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:
NOAA/Inouye Regional Center
NOS/ONMS/PMNM/Attn: Permit Coordinator
1845 Wasp Blvd, Building 176
Honolulu, HI 96818
nwhipermit@noaa.gov
PHONE: (808) 725-5800 FAX: (808) 455-3093

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: Dr. Scott Shaffer
Affiliation: San Jose State University & University of California Santa Cruz

Permit Category: Research
Proposed Activity Dates: 01 January 2016 - 31 December 2020
Proposed Method of Entry (Vessel/Plane): Plane or vessel
Proposed Locations: Tern Island, French Frigate Shoals; Laysan Island; Midway Atoll NWR

Estimated number of individuals (including Applicant) to be covered under this permit: 3

Estimated number of days in the Monument: Approximately 150 days per year. The bulk of the research will be conducted during the albatross incubation and chick-brooding periods (Dec - Mar) and another effort would be conducted in June/July to deploy tags on fledglings. The summer time period would only likely require 2-3 weeks on island. We also understand that the timing of our visits will depend on availability of flights or ship transport to the islands, USFWS schedules, and weather. Note that this number of days in the Monument is likely to be an overestimate.

Description of proposed activities: (complete these sentences):

a.) The proposed activity would…

1) Continue our long-term monitoring of Laysan and black-footed albatrosses at sea using satellite transmitting tags, GPS archival loggers, and/or geolocation data loggers, 2) conduct dual deployments with GPS and geolocating archival data loggers to obtain high resolution tracking data with environmental data (i.e. sea surface temperature; SST) collected by the geolocation logger, 3) obtain feather or blood samples for analysis of stable isostopic (Carbon & Nitrogen) signatures to infer proximate diet, 4) collect feather and blood samples for analysis of contaminants (e.g. heavy metals, organochlorines, pesticides, etc) 5) collect stomach oil from adults to analyze fatty acid signatures, 6) collect eggshell fragments post-hatch from albatross nests, and 7) to study fledgling albatross dispersal from the aforementioned locations in the Northwest Hawaiian Islands

b.) To accomplish this activity we would ….

At EACH location (i.e. Tern Island, Laysan Island, and Midway Atoll), we would deploy GPS loggers or satellite transmitting tags (here after called PTT) in combination with geolocating archival loggers on up to 20 breeding Laysan albatrosses AND on up to 20 breeding black-footed albatrosses during the incubation phase AND up to 20 of EACH albatross species during the brooding phase in EACH breeding season (see Collection Table). In summary, we would study up to 40 individuals of each species at each site in each breeding season. 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). To compare the post-breeding distribution of EACH albatross species at EACH location (i.e. Tern, Midway, and Laysan Islands), we would deploy geolocating archival loggers on 15 breeding adults of EACH species at EACH location in EACH season, and we would recover those tags when the birds return at the beginning of the following breeding season. When possible, EACH bird would be weighed and up to 5 mL of blood sampled for isotopic analysis, contaminants, and genetic profiling. This sample would be collected after the bird returns and the tracking tags are removed. We will conduct post-hoc analyses to compare isotopic signatures from feathers to estimate trophic structure of diet between species. When possible, up to 20g of eggshell fragments will be collected post-hatch from EACH nest of a tracked albatross for heavy metal contaminant analysis. In EACH breeding season and EACH location, we request to collect up to 30 stomach oil samples from tracked adults. In June/July, a technician would return for a few weeks to deploy satellite transmitting tags on up to 10 albatross fledglings (5 on each species).

c.) This activity would help the Monument by …

Providing interannual insight into the foraging behavior, movements, distribution, and habitat use of adult and fledgling Laysan and black-footed albatrosses from Tern Island and Midway Atoll NWR during the breeding and post-breeding periods, as well as dispersal of fledgling albatrosses. We have conducted 11 seasons of tracking at Tern Island (and 9 seasons at Midway Atoll NWR) during the incubation and brooding periods, which is unprecedented because there are only a few research labs in the world who have such longterm data sets. These datasets are essential for examining the interannual variability in behavior in relation to oceanographic conditions. This information may be critical for designing conservation measures that protect sensitive at-sea habitats for each albatross species (i.e. Marine Protected Areas) and can also be used to examine the overlap with fisheries known to catch albatrosses as bycatch. Our at-sea data can be (and is currently) used to evaluate exposure risk from fishing activity. Moreover, our data on foraging behavior and distribution across consecutive breeding seasons can be examined in the context of overall breeding success. For example, in the 1998-99 and 2009-10 breeding seasons when there was an El Nino followed by a

La Nina, albatross breeding performance was lower than normal. This poor breeding performance was likely attributed to unfavorable oceanographic conditions, which could be studied by examining bird distribution and remotely sensed data together. Thus, one of the real values of our effort is the study of how albatrosses adjust foraging effort under variable environmental conditions. Ultimately, this information collectively could be used to create predictive models to forcast long range population trends under different climate change senarios.

Finally, the USFWS (Naughton et al. 2007) released an action plan for the management of both Laysan and black-footed albatrosses. In this action plan, a key provision was the specific need for more information on the at-sea distribution of Laysan and black-footed albatrosses. This information provides greater understanding of how albatrosses respond to environmental variability. Therefore, our continued study will directly contribute to this need. Furthermore, our data are also being used in several new initiatives examining habitat use and interactions with fisheries.

Other information or background:

Background:

The foraging ecology of Hawaiian albatrosses has been previously studied, however, our understanding of the relationships between where birds forage and the physical environment is still limited. For example, we know little about where/when Hawaiian albatrosses disperse to during sabbatical years (how often, why), or where fledglings disperse. The effects of inter-annual variability on the foraging distribution and behavior of albatrosses is also not described for Hawaiian species. Yet, it is clear that many regions in the oceans are heterogeneous with respect to both temporal and spatial scales. Consequently, physical processes that drive biological productivity can alter the behavior of pelagic species on a variety of temporal scales. Surprisingly, only a few studies have examined these effects in seabirds.

There are significant gaps in our knowledge of the relationship between where birds forage, the prey they consume, the energy they expend while foraging, and the physical environment that affects these parameters. Thus, a comprehensive study that combines the use of tracking devices with secondary analyses of diet to measure prey quality and quantity (from previous seasons), stable isotope analysis for determination of trophic levels of foraging. Their integration into comparative studies (i.e. with other species) is essential because 1) many seabird species overlap spatially and trophically with other marine organisms; 2) seabirds return to land to breed and typically nest in large, dense colonies so accessibility is excellent; 3) adult survival rates are high and most species are philopatric to their natal colonies, ensuring a high rate of recapture and successful use of archival tags; 4) large samples of known-age, known-sex, and known-breeding history individuals are available for tagging; and 5) most importantly, they operate over very large spatial scales in a minimum of time, because they can fly quickly over the sea surface (400-500 km/day in albatrosses, Kappes et al. 2010; Gutowsky et al. 2015; Conners et al. 2015).

Hence, the role of seabirds as apex predators is important because they can sample the marine environment quickly, so their response to changes in oceanographic features occurs over relatively short temporal scales. Furthermore, there is the possibility of tracking the movements of individual birds over multiple trips to sea, which could elucidate individual specialization to find oceanic “hotspots”.

The following are highlights of research to date:

MAJOR HIGHLIGHTS

1) Habitat use and segregation at sea of Hawaiian albatrosses throughout the yearly cycle
2) Comparison of habitat use within the California Current System
3) Involvement with several conservation measures to protect albatrosses from their greatest threat – bycatch in fishing operations

SUMMARY

Habitat Use of California Current and North Pacific

Seabirds are one of the most abundant predators in the California Current System (CCS). Black-footed albatrosses and sooty shearwaters come to the CCS and remain for several months during their post-breeding hiatus (Shaffer et al. 2006, Kappes et al. 2010, Block et al. 2011; Maxwell et al. 2013). Black-footed albatrosses breed sympatrically with Laysan albatrosses in the northwest Hawaiian Islands, yet both species segregate when breeding (Kappes et al. 2010 & 2015) and when not breeding (Gutowsky et al. 2015). During the post-breeding period, black-footed albatrosses visit Alaska or the CCS whereas Laysan albatrosses from Hawaii remain the central north Pacific. Within the core habitats, neither species overlaps in their ranges and the environmental conditions that each species experiences differ substantially. For example, black-footed albatrosses more frequently occur in warmer waters with higher productivity along the shelf whereas Laysan albatrosses are more commonly found in cooler North Pacific waters. Residency patterns show that black-footed albatrosses remain in Alaskan waters or the CCS from mid-June to end of October.

APPLICATIONS FOR CONSERVATION

One of our central objectives is to apply what is learned about the distribution of the birds into conservation action. It is clear that the single greatest threat to albatrosses and petrels is the negative interactions with fishing vessels that take birds as bycatch. One of the first steps to address the pervasiveness of the problem is to identify the occurrence of overlap between birds and fishing effort within each Regional Fisheries Management Organization (RFMO; Zydelis et al. 2013; Maxwell et al. 2013). I have worked collaboratively with the US Fish and Wildlife Service to create a comprehensive Albatross Conservation Action Plan (Naughton et al. 2007). This plan outlines several conservation/management actions to be taken to maintain and grow black-footed and Laysan albatrosses in the Hawaiian Islands.

Since the start of our research program in the NWHI, the seabird tracking data (primarily the albatross data sets) have been used in over 10 reports to the Inter American Tropical Tuna Commission (IATTC), West Coast Pacific Fisheries Council (WCPFC), and the committee for Agreement on the Conservation of Albatrosses and Petrels (ACAP). These served the purpose of showing the overlap between birds and fishing effort and have been key in placing pressure on IATTC to mandate observer coverage on 100% of all vessels fishing within IATTC waters. We have also been collaboratively sharing our tracking data with others to examine problems of albatross bycatch in trawl fishing along the coastal shelf waters of Oregon, Washington, Canada, and Alaska (Guy et al. 2013).

All tracking and associated metadata for each seabird species studied have been deposited in the Global Procellariiform Tracking Database, hosted by BirdLife International in the UK. The data in the database have been used for numerous reports, outreach activities, and governmental assessment.

PUBLICATIONS

To date, my research program has published 14 peer-reviewed papers. In addition, there are more papers in review or revision, and at least four unpublished manuscripts. Research on this project has also supported four doctoral students and one postdoctoral researcher. TOPP researchers also co-wrote a chapter in a technical report published by NOAA. Finally, the seabird team has given over 50 presentations at conferences, university seminars, local special interest groups (e.g. bird clubs), and government sponsored meetings since 2003.

Section A - Applicant Information

1. Applicant

Name (last, first, middle initial): Shaffer, Scott A.

Title: Associate Professor of Biology (SJSU) & Associate Research Biologist (UCSC)

1a. Intended field Principal Investigator (See instructions for more information):
Dr. Scott A. Shaffer

2. Mailing address (street/P.O. box, city, state, country, zip): 1) Department of Biological Sciences, San Jose State University (SJSU), [redacted]

[redacted]

[redacted]

[redacted]

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

3. Affiliation (institution/agency/organization directly related to the proposed project):
Department of Biological Sciences, San Jose State University & Institute of Marine Sciences and Ocean Sciences Department, University of California Santa Cruz

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):
Corey Clatterbuck, San Diego State University (co-advised by Dr. Shaffer) - field researcher
Other students TBD at the future date. Once determined, the Monument will be notified before entry. This project is also collaborative in nature in that we will work closely with the refuge biologists and USFWS staff researchers at each site.

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			

☒ Remaining ashore on any island or atoll (with the exception of Midway & Kure Atolls and Field Camp staff on other islands/atolls) between sunset and sunrise.

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

Location Description:
The albatross breeding colonies at EACH locations including areas along the landing strips, bunk houses, and dining halls.

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:***
The main purpose of our research effort is to 1) continue our long term monitoring of Laysan and black-footed albatrosses at sea using satellite transmitting tags, GPS archival loggers, and geolocation data loggers, 2) to conduct dual deployments with GPS and geolocation data loggers to obtain environmental data combined with high resolution locations, 3) to compare the post-breeding distribution of albatrosses breeding at Tern Island, Midway Atoll NWR, and Laysan Island, and 4) to study fledgling albatross dispersal from either Tern Island or Midway Atoll. We have conducted over a decade of tracking during the incubation and brooding periods. This is unprecedented because we can only think of a few research labs in the world who have such longterm data sets. However, these datasets are essential for examining the interannual variability in behavior in relation to oceanographic conditions. Collectively, these data may hold the key to understanding why reproductive success varies (i.e. good and bad years) and how different populations distribute themselves at sea (e.g. overlap or segregate). We hypothesize that reproductive success is intimately correlated with the oceanographic conditions and foraging provinces of each population (e.g. Tern Island, Midway Atoll NWR, Laysan Island, Kaena Point, Oahu, and Guadalupe Island, Mexico) and that this will be evident from our time series tracking data. Furthermore, we hypothesize that each species (Laysan or black-footed) or possibly age classes segregate into different foraging habitats and that this is correlated with at-sea behavior and likely with prey obtained. We have already observed this with our tracking data during the incubation and brooding periods and will begin to examine this in relation to our diet samples collected a few seasons ago (analyses are on going). We believe that this will also become apparent during the post breeding period, which we can determine with our archival tag data. These tags were used to track both species in 2003-04, 2004-2015 seasons. Analyses show distinct differences in habitats frequented by each species (Gutowsky et al. 2015). For example, Laysans tend to remain in the central and western North Pacific whereas black-footed albatrosses tend to remain in the central or eastern North Pacific. The water temperatures recorded by the tags also suggest that Laysans generally remained in cooler water and black-footeds remained in warmer regions. This information may be critical for designing conservation measures that protect sensitive habitats for each albatross species. It may also provide opportunities to explore overlaps with certain fisheries, which is something we plan to examine in the near future. We also hope to establish putative areas where albatrosses undergo molt. We suspect that they molt during the post-breeding period but to date, we have not investigated this intensively with feather collection and/or determining molt score at the time adults return to breed. Therefore, in addition to tag recovery, we will collect feather samples and visually evaluate molt score (i.e. specific patterns of feather regeneration) of adults that return to the colony to breed. This will be done at at the time of tag recovery and should only add a few extra minutes of total handling time. The isotopic signatures from the feathers and blood will help us estimate the diet (i.e. trophic level) of the birds in relation to oceanographic provence. By measuring contaminant levels in tracked birds from feathers, blood, and eggshell fragments, we may be able to discern regions that have higher contaminant levels (i.e. point sources). Similar analyses will be

conducted with the stomach oil that is collected from adults and chicks. By analyzing the fatty acid signatures in the oil samples, we can evaluate/compare the diets of both species in relation to distribution and oceanographic data.

*Considering the purpose of the proposed activities, do you intend to film / photograph federally protected species? Yes ☒ No ☐

For a list of terrestrial species protected under the Endangered Species Act visit:
http://www.fws.gov/endangered/
For a list of marine species protected under the Endangered Species Act visit:
http://www.nmfs.noaa.gov/pr/species/esa/
For information about species protected under the Marine Mammal Protection Act visit:
http://www.nmfs.noaa.gov/pr/laws/mmpa/

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?
We enter the Papahanaumokuakea Marine National Monument knowing that these islands are a resource to be protected and respected for their natural beauty, cultural and historical significance, and importance as a sensitive ecosystem. As a result, we conduct our activities with full awareness of these facts and carefully scrutinize our protocals to ensure proper safeguards for the animals, flora, and cultural and historical artefacts and sites. We avoid unnecessary entry into sites that are covered by our research permits to minimize trampling and habitat destruction, and we only enter sites not associated with our research permits if given permission by Refuge staff. Nothing is collected unless it is associated with our research activities and is covered by our permits.
With regard to our research on seabirds within the PMNM, we carefully evaluate each bird, prior to deployment, to ensure that nervous or poorly conditioned birds are not studied. We will also take every precaution to minimize our impact to surrounding nests and birds. Nest markers (rocks or debris) are temporary only. Each albatross is handled as minimally as possible and with awareness of the increased stress associated with being handled by humans. Despite the inevitability of some amount of stress on the bird from handling time, in our experience, most albatross seem to recover almost immediately when returned to their nest. This quick recovery rate is most pronounced in the incubation period, though it drops off dramatically during the late stages of brooding, which is why most of our deployments will be done in the incubation

phase and in the early stages of chick brooding (Dec-Mar). The total weight of a satellite transmitter paired with an archival datalogger (30-40g) and the total weight of a GPS datalogger paired with an archival datalogger (also 20-40g) is 1-2% of the birds' body mass, which is well below the recommended maximum of 5%. Our tag losses since 2002 have been less than 2% and nest abandonment from research activities that we know of is less than 1%. During the post-breeding period, albatrosses carry only an archival tag (ca. 6g total, or less than 0.5% of bird body mass) for approximately 8-10 months. Given the exceptional tag recovery rates, we have no reason to believe that our tags have caused any significant mortality or morbidity to the study albatrosses. Also, we have not seen any major injuries to the legs of birds carrying our archival tags for durations up to two years. Nevertheless, as done previouvsly, we will compare the duration of foraging trips of equipped birds with a control group to test for any effects of gear and handling time on our experimental group. Though other seabirds like auks appear to be susceptible to adverse effects from the attachment of gear, researchers have deployed tracking devices on other albatrosses, cormorants and sulids with no significant adverse effects. (Phillips et al. 2003, Daunt et al. 2006, Hamer et al. 2007).

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?
Our research has provided new insight into the ecological role that albatrosses play in the ocean environment (see publications and ongoing projects provided below). Given that the Northwest Hawaiian Islands are the population center of two North Pacific species (over 550,000 breeding pairs), they are major consumers of resources (although mostly outside the refuge) but the deposition of their feces is a major link between trophic transfer and energy flux of oceanic and terrestrial ecosystems. Given that albatrosses forage extensively across the Pacific, and in most cases well outside the refuge, our data provide a broader view of the albatross's role within the refuge and the North Pacific ecosystem that ultimately inflences the Hawaiian Islands. Our data have direct implications on the proximate factors that influence population dynamics. For example, there are strong connections between oceanic conditions and the reproductive success and long term evolutionary life history of marine top predators (Pinaud and Weimerskirch 2002). Our data have also provided critical information for determining overlap with fisheries operations, which is a major conservation issue for albatrosses. To date, our data have already directly contributed to nearly a dozen reports to Regional Fisheries Management Organizations (RFMO's) and two additional scientific efforts that will compare bird distribution and fishing activity. Finally, our datasets provide a unique opportunity for education and outreach, which is a goal of the refuge system. This type of research was deemed essential to monitor albatross populations (see USFWS Albatross Action Plan, Naughton et al. 2007). We have highlighted the research we have conducted at Tern Island and Midway Atoll NWR on our award winning website as well as working with nationally recognized media outlets (see National Geographic Magazine, December 2007), which increases the visibility of

the National Wildlife Refuge system and promotes greater awareness of the conservation and protection of natural resources within the Monument. Our research program also enhances the fundamental knowledge of seabirds from a cultural viewpoint because seabirds are so iconic within Native Hawaiian culture and folklore. The results of our research show how albatrosses travel the open ocean in search of food much like the Native Hawaiians so we believe that there would be a strong cultrual interest in our work. Consequently, we are keenly aware of the cultural and historical significance of the Northwest Hawaiian Islands and respect the resources to minimize our impact on these islands. Dr. Shaffer also has first hand experience working at other culturally sensitive sites in New Zealand. Dr. Shaffer obtained the approval and blessing of trial elders of the Rakiura Maori to study Titi (or sooty shearwaters) at Whenua Hou (Codfish Island) in New Zealand. The tribal elders and community were fascinated by our studies that documented the amazing travels of their sacred birds.

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.

Laysan and black-footed albatrosses are important top predators in the North Pacific Ocean ecosystem, and according to the Monument Management Plan, greater than 98 percent of the world's Laysan and black-footed albatrosses breed inside the Monument. The Monument, and specifically Tern Island, Midway Atoll NWR, and Laysan Island, provide a platform from which researchers can access this highly pelagic species while they are "island-bound" during the breeding season. This is the only time where it is possible to examine animal distribution in connection with 1) breeding performance, 2) population demographics, 3) population comparisons of banded individuals, and 4) character attributes of individuals like known breeding status, age, sex, and colony origin. All of these attributes add greatly to our ecological interpretation and understanding of ecosystem dynamics. Other studies have captured albatrosses at sea and have attached satellite transmitters during the post-breeding period, but these studies are limited in the equipment that can be used (i.e. non-recoverable tags) and they often lack any of the demographic information that we deem significant. A unique facet of our ongoing tracking effort at Tern Island has been the ability to integrate animal distribution data across consecutive years to determine whether inter-annual variation in oceanographic habitat affects Hawaiian albatross behavior (Kappes 2009, Kappes et al. 2010 & 2015). These analyses are critical for understanding how albatrosses adapt to perturbations in their environment, and how changes in oceanography affect albatross foraging strategies, and ultimately their reproductive output in a given year. These analyses will allow us to make informed predictions about what larger-scale environmental changes, such as El Nino Southern Oscillation events, or possibly global climate change, may have on albatross populations in the future.

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 mentioned above, the adverse impact of our research upon individual albatrosses is minimal and is limited to a cost of increased stress on a handful of handled individuals. The positive impact of our research, in terms of potential conservation measures and management strategies for the species is, however, monumental. Until innovation and technology gave researchers access to miniature tracking devices, seabird research was limited to colony-based island studies and off-shore sightings. To understand the ecology of a species which exploits vast areas of the North Pacific, both within and outside the Monument, it is critical to understand the movement patterns and foraging behavior of albatross of both species, from multiple breeding colonies and of different age classes, and to examine how their movement patterns respond to inter-annual variation in oceanographic conditions. The findings of this research could have huge implications on management decisions for the conservation of the species, in terms of protecting sensitive habitat and managing conflicts with fisheries that are killing albatrosses as bycatch as well as competing for resources. As noted previously, our research incorporates aspects of outreach to educate and involve the community about scientific research and marine conservation. We also take great care to minimize our foot print on the island by using the minimum number of personnel at field sites and in the minimum amount of time we feel is required to conduct our research in a safe and efficient manner. Finally, we always try to balance using the fewest number of animals possible while still obtaining ecologically meaningful and statistically powerful results. Overall, the knowledge we obtain about albatrosses from our research will help to ensure their longterm protection as a resource to be cherished and respected in a cultural sense as well as their role in the marine ecosystem of the Northwest Hawaiian Islands. As top marine predators, they also serve as sentinals of ocean health and our research promotes greater understanding of this concept at a minimal cost to the Monument.

e. Explain how the duration of the activity is no longer than necessary to achieve its stated purpose.
To understand how albatrosses exploit the marine environment during the breeding season, it is critical to study their movements throughout (at least) both the incubating and brooding phases, because their foraging behavior changes dramatically between these two phases as they adjust their efffort to suit the demands of self feeding only during the incubation phase versus self feeding and chick provision during the brooding phase. In addition, we request only a few weeks in the summer to tag fledgling albatrosses. The fledging process can take place over a month or more as chicks leave the beach. Therefore, a few weeks for this effort is enough of a window to affix tags for a single deployment for each followed bird. Returning in early December will provide us an opportunity to recover all long-term geolocating archival deployments, and will also allow us to continue our tracking study through both phases of the breeding season.

f. Provide information demonstrating that you are qualified to conduct and complete the activity and mitigate any potential impacts resulting from its conduct.
Dr. Shaffer has nearly 20 years of experience studying the foraging ecology of albatrosses and petrels around the world and has personally conducted five field efforts in the Hawaiian Islands NWR complex (Tern Island 2006; Midway Atoll 2006, 2010, 2011, 2012, 2013). He has also managed the research program on albatrosses at Tern Island and Midway Atolll since its beginning (Dec 2002 at Tern and June 2006 at

Midway). Therefore, he is very familiar with the logistical requirements as well as the cultural and biological significance of the Monument. Dr. Shaffer is also acutely aware of the ecological impact this work may have on the Monument's natural and cultural resources, and he and his students take great care to minimize deleterious effects on the fauna, flora, and historical sites of the islands. He will ensure that research results from this work will be published in a timely manner while giving proper acknowledgement to the Monument and Refuge Complex system. As a way to mitigate the impacts on the resources of the Northwest Hawaiian Islands, Dr. Shaffer and his students continuously evaluate and modify their protocols to accommodate new regulations, restrictions, and to minimize any deleterious effects that our research may cause. We also modify our protocols to accommodate changes in equipment (e.g. improved attachment techniques) or methods that improve results and reduce impacts.

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.
Dr. Shaffer is currently seeking funds to support logistical costs to operate on the islands but he has tracking tags and field equipment to conduct the research (e.g. satellite tracking devices and GPS and archival data loggers, banding supplies, and expendable supplies for the research). Given our prior experience working in the Northwest Hawaiian Islands combined with our continuous refinement of protocols and methods used during our research activities, we believe we can minimize the need for mitigating measures within the Monument.

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.
Although we refine when needed, we continue to use the same general methods from our albatross studies during the past nine years on Tern Island and the past five years at Midway Atoll NWR, which have proven to be highly successful and from which we are starting to gather a tremendous database. As previously explained in detail, not only do our methods provide us with an extensive amount of data, but they do so at a minimal cost to individual birds and Monument resources. We also design our studies to provide meaningful and statistically powerful results using the lowest number of individuals. We will remove from the colonies all field equipment and materials not in use at the end of the field season. In addition, all methods and protocols used in this research activity have been approved by the Institutional Animal Care and Use Committees at UCSC and SJSU.

i. Has your vessel been outfitted with a mobile transceiver unit approved by OLE and complies with the requirements of Presidential Proclamation 8031?
N/A

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

Given that we have had an ongoing research program within the Monument since 2002, we believe that our researchers have the knowledge, experience, and sensitivity to be respectful stewards of the natural resources within the Monument. Furthermore, our research activities and purported outcomes are consistent with and mutually beneficial for the Monument to manage and maintain viable albatross populations. We have previously compiled with all permit requirements and submitted detailed reports on our activities. We have also provided images and unpublished data from our research to both NOAA (Alaska) and USFWS (Hawaii and Oregon) and are happy to continue to do so upon request.

8. Procedures/Methods:
Thirty-five gram satellite platform terminal transmitters (herein called PTT, transmitters, or tags) and 6 g Lotek geolocation data loggers will be attached using methods employed in our previous field seasons. Essentially, a PTT will be taped to feathers on the dorsal region between the scapula and a data logger will be glued to a plastic darvic leg band placed around the bird's tarsus. We also plan to use 40 gram GPS loggers that will be deployed with a Lotek geolocation tag. These tags can record a bird location every 10 seconds to 60 minutes at GPS quality. In either situation, the total mass a bird will carry is up to 40 g or about 1-2% of bird body mass. Attachment of GPS tags will be the same as that used for satellite tags. At the end of brooding stage, we will deploy all of the Lotek archival tags (6g only) on breeding individuals to study the post-breeding dispersal phase as we've done in previous seasons. The main difference will be a comparison of island populations (Tern Island, Midway Atoll, Laysan Island). These archival tags would need to be recovered when the birds return during the following breeding season (November - December). Upon recapture, all equipment and tape will be removed (for all deployments). Given that our equipment and methods will be replicated from our previous field efforts, we do not anticipate any logistical changes to our tracking protocols for this season. To evaluate the success of each foraging excursion, we request to weigh all birds with a spring balance before and after a trip to sea. We also request the ability to return to Tern, Midway, or Laysan in June/July to deploy satellite tags on fledgling albatrosses. We have conducted three previous field efforts of this kind and have tracked fledglings over 200 days (Gutowsky et al. 2014). This information is critical because almost nothing is known about this life stage. This research would be a continuation of our previously permitted work (PMNM-2011-015). We also request to sample up to 8 body contour feathers and up to 5 mL of blood from each tracked individual (adults and fledglings) to determine the sex using molecular techniques and for measurement of stable isotopes. When breeding, birds will be captured upon return from a foraging trip, all equipment will be removed, and they will be reweighed. Using aseptic techniques, blood will be collected from the tarsus using a 5 mL syringe to collect approximately 5 mL of blood. After collection, direct pressure will be applied to the site of collection until bleeding ceases. The bird is then released next to its nest and will be visually observed for several minutes after release to ensure that no complications have arisen. Blood samples will be stored in vials filled and then frozen until analyzes are conducted back in the lab of Dr. Shaffer.

Additional sampling of tracked animals will be performed. In each season, up to 30 adult albatrosses will be sampled for stomach oil using a No. 8 french red rubber catheter and a 20 cc syringe. Approximately 10 mL of oil will be suctioned from the proventriculus of the bird, frozen, and stored for fatty acid analyses. This process is low stress and takes approx 1-2 minutes after capture. Diet will be analyzed for fatty acid signatures in stomach oils. After chick hatching, we will collect up to 20g of eggshell fragments by hand from the nest of each tracked albatross and stored in a polypropylene vial for heavy metal analysis.
All work will be performed in collaboration and coordinated with refuge staff as has been done in previous years.

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:
Laysan Albatross; Black-footed Albatross

Scientific name:
Phoebastria immutabilis & Phoebastria nigripes

& size of specimens:
Up to 8 body contour feathers plucked from EACH tracked bird and up to 5 mL of blood collected using asceptic techniques from a blood vessel on the tarsus (i.e. lower leg) or wing of EACH tracked bird. These are both routine procedures, with minimal risk and stress. Up to 30 stomach oil samples from adults. Up to 20g of eggshell fragments post-hatch from the nest of EACH tracked bird.

Collection location:
Within the breeding colony, likely near the birds' nest

☐ Whole Organism ☒ Partial Organism

9b. What will be done with the specimens after the project has ended?
The feathers will be used to measure stable isotope quantities (e.g. Nitrogen and Carbon) to evaluate proximate diet and heavy metal contaminant analysis. Blood samples will be used to determine gender using molecular techniques, breeding diet via isotopic analysis, and contaminant exposure/load via a range of lab techniques, including gas chromatography. All samples are destroyed in the process of their

respective analyses. Like the blood and feathers, stomach oil will be used to evaluate the diet by analyzing the fatty acid signatures in the oil and then matched to the fatty acid signatures found in prey specimens.

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

• General site/location for collections:
In the breeding colony, near the nest of the captured bird.

• 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?
Yes, all equipment will be removed and birds will be released near their nest. Each bird will be studied only once, but handled twice. Once for tag attachment and again for tag removal.

10. If applicable, how will the collected samples or specimens be transported out of the Monument?
The feathers will be sealed in plastic ziplock bags and the blood samples will be stored in plastic screw cap vials for heavy metal analyses or glass vacutainers for plastics and organic contaminant analyses. Stomach oil will be stored in 15 mL screw cap vials. Eggshell fragments will be stored in a capped polypropylene vial. All samples will be transported off the island on a USFWS scheduled flight.

11. Describe collaborative activities to share samples, reduce duplicative sampling, or duplicative research:
We have been collecting these samples (except contaminants) since the start of our program (2002). To our knowledge, no replication of this work is ocurring because the samples are unique to each bird and we are examining differences across years. Nevertheless, we are always happy to share our samples (or data) through collaborative efforts with other investigators. To date, all of our blood samples have been given to Lindsay Young at University of Hawaii for molecular sexing and population genetics. We have also provided tracking data to several collaborators: Dr. Rob Suryan (Oregon State University), Dr. Rebecca Lewison (San Diego State University), and Dr. Simon Hoyle (Secretariat of the Pacific Community and IATTC), Dr. Cleo Small, BirdLife International.

Samples of blood, feathers, egg shell fragments, or stomach oil may be sent to:
Corey Clatterbuck, [redacted]
Biology Department
San Diego State University
[redacted]

Dr. Hillary Young [redacted]
Department of Ecology, Evolution, and Marine Biology
University of California Santa Barbara
[redacted]

Dr. Suzanne Budge [redacted]
Process Engineering and Applied Science
[redacted]

12a. List all specialized gear and materials to be used in this activity:
No special gear is required to collect feather samples. The feathers are plucked from the bird. All blood samples will be collected using a 25 ga. needle and syringe from a vessel on the tarsus or wing using standard asceptic techniques. All supplies will be transported off the island and disposed of at UCSC. Tracking data will be collected following methods described above.

12b. List all Hazardous Materials you propose to take to and use within the Monument:
None

13. Describe any fixed installations and instrumentation proposed to be set in the Monument:
None

14. Provide a time line for sample analysis, data analysis, write-up and publication of information:
All previous samples or data are currently in (or are already completed) analysis stage. Several aspects related to previous research are also in write-up or submission for peer-review (Shaffer et al. in prep, Henry et al. in prep, Kappes et al. in manuscript) or are published (Shaffer et al. 2005, Tremblay et al. 2006, Robinson et al. 2007, Suryan et al. 2008, Kappes 2009, Kappes et al. 2010, Shaffer 2010; Block et al. 2011, Zydelis et al. 2012, Hazen et al. 2012, Maxwell et al. 2013, Gutowsky et al. 2014; Kappes et al.

2015; Conners et al. 2015; Gutowsky et al. 2015). It is also important to note that all of the data collected to date are (were) part of several doctoral theses and will be part of another soon. We anticipate prompt action with the data collected this season and expect to publish the results of this work in top-tier peer-reviewed journals such as Science, Nature, Journal of Animal Ecology, Marine Ecology Progress Series, or any number of avian oriented journals.

15. List all Applicants' publications directly related to the proposed project:
Shaffer, S. A. Costa, D. P., Suryan, R. M., Hyrenbach, K. D. 2004. North Pacific: breeding and non-breeding. In Global Procellariiform Tracking Workshop Report (ed J. P. Croxall). BirdLife International. Cambridge, pp. 47-49.
Shaffer, S. A., Tremblay, Y., Awkerman, J. A., Henry, R. W., Teo, S. L. H., Anderson, D. J., Croll, D. A., Block, B. A., and Costa, D. P. 2005. Comparison of light- and SST-based geolocation with satellite telemetry in free-ranging albatrosses. Marine Biology 147: 833-843.
Tremblay, Y., Shaffer, S. A., Fowler, S. L., Kuhn, C. E., McDonald, B. I., Weise, M. J., Bost, C. -A., Weimerskirch, H., Crocker, D. E., Goebel, M. E., Costa, D. P. 2006. Interpolation of animal tracking data in a fluid environment. Journal of Experimental Biology 209: 128-140.
Robinson, P. W., Y. Tremblay, D. E. Crocker, M. A. Kappes, C. E. Kuhn, S. A. Shaffer, S. E. Simmons, and D. P. Costa. 2007. A comparison of indirect measures of feeding behaviour based on ARGOS tracking data. Deep Sea Research Part II: Topical Studies in Oceanography 54:356-368.
Suryan, R.M., Anderson, D.J., Shaffer, S.A., Roby, D.D., Tremblay, Y., Costa, D.P., Sato, F., and Ozaki, K. (2008) Wind, waves, and wing loading: Their relative importance to the at-sea distribution and movements of North and Central Pacific albatrosses. PLoS One 3(12): e4016. doi:10.1371/journal.pone.0004016.
Burger, A.E. and Shaffer S.A. (2008) Perspectives in Ornithology: Application of tracking and data-logging technology in research and conservation of seabirds. Auk 125(2), 253-264.
Tremblay, Y. Sophie, B., Henry, R.W., Kappes, M.A., Costa, D.P., and Shaffer, S.A. (2009). Analytical Approaches to Investigate Seabird-Environment Interactions: a review. Marine Ecology Progress Series 391, 153-163.
Kappes, M.A. (2009) Comparative foraging ecology and energetics of albatrosses. Doctoral Dissertation, University of California Santa Cruz, CA, p. 173.
Kappes, M.A., Shaffer, S.A., Tremblay, Y., Foley, D.G., Palacios, D.M., Robinson, P.W., Bograd, S.J., and Costa, D.P. (2010) Hawaiian albatrosses track interannual variability of marine habitats in the North Pacific. Progress in Oceanography 86, 246-260.
Shaffer, S.A. (2011) A review of seabird energetics using the doubly labeled water method. Comparative Biochemistry and Physiology 158: 315-322.
Žydelis, R, Lewison, R.L., Shaffer, S.A., Moore, J.E., Boustany, A.M., Roberts, J.J., Sims, M., Dunn, D.C., Best, B.D., Tremblay, Y., Kappes, M.A., Costa, D.C., Crowder, L.D. (2011) Dynamic habitat models: Using telemetry data to understand fisheries bycatch. Proceedings of the Royal Society of London B, 278: 3191-3200,

Block, B.A., Jonsen, I.D., Jorgensen, S.J., Winship, A.J., Shaffer, S.A., Bograd, S.J., Hazen, E.L., Foley, D.G., Breed, G.A., Harrison, A.-L., Ganong, J.E., Swithenbank, A., Castleton, M., Dewar, H., Mate, B.R., Shillinger, G.L., Schaefer, K.M., Benson, S.R., Henry, R.W. and Costa, D.P. (2011) Tracking Apex Marine Predator Movements in a Dynamic Ocean. Nature, 475: 86-90

Winship, A.J., Jorgensen, S.J., Shaffer, S.A., Jonsen, I.D., Robinson, P.W., Costa, D.P., and Block, B.A. (2012) State-space framework for estimating measurement error from double-tagging telemetry experiments. Methods in Ecology and Evolution, 3: 291-302.

Hazen, E.L., Jorgensen, S., Rykaczewski, R., Bograd, S.J., Foley, D.G., Jonsen, I.D., Shaffer, S.A., Dunne, J., Crowder, L.J., Costa, D.P., Block, B.A. (2013) Predicted habitat shifts in Pacific top predators in a changing climate. Nature Climate Change, 3: 234-238.

Maxwell, S.M., Hazen, E.L., Bograd, S.J., Halpern, B.S., Breed, G.A., Nickel, B., Teutschel, N.M., Crowder, L.B., Benson, S., Dutton, P.H., Bailey, H., Kappes, M.A., Kuhn, C.E., Weise, M.J., Mate, B., Shaffer, S.A., Hassrick, J.L., Henry, R.W., Irvine, L., McDonald, B.I., Robinson, P.W., Block, B.A., and Costa, D.P. (2013) Cumulative human impacts on marine predators. Nature Communications 4, 2688-2697.

Gutowsky, S.E., Tremblay, Y., Kappes, M.A., Flint, E.N., Klavitter, J., Laniawe, L., Christenson, B., Costa, D.P., and Shaffer, S.A. (2014). Divergent post-breeding distribution and habitat associations of fledgling and adult Black-footed Albatrosses Phoebastria nigripes in the North Pacific. Ibis 156: 60-72.

Gutowsky, S.E., Gutowsky, L.F.G., Jonsen, I.D., Leonard, M.L., Naughton, M.B., Romano, R.D., and Shaffer, S.A. (2014). Daily activity budgets reveal semi-flightless 'reduced activity stage' at-sea during post-breeding in Hawaiian albatrosses. Movement Ecology 2: 1-14.

Kappes, M.A., Shaffer, S.A., Tremblay, Y., Foley, D.G., Palacios, D.M., Bograd, S.J., and Costa, D.P. (2015) Reproductive constraints influence habitat accessibility, segregation, and preference of sympatric albatross species. Movement Ecology, in press.

Conners, M.G., Hazen, E.L., Costa, D.P., and Shaffer, S.A. (2015) Shadowed by scale: Subtle behavioral niche partitioning revealed at the individual and species level in two sympatric, tropical, chick-brooding albatross species. Movement Ecology, in press.

Thorne, L.H., Hazen, E.L., Bograd, S.J., Foley, D.G., Conners, M.G., Kappes, M.A., Kim, H.M., Tremblay, Y., Costa, D.P., and Shaffer, S.A. (in review) Sympatric North Pacific albatross species show contrasting responses to climate variability. Movement Ecology.

Keller, K.E., Anders, A.D., Shaffer, S.A., Kappes, M.A., Flint, B., Friedlander, A. (2009) Seabirds. Pp. 235-274. In: Friedlander, A., Keller, K.E., Wedding, L., Clarke, A., Monaco, M. (eds.). 2009. A Marine Biogeographic Assessment Of The Northwestern Hawaiian Islands. NOAA Technical Memorandum NOS NCCOS 84. Prepared by NCCOS's Biogeography Branch in cooperation with the Office of National Marine Sanctuaries Papahanaumokuakea Marine National Monument. Silver Springs, MD. 363 pp.

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:

NOAA/Inouye Regional Center
NOS/ONMS/PMNM/Attn: Permit Coordinator
1845 Wasp Blvd, Building 176
Honolulu, HI 96818
FAX: (808) 455-3093

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

PMNM 2015-03, Dr. Scott Shaffer

PMNM Collections Table - Boobies and Frigatebirds

NOTE 1: RFBO - Red-footed Booby, MABO - Masked Booby, BRBO - Brown Booby, and GRFR - Great Frigatebird

NOTE 2: These are maximum numbers requested. In some cases, we would handle fewer individuals. For example, the number of Brown boobies at Tern Island, French Frigate Shoals is low so it is likely that no Brown Boobies would be studied at Tern Island. These numbers are also predicated on future funding levels.

NOTE 3: 1) Up to 3.5 mL of blood would be sampled from EACH bird and 2) Up to 4 body contour feathers would be collected from EACH bird. The volumes are also maximum values. In some cases, the volumes may be less.

NOTE 4: Up to 1 diet sample (regurgitant) may be collected from each bird. The samples would be collected opportunistically IF a bird regurgitates when captured.

GPS Tags - Breeding - Tern Island, French Frigate Shoals

	Breeding Season					Total Sampled			
Species	2016	2017	2018	2019	2020	Birds Tracked	Blood (mL)	No. of Feathers	Diet Samples
RFBO	20	20	20	20	20	100	350	400	100
MABO	20	20	20	20	20	100	350	400	100
BRBO	20	20	20	20	20	100	350	400	100
GRFR	20	20	20	20	20	100	350	400	100
total	80	80	80	80	80	400	1400	1600	400

GPS Tags - Breeding - Midway Atoll NWR

	Breeding Season					Total Sampled			
Species	2016	2017	2018	2019	2020	Birds Tracked	Blood (mL)	No. of Feathers	Diet Samples
RFBO	20	20	20	20	20	100	350	400	100
MABO	20	20	20	20	20	100	350	400	100
BRBO	20	20	20	20	20	100	350	400	100
GRFR	20	20	20	20	20	100	350	400	100
total	80	80	80	80	80	400	1400	1600	400

GPS Tags - Breeding - Laysan Island

	Breeding Season					Total Sampled			
Species	2016	2017	2018	2019	2020	Birds Tracked	Blood (mL)	No. of Feathers	Diet Samples
RFBO	20	20	20	20	20	100	350	400	100
MABO	20	20	20	20	20	100	350	400	100
BRBO	20	20	20	20	20	100	350	400	100
GRFR	20	20	20	20	20	100	350	400	100
total	80	80	80	80	80	400	1400	1600	400

Grand Totals

Species	2016	2017	2018	2019	2020	Birds Tracked	Blood (mL)	No. of Feathers	Diet Samples
4	240	240	240	240	240	1200	4200	4800	1200