ocean Observing System. Data is viewable to the public in near real time via an online portal (https://portal.atn.ioos.us).

Outreach:
To date, our research program in the PMNM has published over 25 peer-reviewed papers. Research on this project has also supported several doctoral students and one postdoctoral researcher. We also co-wrote a chapter in a technical report published by NOAA. Our team has given over 60 presentations at conferences, university seminars, local special interest groups (e.g. bird clubs), and government sponsored meetings since 2003. We have also provided data or analyzed products (e.g. maps or figures) to USFWS and PMNM staff for outreach and reports. For the NFWF albatross fisheries interaction project we plan to coordinate outreach efforts with the Monument's education specialists at Mokupapapa Discovery CenterDiscovery Center (Hilo, HI) and coordinate social media posts with the NOAA Sanctuary Office for the Monument.