



Hawaiian Petrel Monitoring Protocol - Pacific Island Network

Natural Resource Report NPS/PACN/NRR—2015/993



ON THE COVER

Hawaiian petrel (*Pterodroma sandwichensis*) near burrow at Haleakalā National Park
Photograph by: Cathleen Bailey, NPS

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Only changes in the Hawaiian Petrel Monitoring Protocol chapters and appendixes will be logged here. Version numbers will be incremented by a whole number (e.g., Version 1.0, Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers increase incrementally by hundredths (e.g., Version 1.00 to Version 1.01) when there are minor modifications that do not affect requirements or procedures included in the plan. Record the previous version number, date of revision, and author of the revisions, and identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

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Executive Summary

Seabirds are a conspicuous component of both marine and oceanic island terrestrial ecosystems and perform important functions. They are top predators and transfer nutrients from ocean to land (Ellis et al. 2006). Because seabirds exploit marine resources through a variety of feeding methods, they are important ecological indicators of marine environmental health (Thompson and Hamer 2000). In the National Park Service's Pacific Island Network (PACN), seabirds nest and roost in a variety of environments, from coastal shores to alpine regions. Here, too, they are indicators of ecosystem integrity. Seabird communities face a variety of threats, including predation by introduced mammals, habitat destruction, avian disease, human disturbance at or near colonies, and competition for food with the fishing industry. To address a need for population assessment of the endangered Hawaiian petrel (*Pterodroma sandwichensis*), or 'ua'u, PACN has identified seabirds as an important Vital Sign and has developed a program designed to monitor specific species within this group through replicated surveys.

The Hawaiian Petrel Monitoring Protocol will be implemented in two national parks: Hawai'i Volcanoes National Park (HAVO) on Hawai'i Island, and Haleakalā National Park (HALE) on Maui. The implementation of this protocol will not be carried out by the PACN Inventory and Monitoring (I&M) Program due to limited staff and funding. Instead, each park's Resource Management Division will provide financial support to implement the protocol and conduct annual Hawaiian petrel monitoring.

This protocol addresses one monitoring question with three objectives: (1) what is the annual nest density and reproductive (fledgling) success in known Hawaiian petrel colonies, (2) what are the long-term trends in colony distribution and density monitored in approximate 5-year intervals, and (3) are these affected by predator control? The first goal of monitoring is to obtain unbiased estimates of Hawaiian petrel nest density and reproductive (fledging) success from known colonies in HAVO and HALE in order to detect changes in colony growth or decline. The second goal of monitoring is to periodically (approximately every five years) obtain unbiased estimates of nest density from potential Hawaiian petrel habitat. This information can be used to assess changes in density and distribution of subcolonies across the landscape. The third goal is to estimate nest density and fledging success in areas undergoing different management regimes to assess effectiveness of management. Benchmark levels of these estimates could serve as warnings of the need for modified management or further investigation of these colonies.

The focal areas that will be monitored include known Hawaiian petrel colonies on Mauna Loa, HAVO, and on the western rim of Haleakalā Crater, HALE. Additional monitoring within these parks may occur as time and funds allow. For example, additional sampling sites within suitable habitat may be surveyed at HAVO and HALE to search for new Hawaiian petrel burrows.

The sampling frame defines the population to be monitored, and hence, identifies the limits of inference of the monitoring results. For this protocol, the sampling frame for nest density and reproductive (fledging) success monitoring is defined by geographic area, focusing on known breeding colonies of the endangered Hawaiian petrel that occur in HALE and HAVO, and also by the logistic constraint of accessibility. The sampling frame for each park has been divided into two sampling regions. Sampling Frame I is accessible from the park road (HALE), or from trails or by helicopter (HAVO), and will be sampled annually. Sampling Frame II encompasses

backcountry areas requiring extensive hiking and/or helicopter use and will be sampled every five years. At both HALE and HAVO, a 50 x 50 m grid will be overlain onto the sampling frames. Each grid cell, or quadrat, then forms a sampling unit that can be completely canvassed. Current levels of survey time will allow us to census 75 units each year at HALE and 60 units each year at HAVO. Sampling units will be completely canvassed for active burrows to determine density. In those sampling frames that are monitored annually, active burrows in some of the selected sampling units also will be assessed subsequently during the nesting season to determine reproductive (fledging) success.

Park Leads at HALE and HAVO will be primarily responsible for monitoring Hawaiian petrels in the field, data management and analysis, and reporting. I&M will provide GIS support, assistance with management of the Hawaiian petrel database, report review, and will loan equipment (e.g., burrowscope) to Park Leads as needed and available. The I&M Program Manager will work with the Park Leads to provide other guidance and technical or logistical support as needed. Other field personnel may be hired by the parks to assist with monitoring, and each park will be responsible for pre- and post-season preparations, conducting field work, and conducting the bulk of initial data management, quality assurance, and analysis. Minimum staffing for this protocol requires two trained observers to conduct field work at each park.

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Chapter 1. Background and Objectives

The Natural Resource Challenge (NRC), initiated in 1999 under the auspices of the National Parks Omnibus Management Act of 1998, is an action plan for preserving natural resources throughout the National Park Service (NPS) system. The NPS established 32 Inventory and Monitoring (I&M) networks across the nation encompassing 270 national parks. Each network is comprised of NPS units that share geographical and natural resource characteristics, allowing these parks to pool financial resources and expertise (NPS 2006a).

The Pacific Island Network (PACN), one of 32 monitoring networks nationwide, consists of 11 parks. Eight are located in the Hawaiian Islands: World War II Valor in the Pacific National Monument, Kalaupapa National Historical Park, Haleakalā National Park, Ala Kahakai National Historic Trail, Pu'ukohola Heiau National Historic Site, Kaloko-Honokōhau National Historical Park, Pu'uhonua o Hōnaunau National Historical Park, and Hawai'i Volcanoes National Park. Additionally, one park each is located in Guam, the Commonwealth of Northern Mariana Islands and American Samoa: War in the Pacific National Historical Park, American Memorial Park, and National Park of American Samoa, respectively

The Inventory and Monitoring Program's first objective was to complete basic inventories of natural resources in all parks. This information formed the baseline for long-term monitoring efforts. Because program funding is limited and not everything within park ecosystems can be monitored, monitoring programs were assembled to measure critical parameters (Vital Signs) within each network in order to gauge ecosystem health. The information gained by monitoring will be used for natural resource management decision-making.

As defined by the NPS, Vital Signs are a subset of physical, chemical, and biological elements and processes of park ecosystems that are selected to represent the overall health or condition of park resources, known or hypothesized effects of stressors, or elements that have important human values. This subset of monitored resources and processes is part of the total suite of natural resources that park managers are directed to preserve "unimpaired for future generations" (National Park Service Organic Act of 1916), including water, air, geological resources, plants and animals, and the various ecological, biological, and physical processes that act on those resources.

Long-term monitoring is the collection and analysis of repeated observations or measurements of a specific set of variables over a long time period (Vos et al. 2000, Elzinga et al. 2001). Monitoring can be distinguished by (1) an "early warning function," whereby environmental change can be detected and causes of change subsequently identified to determine management actions needed to prevent possible future damage, and (2) an "early control function," whereby information from monitoring is used to determine if management actions are successful or not, and to evaluate the efficiency or effectiveness of specific actions or measures (Vos et al. 2000). In this latter function, monitoring plays a central role in adaptive management, providing information that feeds back to evaluate the impacts of management actions and one's hypothesized understanding of the system (Williams et al. 2007). Monitoring provides useful information on the status and trends of natural and cultural resources, evaluates human impacts on the environment, and ideally detects environmental problems before severe damage occurs

(Sadoul 1997, Dearborn et al. 2001, Bennetts et al. 2007). This information is particularly useful for managers when making informed decisions about threats to habitat and species, protection and use of resources, and restoration needs (Gibbs et al. 1999, Wolf et al. 2000, Parrish et al. 2003).

The Pacific Island Network (PACN) has identified seabirds as a Vital Sign to assess the status and trends of seabird communities within the network's national parks. The overall goal of the NPS seabird monitoring program is to gather data to improve scientific understanding of seabird density, distribution and reproduction in national park areas, and thus better inform resource management decisions. National Park Service management policies mandate that parks strive to maintain, protect and recover both federally-listed (threatened and endangered [T&E] species) and non-listed native species in park ecosystems (NPS 2001). Furthermore, monitoring native species is an important part of the NPS Inventory and Monitoring Program for the entire nation. Monitoring objectives and vital signs are identified in the formal PACN monitoring plan at: http://www1.nature.nps.gov/im/units/pacn/monitoring/plan/PACN_MP_2006final.pdf.

Rare, threatened and endangered seabird species are of great concern to the National Park Service. The Hawaiian petrel (*Pterodroma sandwichensis*), or 'ua'u, is currently listed as endangered at both the federal and state level (Mitchell et al. 2005, USFWS 2005). This protocol focuses on monitoring the Hawaiian petrel in Hawai'i Volcanoes National Park (HAVO) and Haleakalā National Park (HALE). The core parameters chosen for Hawaiian petrel monitoring include trends in colony density, distribution, and reproductive (fledging) success.

Seabirds in the Pacific Islands

Seabirds currently form a reduced component of the native terrestrial vertebrate fauna for islands in the Pacific Island Network. Prior to human colonization, they nested widely in enormous numbers and great diversity on all network islands (Olson and James 1982, Harrison 1990, Steadman 1995). Currently, however, the group is marked by precipitous declines and extirpations on all inhabited islands (Loope 1998, USFWS 2005). Any extant colonies are remnants in dire need of protection, active monitoring, and management (Olson and James 1991, Steadman 1995, 2006).

Historically, seabirds served as food sources for Polynesians throughout the Pacific Islands (USFWS 2005). Seabirds played and continue to play additional roles in native Polynesian cultures. They have helped both historic and modern peoples to navigate to pelagic fishing locations and back to land (Irwin 1992), and some modern Hawaiian families identify themselves with particular seabird species through chants and dances (NPS, C. Natividad Bailey, Wildlife Biologist, personal communication, 7 June 2007).

Ecologically, seabirds play a significant role in cycling nutrients as huge numbers of birds bring marine food to land to feed chicks and deposit guano across the landscape (Loope 1998, Ellis et al. 2006). Seabirds can also be strong ecological indicators of the condition of their marine food sources, marine habitat condition, nesting and roosting habitat integrity, invasive species impacts, and the effects of human population expansion and associated habitat loss (Montevecchi 2002).

Threats and Concerns

Seabirds are an important link between marine and terrestrial ecosystems, dependent on both realms for survival, and cycling nutrients derived from marine sources to terrestrial environments (Figure 1.1). Natural and anthropogenic stressors (Figure 1.1) have reduced this nutrient cycle as seabird populations have declined in the Pacific Islands, which in turn may have affected distribution, abundance, and density of nesting colonies through changes in nesting vegetation.

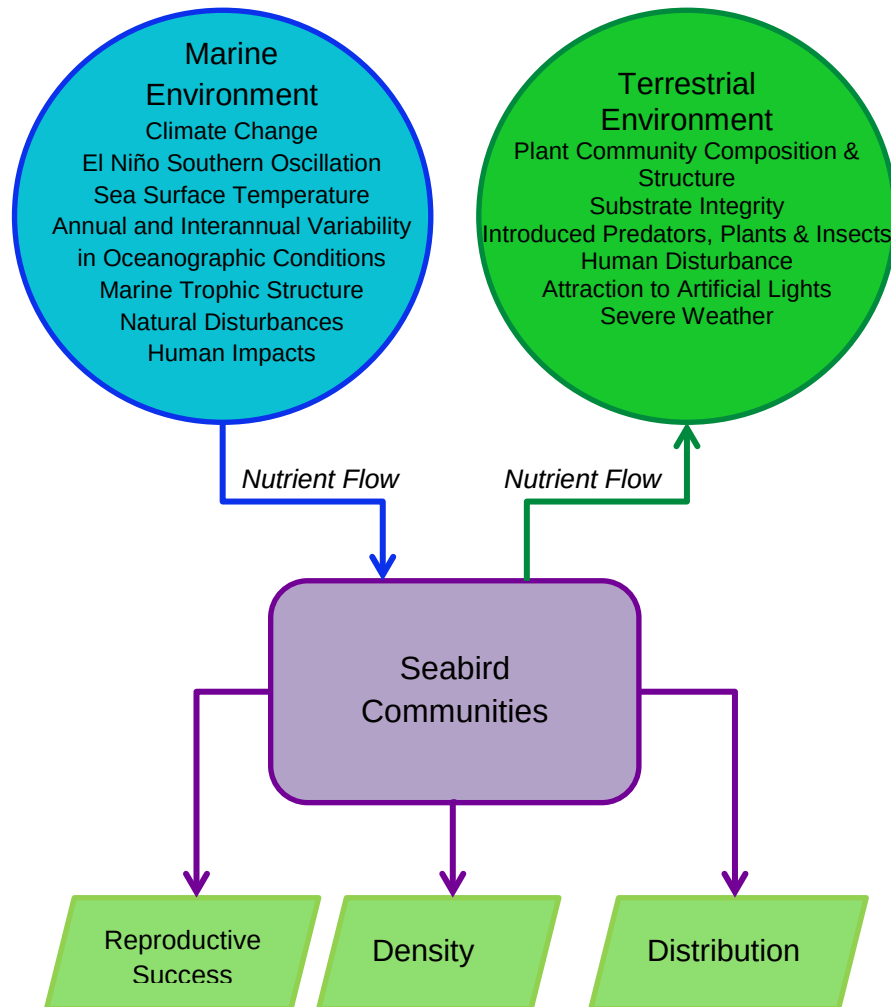


Figure 1.1. Conceptual model illustrating ocean and land-based ecosystems and their associated natural and anthropogenic stressors, the nutrient flow between seabirds and these ecosystems, and the resulting population measures that will be monitored in PACN parks.

Terrestrially-based stressors to nesting and roosting seabirds include habitat alteration and loss, human disturbance of colonies during the breeding season, invasive plant and insect species that spread into remote coastal areas, and alien predators that decimate both adults and young. Hawaiian petrels are attracted to artificial light sources, and disoriented birds have been found dead or injured in urban areas (Harrison 1990).

One of the most serious and far-reaching environmental threats comes from human-induced global climate change. As mean surface air temperatures increase, seabirds may be significantly impacted, especially those that breed at high latitudes (Thompson and Hamer 2000). In the southern hemisphere, Cunningham and Moors (1994) found that rockhopper penguin (*Eudyptes chrysocome*) populations in New Zealand experienced a 94% decline in the past 50 years, which was attributed to prey moving farther from shore and away from bird feeding grounds due to warmer sea temperatures. Increasingly frequent El Niño Southern Oscillations (ENSOs) may affect seabirds breeding at lower latitudes (Duffy 1993, Timmermann et al. 1999) through high mortality and reproductive failure caused by reduction in food resources (Schreiber and Schreiber 1984). Shoreline erosion due to sea level rise and storm-surge flooding associated with climate change may cause loss of breeding habitat for coastally-dependent species, including seabirds (Duffy 1993, McLean et al. 2001, Baker et al. 2006).

Hawaiian Petrels in the Hawaiian Islands

The Hawaiian petrel, or 'ua'u, currently breeds on only a few islands in Hawaii. This burrowing species once nested widely and abundantly throughout the main Hawaiian Islands (Perkins 1903, Munro 1955), but breeding colonies today occur only on the islands of Hawai'i, Maui (Simons and Hodges 1998), Kaua'i (Day and Cooper 1995, Ainley et al. 1997), Lāna'i (DLNR, J. Penniman, Maui Endangered Species Research Specialist, unpubl. data, 26 October 2006), and probably on Moloka'i (Day and Cooper 2002). Hawaiian petrel surveys and monitoring have been conducted at HALE since the late 1960s (Simons 1985, Simons and Hodges 1998, Hodges and Nagata 2001) and at HAVO since the mid-1990s (Hu et al. 2001). This work provides baseline and legacy data on nesting cycles, habitat utilization, subcolony distribution, reproductive success, and predation-related mortality. Appendix D describes the species and summarizes its biology.

The Hawaiian petrel, like most other seabird species in Hawai'i, has suffered large population reductions over time (Simons and Hodges 1998). Birds once nested from sea level to high elevations in a variety of habitats (Munro 1944, Olson and James 1982, Simons 1985). Fossil evidence suggests that this species was no longer found at lower elevation nesting sites before the arrival of Europeans to the Hawaiian Islands (Olson and James 1982, Simons and Hodges 1998). Some factors that played significant roles in this decline include introduced mammalian predators (Munro 1955, Berger 1972, Atkinson 1977, Simons 1983, USFWS 1983, Hodges and Nagata 2001), habitat destruction (Berger 1972), and human consumption of adults and chicks (Bryan 1914, Munro 1955). Nestlings were considered a delicacy, reserved for Hawaiian royalty or 'ali'i (Henshaw 1902), and there is direct archeological evidence of their use as food in HAVO (NPS, J. Moniz-Nakamura, HAVO Archeologist, personal communication, October 2007). However, Hawaiians may not have removed all petrels from a burrow, but rather left some behind so birds would continue to use that burrow (Kahiolo 1863), as practiced by Maori in the harvest of the Titi or Sooty shearwater *Puffinus greseus* (Moller et al. 2009).

Today, Hawaiian petrels nest at high elevations, probably in less than optimal habitat (Hodges and Nagata 2001). The largest known breeding colony, over 1000 documented burrows, occurs in and around HALE in subalpine dry scrubland between 2,500 and 3,000 m elevation (Simons 1985, Hodges and Nagata 2001). Most burrows are located along the western rim and rocky

slopes of Haleakalā Crater (Simons 1985, Brandt et al. 1995, Natividad Bailey 2009), with additional nests on the crater's eastern and southern rims and slopes (Simons 1983, 1985; HALE unpublished data). Many burrows are found at the bases of rocky outcrops where erosional debris provides good burrowing substrate (Simons 1985).

A smaller breeding population persists in subalpine habitat on weathered pāhoehoe lava flows (basaltic lava with a smooth or ropy surface) on the south and southeast flanks of Mauna Loa in HAVO (Hu et al. 2001). Since 1993, Hawaiian petrel burrows have been located and monitored between 2,440 and 2,800 m elevation in this national park (Hu et al. 2001, Swift et al. 2004, 2006a, 2006b unpubl. reports, Judge et al. 2007 unpubl. report). Most of these nests are clustered in three subcolonies, with all or most nests in each group occurring on the same flow. Flows used by nesting petrels range in age from about 1,000 to 8,000 years, and burrows occur in a variety of features including shallow lava tubes, spaces under lava slabs, and pits that may have been modified or expanded by humans (Hu et al. 2001). Surveys of habitat in the Kahuku portion of the park were completed in 2006-2007 (Judge et al. 2007 unpubl. report). While nests located in Kahuku were not subsequently monitored due to their remoteness, new nests found opportunistically in previously-identified HAVO subcolonies have been added to the list of nests monitored.

The most complete monitoring data has been collected in two subcolonies (Keauhou and Central). Of the 128 known nest sites monitored in 2007, 57 nests were occupied ("active") and 18 fledged young (32% nest success), with 14 more nests possibly fledging young. The remaining 71 nest sites did not show signs of activity. Sixteen of 21 Hawaiian petrel carcasses found throughout the HAVO study area (five in the two subcolonies) were depredated by feral cats (Judge et al. 2007 unpubl. report). Although these predators have been infrequently trapped near colonies (Hu et al. 2001, Swift et al. 2004 unpubl. report, Judge et al. 2007 unpubl. report), feral cats pose a serious threat to this population (Hu et al. 2001).

Both new habitat surveys and nest monitoring in known subcolonies at HAVO are conducted during daylight hours to detect signs of activity at burrow entrances. However, auditory detections of night flying birds have assisted observers in locating the general vicinity of active burrows or in assessing colony activity, so night surveys may be used to supplement daytime surveys.

Hawaiian petrel surveys began at HALE in 1968 (Kunioki 1968 unpubl. report) and at HAVO in 1993 (Hu et al. 2001). The goal of both these programs was to monitor nest activity, productivity and depredation at known nests, where the list of nests was augmented opportunistically. As the number of known nests increased at HALE, nest monitoring at that park changed from monitoring all known burrows to a random sample from the list of known nests (Haleakalā National Park 1994-2008 unpubl. reports). While this approach has provided valuable long-term data on nesting success, we recognize that it does not provide an unbiased sample with which to monitor status or trends in colony density or colony expansion or contraction across the landscape.

Burrows in the inner west rim of the crater at HALE have been monitored throughout the breeding season, from mid-February through late October or November, since 1988 (Hodges and

Nagata 2001). Burrows scattered outside the main concentration are monitored only when time permits (Haleakalā National Park 1994-2008 unpubl. reports). Monitoring surveys are conducted primarily during daylight hours when burrows are assessed for signs of occupancy (e.g., droppings, footprints, feathers). Night surveys are reserved for banding birds (Haleakalā National Park 1994-2008 unpubl. reports). Much of the colony is protected by fences that exclude goats and pigs, which can trample burrows, and traplines to control feral cat and mongoose predators (Brandt et al. 1995, Hodges and Nagata 2001).

Parks Where Protocol Will Be Implemented

This monitoring protocol will be implemented at Hawai'i Volcanoes National Park (HAVO) on the island of Hawaii, and Haleakalā National Park (HALE) on the island of Maui.

At both parks, the Hawaiian petrel is a flagship conservation species and serves as one indicator of the health of subalpine and alpine ecosystems in which it nests. In conjunction with other Vital Sign and park-based monitoring, information from this protocol will permit parks to more comprehensively and broadly assess the state of this ecosystem.

Because Hawaiian petrel nests are cryptic and require careful searches that can cover only a limited amount of habitat at a time, most petrel nest surveys at HALE and HAVO have not been conducted in direct combination with other park work (e.g., vegetation and ungulate surveys, fence crews). However, field crews working in potential or known petrel habitat typically do watch for and report fortuitously-encountered nest sites or calling birds. Although at this time, different sampling periods and sampling schemes suggest that combining monitoring work will not be possible, as monitoring is implemented, park and I&M staff will be alert for opportunities to co-conduct some aspects of field work.

Measurable Hawaiian Petrel Monitoring Objectives

Successful monitoring programs are developed around specific questions and measurable objectives (NPS 2006b). These objectives are detailed statements that provide additional focus about the purpose or desired outcome of the monitoring program and should be consistent and justifiable with current scientific knowledge (NPS 2006b). Monitoring is an ongoing effort to better understand how to sustain or restore ecosystems, and serves as an early warning to detect declines in ecosystem integrity and species viability before irreversible loss occurs. In cases where natural systems in or surrounding parks have been so highly altered that natural processes no longer operate, managers must understand how the altered systems function in order to determine the most effective approach for restoration.

Monitoring Hawaiian petrels as part of the Seabird Vital Sign in the Pacific Island Network will address the following specific, measurable monitoring question and objectives:

Question: What are long-term trends in colony distribution, colony density and reproductive (fledging) success of Hawaiian petrels at HALE and HAVO, and how are these affected by predator control?

Objective a: Detect landscape level changes in distribution of Hawaiian petrel colonies by searching suitable nesting habitat at approximate 5-year intervals. For colonies found, calculate density by delineating colony area and locating active nests.

Objective b: Determine long-term trends in density of active nests and annual fledging success of Hawaiian petrels at HAVO and HALE.

Objective c: Where predator control is or will be undertaken by the National Park Service, compare density of active nests and fledging success with areas in which there is no management, or with data collected before management was initiated.

Justification: The Hawaiian petrel is the only federally endangered seabird breeding in the Pacific Islands (USFWS Code of Federal Regulation 50 CFR 17, 1999). HALE and HAVO contain the only colonies within actively managed reserve areas in Hawai'i. Current threats to the Hawaiian petrel at HALE and HAVO include habitat loss as a result of feral ungulates and predation by introduced mammals (Simons 1983, Hodges and Nagata 2001, Hu et al. 2001). Baseline information is extensive at HALE because of the relative ease in accessing the population. This information shows that the population at HALE is relatively healthy, with over 1000 documented burrows, and is slowly increasing (NPS, C. Natividad Bailey, Wildlife Biologist, Wildlife Society Seabird Workshop poster presentation, October 2006). Although baseline information is less extensive at HAVO because colonies are logistically more difficult to access, current information suggests the population is in danger, with less than 100 known, active burrows, all at risk from feral cat depredation. Without management, the HAVO population may be extirpated (Hu et al. 2001). The NPS currently conducts trapping to varying extents at both HAVO and HALE to reduce feral animal populations around the seabird colonies.

Sampling Objectives

Sampling objectives, which are usually written as companion objectives to management or monitoring objectives, specify target levels of precision, power, acceptable Type I and Type II error rates, and magnitude of change we hope to detect. The parameters of interest, listed above, vary across space and time, and as such, no single design can provide maximum statistical precision, power, or acceptable error rates for all parameters simultaneously. Consequently, the sampling design for this protocol was developed to maximize the statistical power of the Hawaiian petrel data for HAVO and HALE. Our sampling objective for monitoring objectives 'b' and 'c' of this protocol, which focuses on trends over time both within the same subcolony and between managed and unmanaged subcolonies, is to achieve an 80% probability of detecting a 50% change in Hawaiian petrel density and fledgling success after 10 years of monitoring, with a Type I error rate of 5%. Our sampling objective for monitoring objective 'a', detection of landscape level changes in distribution of Hawaiian petrel colonies, is the same but with the recognition that it will take 50 years to complete 10 years of monitoring at the proposed five year sampling interval. We view detection of trends within known important nesting subcolonies of highest importance, and longer time horizons are acceptable for detection of larger-scale recovery trends.

Cultural Resources In or Near Hawaiian Petrel Colonies

Archeological resources are found throughout the national parks in Hawaii, often in conjunction with natural resources that parks plan to monitor. Under Section 106 of the National Historic Preservation Act (NHPA), federal agencies must take into account the effect of any project on historic properties (i.e., district, site, building, structure, or object) listed or eligible for listing on the National Register of Historic Places (NRHP). All monitoring projects, including the Hawaiian Petrel Monitoring Protocol, must adhere to this legislation. In order to avoid or minimize disturbance to cultural sites within or near petrel colony locations, it will be necessary to confer with archeological staff at each park to identify where these sites and associated features are located.

HAVO has nominated one site to the National Register (current status: Determination of Eligibility) located in the vicinity of known Hawaiian petrel subcolonies on Mauna Loa (Dougherty 2004). The Mauna Loa Trail is a 31.6 km (19.6 mile) single-file foot trail over lava that runs through a petrel subcolony up to the summit. This trail was constructed in 1915 for convenient access to the summit (Dougherty 2004). Limited archeological surveys have been conducted around this trail, including the documentation of three 19th century camp sites (Tuggle and Tomonari-Tuggle 2008).

Several human-modified pits excavated in pāhoehoe lava flows on Mauna Loa have been found at the location of an active breeding colony (Hu et al. 2001, Dougherty 2004). These pits may have functioned to enhance petrel nesting habitat and increase the ability of native Hawaiians to capture these seabirds (Hu et al. 2001, Dougherty 2004, Tuggle and Tomonari-Tuggle 2008). Some pits are apparently still in use by petrels, evidenced by one pit with a petrel carcass and feathers (Dougherty 2004).

A Mauna Loa reconnaissance survey in 2003 placed transects through one subcolony to identify archeological features in the area. Eighty-three features, including habitation complexes, a cave, rock shelters, wall remnants, and 59 excavated pits were documented (Dougherty 2004). While many of these features were found near the Mauna Loa Trail, they likely predate the trail (Dougherty 2004).

The Crater Historic District at HALE is listed as a historic property on the NRHP, encompassing all of Haleakalā Crater including the inside slopes, upper portions of the Ko'olau and Kaupō gaps, and part of the upper western slope of Haleakalā Mountain (NPS 2004). The largest concentration of nesting Hawaiian petrels is found in and near the crater and within this district. The summit is significant as a traditional cultural place, sacred to native Hawaiians.

Over 279 pre-contact (i.e., before 1778) archeological sites have been identified along the rim of the summit and within the crater of this district, including burial caves, platforms, trails, heiau, walls, and shrines (Wells and Hommon 2000, NPS 2004). Many historical sites and buildings associated with agriculture, homesteading and ranching also exist in the district (NPS 2004). However, less than two percent of the district has been archeologically surveyed to current professional standards, and additional surveys will likely reveal other cultural resources (Wells and Hommon 2000, NPS 2004).

Management Role at PACN Parks

HAVO and HALE are important refugia for Hawaiian petrels that depend on park lands for breeding. Therefore, it is important for the national parks to assume a substantial role in monitoring and protecting this species within and near these national parks. By understanding and detecting the ecological stressors that affect petrel communities, park resource staff can identify potential problems and develop realistic management goals and implementation strategies. Results from this long-term population monitoring may be used in population models to further assess long-term viability of park petrel colonies, set specific monitoring thresholds that would trigger management action, and refine management goals. Stressors originating within or near park boundaries may be addressed through direct management action. Those originating outside the parks may be more difficult to control and may need to be addressed through other means (e.g., by partnering with other agencies with jurisdictional control over those areas, or by proposing recommendations to these agencies).

A park management plan that encompasses Hawaiian petrel populations, and seeks to maintain on-shore and near-shore habitat while providing adequate protection from anthropogenic stressors, is necessary to ensure the long-term viability of this species within national park boundaries. Management activity conducted for administrative purposes and to enhance visitor enjoyment (i.e., road, building or trail improvements) may conflict with populations of Hawaiian petrels and other seabird species. Therefore, such activity should be scrutinized to avoid colony disturbance, especially during the breeding season.

Partnerships with Other Agencies

Currently, there are no adjacent or nearby governmental or non-governmental entities conducting similar Hawaiian petrel monitoring on Hawai'i Island. On Maui, HALE will partner with nearby entities that have just begun petrel monitoring as a result of state and federally-mandated mitigation for development projects. Both parks also have exchanged monitoring techniques and results information, both with the state Department of Land and Natural Resources and the National Tropical Botanical Garden on Kauai. Because most colonies being located and surveyed outside the national parks are in heavily-vegetated habitat, our monitoring techniques developed for sparsely-vegetated subalpine and alpine habitat are not readily transferrable.

Chapter 2. Sampling Design

Monitoring natural resources requires good quality data, sound sampling design, and effective analytic protocols. Wildlife monitoring, in particular, presents unique challenges, as some species are highly mobile and difficult to detect, or species' habitat preferences or basic natural history are poorly understood. Establishing monitoring strategies for Hawaiian petrels is no exception to these challenges. Therefore, the sampling design for this protocol was developed to achieve the best design within the constraints of available resources of time and personnel, with particular attention to defining the most efficient sampling unit and to detecting trends in a species scattered unevenly over an extensive landscape. Field site visits and data collected from past years were critical to this development process, while personnel safety concerns, spatial coverage, and logistical and fiscal constraints were also considered.

The monitoring program outlined here combines elements of previous monitoring programs with probabilistic sampling to monitor status and trends in nest density and nesting success within large spatial units of known and potential habitat. This is accomplished by changing from the previous nest-based sampling (especially at HALE) to spatial unit-based sampling. The revised program retains a number of legacy burrows by identifying legacy spatial units having high numbers of burrows with long histories of occupancy. This revised monitoring program will make the best use of legacy data, while also allowing parks to begin documenting changes in colony density and distribution based on unbiased sampling. Monitored variables (i.e., nest density, occupancy rate, and nesting success) can be directly comparable between the two parks.

The first goal of this monitoring is to obtain unbiased estimates of Hawaiian petrel nest density and fledging success from known subcolonies in HAVO and HALE in order to detect changes in these important measures of colony growth or decline. The second goal is to estimate nest density and fledging success in areas undergoing different management regimes to assess effectiveness of management. Benchmark levels of these estimates could serve as warnings of the need for modified management or further investigation of these colonies. The third goal of monitoring is to periodically (approximately every 5 years) obtain unbiased estimates of nest density from potential petrel habitat. This information can be used to assess changes in density and distribution of subcolonies across the landscape.

General Monitoring Considerations

Several constraints must be considered when designing a sampling program to attain the monitoring objectives.

Maximizing personnel safety

Monitoring remote seabird colonies presents special challenges and hazards. See Field Methods chapter below and SOP #3 "Safety Procedures" for more details.

Logistical constraints

Field activities such as site selection and sampling events are constrained by personnel and equipment availability, site location and access, topography and weather. Sampling is dependent upon Hawaiian petrel reproductive chronology, as these birds prepare nests, lay eggs and rear

young at relatively specific times of year and disperse to equatorial waters far from land when not breeding. Thus, there is a somewhat restricted time window for acquiring Hawaiian petrel data, which in turn may limit the number of sample units that can be reasonably monitored each year.

Fiscal constraints

Some Hawaiian petrel surveys may require the use of a helicopter or other specialized equipment, and additional trained staff. Fiscal constraints within this program that affect both the availability of sampling equipment and staffing levels will restrict the frequency and number of sampling units that can be visited each year.

Surveying for a Low-Density, Nocturnally-active, Burrow-nesting Species

On land, Hawaiian petrels are nocturnally-active at the nesting colonies, returning to and departing from underground burrows at or well after dusk in between multi-day pelagic foraging bouts. The nest chamber in most burrows is at the end of a long, twisting passage. Thus, surface cues around the burrow entrance are assessed in daylight hours to evaluate the status of the burrow (see SOP #7 “Collecting, Evaluating and Summarizing Hawaiian Petrel Burrow Data”).

Hawaiian petrel nest density is low. At HAVO there are 162 known active nests in three subcolonies (Kapapala, Central, Keauhou) having a total area of 717 hectares (1772 acres), of which 236 hectares (583 acres) have been surveyed, for a density of $162/236 = 0.7$ nests/ha. At this density the average area per nest is $(10,000 \text{ m}^2/\text{ha})/(0.7 \text{ nests/ha}) = 14,500 \text{ m}^2/\text{nest}$, for an average distance of $(14,500/\pi)^{1/2} = 70 \text{ m}$ between nests. Most potential Hawaiian petrel habitat is remote, especially at HAVO. This species can nest in a wider range of substrate types and at lower elevations (it was formerly found in abundance on all main islands; there were dense colonies at or near sea level, and there still are some remnant nests as low as 1,600 m [5,249 ft] at HAVO). The sparse distribution of burrows across the landscape is characteristic of the species, and requires a design that avoids allocating substantial effort to censusing empty spatial units. For more information on Hawaiian petrel breeding chronology and habitat characteristics, see Appendix D: Hawaiian Petrel Species Summary.

Minimizing Damage to Landscape

Much of the Hawaiian petrel habitat is in areas of the parks that are designated as Wilderness Areas (i.e., an area of federal land set aside under the Wilderness Act of 1964; Public Law 88-577; 16 U.S. C. 1131-1136. Human activities in wilderness areas are restricted to scientific study and non-mechanized recreation). Therefore, surveyors are trained to practice Leave-No-Trace ethics. Additionally, Hawaiian petrel habitat is in areas that are culturally sensitive to the native Hawaiian community. Surveyors are also trained on cultural sensitivity of these areas. See SOP #2 “Training Observers” for details.

Selected Sampling Design

This section outlines the factors considered in designing the sampling program, discusses the variables to be monitored, evaluates existing data sets, and presents the rationale for design choices. Every effort was made to provide practical and easy to follow methods with the intent that they may be used or modified readily by others. It is imperative that the methods and

rationale are documented adequately to allow subsequent surveyors to evaluate and/or repeat the methods.

This protocol assumes that the individuals selecting sites and methods may not be the individuals conducting future surveys, which may continue for 50+ years or well into the future. If modifications to the protocol narrative are made, revisions should be documented in the Revision History Log found on page iii of the narrative.

Target Population

The target population is that set of elements about which information is wanted and estimates are required (Statistics Canada 2003). The target population for this monitoring is all active petrel burrows within the spatially defined sampling frames. An active burrow is defined as one which has shown signs of being used by a Hawaiian petrel in the last year (Brandt et al. 1995). At HALE, there are a proportion of burrows that have not shown signs of activity in several years.

Sampling Frame

The sampling frame defines the population to be monitored, and hence, identifies the limits of inference of the monitoring results. For this protocol, we do not have a complete list of all nests, nor can this be obtained by methods such as photography. So we have instead chosen to define the sampling frame by geographic area, focusing on breeding colonies of the endangered Hawaiian petrel that occur in HALE and HAVO. Annual monitoring (Frame I), will assess nest density and fledging success, focusing on those colonies already known and previously monitored. Supplementary monitoring (Frame II) will be less frequent (approximately every 5 years) to monitor suitable habitat for changes in densities of active burrows. The sampling design thus will allow discovery of new colonies in potential habitat.

Haleakalā National Park

The sampling frames for estimating nest density and fledging success at HALE were defined by known nesting activity, habitat characteristics, and logistics. All known burrows (active and inactive) at Haleakalā National Park are located in and around Haleakalā Crater at elevations ranging from approximately 2,043 m (6,700 ft) to 2,987 m (9,800 ft) above sea level. Nesting habitat consists of sloped areas that average 27° (SD = 12.29°) (Haleakalā National Park unpubl. data).

Two frames have been identified (Figure 2.1), based primarily on the logistic constraint of accessibility, which produces substantial differences in cost per unit and, hence, differences in the frequency with which each frame can be sampled. Sampling Frame I is accessible from the park's road and will be sampled annually. Frame II encompasses backcountry areas requiring extensive hiking and over-night stay. It will be sampled every 5 years.

Frame I is divided into three strata (Figure 2.1) based on management actions and vegetation cover suspected to affect nest density and fledging success. Stratum I currently (based on 2006 field surveys) contains approximately 515 known active burrows in an area of 212 ha, of which less than half (33% - 50%) has been searched (Haleakalā National Park unpubl. data). This stratum is within the park's boundary fence and is protected from feral ungulates and introduced

predators. Because it is accessible by road, this stratum has a substantial history of monitoring effort. Stratum II is adjacent to Stratum I. It currently contains approximately 39 known active burrows in an area of 150 ha, of which half (50%) has been searched. This stratum is outside the park's boundary and it is not protected from feral ungulates and predators. Stratum III is also adjacent to Stratum I. It contains known active burrows, but has been visited less frequently than Stratum I or II because it is less accessible. Unlike Strata I and II where vegetation is sparse (1-20% cover), vegetation in Stratum III is dense (>60% cover) and consists mainly of shrubs with some grass. All three strata in Frame I will be sampled annually to determine changes in nest density. However, because of cost constraints, only Strata I and II can be sampled for fledging success. Comparison of Stratum I with Stratum II will allow measurement of the efficacy of the park's predator removal program to reduce the impact of introduced animals on nesting petrels.

Frame II was initially defined as all potential nesting habitat in remote areas in and around Haleakalā Crater and within the park's boundary fence. However, sampling the entire area is cost-prohibitive. Therefore, Frame II is restricted to high quality habitat or habitat known to be occupied. High quality habitat is defined as having slopes greater than 27° and at least sparse vegetation. Occupied habitat is defined as areas within 100 m of any of the existing known burrows discovered by opportunistic search over a period of approximately 15 years. Because of the higher cost of surveys in back country areas, Frame II will be sampled for density only, as this requires only one visit per year. It will not be monitored for fledging success, which requires multiple visits per year. Frame II will be sampled less frequently (approximately every 5 years).

Frame II, defined by habitat quality and known nests, originally consisted of five blocks within the park boundary (Figure 2.1). As data accumulates, these blocks could be used in a stratification scheme to increase the sensitivity of the monitoring program. At present, stratified allocation is not recommended, given the sparsity of information from these blocks and the fact that the two largest blocks consist of extensive tracts of unsearched area. Thus the five blocks are treated as a single stratum. A second stratum was added to Frame II based on management actions. Frame II Stratum II was defined as high quality habitat outside the park boundary, and adjacent to the southern-most block in Frame II Stratum I. This stratum, like Stratum II in Frame I, is not protected from feral ungulates and predators.

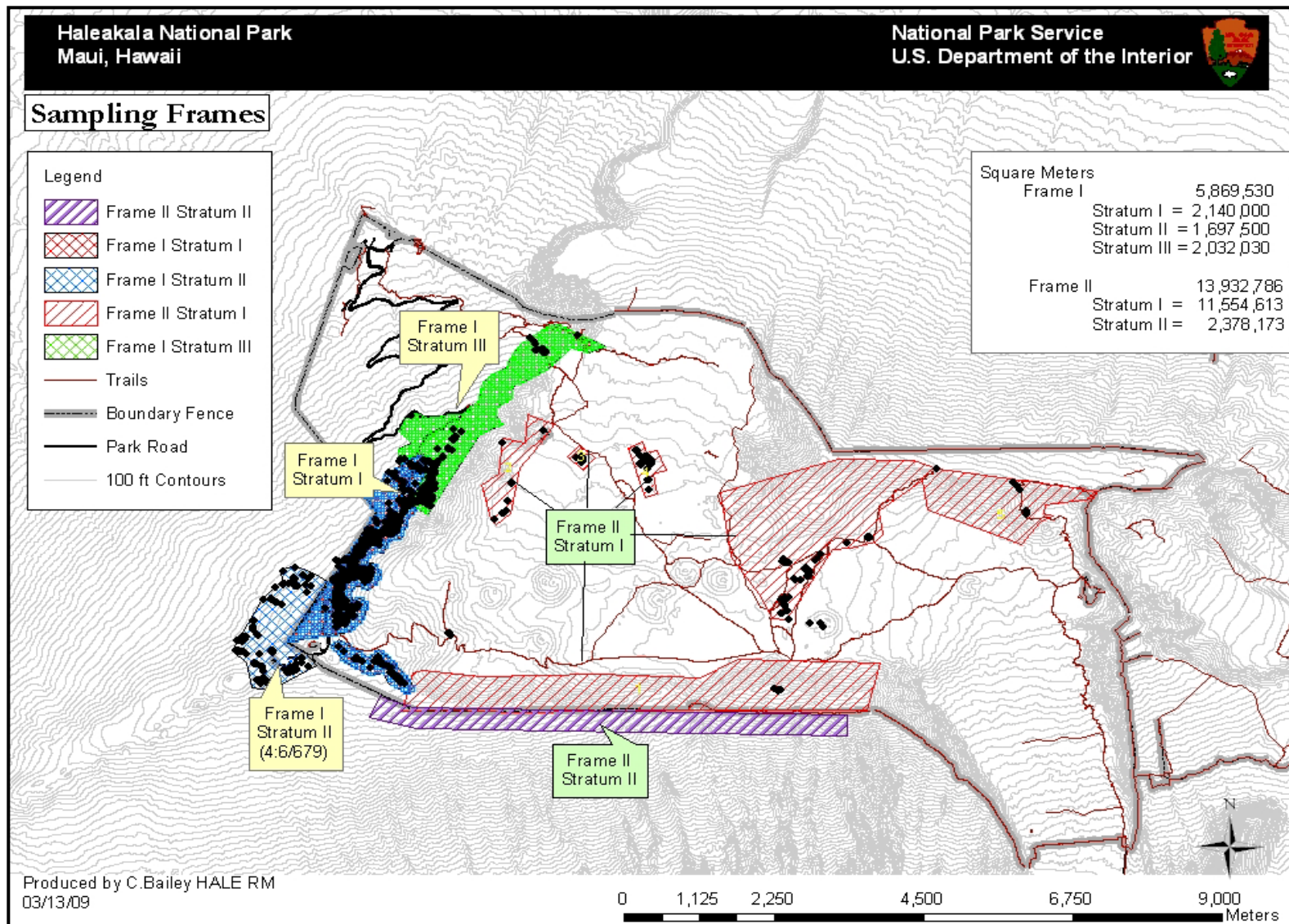


Figure 2.1. Sampling Frames I and II at Haleakalā National Park. All strata in Frame I will be monitored annually for density. However, only Strata I and II will be monitored annually for fledging success. Frame II will be monitored for density approximately once every 5 years. The black dots represent Hawaiian petrel nesting sites.

Hawai'i Volcanoes National Park

The sampling frame for nest density and reproductive (fledging) success monitoring at HAVO is defined by known nesting habitat. All extant, known petrel burrows within HAVO are on Mauna Loa. Based on inventories, the park has three main nesting concentrations or subcolonies: Kapapala, Central and Keauhou subcolonies (identified in Figure 2.2). Most nests in these subcolonies are in weathered pāhoehoe lava flows older than 1500 YBP (years before present) and between 2,470-2,925 m (approximately 8,100-9,600 ft) in elevation. The terrain is undulating, often punctuated by tumuli (small volcanic hills or mounds). The surface texture of the rock can range from fairly smooth to extremely rubbly and broken.

Two frames have been identified based to some degree on logistics, but primarily on known clusters of nests. Frame I consists of six strata (Figure 2.2) in the three subcolonies. The Kapapala subcolony consists of two strata, Lower Blue and Main Old. There are 23 known nests in this subcolony in an area of ca 79 hectares (195 acres), of which about 25% has been searched. The Central subcolony consists of two strata, Camp and East. This subcolony has 83 known nests in an area of ca 138 hectares (341 acres), of which about 25% has been searched. The Keauhou subcolony consists of two strata, Main and Southwest. This subcolony has 56 known nests in an area of 387 hectares (956 acres). About half of the Main stratum has been searched. The Southwest stratum has not been searched recently.

The two subcolonies with the densest known nesting concentrations (Kapapala and Central) are far from roads and trails. The third subcolony (Keauhou) is accessible via a two hour hike to the site. The difficult terrain and lack of water sources necessitate helicopter transport of personnel and/or gear to all these sites. Due to considerations of accessibility and associated cost, the annual survey of density and fledging success will be confined to only one stratum per subcolony. These first priority strata are Main (Keauhou subcolony), Camp (Central subcolony), and Main Old (Kapapala subcolony). Of the three, two strata (Main and Camp) account for $108/162 = 67\%$ of the known nests. The Camp stratum consists of a single 3000-5000 year old lava flow surrounded by newer 'a'a flows. The Main stratum, adjacent to the park's Keauhou boundary, consists of that portion of a 1500-3000 year old lava flow above 2,470 m (about 8,100 ft) elevation.

Frame II (shown as red polygons in Figure 2.3) within HAVO consists of potential habitat that will be sampled approximately every five years. Potential habitat is defined as pāhoehoe lava flows older than 1500 YBP, lying between 2,470-2,925 m (about 8,100-9,600 ft) in elevation. The area of potential habitat is too extensive for probabilistic sampling of the entire frame, so sampling will be limited to six strata. These six strata either harbor a small number of known nests (Strata I, II, and III) or lie close to one of the three known subcolonies of Frame I (Strata IV, V, and VI). The single exception to the elevation boundaries is Stratum I, which lies between 1,524 to 1,950 m (5,000 – 6,400 ft) in elevation, which currently has two nests.

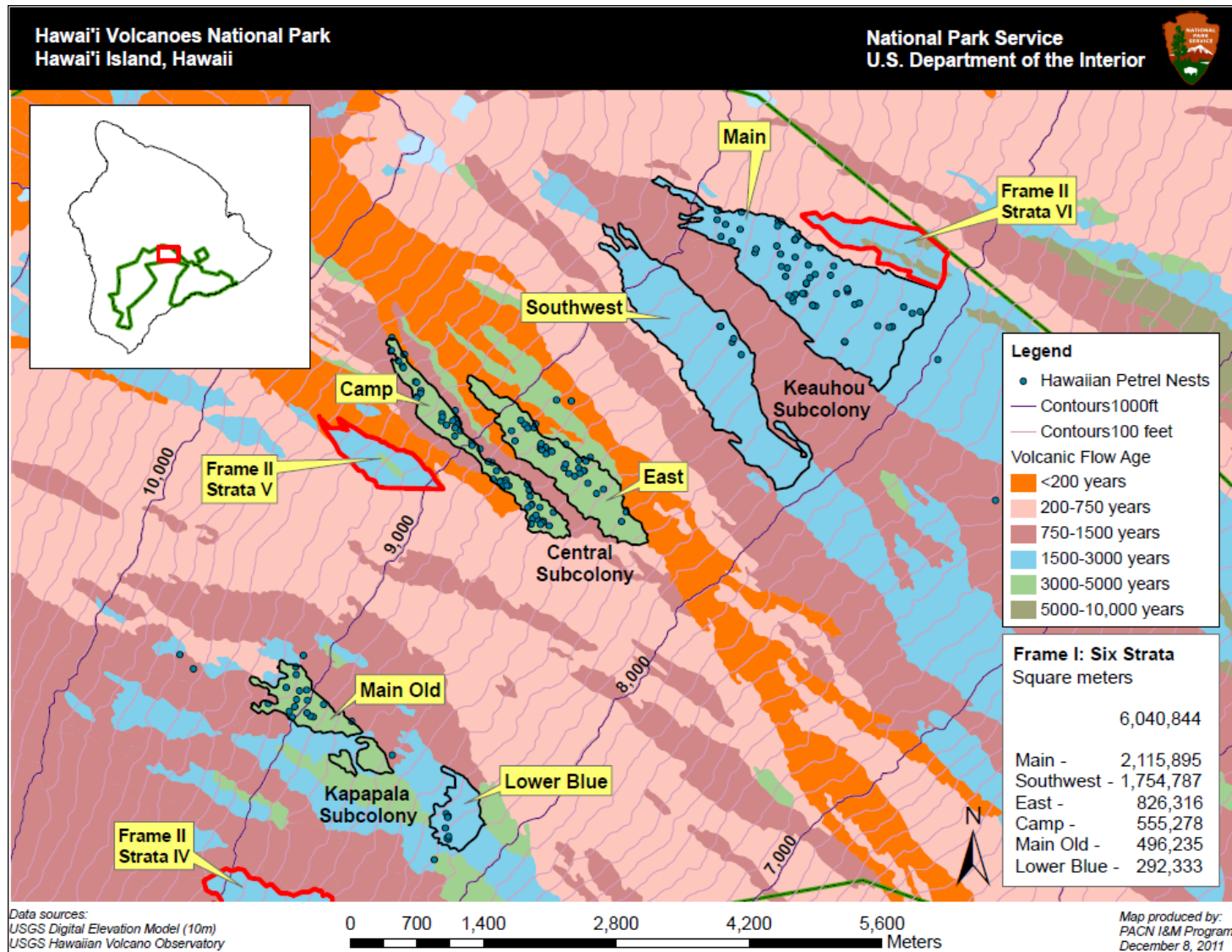


Figure 2.2. Six strata in three subcolonies within Sampling Frame I at Hawai'i Volcanoes National Park. This frame will be monitored annually for density and fledging success of active burrows. The six strata are outlined in black with names provided. Areas outlined in red represent three strata in Frame II (see Figure 2.3). Dots represent locations of known burrows.

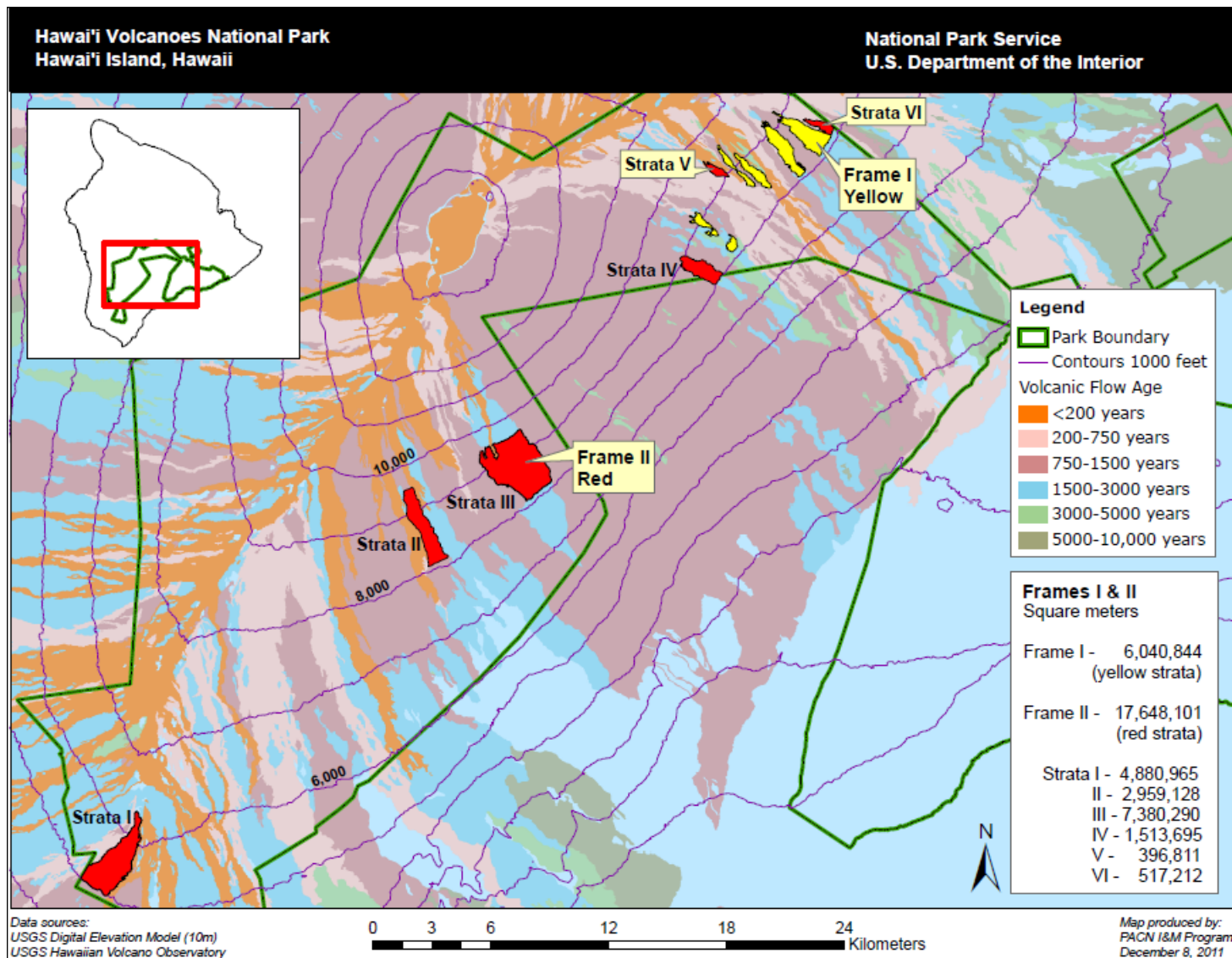


Figure 2.3. Hawai'i Volcanoes National Park Sampling Frames I and II. Frame II is composed of six strata (red areas on the map), which will be monitored approximately once every five years for density and distribution of Hawaiian petrel burrows. The six strata of Frame I (shown in more detail in Figure 2.2) are represented by yellow areas.

Sampling Units

A sampling unit is a division of the sampling frame created for the purpose of sampling. Each unit is regarded as individual and indivisible (Dodge 2003). Prior to development of this protocol, both parks used individual petrel burrows as the sampling unit. New burrows, found opportunistically when traveling to known nests, were added as they were encountered. Although burrow-based sampling allowed us to follow the fate of individual nests over time, this approach did not permit unbiased monitoring of changes in the number of pairs attempting to nest in an area, an aspect of colony health important to monitor. Thus, for this protocol, we have redefined the sampling unit as a spatial unit, which will allow us to use probabilistic sampling to obtain unbiased estimates of fledging success and density of active burrows.

At both HALE and HAVO, a 50 x 50 m grid will be overlain onto the sampling frames using a GIS program. Each grid cell, or quadrat, then forms a sampling unit that can be completely canvassed.

Prior to selecting the 50 x 50 m sampling unit, we investigated the efficiency of a smaller (20 x 20 m) sampling unit. To do this we used field estimates of time to: (1) set up a quadrat, (2) survey a quadrat for active nests, (3) assess nest status, and (4) travel between units. In comparing efficiency (number of square meters censused per field day) between the two different sized sampling units, we found that efficiency was roughly proportional to the ratio of areas. The 50 x 50 m units were 2.5 to 3 times more efficient than the 20 x 20 m unit in both HAVO and HALE. The increase in efficiency is due primarily to the greater amount of time searching within a unit, with less time traveling between units or setting up units. The increase in efficiency results in more area searched per year, and hence can be expected to increase the number of nests encountered. Because the total sampling time is fixed, the adoption of the larger unit necessarily reduces the number of units that can be surveyed. The increase in efficiency and hence area searched was considered an acceptable trade-off against loss of number of units. Moreover, the greater number of units surveyed with the smaller unit is expected to generate a substantial number of empty units, given the sparsity of nests on the landscape.

In the interests of efficiency (m^2 surveyed per day) we also considered using transects as the sampling unit, particularly for HAVO, where known active nests are extremely sparse. We investigated the relative efficiency of strip transects versus quadrats, comparing 50 m^2 quadrats versus strip transects 1.5 m wide such that the total area surveyed was the same. The result depended strongly on the time needed to set up each different type of unit: at five minutes per transect, the efficiency is twice as high for transect as for quadrat sampling, but at 10 minutes per transect the efficiency was the same as for 50 m^2 quadrats. We chose to use quadrats as the sampling unit at HAVO, since our estimates of set-up time yielded little or no gain in efficiency, and the use of quadrats will allow us to compare estimates between HAVO and HALE.

Number of Sampling Units

Current levels of survey time will allow us to census 75 units each year at HALE and 60 units each year at HAVO. Sampling units will be completely canvassed for active burrows to determine density. In those sampling frames monitored annually, active burrows in some of the selected sampling units also will be assessed subsequently during the nesting season to determine reproductive (fledging) success. If fiscal constraints reduce the number of units censused each year, park staff must re-evaluate allocation of effort and calculate (or simulate) resulting

reduction in power. Reduction of sampling effort will reduce power, and parks are aware that this should only be done as a last resort.

Allocation of Effort to Legacy Units

Probabilistic sampling produces unbiased estimates but will likely result in substantial effort in units that have few burrows (HALE) or units that are empty (HAVO). To protect against this outcome, while retaining the advantages of a probabilistic survey, we will allocate some of the annual effort to “legacy” sampling units that contain nests that have been monitored for relatively long time periods (decades, in the case of some burrows at HALE). The burrows, and hence the legacy units, are known to be occupied year after year. Long-term data on known nests, particularly with banded birds, can yield a wealth of demographic and life history information. We felt such hard-earned data should not be discontinued. These legacy units will be monitored in the same manner as probabilistic units. Information on fledging success between legacy units and probabilistic units will be compared to determine if legacy units show similar trends as probabilistic units.

Haleakalā National Park

To evaluate the question of how many sampling units to allocate to legacy vs. probabilistic sampling, we examined the number of 50 x 50 m units known to have active burrows (nests) (Table 2.1). At HALE the number of units with known active burrows was $182/856 = 21\%$ in Stratum I and $31/528 = 5.9\%$ in Stratum II (Table 2.1). This suggests a high number ($1384 - 213 = 1171$) and hence a high proportion ($1171/1448 = 81\%$) of unoccupied units. However, a substantial fraction of the 1171 are unknown rather than true zero counts. To obtain an estimate of the proportion of units with no nests, we used data from 651 burrows (active and inactive) in 261 units (Stratum I). Based on these data, $88/261 = 34\%$ of probabilistic sampled units in Stratum I would be empty. We then estimated the number of unoccupied units, working from the percent area censused (33% - 50%) in Stratum I. Table 2.1 shows the flow of calculations. At 33% of the area surveyed, the number of units surveyed in Stratum I is $856/3 = 282$ units. The number of unoccupied units by this calculation is then $282 - 182 = 100$ (Table 2.1), or $100/282 = 35\%$. At 50% of the area surveyed, the same calculation comes to $856/2 = 428$ units, with $(428 - 182)/428 = 57\%$ unoccupied. In addition, burrows are not randomly distributed but are instead clumped at the scale of the 50 x 50 m unit. In Frame I, the number of active burrows per 50 m² unit ranges from 0 to 11 active burrows per unit in Stratum I, and 0 to 3 active burrows per unit in Stratum II. Active burrows are concentrated in a small number of units in Stratum I, and consequently probabilistic sampling has only a small chance of censusing a unit with a large number of active burrows.

Table 2.1. Number and density of known active burrows (nests) inside and outside Haleakalā National Park, Frame I. Units are 50 m by 50 m (1/4 ha or 0.62 acre). The variance explained by Strata I and II within Frame I was $r^2 = 22.2\%$.

	Stratum I (inside)	Stratum II (outside)	Sum	Combined
Nominal Area (ha)	212	150	362	
Units (full and partial)	856	528	1384	
Area (ha) from Units	214	132	346	
% area surveyed	33%	50%		
Area (ha) surveyed	70.6	66	136.6	
Units from % area	282	264	546	
Occupied units	182	31	213	
Unoccupied units	100	233	333	
Active burrows (nests)	515	39	554	
Nests/unit (surveyed area)	1.826	0.148		1.015
Nests/ ha (surveyed area)	7.305	0.591		4.06
Nesting pairs	1563	78	1641	
SSwithin	1290.5	53.2	1343.7	
Variance within	4.592	0.202		
Variance/mean	2.51	1.37		
Source	N	df	SS	$r^2 =$
among	2	1	384.16	0.222
within	546	544	1343.72	
			1727.88	

To address the problem of substantial effort allocated to unoccupied units, we used the frequency distribution of nest number per 50 m² unit to choose a small number of legacy units that would yield a large number of burrows. Inspection of the frequency distribution at HALE (Table 2.2) revealed that designating 18 of the 75 sampling units as legacy units (12 in Stratum I and six in Stratum II) would yield information on 99 burrows (Stratum I) and 14 (Stratum II) burrows.

Table 2.2. Frequency distribution of known active burrows in 50 x 50 m units at Haleakalā National Park. Estimate of units with no active burrows were taken from Table 2.1. N = number of active burrows (Freq * Nests/unit). Shaded areas within boxes show legacy units.

Nests per unit	Stratum I (inside)		Stratum II (outside)	
	Freq	N	Freq	N
0	100	0	233	0
1	59	59	25	25
2	45	90	4	8
3	26	78	2	6
4	20	80	0	0
5	11	55	0	0
6	9	54	0	0
7	5	35	0	0
8	3	24	0	0
9	1	9	0	0
10	2	20	0	0
11	1	11	0	0
12	0	0	0	0

It is expected that many of these 113 burrows will have long histories of occupancy. This list of 18 units will be adjusted somewhat if more burrows with long histories can be obtained by substituting units with lower densities than the 18 highest density units.

The frequency distribution of active burrows (Table 2.2) was used to estimate nest density and colony size. In Stratum I, there were 515 active burrows and an estimated 282 units surveyed, for a density of 1.83 nests/unit surveyed (7.3 nests/ha surveyed). In Stratum II, there were 39 active burrows in 264 units, for a density of 0.15 nests/unit surveyed (0.59 nests/ha surveyed). The estimate of population size was $866 \text{ units} * 1.826 \text{ nests/unit} = 1563 \text{ nesting pairs}$ in Stratum I, $528 \text{ units} * 0.148 \text{ nests/unit} = 78 \text{ nesting pairs}$ in Stratum II. The variances were 2.5 and 1.4 times the mean (Table 2.1).

Hawai'i Volcanoes National Park

At HAVO densities are far lower (Table 2.3) than at HALE. Variances at HAVO are approximately equal to the mean, indicating that burrows are random at the scale of 50 x 50 m units.

Table 2.3. Number and density of known active burrows at six locations in Frame I at Hawai'i Volcanoes National Park. The variance explained by the six strata was $r^2 = 15.6\%$

Flow Names	Subcolony I Kapapala		Subcolony II Central		Subcolony III Keauhou		Sum
	Main Old	Lower Blue	Camp	East	Main	SW	
Nominal Area (ha)	49.62	29.23	55.53	82.63	211.59	175.48	604.08
50 m by 50 m units	275	147	291	394	938	815	2860
Area (ha) from units	68.75	36.75	72.75	98.5	234.5	203.75	715
% area surveyed	25%	25%	30%	20%	50%	25%	
Area surveyed (ha)	17.2	9.2	21.8	19.7	117.3	50.9	236.1
Units from % area	69	37	87	79	469	204	945
Occupied units	16	5	46	24	46	4	141
Unoccupied units	53	32	41	55	423	200	804
Nests	16	7	56	27	52	4	162
Nests/unit (surveyed area)	0.2319	0.1892	0.6437	0.3418	0.1109	0.0196	0.1714
Nests/ha (surveyed area)	0.928	0.757	2.575	1.367	0.443	0.078	0.686
Nesting pairs	12.2899	9.6757	43.9540	23.7722	60.2345	3.9216	153.85
SSwithin (Nests/unit)	0.1807	0.2688	0.5111	0.3048	0.1287	0.0193	
Varwithin (Nests/unit)	0.359	0.032	20.370	2.616	1.123	4.010	28.51
Var/Mean	0.78	1.42	0.79	0.89	1.16	0.99	
Source	N	df	SS	r^2			
among	6	5	28.38	0.156			
within	945	939	153.85				
			182.23				

Of the 2860 units in Frame 1 (Table 2.3), only 141 are known to be occupied. Roughly 1/4 of the total area has already been searched (half in Main). Taking into account the percent area censused in each of the six locations, the estimated number of censused units comes to 945. The proportion of unoccupied units is on the order of $804/945 = 85\%$. The expected outcome of 60 randomly placed units each year would be $85\% \times 60 = 51$ unoccupied units and only 9 occupied units. To address this problem, we examined the frequency distribution of burrow number per 50 m² unit. Of the 141 occupied units, only 18 have more than one nest (Table 2.4). Designating these as legacy units would result in long-term monitoring of 39 nests, of which 18 are at Main and 11 are at Camp.

Table 2.4. Frequency distribution of known active burrows in 50 x 50 m units at Hawai'i Volcanoes National Park. Estimate of units with no active burrows was taken from Table 2.3. N = number of active burrows (Freq * Nests/unit). Shaded areas within box show units with legacy burrows.

Nests per unit	Subcolony I Kapapala				Subcolony II Central				Subcolony III Keauhou			
	Main Old		Lower Blue		Camp		East		Main		SW	
	Freq	N	Freq	N	Freq	N	Freq	N	Freq	N	Freq	N
0	53	0	32	0	41	0	55	0	423	0	200	0
1	16	16	3	3	38	38	21	21	41	41	4	4
2	0	0	2	4	6	12	3	6	4	8	0	0
3	0	0	0	0	2	6	0	0	1	3	0	0

Stratification

Stratification within sampling frames improves precision of estimates by using defined criteria to group sampling units into strata that have marked differences in the mean of the parameter of interest (here, burrow density). Strata may be defined either geographically or by criteria applied to each sampling unit. In either case, they are defined such that each sampling unit can have membership in only one stratum.

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At HALE, Sampling Frame I is divided into three strata based on management actions and vegetation cover (Table 2.5).

Table 2.5. Stratification of Frame I, Haleakalā National Park.

Stratum	Strata Characteristics	Habitat Characteristics	Management Action
I	Contains known burrows Within park boundaries Managed with fencing	Sparse vegetation	Sample annually: Reproductive (fledging) success, density
II	Contains known burrows Outside park boundaries Not managed (no fencing)	Sparse vegetation	Sample annually: Reproductive (fledging) success, density
III	Contains known burrows Within park boundaries Managed with fencing	Dense vegetation, many shrubs and grasses	Sample annually: Density only

At HALE, the variance explained by Stratum I and II within Frame I was $r^2 = 22.2\%$ (Table 2.1), and hence there was potential for gain in precision due to stratification. Given the variances in this table, and assuming equal cost per unit in the two strata, the optimal allocation of the 75 total - 18 legacy = 57 probabilistic units would be 7 units outside and 50 units inside (Table 2.6). If we assume, in the absence of information, that the variance in Stratum III is the same as Stratum

I, then the allocation of 75 units becomes 33 units to Stratum I, 16 units to Stratum II (outside), and 26 to Stratum III (Table 2.6).

Table 2.6. Simple and stratified random allocation in Frame I Stratum I (inside park) vs. Stratum II (outside park) compared to simple and stratified random allocation in all three Frame I strata (Strata I, II, and III) for Haleakalā National Park. Calculations assume equal cost in all strata and equal variance,

Stratum	Ah	Ai	Nh	Sh	Nh*Sh	Optimal			Simple		
						nh	Legacy	Total	Random	Legacy	Total
I (inside)	2140000	50	856	2.143	1834.41	50	6	56	35	6	41
II (outside)	1320000	50	528	0.450	237.56	7	12	19	22	12	34
Total			1384		2071.97	57	18	75	57	18	75

Stratum	Ah	Ai	Nh	Sh	Nh*Sh	nh	Legacy	Total	Random	Legacy	Total
I (inside)	2140000	50	856	2.143	1834.41	27	6	33	22	6	28
II (outside)	1320000	50	528	0.450	237.56	4	12	16	14	12	26
III (inside)	2032030	50	813	2.143	1742.26	26	0	26	21	0	21
Total			2197		3814.24	57	18	75	57	18	75

$Sh(III) = Sh(I)$ (calculations from Cochran 1977, Equation 5.26). Ah = stratum area (m^2); Ai = unit area (m^2); Nh = units in each stratum; Sh = true st.dev in each stratum; nh = sample size in each stratum; n = sum(nh) total sample size.

Optimal allocation under stratification substantially reduces the number of units outside the park. In the case of the annual survey (Strata I and II only), the number outside (not counting legacy units) drops from 22 to 7 units (Table 2.6). This reduction is due to the greater variance in Stratum I than II, which in turn is linked to the greater burrow density (the variance increases with the mean for count data). Thus, stratification increases the chance that in any one year no petrel nests are measured in the randomly placed units in Stratum II. This becomes a more serious problem if the goal of the annual survey is status each year, rather than trends. It is less of a problem if the goal is comparison of trends inside and outside of the park. In the latter case the potential for a zero count in Stratum II is offset by the greater precision in Stratum I under stratification than under a simple random allocation. It should be noted that in a stratified random design there is a new draw each year, that this allocation is based on an improved estimate of variances in each stratum, and hence the gains in precision in Stratum I during the course of the monitoring program will enhance the capacity to detect differences in density trends inside and outside the park. Under a simple random design there is also a new draw each year, but on average this draw will follow the allocation of sample number shown in Table 2.6, with no opportunity for change if precision increases (standard deviation decreases).

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At HAVO, Sampling Frame I is divided into six strata consisting of specific and well-demarcated kipuka (islands of lava substrate surrounded by differently-aged flows) within three known subcolonies. These subcolonies are defined by their general location within the Mauna Loa Strip area of HAVO (Table 2.7).

Table 2.7. Stratification of Frame I, Hawai'i Volcanoes National Park.

Stratum	Stratum Location	Flow Characteristics	Number of Random Units Sampled	Number of Legacy Units Sampled
Kapapala Main Old	Near Kapapala boundary of the Mauna Loa Strip area of HAVO	Pahoehoe 3,000-5,000 years old		
Kapapala Lower Blue	Near Kapapala boundary; on slightly younger pahoehoe substrate (denoted on geologic maps by the color blue) SE of Main Old	Pahoehoe 1500-3000 years old		
Central Camp	In central portion of the Mauna Loa Strip area of HAVO on the western-most of two flows that were bisected by the 1899 a'a flow	Pahoehoe 3,000-5,000 years old	16	8
Central East	In central portion of the Mauna Loa Strip area of HAVO on the eastern-most of two flows that were bisected by the 1899 a'a flow	Pahoehoe 3,000-5,000 years old		
Keauhou Main	In the Keauhou subcolony (nearest the Keauhou boundary), crossed by the Mauna Loa trail in its SW corner	Pahoehoe 1500-3000 years old	31	5
Keauhou Southwest	In the Keauhou subcolony (nearest the Keauhou boundary), SW of Keauhou main, separated by an 'a'a flow.	Pahoehoe 1500-3000 years old		
Total Units Sampled			47	13

An analysis of data from six different flows (Table 2.3) gave densities ranging from 2.575 active burrows/ha (Camp) to 0.078 active burrows/ha (Southwest). The variance explained by the six

strata was $r^2 = 15.6\%$ (Table 2.3). Thus, gains in precision due to stratification can be expected. Due to the greater logistic cost of sampling all three subcolonies, annual sampling in Frame I will be confined to just two subcolonies: the Keauhou subcolony (Main) and the Central subcolony (Camp). Camp and Main were chosen because of the existence of good time series and because they hold 13 of the 18 legacy units in Frame I. If resources in the future permit, one stratum (Main Old) from the Kapapala subcolony will be added to the annual sampling of Frame I. The optimal allocation to Camp and Main, assuming equal cost per stratum and 13 legacy units, is 16 units/year to Camp and 31 units/year to Main (Table 2.8).

Table 2.8. Simple and stratified random allocation in Hawai'i Volcanoes National Park, Frame I, Camp (Stratum II) and Main (Stratum III) flows. Camp has 24 units known to be occupied, and Main has 12 such units. Calculations assume equal cost in all strata (calculations from Cochran 1977, Equation 5.26).

Flow	Ah	Ai	Nh	Sh	Nh*Sh	Optimal nh	Legacy	Total	Simple Random	Legacy	Total
Camp	555278	50	222.11	0.71491	158.789	16	8	24	10	8	18
Main	2115895	50	846.36	0.35876	303.636	31	5	36	37	5	42
Total			1068.5		462.425	47	13	60	47	13	60

Ah = stratum area (m^2); Ai = unit area (m^2); Nh = units in each stratum (h); Sh = true st.dev in each stratum (h);

nh = sample size in each stratum (h); n = sum(nh) total sample size.

This differs only slightly from simple random allocation (Table 2.8) because the effects of variance and stratum area offset each other: the variance is higher in the smaller stratum (Camp). The variances in the two strata are not expected to diverge from each other in the future unless the average densities in the strata diverge, as the variance is linked to the average with sparse count data. Thus, in the absence of substantial increase in active nests, there is no reason to expect that the variances will change. At HAVO, a simple random design can be used if it is simpler to implement. Under a simple random scheme the stratification is ignored and the units are chosen randomly each year from the entire frame. The frame consists of $291 + 938 = 1229$ units (see Table 2.3) when sampling is confined to Main and Camp. The frame consists of $291 + 938 + 275 = 1504$ units if all three first priority strata are sampled.

At both parks, if steep terrain in either frame precludes safe access to a selected unit (particularly likely at HALE), the selected unit will be discarded and a second probabilistic site substituted (see SOP 17 for more details). While this unavoidable substitution may bias the data towards more accessible sites, HALE park staff estimate that less than 10% of units will need to be discarded.

Sampling with Partial Replacement (SPR) Panel Design

The burrow-based program used in the past does not include sites without burrows, and hence the variance due to unoccupied sites does not appear in the calculations of uncertainty of trends. This creates the potential for bias due to changes in density or success of burrows not included in the list of burrows monitored. Probabilistic sampling eliminates the bias, at the cost of a reduction in power due to the introduction of a new source of variance, the spatial variance from sampling new units dispersed over the landscape. To some degree this increase can be offset by

using sampling with partial replacement (Skalski 1990). The simplest such SPR design consists of two panels, one that is sampled every year, and the other consisting of new probabilistic samples selected randomly each year, interspersed among the fixed units. The probabilistic samples minimize the bias that can develop with fixed locations (even if these are unbiased at the start of the program). In addition, back-calculated time series at the fixed locations can be used to reduce the variance of the overall estimate (Skalski 1990). The optimal balance between fixed and newly selected probabilistic units in this two panel design depends on the year to year correlation. The higher the correlation, the more information from the fixed location samples and hence, the fewer fixed locations are needed to offset the spatial variance contained in the probabilistic samples. The optimal balance (J. R. Skalski, personal communication) between fixed and new (probabilistic) samples in such a design is

$$\text{Proportion of fixed} = \frac{\sqrt{1-r^2}}{1+\sqrt{1-r^2}}$$

Equation 2.1 where r is the year to year correlation at fixed sites.

The use of legacy units, defined as units with at least two active nests, in effect creates a two panel SPR design. We investigated the optimal proportion (as above) to compare it to the fixed proportion created by legacy units. In the absence of data from HAVO, we used data from HALE for both parks. The rationale for this is that the year to year correlation for HALE data will be due to the degree of nest site fidelity of Hawaiian petrels, which is expected to be similar in both parks.

Hawaiian petrels at HALE exhibited very high correlation in nest site usage from year to year (Table 2.9). The average correlation across the six values in Table 2.9 was $r = 0.963$, for which the proportion of fixed to random sites would be 21%. This compares to $18/75 = 24\%$ allocation to fixed units at HALE, and $13/60 = 22\%$ allocation to fixed units at HAVO. The legacy allocations at HALE and HAVO (i.e. the fixed portion of the design) were almost the same as for the optimal allocation for a two panel SPR design.

Table 2.9. Year to year correlation in number of active burrows in 29 units (50 x 50 m) at Haleakalā National Park, where information was available (1998, 2003, 2004, and 2005).

	1998	2003	2004
2003	0.94		
2004	0.96	0.98	
2005	0.95	0.97	0.98

These calculations for HAVO and HALE were based on available data, not on a designed pilot study, and thus must be considered as guides for sampling during the first year. Moreover, the fixed panel (legacy units) is far from a representative sample of the frame. Hence, reproductive success data from the fixed (legacy) and random panels cannot be combined as estimates of the same quantity. Instead, the monitoring program will use the random panel (representative, but with few nests) to validate the trends from the fixed (legacy) panel.

Estimate of Statistical Power

Nest densities in Tables 2.2 and 2.4 are not normally distributed, and thus, parametric approaches to power analyses are not appropriate. Nonetheless, traditional power analyses can help identify limitations of the proposed sampling scheme, and thus, we chose to conduct them here. However, we also discuss an alternative approach at the end of this section.

Statistical power, sample size, and detectable change for the designs at HALE and HAVO were investigated under the criteria of Type I error at 5% and Type II error at 20% (power = 80%). At HALE, mean density and its standard deviation were calculated as in Tables 2.1 and 2.2. Power calculations were made assuming 50 probabilistic units per year are assigned to Frame I Stratum I under a stratified design (Table 2.6). Consistent with the tendency of nesting petrels to aggregate, a constant degree of aggregation (constant coefficient of variation) was assumed, rather than a constant standard deviation. The effect of this assumption is that decrease is easier to detect than increase, because the standard deviation decreases as the mean decreases (in accord with park biologists' priorities for endangered species management). Thus, the minimum sample size to detect a 50% increase between two sampling rounds at HALE was 141 units per year (Table 2.10), well above the feasible limit of 75 units per year. However, the minimum sample size to detect a 50% decrease was 55 units per year. Similarly, the power of 50 probabilistic units per year to detect a 50% increase in Stratum I was only 39% (Table 2.10), well below the 80% target. In contrast, the power to detect a 50% decrease was 77%, acceptably close to the 80% target for power. With 50 samples in two years, the minimum detectable increase was 95%, and the minimum detectable decrease was 46% (Table 2.10). The power decreases in Stratum I if 35 units per year are assigned to this stratum (Table 2.10), according to a simple random design (Table 2.6).

Table 2.10. Sample size, power, and percent detectable change in petrel density for two rounds of sampling in Frame I Stratum I, Haleakalā National Park. Shaded values within boxes are calculated from other values in the same line and from initial density = 1.826 nests/unit, initial standard deviation = 2.143 nests/unit and cv fixed at 1.173. N = samples per year; Final density = (1+%change)(initial density); Final stdev = (1+%change)(initial stdev).

% Change	Final Density	Final stdev	Power	N
50%	2.739	3.215	0.80	141
-50%	0.913	1.072	0.80	55
10%	2.009	2.357	0.063	35
25%	2.283	2.679	0.124	35
50%	2.739	3.215	0.287	35
10%	2.009	2.357	0.069	50
25%	2.283	2.679	0.156	50
50%	2.739	3.215	0.386	50
-10%	1.644	1.929	0.073	50
-25%	1.370	1.607	0.226	50
-50%	0.913	1.072	0.769	50
95%	3.561	4.179	0.80	50
-46%	0.840	0.986	0.80	50

The same calculations were then carried out for Stratum II (outside the park), using data from Tables 2.1 and 2.2. After applying the correction for percent area surveyed, the mean density in Stratum II came to 0.148 active burrows per unit, substantially less than the density of 2.143 burrows per unit inside the park (Table 2.1). The standard deviation was $(0.202)^{1/2} = 0.450$, resulting in a coefficient of variation of $(0.202)^{1/2} / 0.148 = 3.046$. This was used to compute the expected standard deviation on a second round of sampling, following the formula in Table 2.9. At the 5% criterion for significance, the sample size needed to detect a 50% increase in Stratum II was 9496 units in each of two years. The sample size to detect a 50% decrease was 363 units in each of two years, which also is well beyond the capacity of the park to sample. The protocol clearly will not be able to meet Objective B, detection of changes in density, for Stratum II.

A power analysis comparing nest densities in units with and without predator control at HALE (Stratum I inside the park and Stratum II outside the park; Monitoring Objective C), suggests that detection of differences will be readily achievable. At optimal sample allocation of $n=50$ for inside park and $n=7$ for outside park, and using observed variances in nest densities for the two strata (Table 2.1), power is greater than 95%.

At HAVO, mean density and its standard deviation were calculated for the Main and Camp strata, using data from Table 2.3. Power calculations were made assuming 16 probabilistic units per year assigned to Camp and 31 assigned to Main under a stratified design (Table 2.8). As for HALE, an assumed constant degree of aggregation (constant coefficient of variation) was used to obtain the expected final standard deviation. At power equal to 80%, the park needs a minimum number of 1086 units per year to detect a 50% change in the Main stratum, and 126 units for the Camp stratum (Table 2.11). The power to detect change in Main, with the unit allocation of 31/year under a stratified random design (Table 2.8), was far below the 80% target: With only 31 units per year, even the greatest achievable statistical power (which occurs at 100% loss) was only 24% (Table 2.11). Thus, a minimum detectable difference at a power of 80% could not be obtained for Main. However, in Camp, with 16 units per year, the minimum detectable decrease was 60% at a power of 80%, which is within the target set for change detection.

Table 2.11. Sample size, power, and percent detectable change in petrel density for two rounds of sampling in Main and Camp strata at Hawai'i Volcanoes National Park. Final density and standard deviations were calculated as in Table 2.9.

Stratum	Initial Density	Initial stdev	% Change	Final Density	Final stdev	Power	N
Main	0.111	0.359	50%	0.166	0.538	0.80	1086
			-50%	0.055	0.179	0.80	403
			10%	0.122	0.395	0.051	31
			25%	0.139	0.448	0.054	31
			50%	0.166	0.538	0.063	31
			-100%	0.000	0.000	0.235	31
Camp	0.644	0.715	50%	0.966	1.072	0.80	126
			-50%	0.322	0.357	0.80	49
			10%	0.708	0.786	0.063	16
			25%	0.805	0.894	0.123	16
			50%	0.966	1.072	0.285	16
			-60%	0.257	0.286	0.80	16

These calculations assume a normal distribution of outcomes around the initial (null hypothesis) and final (alternative hypothesis) densities. The assumption was clearly untenable due to counts consistent with a Poisson distribution (variance/mean near unity at all six strata in Frame I at HAVO) and due to count data bounded at zero. When assumptions of normal and homogeneous errors are violated, calculations of sample size and minimum detectable difference within the framework of the Generalized Linear Model (GzLM) and the analysis of deviance (Nelder and Wedderburn 1972, McCullagh and Nelder 1989) are recommended. GzLMs allow non-normal errors, including Poisson and overdispersed gamma and negative binomial distributions. Analysis of deviance (ANODEV), like the analysis of variance (ANOVA), rests on maximum likelihood estimation. ANODEV emphasizes improvement in fit, while ANOVA emphasizes the ratio of explained to unexplained variance. ANODEV is thus appropriate to monitoring studies, where evaluating uncertainty is more important than explained relative to unexplained variance. ANODEV relies on an estimate of the relation of the variance to the mean, and thus lends itself to situations (like this one) where the variance is expected to depend on the mean. While hypothesis testing with ANODEV is now implemented in most statistical packages, power and sample size calculations are not. Well established routines (e.g., SAS, S-Plus) produce estimates of Type I error, and so can be used to compare minimum sample sizes under ANODEV and ANOVA. Established ANODEV routines can be used in an iterative fashion to estimate minimum detectable differences, at 5% tolerance of Type I error.

In addition to more appropriate handling of the error distribution, GzLMs usually increase the power of analysis when variance depends on the mean, as is the case with the Hawaiian petrel data. In a preliminary study, the frequency distribution from HALE Stratum I (Table 2.2) was used to investigate the change in power with ANODEV. In the analysis of 50% change based on 35 samples (Table 2.10), the Type I error was $p = 0.34$ ($t = 0.961$, $df = 68$) with analysis of

variance. When re-analyzed with analysis of deviance, the Type I error dropped to $p = 0.0443$ (Deviance = 4.044, $df = 1$). The drop in Type I error was substantial, reflecting a substantial increase in power. As a result, change that was not significant within the traditional framework of ANOVA was significant within the more modern framework of analysis of deviance.

Each year of a monitoring program increases the precision of estimates by increasing the number of samples. This effect decreases in each successive year and so the greatest effect is expected going from year 2 to year 3. In a preliminary study with the data from HALE Stratum I (Table 2.2) and a sample size of 50 units/year over three years, the minimum detectable change as estimated by regression with ANODEV was 16.4% from year 1 to year 3, or 8.5% per year. This change was statistically significant with ANODEV (Dev = 3.89, $df = 1$, $p = 0.0487$) but not with ANOVA ($F[1,28] = 0.28$, $p = 0.6$). A similar result was obtained with HALE Stratum II data (Table 2.2). As estimated by regression, the minimum detectable change with ANODEV was 18% from year 1 to year 3, or 9.4%/year. This change was statistically significant with ANODEV (Dev = 3.875, $df = 1$, $p = 0.049$) but not with ANOVA ($F[1,28] = 0.107$, $p = 0.75$).

With the HAVO data (Camp and Main combined) and a sample size of 30 probabilistic units per year over three years, the minimum detectable change with ANODEV was 27% from year 1 to year 3, or 14.5% per year. This change was statistically significant with ANODEV (Dev = 3.90, $df = 1$, $p = 0.0484$) but not with ANOVA ($F[1,8] = 0.24$, $p = 0.882$).

These preliminary studies showed that analysis of deviance could detect change on the order of 20% or less per year, given a 5% criterion for significance with sample sizes of 30 units per year (HAVO) and 50 per year (HALE). For the Hawaiian petrel, trial use of the analysis of deviance is recommended for the statistical evaluation of the density data collected by the field protocol in both parks following the first three years of data collection.

Changes in burrow density are the definitive standard for whether parks are meeting their conservation and recovery goals for Hawaiian petrels over longer time periods. We use RS mostly as a short-term indication of conditions, both in-colony (primarily predation) and for short-term marine phenomena like El Niño that can impact success for a season. However, we recognize that long-term changes in success, particularly declines, also are important to assess.

To evaluate our ability to detect changes in reproductive success over time, we modified the suggested data analysis technique for reproductive success, in which logistic regression is used to identify the significance of the model regression term Year on the binary success response variable (see SOP # 17 “Data Analysis”). In the preliminary reproductive success trend analysis outlined in SOP 17, we conclude that Year is a significant model term, with a positive coefficient (odds ratio), indicating an overall increasing trend in reproductive success. Using dummy data for HAVO (total number of nests and initial success are based on actual data), we then used logistic regression to identify the minimum detectable slope of the model term Year by successively inputting data with decreasing rates of declines in success, holding numbers of nests constant. While not a power analysis, this approach is intuitive and directly relevant to data collection.

We began with a 6% annual decline in success (which results in a 43% total decline over 10 years); in this case, the improvement in fit by including Year was $G=25.17$, which is significant with $df=1$ at $p<0.000001$. By simulating further incremental 1% declines, we find that an annual decrease of 2% over 10 years yields $G=3.877$, which just reaches significance at $p=0.049$. A 1% annual decline in success does not result in a significant improvement in model fit, and thus, would not result in a conclusion that there had been a significant decline in reproductive success over the time period monitored. We expect to be able to detect similar or smaller declines at HALE, particularly if the number of nests monitored is greater.

Sampling Parameters

This protocol addresses the sampling parameters of density and reproductive (fledging) success of active nests in the target population of Hawaiian petrels at HAVO and HALE (Table 2.12). It also addresses the distribution of active nests. Where possible, comparisons of the sampling parameters will be made at subcolonies with and without predator and ungulate control or before and after the initiation of control.

Table 2.12. Hawaiian petrel protocol sampling parameters and associated measurements.

Parameter	Measurement
Distribution of colonies	Sample and search possible colony habitat; map active burrows
Density of active burrows	Count the number of active burrows in defined colony area
Reproductive (fledging) success	Proportion of active burrows that show evidence of fledging chicks during one nesting season

Distribution and density of colonies in potential habitat

Spatial distribution of active burrows over potential petrel habitat and densities of nests found within specified sampling frames will be determined once every approximately five years at HALE and HAVO. Sample units will be randomly selected from within sample Frame II at both HALE and HAVO. This information will help in determining if Hawaiian petrel populations are expanding and establishing new nest sites or are in the process of declining towards extirpation.

Sample units will be randomly selected from within sample Frame II at both HALE and HAVO, as there are no legacy units (units known to have a relatively high number of burrows in past surveys). If, as is possible at HAVO, all units in a year have no burrows, then the result will be a minimum estimate (fewer than n/N birds, where n is number of sampled units and N is number of units in the frame). If the cost of moving among flows at HAVO reduces sample size substantially, and there is information that indicates a greater chance of finding birds on one flow than another, then sampling of Frame II at HAVO will be restricted to that flow.

Density of active burrows

The number of active burrows in a colony will be estimated on an annual basis by sampling random grid units within colonies in the three strata in Frame I at HALE and two strata in Frame I at HAVO.

Reproductive (Fledging) Success

We define reproductive success as the proportion of active nests that yield fledglings in a breeding season. Most nests cannot be viewed to determine the fate of eggs. However, fledglings leaving their burrows typically leave evidence near burrow entrances (e.g., footprints, downy feathers, fecal droppings). This information has been collected for the Hawaiian petrel at HALE and HAVO for multiple years. Including this in monitoring allows comparisons with older data and also provides basic information for population models which can be used to assess viability of colonies. Fledgling success will be monitored on an annual basis by repeatedly surveying nests in grid units within Strata I and II in Frame I at both HALE and HAVO.

Sampling Frequency, Replication, and Timing (Temporal Design)

The breeding phenology of Hawaiian petrels (Figure 2.4) determines when it is most productive for field crews to enter colonies to gather burrow activity and reproductive data. Observations of Hawaiian petrel activity at HALE indicate that most adults return to the colony in late February to begin enlarging burrow chambers in the loose cinder substrate, removing debris and adding nest material. A pre-laying absence at HALE occurs in late March, extending for several weeks until egg-laying, which begins in the last week of April until mid-May (Simons and Hodges 1998). Chicks hatch from late June to mid-July and fledge in October (Simons 1985). Birds with failed nests and non-breeding birds leave the colony by mid-September (Hodges and Nagata 2001), and most breeding adults leave the colony by early October (Simons and Hodges 1998). At HAVO, where birds nest in pāhoehoe lava flows at high elevations, less information is known about petrel breeding (Hu et al. 2001). Limited information suggests that adults arrive at burrows in early April, and at least some chicks remain at the nest until well into November (Judge 2011), suggesting a somewhat later breeding cycle than at HALE. Green bars with question marks in Figure 2.4 indicate that the timeframe for these breeding events are inferred based on what is known about Hawaiian petrel reproduction at HAVO and elsewhere. For further information about Hawaiian petrel phenology, see Appendix D: Hawaiian Petrel Species Summary.

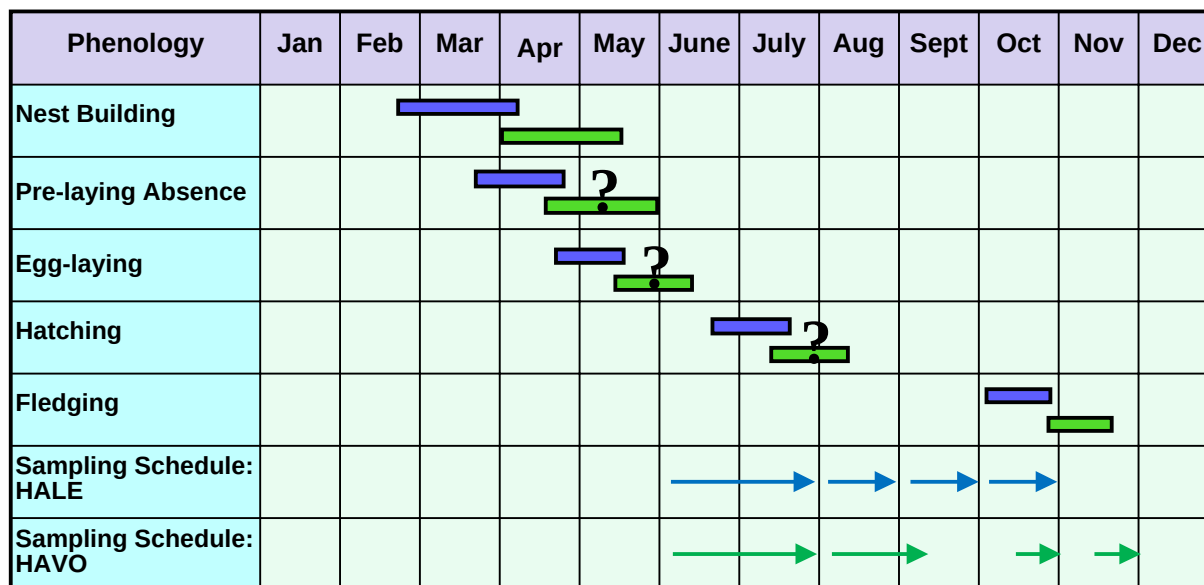


Figure 2.4. Hawaiian petrel breeding phenology at Haleakalā National Park (blue bars: adapted from Simons and Hodges 1998) and Hawai'i Volcanoes National Park (green bars: Judge 2011), and sampling schedule by park.

Annual known colony density surveys will be conducted over a two-week period during or just after hatch (early July for HALE), when external clues to nest occupancy are more likely to be visible due to recent adult visits. Three subsequent follow-up visits to active nests will determine nest fate for reproductive success calculations. One of the last visits should be timed to occur during the period of peak down loss of chicks (mid-November at HAVO in 2007, unpubl. data; mid-October at HALE) prior to fledging (Figure 2.4). Since there is some evidence that Hawaiian petrels fledge later at HAVO than at HALE, the proposed timing allows for comparisons of monitoring data collected during similar nesting and fledging states at the two parks.

Landscape-level colony distribution and density monitoring also should be conducted in summer months. If known colonies also are being monitored, the larger-scale monitoring surveys could be scheduled in August, in between the known colony density survey and the first follow-up reproductive success nest check.

Previous Data Sets

Data on reproductive success and maps identifying distribution of known burrows and colony sites are stored at both parks. Much of this information has been used to formulate this protocol.

Chapter 3. Field Methods

The field methods section is intended to ensure consistent methodology and repeatability in light of changing personnel (Beard et al. 1999). This chapter is supplemented by standard operating procedures (SOPs), detailed written instructions intended to ensure uniformity and consistency of discreet procedures within the protocol. Therefore, this section describes general methods for gathering burrow density and reproductive success data. For more information on specific field details, please see the appropriate SOP.

Field Season Preparations and Equipment Setup

Prior to the field season, the Park Lead, Field Lead and other field observers will review this protocol, including all SOPs and appendices, as well as pre-trip information and past trip or survey reports. The Field Lead should pay particular attention to the tasks described in SOP #1 “Before the Field Season” and SOP #2 “Training Observers.” Prior to conducting field work in HAVO or HALE, all observers must read and be familiar with procedures outlined in SOP #3 “Safety Procedures.” Any revisions to field procedures based on review of these documents must be discussed with the Park Lead and documented in the appropriate SOP.

A U.S. Fish and Wildlife Service (USFWS) threatened and endangered species recovery permit is required and has been issued to each park’s natural resource management division. These permits must be maintained in order to undertake conservation actions involving the species within the parks. Although terms of the permits are written carefully to minimize the chance of any birds being disturbed or otherwise harmed, the permit also specifies the number of individuals of a listed species that can be “taken” accidentally during the course of permitted activities. Without this permit, such accidental take is illegal. If this permit is expiring in the current year, the listed permittee must apply for a continuation of the permit.

All monitoring protocols should receive an NPS research permit prior to the start of field work. Although durations of NPS research permits vary, most are good for one to two years. Park Leads should submit requests for park research permits at least two months ahead of the start of annual field work.

As a NRM project, this monitoring protocol must go through park compliance prior to implementation. The Park Lead works with the NRM division chief to submit a Project Review and Environmental Screening Form (PR ESF) to the park Resource Council as part of the compliance process. The PR ESF ensures that all National Environmental Policy Act (NEPA) and National Historic Preservation Act (NHPA) compliance is addressed. The protocol will need this review only once unless there are substantial changes in procedures that could impact other resources in the area.

Equipment and supplies listed in SOP #1 “Before the Field Season” will be organized and readied for the field season by the Park Lead or Field Lead, who will ensure the equipment is logged out of the equipment room at the PACN I&M Program’s main office. Copies of the field data form (in SOP #7 “Collecting, Evaluating, and Summarizing Hawaiian Petrel Burrow Data”) will be made on weatherproof paper. GPS units will be uploaded (see SOP #9 “Downloading and

Uploading Data between Garmin GPS and ArcGIS”) with the coordinates for all known Hawaiian petrel burrows and grid points before the start of a sampling season. Batteries and spare batteries must be charged for all GPS units, including backup units.

The Park Lead will schedule field sampling and organize logistics at least two months prior to field sampling. Housing for field crews and vehicle use must be secured prior to the field season and may need to be arranged up to three months in advance.

Field crews will consist of at least two persons, and may be a combination of the Park Lead, a Field Lead, other park staff, interns or volunteers.

Training

All members of the field crew must attend a safety briefing and review safety plans regarding field check-in methods and times, contingency plans, and emergency procedures with the Park Lead. The field crew will also participate in burrow identification training sessions, where the Park Lead and/or Field Lead will also discuss procedures for collecting data and describe Hawaiian petrel behavioral characteristics and habitat use. The field crew will also participate in a cultural resources overview of the areas where monitoring will occur, as many archeological sites and features are found in and near petrel subcolonies and other locations around the parks. This overview will provide details on identifying sites and features, and how to avoid or minimize disturbance to these sensitive resources.

Each observer should be trained in setting up a 50 x 50 m grid, locating burrows within a grid, examining a burrow using both direct and indirect methods to assess activity, identifying all burrow entrances, and tagging entrances and flagging nearby vegetation (only for nests that will be visited repeatedly). All observers shall review literature on Hawaiian petrel breeding phenology and survey techniques used to monitor this species. See SOP #1 “Before the Field Season” for a list of literature and SOP #2 “Training Observers” for procedures on training observers in field methodology.

The primary responsibilities for the field crew include: (1) traveling to petrel colony sites within a park, (2) setting up equipment, (3) collecting information about burrow density, activity of burrows, and fledgling success (see SOP #7), (4) recording this information on standardized field data forms or in field notebooks, (5) taking and storing photographs of the burrow, including all entrances and nearby habitat features (see SOP #12 “Managing Photographic Images”), (6) taking UTM coordinates of burrow and grid locations (see SOP #4 “Using Garmin Global Positioning System (GPS) Units” and/or SOP #5 “Using Trimble Global Positioning System (GPS) Units,” depending on the unit being used), (7) using prepared maps to identify each known burrow within the landscape, and (8) performing data entry into the Hawaiian petrel database.

Observers should become familiar with colony sites and monitoring methods, and should be or become proficient in operating equipment, including GPS unit, burrowscope, GPS camera (if available), computer and vehicles. Once in the field, a daily routine should be planned out, allowing ample time for data entry at the end of the day where field conditions permit.

For further information on qualifications and training needs for field personnel, see Chapter 5: Qualifications and Training, as well as SOP #2 “Training Observers.”

Locating and Establishing Monitoring Sites

Once on site, the field crew will navigate to sampling sites with a GPS unit (see SOP #4 “Using Garmin Global Positioning System (GPS) Units” and SOP #5 “Using Trimble Global Positioning System (GPS) Units”). Park conditions vary greatly, so all monitoring crew members should plan accordingly. For instance, weather in HAVO and HALE can change from dry and sunny to misty and cold in a matter of minutes. Therefore, when planning field work in either park, crew members should be prepared with sun hats, sunglasses, sunscreen, plenty of water, lightweight, loosely-fitting clothes, and warmer clothing, including rain gear.

Before the start of each field session, monitoring locations will be organized by the Park Lead into convenient and efficient routes through the survey areas. These routes, which may consist of trails and/or roads, or travel in general directions across lava fields, will be printed on waterproof paper and provided to the field crew. At HAVO, helicopters will be required to access some annually-visited colony locations (Frame I, Strata I and II). The Park Lead will assign the field crew to a survey site and provide them with a list of known burrows to be visited, and new locations (at specific 50 x 50 m grid units) to investigate. It is important that the crew member navigating with the GPS unit focuses on the UTM coordinates for these burrows or grid locations, and not the current surroundings, while approaching the waypoint location. Once the GPS unit shows that the coordinates for a grid site or burrow have been reached, the crew then investigates the burrow site for signs of petrel activity or finds the corners if a grid unit and searches the entire grid for burrows and signs of activity (see SOP #6 “Setting Up Sampling Units at Colonies” for details on setting up grids, and SOP #7 “Collecting, Evaluating, and Summarizing Hawaiian Petrel Burrow Data” for details on identifying and documenting burrow signs).

Specific instructions on accessing colony or burrow sites will not be provided in this document due to the sensitive nature of this species and its status as an endangered, protected species.

Safety during Field Monitoring

While collecting seabird data, safety is of the highest priority, and survey teams should adopt the concept of “Safety First” in all of their activities. See SOP #3 “Safety Procedures” for guidelines which all field crews should follow before, during, and after each field survey trip. A brief discussion of safety issues potentially encountered for each survey type follows.

Transportation

When traveling on either highways or park roads, safe driving practices must be practiced at all times. All passengers requiring travel by four-wheel drive vehicle must be familiar with driving this type of vehicle in off-road situations.

All passengers required to travel in a helicopter for fieldwork must complete, minimally, an 8-hour Basic Aviation (B-3 Basic Safety) training. In addition to SOP #3, review guidelines at the Office of Aviation Services website at <http://oas.doi.gov/>. Contingency plans must be made in

the event helicopter transportation is cancelled. When in remote areas, observers must be prepared to spend additional nights in the field or hike out to their final destination if possible.

Travel on Foot

Surveying on foot over uneven and/or loose substrate can be hazardous, and falls or joint/foot injuries are the primary concern. Observers should watch their footing closely near cliff edges or steep slopes and keep back from areas where sliding down-slope could occur. Wear sturdy boots or shoes and long pants, and wear gloves when traversing 'a'a or other rough surfaces to protect hands.

Field Communications

Observers are required to carry a reliable park radio and/or a cell phone with extra batteries whenever in-field monitoring is conducted. Radio or cell phone contact between field personnel and park dispatch or other park offices (e.g., resource management or I&M) is required to ensure the safety of field crews when monitoring occurs in remote locations (e.g., Mauna Loa at HAVO). Each park has radio procedures distinctive to that park, including which radio channels to use and who to contact in the event of an emergency. Guidelines for field radio usage can be found in SOP #3 “Safety Procedures” and in the radio communications guides for HAVO and HALE at the I&M office, at the dispatch office at HAVO, and at the HALE resource management office.

Briefly, field crews must inform the appropriate office of their field schedule at least one day prior to departure, including when they are leaving, where they are going, and when they are planning to return. All field observers must be back in the office at least one hour before the end of the work day. If a later return is anticipated, they must contact the appropriate office via radio or cell phone. During backcountry trips where an overnight stay is required, observers must contact the appropriate office or park dispatch daily. When hiking out of the backcountry base site, observers should contact the office prior to departure. For helicopter transport, current NPS flight requirements must be followed. This includes use of a currently-trained helicopter manager to manage all flights. The pilot will communicate with the manager about any schedule changes needed due to weather or other events.

Other Concerns

Primary risks from high elevation field work are: over-exposure to sun, extremes in temperature, and altitude sickness. Field participants should be prepared for rapid changes in temperature and sudden precipitation, and also know the symptoms of hypothermia and altitude sickness and how to treat these conditions.

Conducting Field Surveys

Detailed instructions on collecting field data are provided in SOP #6 “Setting Up Sampling Units at Colonies” and SOP #7 “Collecting, Evaluating, and Summarizing Hawaiian Petrel Burrow Data.” Monitoring fledgling success involves at least four visits to Hawaiian petrel colonies during the breeding season. High winds and heavy rains are to be avoided, as these will impede monitoring efforts and create hazardous working conditions.

See SOP #6 for details on establishing 50 x 50 m sampling units. This SOP also addresses permanent grid units which are visited repeatedly, and temporary units which are visited once and not re-visited in subsequent years.

Colony Density and Burrow Distribution

Once a stratum in Frame I is chosen for monitoring and a grid of sampling units has been laid over the strata using a GIS program, selected units are chosen and systematically canvassed for active and inactive burrows. Activity is noted and burrow locations are recorded with a GPS unit.

In order to standardize data collection, the following procedures should be followed for Hawaiian petrel monitoring:

1. All data will be collected at approximately the same times of year within each park to capture activity and reproductive information, and to identify variations in phenology from one year to the next. If nesting phenology at HAVO trails HALE, as is suggested by current work, timing will be adjusted so that monitoring occurs at the same time in the breeding cycle at the two parks (e.g., egg laying will occur sooner in the year at HALE than HAVO). See Table 2.12 for a suggested sampling schedule at each park.
2. Determine weather conditions for the day of sampling. Initial density surveys and final reproductive success surveys depend on detection of sometimes subtle cues (e.g., footprints in dust and bits of down clinging to rock or vegetation). If weather is relatively calm with little rain or wind, surveys should be conducted. Avoid conducting the season's initial or final surveys when winds exceed 25 mph (category 4 on the Beaufort scale) or visibility is poor due to rain or fog. Also, some of the field equipment is very sensitive to moisture (i.e., burrowscope and cameras) and must be well protected from mist and rain.
3. Burrow searches must be conducted during the day when adult birds are likely to be foraging at sea and when observers can see visual cues. However, some burrow locations may require more time to access than others, and therefore burrow search times may not be consistent from one day to the next.
4. If a grid is being searched, but sudden poor weather precludes finishing the search, it is necessary and important to repeat the grid survey as weather and time permit. Repeating the grid survey also could give the NPS insights into searcher efficacy at finding nest entrances. If time allows, parks should conduct repeat searches periodically with the specific aim of gauging the effectiveness of individuals to locate burrows.
5. At each burrow, the observer records a burrow identification number and the number of entrances. New nests (not previously discovered) are documented using the Hawaiian Petrel New Nest Form in SOP #7. Because adults and chicks typically are not visible from the burrow entrance, the observer also assesses activity by looking for and noting any visual cues of bird presence (e.g., droppings, footprints, feathers, odor), predator sign, and other pertinent data on the Hawaiian Petrel Nest Check Form (also in SOP #7).

6. Other incidental natural history observations or details about events or field findings should be recorded in a field notebook or in the comments field on the Hawaiian Petrel Nest Check Form. This supplemental information may prove helpful in evaluating data.

Assessing Reproductive Success

In addition to the visual cues noted in step 5 above, in grids where fledging success will be monitored, toothpick “fences” are set across burrow entrances (where burrow floor substrate permits). These nests are checked at least three more times during the breeding season. In addition to searching for indirect cues such as droppings, feathers, footprints, chick down, and movement into or out of the nest through the toothpick fences, visual checks may include use of a burrowscope and/or flashlight to view nest chamber contents. Over the breeding season, visual cues to activity, combined with toothpick fence and burrowscope information, indicate use of burrows by Hawaiian petrels and, ultimately, nest success or failure. See SOP #7 for details.

Post-collection Data Entry

The Park Lead and/or Field Lead (if one has been hired during the field season) is responsible for the safekeeping and organization of data forms and field notebooks and ensuring that data collected in the field is entered into the Hawaiian petrel database (see SOP #13 “Data Entry and Verification” for details). Paper data forms will be inspected by the Park Lead or Field Lead or other designated field person at the end of each field day, as a key step in the quality assurance and quality control process (QA/QC). After completion of daily or weekly field work, Park Leads, Field Leads and/or other field staff will enter data from data forms and field notebooks into the Hawaiian petrel Microsoft Access database. Validation rules programmed into the database will help detect logical inconsistencies. Data forms and field notebooks will be scanned, and both original and digital copies will be archived by the Park Lead for five years (or longer as determined by the Park Lead), which will allow sufficient time for all possible QA/QC problems to be resolved. The archived Microsoft Access database will be the sole repository for long-term data storage for this project. Any digital photographs taken should be downloaded onto computer files to free up space on the camera’s picture memory card (see SOP #12 “Managing Photographic Images” for details).

End-of-Season Procedures

Following the field season, any equipment borrowed from the I&M program (e.g., burrowscope) should be returned to the I&M main office. Because some equipment used for petrel monitoring may be shared with other park biologists or field crews, thorough organization and documentation of equipment location, condition and working status, and needed repairs or replacements is important. The Park Lead and/or Field Lead is responsible for collecting all field gear, data forms, notebooks and other field supplies from the field crew. The Park Lead is responsible for ensuring that all field equipment is returned to park storage and to the I&M office at HAVO. The Park Lead or designated field person will scan and archive all field data forms and field notebooks. The Park Lead will ensure that all field data are compiled in the project database and that maps are submitted following steps outlined in Chapter 4: Data Management, Analysis and Reporting. Data entry should begin as soon as possible after a field survey in order to address outstanding QA/QC problems before memories fade and personnel change. In addition, the Park Lead will compile Hawaiian petrel and habitat use data, conduct a summary

analysis for the monitoring season, and generate the annual I&M and USFWS permit report. See SOP #8 “After the Field Season” and SOP #18 “Reporting” for additional information.

Chapter 4. Data Handling, Analysis and Reporting

Data handling, analysis, and reporting are treated as three interrelated steps in managing Hawaiian petrel monitoring information. Additional details and context for this chapter may be found in the PACN Data Management Plan (Dicus 2006), which describes the overall information management strategy for the network. The PACN website¹ also contains guidance documents on various information management topics (e.g., report development, GIS development, and GPS use).

Project Information Management Overview

Project information management may be best understood as an ongoing or cyclic process, as shown in Figure 4.1. Specific yearly information management tasks for this project and their timing are described in Appendix C: Yearly Project Task List. Readers may also refer to each respective chapter section below for additional guidance and instructions.

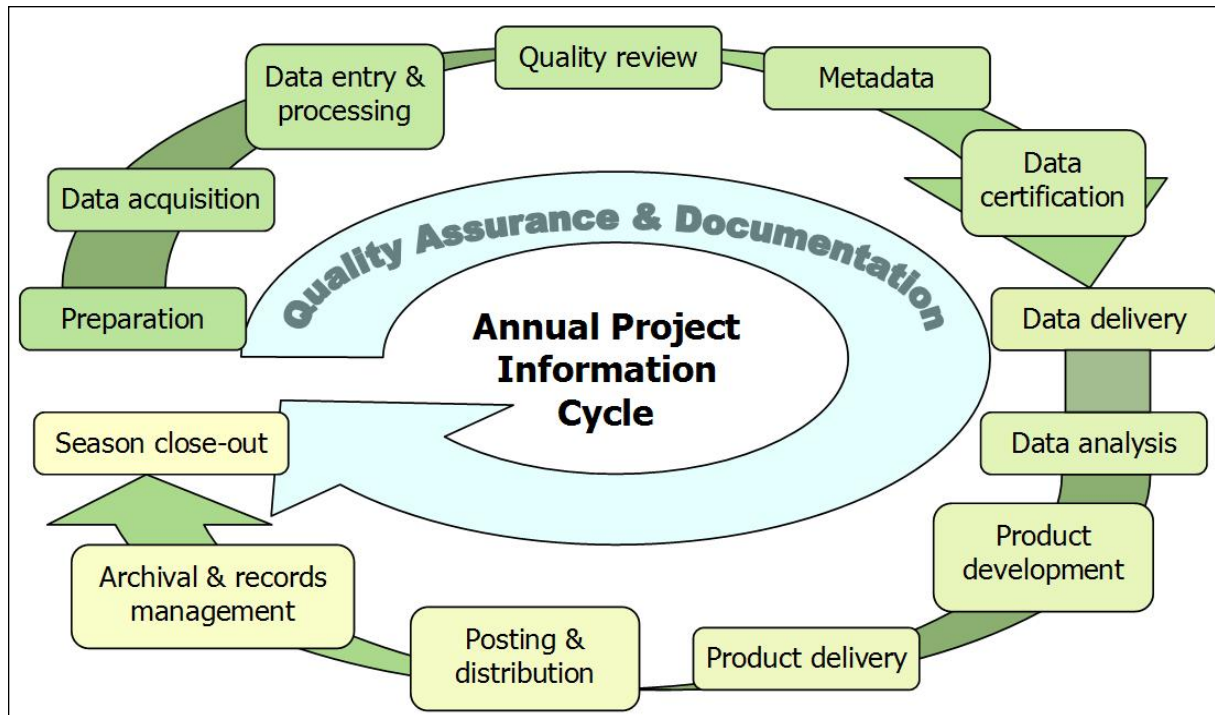


Figure 4.1. Idealized flow diagram of the cyclical stages of project information management, from pre-season preparation to season close-out. Note that quality assurance and documentation are thematic and not limited to any particular stage.

The stages of this cycle are described in greater depth in later sections of this chapter, but can be briefly summarized as follows:

- *Preparation* – Training, logistics planning, print forms and maps
- *Data acquisition* – Field trips to acquire data

¹ <http://www1.nature.nps.gov/im/units/pacn/data.cfm>

- *Data entry & processing* – Data entry and uploads into the working copy of the database, GPS data processing
- *Quality review* – Data are reviewed for quality and logical consistency
- *Metadata* – Documentation of the year’s data collection and results of the quality review
- *Data certification* – Data are certified as complete for the period of record
- *Data delivery* – Certified data and metadata are delivered for archiving and uploaded to the master project database
- *Data analysis* – Data are summarized and analyzed
- *Product development* – Reports, maps, and other products are developed
- *Product delivery* – Deliver reports and other products for posting and archival
- *Posting & distribution* – Distribute products as planned and/or post to NPS clearinghouses
- *Archival & records management* – Review analog and digital files for retention (or destruction) according to NPS Director’s Order 19². Retained files are renamed and stored as needed
- *Season close-out* – Review and document needed improvements to project procedures or infrastructure, complete administrative reports, develop work plans for the coming season

Preparations for Information Management

Set Up Project Workspace

A section of the networked HAVO server (i.e., S-drive) is reserved for this project, and access permissions are established so that project staff members have access to needed files within this workspace. Prior to each season, the Park Lead should make sure that network accounts are established for each new staff member, and that the Data Manager is notified to ensure access to the project workspace and databases. If network connections are too slow for efficient data entry and processing, individual staff members may set up a workspace on their own workstation, with periodic data transfer to the PACN server. Daily back-ups of the workstation to an external hard drive will ensure that no data is lost. Additional details may be found in SOP #10 “Workspace Setup and Project Records Management.”

GPS Loading and Preparation

The GIS Specialist and Park Lead should work together to ensure that target coordinates and data dictionaries are loaded into the GPS units prior to the onset of field work, and that GPS download software is available and ready for use. Additional details on GPS use and GPS data handling may be found in SOP #4 “Using Garmin Global Positioning System (GPS) Units” and SOP #5 “Using Trimble Global Positioning System (GPS) Units,” and on the PACN website³.

Implement Working Database Copy

Prior to the field season, the Data Manager will implement a blank copy of the working database and ensure proper access on the part of the project staff. Refer to the section Overview of

² <http://data2.itc.nps.gov/npspolicy/DOrders.cfm>

³ <http://www1.nature.nps.gov/im/units/pacn/gis/SOP.cfm>

Database Design for additional information about the database design and implementation strategy.

Overview of Database Design

The PACN data management staff has designed customized relational database applications to store and manipulate the data associated with this project, although they are not yet final. The design of the Hawaiian petrel monitoring databases follow the hierarchical data table organization of the Natural Resource Database Template⁴, the standard for the NPS I&M Program (see the data dictionary and other documentation in Appendix E: Hawaiian Petrel Database Documentation). The PACN data management staff is responsible for development and maintenance of the database, including customization of data summarization and export routines.

The database is divided into two components, one for entering, editing and error-checking data for the current season (i.e., the “working database copy”), and another that contains the complete set of certified data for the monitoring project (i.e., the “master project database”). A functional comparison of these two components is provided in Table 4.1.

Table 4.1. Functional comparison of the master project database and the working database.

Project database functions and capabilities	Working database	Master database
Software platform for back-end data	MS Access	MS SQL Server or MS Access
Contains full list of sampling locations and taxa	X	X
Portable for remote data entry	X	
Forms for entering and editing current year data	X	
Quality assurance and data validation tools	X	X
Preliminary data summarization capabilities	X	
Full analysis, summarization and export tools		X
Pre-formatted report output		X
Contains certified data for all observation years		X
Limited editing capabilities, edits are logged		X
Full automated backups and transaction logging		X

Each of these components is based on an identical underlying data structure (tables, fields and relationships, as shown in Appendix E: Hawaiian Petrel Database Documentation). The working database is implemented in Microsoft Access to permit greater flexibility when implementing on computers with limited or unreliable network access. Eventually, we would like to have the master database be implemented in Microsoft SQL Server in order to take advantage of the backup and transaction logging capabilities of this enterprise database software.

Both components have an associated front-end database application (“user interface” with forms, queries, etc.) implemented in Microsoft Access. The working database application has separate screens for data entry, data review, and quality validation tools. The master database application contains the analysis and summarization tools, including pre-formatted report output and exports to other software (e.g., for analysis and graphics production). This front-end application

⁴ <http://science.nature.nps.gov/im/apps/template/index.cfm>

arrangement allows for modification and update of the user interface with no disruption to data entry continuity (i.e., an improved front-end file can be distributed to data entry staff, who link it to the back-end file, discard the out-dated front-end file, and proceed with their data entry work). Under this arrangement, data entry staff have no need to open the back-end file, thereby reducing the risk of improper deletions or other inadvertent data loss occurring within the protocol-specific data tables. In addition, a multi-user environment can be accommodated by storing the back-end file on a server available to all users via a computer network.

During the field season, each project crew will be provided with its own copy of a working database into which they enter, process, and quality-check data for the current season (refer to the next section and SOP #13 “Data Entry and Verification”). Once data for the field season have been certified they will be uploaded into the master database, which is then used to inform all reporting and analysis. This upload process is performed by the Data Manager, using a series of pre-built append queries.

Data Entry and Processing

The functional components for data entry into the working database are described in SOP #13 “Data Entry and Verification.” Each data entry form is patterned after the structure of the field form, and has built-in quality assurance components such as pick lists and validation rules to test for missing data or illogical combinations. Although the database permits users to view the raw data tables and other database objects, users are strongly encouraged only to use these pre-built forms as a way of ensuring the maximum level of quality assurance.

Regular Data Backups

Upon opening the working database, the user will be prompted to make a backup of the underlying data (see SOP #13 “Data Entry and Verification”). It is recommended that this be done on a regular basis – perhaps every day that new data are entered – to save time in case of mistakes or database file corruption. These periodic backup files should be compressed to save drive space, and may be deleted once enough subsequent backups are made. All such backups may be deleted after the data have passed the quality review and been certified.

Data Verification

Analyses performed to detect ecological trends or patterns require data that are recorded properly and have acceptable precision and minimal bias. Poor quality data can limit detection of subtle changes in ecosystem patterns and processes, and may lead to incorrect conclusions. Quality assurance/quality control (QA/QC) procedures applied to ecological data include four procedural areas (or activities), ranging from simple to sophisticated, and inexpensive to costly:

- defining and enforcing standards for electronic formats, locally defined codes, measurement units, and metadata
- checking for unusual or unreasonable patterns in data
- checking for comparability of values between data sets
- assessing overall data quality

To the greatest extent possible, the Hawaiian petrel database applications incorporate QA/QC strategies involving the first activity (defining and enforcing standards). The database design and the allowable value ranges assigned to individual fields within the data tables help to minimize the potential for data entry errors and/or the transcription of erroneously recorded data. The other activities are integrated in the validation phase (see Data Quality Review in this chapter, and SOP #14 “Post-season Data Quality Review and Certification” for more details).

Field Form Handling Procedures

As the field data forms are part of the permanent record for project data, they should be handled in a way that preserves their future interpretability and information content. To minimize the possibility of data loss, hardcopy data forms and field notebooks should be stored in a well organized fashion in a secure location, with photocopies and scanned data forms stored in a separate location (e.g., on the PACN data server). Refer to SOP #11 “Field Form Handling Procedures” for more details.

Image Handling Procedures

Photographic images should also be handled and processed with care. Refer to SOP #12 “Managing Photographic Images” for details on how to handle and manage these files.

GPS Data Procedures

The following general procedures should be followed for GPS data (see SOP #4 “Using Garmin Global Positioning System (GPS) Units” or SOP #5 “Using Trimble Global Positioning System (GPS) Units,” and Appendix C: Yearly Project Task List):

1. GPS data should be downloaded by the field crew from the units at the end of each field trip and stored in the project workspace (see SOP #10 “Workspace Setup and Project Records Management”).
2. Raw files should be sent in a timely manner to the GIS Specialist for processing and correction.
3. The GIS Specialist will process the raw GPS data and store the processed data in the project workspace.
4. The GIS Specialist will upload corrected coordinate information into the database and create any GIS data sets.

The Park Lead and/or Field Lead should periodically review the processed GPS data to make sure that any problems are identified early on in the data collection process.

Data Quality Review

After the data have been entered and processed, they need to be reviewed by the Park Lead for quality, completeness, and logical consistency. The working database application facilitates this process by showing the results of pre-built queries that check for data integrity, data outliers and missing values, and illogical values. The user may then fix these problems and document the fixes. Not all errors and inconsistencies can be fixed, in which case a description of the resulting errors and why edits were not made is then documented and included in the metadata and certification report (see Metadata Procedures and Data Certification and Delivery in this chapter, and SOP #14 “Post-season Data Quality Review and Certification”).

Data Edits after Certification

Due to the high volume of data changes and/or corrections during data entry, it is not efficient to log all changes until after data are certified and uploaded into the master database. Prior to certification, daily backups of the working database provide a crude means of restoring data to the previous day's state. After certification, all data edits in the master database are tracked in an edit log so that future data users will be aware of changes made after certification. In case future users need to restore data to the certified version, we also retain a separate, read-only copy of the original, certified data for each year in the PACN Digital Library (refer to SOP #19 "Product Delivery Specifications").

Geospatial Data

The Park Lead and GIS Specialist may work together to review the surveyed coordinates and other geospatial data for accuracy. The purpose of this joint review is to make sure that geospatial data are complete and reasonably accurate, and also to determine which coordinates will be used for subsequent mapping and field work.

Metadata Procedures

Data documentation is a critical step toward ensuring that data sets are usable for their intended purposes well into the future. This involves the development of metadata, which can be defined as structured information about the content, quality, condition, and other characteristics of a given data set, both tabular and spatial. Additionally, metadata provide the means to catalog and search among data sets, thus making them available to a broad range of potential data users. Metadata for all PACN monitoring data will conform to Federal Geographic Data Committee (FGDC) guidelines and will contain all components of supporting information such that the data may be confidently manipulated, analyzed, and synthesized.

At the conclusion of the field season (according to the schedule in Appendix C: Yearly Project Task List), the Park Lead will be responsible for providing a completed, up-to-date metadata interview form to the Data Manager. The Data Manager and GIS Specialist will facilitate metadata development by consulting on the use of the metadata interview form, by creating and parsing metadata records from the information in the interview form, and by posting such records to national clearinghouses. Refer to SOP #15 "Metadata Development" for specific instructions.

Data Certification and Delivery

Data certification is a benchmark in the project information management process that indicates that: (1) the data are complete for the period of record, (2) they have undergone and passed the quality assurance checks (Quality Review), and (3) that they are appropriately documented and in a condition for archiving, posting and distribution as appropriate. Certification is not intended to imply that the data are completely free of errors or inconsistencies which may or may not have been detected during quality assurance reviews.

To ensure that only quality data are included in reports and other project deliverables, the data certification step is an annual requirement for all tabular and spatial data. The Park Lead is primarily responsible for completing a PACN Project Data Certification Form, available from

the Data Manager or on the PACN website. This brief form should be submitted with the certified data according to the timeline in Appendix C: Yearly Project Task List. Refer to SOP #14 “Post-season Data Quality Review and Certification” and SOP #19 “Product Delivery Specifications” for specific instructions.

Data Analysis

Annual Hawaiian petrel density and reproductive data, as well as long-term trends in density and distribution, will be summarized by tables and figures. Refer to Appendix C: Yearly Project Task List for the specific analysis tasks and their timing, and to SOP #17 “Data Analysis” for a more detailed description of analytical procedures.

Data analysis addresses data validation issues and helps translate raw data into meaningful management information. Three initial steps for Hawaiian petrel monitoring data have been identified: (1) quality assurance and quality control (QA/QC), (2) summarization, (3) analytical approaches and procedures. Ultimately, analyses of monitoring data are intended to detect changes in Hawaiian petrel populations and assess resource status. These initial steps are encompassed in the larger construct of data management and data stewardship.

Status and Trend Analyses

The primary analytical strategies of interest to managers are anticipated to be status and long-term trends assessment (change detection). SOP #17 “Data Analysis” identifies the specific processes and methods used when preparing these analyses.

The number of nests or burrows per unit in HALE and HAVO should be recalculated and summarized each year using the formats of Tables S17.1 and S17.2 (SOP #17 “Data Analysis”). When estimating population density and population size at each park, Table S17.4 in the same SOP should be used as a template to summarize this data. In addition, maps containing burrows and colony boundaries should be created each sampling year, using Figures 2.1 and 2.2 in Chapter 2 as guides.

Reporting and Product Development

Refer to Appendix C: Yearly Project Task List and SOP #19 “Product Delivery Specifications” for the complete schedule of project reports and other deliverables and the people responsible for them.

Report Content

A summary report will be produced annually, with a more detailed report produced every five years. The annual report will:

- List project personnel and their roles
- List Hawaiian petrel sampling locations (by park, frame and stratum) completed during the current year
- Provide a summary history of the number of sampling locations completed during each year of the study (enumerated by elevation and park)

- Indicate the number of active burrows detected during the current year, in each park as a whole, and in the annual panel of sampling locations
- Indicate density, distribution and fledgling success of burrows by park, frame and stratum. Results from legacy and random sampling grids should be reported separately.
- Identify any data quality concerns and/or deviations from protocols that affect data quality and interpretability

Detailed reporting guidelines and table structures are provided in SOP #17 “Data Analysis” and SOP #18 “Reporting.”

A more in-depth analysis report will be produced every five years. In addition to the above, the five-year report will also:

- Provide annual density estimates and distribution of Hawaiian petrel nests during the previous five years
- Provide summary and detailed trend results with an adequate sample size for estimating density and assessing trends
- Assess spatial patterns in the density estimates
- Identify any possible distributional changes within the parks
- Provide summary and detailed trend results for fledgling success in known Hawaiian petrel colonies during the previous five years
- Evaluate operational aspects of the monitoring program, including assessment of sampling locations for elimination or relocation due to access problems, appropriateness of sampling period (e.g., the optimal sampling season could conceivably change over time in response to climate change), and assessment of sampling design

Resource Management staff who collect data on Hawaiian petrels operate under a U.S. Fish and Wildlife Service endangered species permit (HAVO operates under permit TE-018078-14; HALE operates under permit TE-014497-11). A report of activities must be completed annually for each park following each year that the permit is in effect. The annual permit report will be formatted following permit instructions, and include Hawaiian petrel data collected and summarized, the overall health of the population, and signs of illness and/or disease.

Standard Report Format

Annual reports and trend analysis reports will use the NPS Natural Resource Publications template, a pre-formatted Microsoft Word template document based on current NPS formatting standards. Annual reports, trend analysis and other peer-reviewed technical reports will use the Natural Resource Technical Report template. This template and documentation of the NPS publication standards are available at the NPS Natural Resource Publications website⁵.

Review Products for Sensitive Information

Certain project information related to the specific locations of rare or threatened taxa may meet criteria for protection and as such should not be shared outside NPS except where a written confidentiality agreement is in place prior to sharing. Before preparing data in any format for

⁵ <http://www.nature.nps.gov/publications/NRPM/index.cfm>

sharing outside NPS (including presentations, reports, and publications), the Park Lead should refer to the guidance in SOP #16 “Sensitive Information Procedures.” Certain information that may convey specific locations of sensitive resources may need to be screened or redacted from public versions of products prior to release.

Product Delivery, Posting and Distribution

Refer to SOP #19 “Product Delivery Specifications” for the schedule for project deliverables and the people responsible for them, as well as for detailed instructions on how to deliver final products. Upon delivery products will be posted to NPS websites and clearinghouses (e.g. NPSpecies⁶, Data Store⁷) as appropriate (refer to SOP #20 “Product Posting and Distribution” for more information).

Holding Period for Project Data

To permit sufficient time for priority in the publication process, certified project data will be held upon delivery for a period not to exceed 2 years after it was originally collected. After the two year period has elapsed, all certified, non-sensitive data will be posted to the Data Store. Note that this hold only applies to raw data, and not to metadata, reports or other products which are posted to NPS clearinghouses immediately after being received and processed.

Special Procedures for Sensitive Information

Products that have been identified upon submission by the Park Lead as containing sensitive information will either be revised into a form that does not disclose the locations of sensitive resources, or withheld from posting and distribution. When requests for distribution of the unedited version of products are initiated by the NPS, by another federal agency, or by another partner organization (e.g., a research scientist at a university), the unedited product (e.g., the full data set that includes protected information) may only be shared after a confidentiality agreement is established between NPS and the other organization. Refer to SOP #16 “Sensitive Information Procedures” for more information.

All official Freedom of Information Act (FOIA) requests will be handled according to NPS policy. The Park Lead will work with the Data Manager and the park FOIA representative(s) of the park(s) for which the request applies.

Archival and Records Management

All project files should be reviewed, cleaned up, and organized by the Park Lead on a regular basis (e.g., annually in January). Decisions on what to retain and what to destroy should be made following guidelines stipulated in NPS Director’s Order 19⁸, which provides a schedule indicating the amount of time that records should be retained. Refer to SOP #10 “Workspace Setup and Project Records Management.”

⁶ <https://irma.nps.gov/NPSpecies/>

⁷ <https://irma.nps.gov/App/Reference/Welcome>

⁸ <http://www.nps.gov/policy/DOrders/DOrder19.html>

Season Close-out

After the conclusion of the field season, the Park Lead, Field Lead, Data Manager, and GIS Specialist should discuss the recent field season and document any needed changes to the field sampling protocols, the working database application, or to any of the SOPs associated with the protocol (see SOP #23 “Revising the Protocol”). Refer to Data Entry and Verification in this chapter for additional close-out procedures not specifically related to project information management.

Chapter 5. Personnel Requirements and Training

Hawaiian petrel monitoring will be led and conducted by park and initially, regional office-based staff. The I&M Program Manager, Data Manager, and GIS Specialist will provide some additional guidance and support.

The Park Lead will have primary responsibility for petrel monitoring at each park. Field crews will consist of one or more two-person teams that may include the Park Lead, a Field Lead, and/or other park staff (e.g., biological technicians, interns, and volunteers).

Cathleen Bailey, Wildlife Biologist, will serve as Park Lead for HALE. She developed and has supervised annual Hawaiian petrel monitoring for the past decade at this park and is familiar with sampling in and around Haleakalā Crater.

At HAVO, wildlife biologist Kathleen Misajon and Pacific West Regional Office (PWRO) ecologist Darcy Hu initially shared monitoring responsibility as Park Co-Leads during a transition period during protocol trials. Misajon is HAVO's only bird specialist, currently oversees the park's long-term nene and petrel monitoring and management, and has assumed Park Lead responsibilities for the protocol. Hu has been involved in Hawaiian petrel monitoring at HAVO for 18 years. Additionally, Jill Lippert, a biologist at HAVO now working in the park's maintenance division, will help implement the protocol. Lippert has almost two decades of experience working with this species within the park, although her present position allows her only limited time for biological work.

Roles and Responsibilities

The Hawaiian Petrel Monitoring Protocol will be implemented using both existing and to-be-determined park staff (Table 5.1). Appendix B identifies current names and contact information for various personnel associated with development and implementation of this protocol.

Table 5.1. Roles and responsibilities and names (where known) of personnel involved in development and implementation of the Hawaiian Petrel Monitoring Protocol.

Role	Responsibilities	Name / Position
<i>Protocol Development</i>		
Principal Investigator / Park Lead	- Responsible for developing, reviewing and revising the protocol - Primary points of contact for questions during development and early implementation, including field schedules, database design, tasks associated with monitoring, and roles of others in monitoring Hawaiian petrels at HAVO and HALE	PIs: Darcy Hu / PWRO David Duffy / UH-Manoa PCSU Park Lead: Cathleen Bailey / HALE

Table 5.1. Roles and responsibilities and names (where known) of personnel involved in development and implementation of the Hawaiian Petrel Monitoring Protocol.

Role	Responsibilities	Name / Position
Pacific Cooperative Studies Unit (PCSU) Protocol Coordinator	- Responsible for developing and reviewing the protocol; assists with revisions - Tracks project schedules, deadlines, and progress toward project objectives - Assists Data Manager in developing and/or reviewing the database - Acquires and maintains field equipment	Gail Ackerman / Vertebrate Fauna Specialist
Quantitative Services	Leads development of sampling design and analysis techniques for protocol; writes relevant portions of the protocol.	David Schneider, Statistician (PCSU/ University of Newfoundland)
<i>Protocol Implementation</i>		
I&M Program Manager	- Coordinates sharing any I&M equipment between Hawaiian petrel and other monitoring protocols - For 5-year density and distribution monitoring, assists as possible with efforts to secure additional personnel and transport - Acquires field equipment as needed and as I&M program can afford - Ensures maintenance of I&M field equipment	Ryan Monello / PACN I&M Program
Park Resource Chiefs	- Reviews annual NRTR report - Coordinates peer review of annual report - Ensures project compliance with park requirements - Communicates with Park Lead on any budget concerns - Provides overall oversight to ensure work remains relevant to park management.	Stephen Robertson / HALE Rhonda Loh / HAVO

Table 5.1. Roles and responsibilities and names (where known) of personnel involved in development and implementation of the Hawaiian Petrel Monitoring Protocol.

Role	Responsibilities	Name / Position
Park Lead	• Implements Hawaiian petrel monitoring at HAVO and HALE, providing annual field program coordination, evaluation, analysis and reporting • Tracks project schedules, deadlines, budget, and progress toward project objectives • Acquires and maintains park field equipment • Coordinates personnel to assist in monitoring • Communicates with I&M Program Manager about monitoring efforts and any equipment needs • Communicates with NPS Technical Advisor as necessary • May communicate with I&M Data Manager and I&M GIS Specialist to maintain and update databases and spatial data and products • Supervises, trains, and ensures safety of field crews • Primary point of contact to address problems and inquiries from the field • Oversees and may participate in data collection, entry, verification and analysis • Performs data summaries, statistical analyses, and trend analysis, and updates analysis log files • Completes reports, metadata and other products according to schedule • Responsible for preparing and disseminating permit report and annual report • Presents monitoring results and discusses management implications with the park and other interested parties • Ensures data and records have been managed and archived properly	Cathleen Bailey / HALE Kathleen Misajon / HAVO
Field Lead	• Responsible for conducting field data collection, data entry, data verification and data management • Plans and executes field visits • Responsible for pre- and post-season field preparations • Supervises, trains and ensures safety of field crews • Records observations on data sheets or in field notebooks • Assists with equipment management and maintenance • May work with Data Manager to maintain and update database • May assist with or prepare reports in consultation with Park Lead	TBD, HALE Charlotte Forbes Perry PCSU at HAVO
Field Biologist (as available)	• Same as above Field Lead except does not supervise, but can train and ensure safety of field crews	Jill Lippert, HAVO

Table 5.1. Roles and responsibilities and names (where known) of personnel involved in development and implementation of the Hawaiian Petrel Monitoring Protocol.

Role	Responsibilities	Name / Position
Field Assistant	- Assists with field data collection - Records observations on data sheets or in field notebooks - Assists with data entry, data verification and possibly data management - Assists with equipment management and maintenance	Intern / Volunteer
NPS Technical Adviser	- Available for consultation on all aspects of protocol implementation - Participates in or assists with data analysis and report writing - May participate in training, field data collection, data entry, data verification and data management - May assist Park Leads with presentation of monitoring results and be involved in discussions of management implications with the park and other interested parties	Darcy Hu, PWRO
Data Manager	- Consults on data management activities - Provides guidance and assistance with adaptive database design and maintenance over time, database integration and data distribution, and archiving - Reviews the data and database-related practices of park staff to ensure they meet programmatic and protocol standards and needs - Provide database training as needed	Kelly Kozar, I&M Data Manager
GIS Specialist	- Consults on spatial data collection, GPS use, and spatial analysis techniques - Facilitates spatial data development, coordinate generation, and map output(s) - Works with Park Leads to analyze spatial data and develop metadata for spatial data products - Primary steward of GIS data and products - Provides GIS training as needed	Scott Kichman, I&M GIS Specialist
Partners	- Issues permits - Participates in information exchange to improve recovery efforts	US Fish and Wildlife Service (USFWS), Department of Land and Natural Resources (DLNR)

Qualifications and Training

Seabird monitoring requires a basic knowledge of the natural history and identification of the birds being monitored and those likely to be encountered. Therefore, observers should be able to demonstrate these skills. Observers should also be experienced, or can be trained, in the use of GPS units, compass, burrowscope, and other field equipment. Moderate training can provide many of these skills. Since driving will be necessary to access some petrel colonies, observers also should have a current driver's license and be able to operate a vehicle safely. For remote work requiring helicopter transport, a helicopter manager must participate in all flights, and field crews are required to be trained in helicopter safety.

Each position requires minimum background knowledge, skills, and abilities. The Principal Investigator, Park Lead and I&M Program Manager positions require an advanced degree or equivalent experience in a related discipline (e.g., biological sciences), taxonomic experience in the field, and data manipulation and reporting experience.

Field Leads (e.g., biological technician) minimally require a bachelor's degree in a biological field or similar specialized experience in a related discipline. This position must be capable of collecting Hawaiian petrel data in the field, as well as data entry, data management, post-processing, basic data analysis (e.g., data summarization), and equipment maintenance. Technicians optimally will be familiar with the parks, terrain, and seabird species being surveyed. Driving to sites may be required. Ability to communicate effectively with park and protocol personnel is necessary.

Suggested requirements for an intern position include at least one year of college education and some experience in a related discipline. An intern should have experience in collecting field data. This person may have little or no experience in seabird data collection, but must have a strong willingness to learn and ability to receive direction from others. After a period of training, an intern should be capable of most or all routine tasks associated with the biological technician position.

Prior to the start of each field season, all participating field personnel must refresh their methodological skills by reviewing the protocol narrative and all SOPs. All staff should know safety procedures prior to the start of any field work (see SOP #3 "Safety Procedures" for details), and must be able to work independently. Although field observers will usually be paired, observers will be independently examining different burrows at the same time. Field observers must be able to work outdoors in rough terrain, inclement weather, and high altitudes, follow relevant SOPs, and carry loads of at least 25 lbs. Field observers must also be able to traverse areas with steep cliffs and fly in helicopters.

Observers can learn and review survey techniques using a variety of methods, including reviewing recorded vocalizations, reviewing images of reproductive success clues (e.g., droppings, natal down), and visiting colonies with a knowledgeable observer. In addition, books, journal articles and on-line references provide information about Hawaiian petrels.

At the beginning of each field season, it is critical that the Park Lead and/or Field Lead accompany the field crew during the first one to two surveys to the petrel colonies to provide sufficient guidance for field operations and to answer any questions. Inexperienced crew members will not be sent into the field unsupervised until the Park Lead or Field Lead has observed them in the field and feels confident in their abilities to properly navigate with GPS, conduct the fieldwork with accuracy and adequate attention to detail, and observe all safety requirements.

Chapter 6. Operational Requirements

This section outlines preparatory work necessary before monitoring occurs (pre-monitoring documents, e.g., SOP #s 1-3), permits and permissions, annual workloads and field schedule, facility and equipment needs, start-up costs, and annual budgets.

Pre-Monitoring Documents

Requisite preparations for annual monitoring activities are summarized in SOP #1 “Before the Field Season.” At a minimum, the I&M Program Manager, Park Leads and field crew should review all SOPs, the associated database, and other products prior to initiating annual monitoring. As needed, the protocol narrative, appendices, SOPs, and database will be updated prior to initiating field-based monitoring efforts.

Permits and Permissions

Various research permits and compliance procedures are required to implement and conduct annual monitoring for the Hawaiian Petrel Monitoring Protocol (i.e., USFWS Endangered Species Permits and park research permits must be in place prior to each annual field season, and the protocol must undergo a one-time environmental compliance review ahead of the initial protocol implementation. The Park Leads, in cooperation with NPS point of contacts, will proceed through project compliance according to federal or park compliance processes. See Appendix A: Permits and Permission for further details.

Protocol Funding

The I&M Program is currently funding highest priority protocols. As a secondary priority, implementation of the Hawaiian Petrel Monitoring Protocol will not be funded by I&M, although some staff time is available for data management (including GIS support) and to provide some technical assistance on analyses. The Resource Management divisions at HAVO and HALE will therefore finance and staff implementation and annual monitoring, including additional resources for data management and analysis and report preparation (~30%). Should these resources not be enough, particularly for aspects of data analysis, parks are prepared to secure additional services on an as-needed basis either via cooperative agreements, small purchases, or temporary hires.

Annual Workload and Field Schedule

The preceding chapter on “Personnel Requirements and Training” provides an overview of the roles and tasks required to complete all aspects of Hawaiian petrel monitoring (Table 5.1). Table 6.1 below provides additional details of the annual schedule, including data management, analysis, and reporting activities. Standard operating procedures developed for this protocol provide a comprehensive step-by-step description of the annual workload and tasks required for completion, including data management tasks and product deliverables.

Hawaiian petrel monitoring will be conducted annually at HAVO and HALE to monitor density and fledgling success of known petrel subcolonies. The preferred field sampling window is during the months when petrels are actively nesting at burrow sites. This species will be

monitored four times per year during approximately June or July, August, September, and October at HALE, and June or July, August to early September, October and November at HAVO (due to slightly different reproductive timing of petrels at each park). Inclement weather, personnel workloads and availability, and other factors may preclude the scheduling of sampling to specific annual dates. However, in order to limit sources of inter-annual variability, a 1-2 month window will be adopted when monitoring will occur at these parks.

Landscape-level changes in subcolony density and distribution that are monitored every five years will necessitate a larger field staff or longer time in the field. See the Sampling Frequency, Replication, and Timing section of Chapter 2: Sampling Design for details of timing related to petrel breeding chronology.

Table 6.1. Annual (fiscal year) schedule of major tasks and responsible individuals.

Month	Preparation & Maintenance	Responsible Party
Nov – Jan	Complete data verification and QA/QC	Park Lead and field staff
January	Preliminary analysis of previous year's field data	Park Lead and field staff
	Complete USFWS permit report for previous year's field season	
	Metadata production for previous field season	
March	Complete data analysis and annual report for previous year's monitoring	Park Lead
	Plan monitoring activities and logistics for current year	
	Initiate hiring announcements for seasonal field crew (Field Lead and any interns or volunteers) for current year field season	
	Evaluate equipment needs and repair/purchase equipment	
	Complete park compliance for field season	
April	Post and archive data from previous year	Park Lead
May	Finalize seasonal hires and train in field methods, data entry, data management, and safety	Park Lead
June–Nov	Field data collection, data entry, and data QA/QC activities	Park Lead and field staff
September	Close out protocol fiscal year-end budget	Park Lead
October	Finalize protocol budget for next fiscal year	Park Lead

Facilities and Equipment Needs

The Park Lead at each park will ensure that desk space, computer access, one or more filing cabinets, software (e.g., ArcGIS, Access) and office supplies are available for personnel working on this protocol. Equipment needs for this protocol are outlined in SOP #1 “Before the Field Season.” Instructions for using the equipment can be found in SOP #4 “Using Garmin Global

Positioning System (GPS) Units,” SOP #5 “Using Trimble Global Positioning System (GPS) Units,” and SOP #7 “Collecting, Evaluating, and Summarizing Hawaiian Petrel Burrow Data.”

This protocol requires that two GPS units, if available, be carried into the field to ensure that field work can continue in the event that one unit malfunctions or breaks. Both parks have suitable units and are prepared to use them for this monitoring. A burrowscope will be available at each park to investigate nest chambers within burrows. These and other equipment should be carefully and properly maintained due to sensitivity to weather and high costs associated with replacement. In the event that this equipment does become damaged and/or inoperable, the Park Lead or I&M Project Liaison (depending on whether the equipment is owned by the park or I&M) will immediately make arrangements for repairs and possible replacements.

Existing vehicles at HALE and HAVO are available for collecting petrel data at each park. Where necessary, parks also will provide helicopter support.

Start-up Costs and Budget Considerations

Start-up costs are identified separately from annual, implemented monitoring and maintenance expenses. Most annual expenses are personnel, travel, and field and office supplies, and thus are recurring costs that while fixed, are subject to inflation.

Approximately \$11,466 in start-up costs for equipment has been spent, reflected in Table 6.2. Two burrowscopes, used for investigating Hawaiian petrel burrows, have been purchased by I&M. One burrowscope is currently housed at HALE, and the other at the I&M office at HAVO. Prior to the field season, the HAVO Park Lead will borrow the burrowscope from the I&M program and will return it at or near the end of the field season when it is no longer needed. If other equipment is needed (e.g., GPS unit), the Park Lead will check availability with the I&M Project Liaison, and conduct proper check-out procedures when borrowing the equipment.

Table 6.2. Estimated start up costs for the Hawaiian Petrel Monitoring Protocol, Hawai'i Volcanoes National Park and Haleakalā National Park.

Equipment and Supplies	HAVO Start Up Costs	HALE Start Up Costs
Burrowscope	5,728	5,728
Flagging stakes	10	0
TOTAL = \$ 11,466	\$ 5,738	\$5,728

Annual Budget

Annual expense estimates for Hawaiian petrel monitoring are outlined in Table 6.3. These expenses are based on annual sampling in each park, using biological technicians (i.e., Field Leads) for primary field work (along with the Park Leads), with interns or volunteers (i.e., Field Assistants) as additional field crew. Most expenses are recurring fixed costs: personnel, training and travel. Personnel salaries are based on the 2011 pay schedule, with cost of living adjustment, locality pay and benefits included. Time for conducting data entry, analysis and reporting is included in biotechnician and intern salary costs.

HAVO will need one seasonal Field Lead plus an intern or volunteer as a Field Assistant. At HAVO, the Field Lead and Field Assistant will conduct density sampling and nest monitoring for fledging success, enter data, and assist with fledging success assessments. They also may assist with report writing. HALE will conduct its annual monitoring using present park staff, although the addition of a Field Lead and intern or volunteer as a Field Assistant may be needed. Existing park-based staff may be available to assist with field work at both parks. As this protocol, sample design, field visit schedule, and safety and other considerations evolve, this budget will need refining.

We anticipate that the Field Lead at HAVO will devote four and a half months to this protocol (spread out over a longer time period). The Field Assistant will work approximately two months, primarily to participate in canvassing sampling units for density estimates. Salaries and monitoring-associated travel for the Park Leads and other park staff are paid out of existing park or program funds. Thus, these expenses have not been included.

Primary duties for the Field Lead include: Preparing for the field season (e.g., preparing data forms, organizing equipment, scheduling field days), leading field operations, supervising field crews, entering and summarizing data, and draft reporting, and conducting post-season activities (e.g., cleaning and storing field equipment, finalizing field notes and photographs, data certification). The Field Assistant will conduct field work and assist in data entry. From the I&M Program, requested resources come from the Data Manager (2%) and GIS Specialist (2%), who will assist in pre- and post-field season data management and analysis.

Table 6.3. Annual itemized cost (in 2013 dollars) for the Hawaiian Petrel Monitoring Protocol, by park.

Annual Itemized Expense Categories	HAVO	HALE	TOTAL
Personnel			
Biological Technician (GS 7, 100% FTE, 4.5 months)	\$14,846	\$14,846	\$29,692
Benefits (30%)	4,454	4,454	8,908
Indirect Cost (CESU rate of 17.5%)	3,377	3,377	6,755
Intern or volunteer, 2 months	500	3,000	3,500
Intern or volunteer housing, 2 months	500	1,400	1,900
Travel			
Helicopter Travel (\$ 975/hr): 8 hours	7,800	0	7,800
Equipment and Supplies			
Office supplies	100	100	200
Field supplies (consumable, e.g., vehicle fuel, batteries)	300	250	550
Equipment repair/replacement	300	300	600
TOTAL	\$32,177	\$27,727	\$59,905

The Park Leads will utilize their time for this protocol in making preparations before and after the field season, overseeing field operations, supervising Field Leads, conducting field work, data management and analysis, and reporting of annual findings. Table 6.4 reflects the estimated time in weeks that each Park Lead anticipates will be needed to complete these tasks. The

HAVO Park Lead will devote approximately 15.5 weeks to these monitoring tasks (30% annual time) and the HALE Park Lead about 16.5 weeks (32% annual time). The HALE Park Lead requires more time to complete tasks because HALE has more quadrats to search, with many more nests per quadrat, and because field work is generally done in day trips (in contrast with HAVO, where camping permits longer field days). These are approximations only, as each monitoring year may present special challenges that require more or less time.

Table 6.4. Park Lead annual time allotment for major Hawaiian petrel monitoring tasks.

Monitoring Activities	HAVO Park Lead (Time allotted)	HALE Park Lead (Time allotted)
Pre-Field Season Preparations	1.5 weeks	1.5 weeks
Field Work	7 weeks	8 weeks
Post-Season Preparations	1 week	1 week
Data Management	1 week	1 week
Data and Trend Analysis	3 weeks	3 weeks
Reporting	2 weeks	2 weeks
Weeks annually	15.5 weeks	16.5 weeks
Total % time spent annually	30%	32%

Table 6.5 details data management, analysis and reporting activities to specific personnel associated with this protocol. Time in weeks that these personnel will spend annually on these activities, as well as time needed from the I&M team, is listed. Almost 33% of time is allocated to data management: 15% to entry and verification of field data and 18% to data analyses and production of field and technical reports.

Table 6.5. Personnel time allocated to data management, analysis and reporting.

Personnel	Time		Responsibilities
	Data Management Weeks	Total Weeks	
Park Resource Chiefs	0.4	0.4	Review NRTR report
Park Leads/HAVO	5	15.5	Data verification, analysis and reporting
Park Lead/HALE	5	16.5	Data verification, analysis and reporting
Field Lead	6	18	Data entry, verification, and reporting
Field Assistant	1.4	8	Data entry, verification
I&M Data Manager (GS-11.3)	0.6	0.6	Pre- and post-field season data analysis and reporting
I&M GIS Specialist (GS-11)	0.4	0.4	Pre-season preparation and post-season data analysis and reporting
Technical Advisor	1.5	3	Assistance with sample scheme evaluation, analysis, interpretation
TOTAL weeks	20.3	62.4	
TOTAL percentage	32.5%		

Budget for Periodic Colony Search Portion of the Monitoring Protocol

The periodic colony search portion of the protocol, while broader in geographic scope, consists of a single survey for active nests in randomly-selected grids within Frame II approximately every five years to assess trends in change of geographic colony extent. Cost per periodic survey largely depends on the number of grids selected. Estimated costs in Table 6.6 (in 2013 dollars) are based on the same total number of grids as is planned for annual monitoring at each park: 60 at HAVO and 75 at HALE.

Table 6.6. Itemized cost of the periodic Hawaiian petrel colony search portion of the monitoring protocol, by park. Costs are in 2013 dollars.

Itemized Expense Categories for Periodic Monitoring	HAVO	HALE	TOTAL
Personnel			
Biological technician lead (cooperator at GS 7 payscale, 100% FTE, 3.5 months)	\$11,547	\$11,547	\$23,094
Biological technician assistant (cooperator at GS 5 payscale, 100% FTE, 2.5 months)	\$6,658	\$6,658	\$13,317
Benefits for GS 7 (30%)	\$3,464	\$3,464	\$6,928
Benefits for GS 5 (30%)	\$1,998	\$1,998	\$3,995
Indirect cost (17.5% CESU rate)	\$4,142	\$4,142	\$8,283
Intern or volunteer, 2 months	\$500	\$3,000	\$3,500
Intern or volunteer housing, 2 months	\$500	\$1,400	\$1,900
Travel			
Helicopter Travel (\$ 975/hr 2013): 8 hours	\$7,800	\$0	\$7,800
Equipment and Supplies			
Office supplies	\$100	\$100	\$200
Field supplies (consumable, e.g., vehicle fuel, batteries)	\$300	\$250	\$550
Equipment repair/replacement	\$300	\$300	\$600
TOTAL	\$30,308	\$32,858	\$70,167

We anticipate that staff effort will be similar to that needed for annual monitoring.

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Appendix A. Permits and Permission

Various research permits and compliance procedures are required to conduct annual monitoring. As this protocol is implemented, the Park Leads, in cooperation with other NPS park biologists, will proceed through project compliance as appropriate for Hawai'i Volcanoes National Park and Haleakalā National Park, according to federal guidelines or any other compliance processes. The Park Leads will ensure full compliance with all existing and future regulations. All permitting will be reviewed (if permit type applicable) by a park designee (e.g., Park Point of Contact) responsible for the National Environmental Policy Act (NEPA), Section 7 of the Endangered Species Act, Section 106 of the National Historic Preservation Act (NHPA), park research permits, and approved by the compliance specialists. The Park Leads are responsible for ensuring appropriate park permitting contacts are notified. Some specific permits required and identified by this protocol follow with descriptions. The Park Leads are responsible for following all stipulations identified through the compliance process.

Federal

NPS

As part of park compliance, the Natural Resource Management (NRM) divisions at HAVO and HALE require a Project Review Environmental Screening Form (PR ESF) in advance of any field activities in the park where Hawaiian petrel monitoring will be conducted. The PR ESF will be evaluated and approved by the Chief of NRM. The Park Leads will not begin any work until this process has been followed and approved. The PR ESF form is available through NRM at each park. The PR ESF ensures that all National Environmental Policy Act (NEPA) and National Historic Preservation Act (NHPA) compliance is addressed.

NPS research permits are required prior to the start of field work. Although durations of NPS research permits vary, most are good for one to two years. Park Leads should submit requests for park research permits at least two months ahead of the start of annual field work.

NEPA

After discussions with park and other NPS staff regarding NEPA, we anticipate that this protocol falls under a Categorical Exclusion (CE) where “a category of actions which do not individually or cumulatively have a significant effect ...and for which, therefore, neither an environmental assessment nor an environmental impact statement is required” (40 CFR 1508.4). Under Directors Order 12 a CE (or CX) is “an action with no measurable environmental impact which is described in one of the categorical exclusion lists in section 3.3 or 3.4 and for which no exceptional circumstances (section 3.5) exist.” To remain consistent with NEPA and park policy, NEPA compliance review and documentation will occur as part of the NPS research permitting process.

NHPA

Section 106 of NHPA requires the head of any Federal agency, prior to the approval of expenditures of Federal funds, take into account the effect of any undertaking (e.g., monitoring project) on any historic properties (i.e., district, site, building, structure, or object) listed in or

eligible for listing in the National Register of Historic Places (NRHP). The Section 106 process establishes guidelines for NPS to conduct archeological reviews of park projects to meet Section 106 requirements. The Hawaii State Historic Preservation Office advises and assists NPS with their efforts to assess a project's effects and seek ways to avoid, minimize or mitigate any adverse effects on historic properties. To remain consistent with NHPA and park policy, NHPA compliance review and documentation will occur as part of the NPS research permitting process.

Standard Operating Procedures:

1. Consult the HAVO or HALE Archeologist/Cultural Resource Manager to determine whether or not historic properties or objects or archeological features are located in or adjacent to the monitoring area. If no cultural resources are present, proceed with monitoring. If cultural resources are present, follow SOPs 2 through 4 below.
2. All cultural resources will be "flagged" or otherwise identified by the park Archeologist before surveys begin. The park Archeologist will also convey to the person(s) performing this work any avoidance measures that need to be followed and special concerns about a particular property or feature.
3. Use of equipment and/or methodology will be reviewed and approved by the park Archeologist before work begins to ensure as little disturbance as possible to cultural resources.
4. If rocks are accidentally dislodged from a cultural resource, monitoring will be halted in the immediate area and the park Archeologist will be contacted. Every effort will be made to return the rocks to the exact location in consultation with the park Archeologist.

US Fish and Wildlife Service

A USFWS threatened and endangered species permit is required and has been issued to each national park's natural resource management division. It is renewed periodically to authorize permittees to "take" the federally-listed endangered Hawaiian petrel for conservation, ecological, and demographic studies within the parks or specified geographic boundaries. This permit allows a permittee to "capture, hold, band, measure, weigh, bleed, radio-tag, recapture and release" petrels, and use a still camera to document burrow occupancy. HAVO currently operates under endangered species permit TE-018078-14 (amendment issued March 2007). HALE operates under endangered species permit TE-014497-11. If this permit is expiring in the current year, the listed permittee must apply for a continuation of the permit.

Where predation occurs, collection of any Hawaiian petrel carcasses or associated materials may be necessary when removing and examining nest contents. However, collection of carcasses, bones, feathers or other materials not associated with permitted activities is not included under this permit. Such collections require a federal salvage permit, which parks will be/are in the process of requesting.

State of Hawai'i

No permits are required from the state of Hawaii for monitoring Hawaiian petrels in HAVO or HALE. However, all wildlife activities conducted under the USFWS permit in Hawaii must be coordinated with the Department of Land and Natural Resources, Division of Forestry and Wildlife (Honolulu office: 808-587-0166; Hilo office: 808-933-4221).

Appendix B. Personnel Names and Contact Information

This appendix to the protocol narrative identifies past and current names and contact information of various personnel identified in Chapter 5. Titles of positions are based on those in Chapter 5. Current personnel are listed in Table B.1. As personnel change, new names will be added and individual tables added for each position.

Table Field Definitions

Name

Name of individual holding position. If no individual is assigned for a time period, designate as “Vacant.” If a responsibility is delegated, such as the PACN Data Manager delegates the role to a subordinate, identify the individual to whom responsibility is delegated. The most recent/present individual with this responsibility is always listed first, followed in reverse chronological order by predecessors.

Start Date

Initial date the named individual assumed this responsibility. Note: only a single, contiguous time period is referenced for each table row. If one individual assumes the same role for multiple non-contiguous time periods, each period of time shall be referenced in a separate table row.

End Date

Terminal date the named individual relinquished or was relieved of this responsibility.

Role

Formal or Acting: Boolean response indicating if this responsibility was assigned as part of standard job duties (formal), or assigned in a temporary capacity and temporary time period while other arrangements were being made (acting).

Physical Duty Station Address

Mailing address.

Park Administratively Assigned

Park or office where named individual is formally stationed.

Job Title

Official OPM type, including grade, if appropriate.

Email

Email address used. Note that in Table E.1 there are no blank spaces (between the username and address, separated by the “@” character) contained within email addresses.

Phone

Phone number used.

Table B.1. Current individuals holding positions listed in Chapter 5.

Protocol Development					Protocol Implementation				
	Principal Investigator	Principal Investigator	Park Lead	UH Cooperator	Park Resource Chiefs	HALE Park Lead	HAVO Park Leads	Field Lead	Data Management
Name	Darcy Hu	David Duffy	Cathleen Bailey	Gail Ackerman	Stephen Robertson, Rhonda Loh	Cathleen Natividad Bailey	Kathleen Misajon	TBD (HALE), Charlotte Forbes Perry (HAVO)	Kelly Kozar
Start Date	September 2006	September 2006	September 2006	September 2006	TBD	September 2006	2013	2013	August 2006
End Date	Ongoing	2014	2014	2009	Ongoing	Ongoing	Ongoing	TBD	Ongoing
Role	Protocol development + technical assistance with implementation	Protocol development	Protocol development	Protocol development	Compliance, reviews reports, provides monitoring oversight and support as needed	Compliance, field monitoring, data analysis and reporting	Compliance, field monitoring, data analysis and reporting	Data collection, data entry and analysis	Manages data products & databases
Physical Duty Station & Address	Hawai'i Volcanoes National Park PO Box 52 Hawaii Nat'l Park, HI 96718	UH-Manoa Dept. of Botany 3190 Maile Wy St. John Hall #101 Honolulu, HI 96822-2279	Haleakalā National Park Resource Mgmt. PO Box 369 Makawao, HI 96768	Hawai'i Volcanoes National Park PO Box 52 Hawaii National Park, HI 96718	Same as park leads	Haleakalā National Park Resource Mgmt. PO Box 369 Makawao, HI 96768	Hawai'i Volcanoes National Park Resource Mgmt PO Box 52 Hawaii National Park, HI 96718	Hawai'i Volcanoes National Park Resource Mgmt PO Box 52 Hawaii National Park, HI 96718	HAVO I&M Program PO Box 52 Hawaii National Park HI 96718
Job Title	Senior Science Advisor	PCSU Director, Professor of Botany	Wildlife Biologist	Vertebrate Fauna Specialist	Resources Chief or specialized series	Wildlife Biologist	Biological Technician	PCSU Petrel/Nene Research Technician	Data Manager
Email	Darcy_Hu@nps.gov	dduffy@hawaii.edu	Cathleen_Bailey@nps.gov		Steve_Roberts_on@nps.gov , Rhonda_loh@nsp.gov	Cathleen_Bailey@nps.gov	Kathleen_misajon@nps.gov	Charlotte_forbes-Perry@nps.gov	Kelly_Kozar@nps.gov
Phone	808-985-6092	808-956-8218	808-572-4491		808-572-4490, 808-985-6183	808-572-4491	808-985-6194	808-985-6094	808-985-6186

Appendix C. Yearly Project Task List

This table identifies each task by project stage, indicates who is responsible, and establishes the timing for its execution for both parks (which are on the same schedule). For field work, The Park Lead and/or the Field Lead may take on some of the tasks, depending on the park and level of involvement.

Project Stage	Task Description	Responsibility	Timing
Preparation	Meet (or conference call) to recap past field season, discuss the upcoming field season, and document any needed changes to field sampling protocols or the working database	Park Lead, Park resource chief, Data Manager and GIS Specialist	by Jan 30
	Initiate announcements for seasonal technician and intern positions	Park Lead	March
	Notify Data Manager and GIS Specialist of specific needs for the coming season (field maps, GPS support, training)	Park Lead	by March 30
	Plan schedule and logistics, including ordering any needed equipment and supplies (SOP #1)	Park Lead	by March 30
	Ensure that project workspace is ready for use and GPS download software is loaded at each park (SOP #9)	Park Lead, Data Manager and GIS Specialist	by March 30
	Implement working database copy	Park Lead and Data Manager	by March 30
	Ensure all project compliance needs are completed for the coming season	Park Lead	April
	Generate roster of sample points and coordinates from the database (SOP #1)	Park Lead and Field Lead and GIS specialist as needed	by May 1
	Prepare and print field maps (SOP #1)	Park Lead (& GIS Specialist as needed)	by May 1
	Finalize seasonal hires	Park Lead	by May 1
	Update and load data dictionary, background maps, and target coordinates into GPS units (SOP #1)	Park Lead (GIS Specialist as needed)	by May 15
	Initiate computer access and key requests	Park Lead	by May 15
	Provide field crew email addresses and user logins to Data Manager	Park Lead	by May 15
	Provide database/GPS training as needed	Data Manager and GIS Specialist	by May 31
	Train field crew in sampling methods (SOP #2) and safety (SOP #3)	Park Lead and/or Field Lead	by May 31
Data Acquisition	Obtain necessary backcountry permits and file helicopter flight plans prior to each trip	Park Lead and/or Field Lead	before each tour in field
	Collect field observations and position data during field trips	Park Lead and/or Field Lead	June – Nov

Project Stage	Task Description	Responsibility	Timing
	Review data forms after each day	Park Lead or Field Lead and assistants	daily
	De-brief crew on operations, field methods, gear needs	Park Lead and/or Field Lead	after each tour
Data Entry & Processing	Download GPS data for any nests found	Park Lead or Field Lead	after each tour
	Download and process digital images (SOP #12)	Park Lead or Field Lead and assistants	after each tour
	Enter data into working copy of the database (SOP #13)	Park Lead or Field Lead and assistants	after each tour
	Verification of accurate transcription as data are entered	Park Lead or Field Lead	after each tour
	Review of GPS location data and database entries for completeness and accuracy	Park Lead and/or Field Lead	after each tour
	Upload processed and verified GPS and other data files to database, and store data files in PACN Digital Library ¹ and Resource Management petrel folder on park servers (SOP #19)	Park Lead, GIS Specialist and Data Manager	by Jan 15 of the following year
Product Development	Complete permit report per USFWS permit compliance	Park Lead	by Jan 31
Product Delivery	Send permit report to Field Supervisor, Pacific Islands Fish and Wildlife Office (PIFWO)	Park Lead	by Jan 31
Quality Review	Quality review and data validation using database tools (SOP #14)	Park Lead	Nov – Jan
	Prepare coordinate summaries and/or GIS layers and data sets as needed for spatial data review	Park Lead and/or GIS Specialist	by Jan 15
	Joint quality review of GIS data, determine coordinates for subsequent field work	Park Lead and GIS Specialist	by Jan 15
Metadata	Identify any sensitive information contained in the data set (SOP #16)	Park Lead	by Jan 15
	Update project metadata records (SOP #15)	Park Lead	by Jan 15
Data Certification & Delivery	Certify the season's data and complete the certification report (SOP #14)	Park Lead	by Jan 31
	Deliver certification report, certified data, digital photographs, and updated metadata to I&M Data Manager (SOP #14)	Park Lead	by Jan 31
	Upload certified data into master project database, store data files in PACN Digital Library ¹ and Resource Management petrel folder on park servers (SOP #19)	Data Manager	by Feb 15
	Notify Park Leads of uploaded data ready for analysis and reporting	Data Manager	by Feb 15

Project Stage	Task Description	Responsibility	Timing
	Update project GIS data sets, layers and associated metadata records	GIS Specialist	by Feb 15
	Finalize and parse metadata records, store in PACN Digital Library ¹ (SOP #15)	Data Manager and GIS Specialist	by Feb 15
Data Analysis Note: The tasks in this section occur every year	Annual data QA/QC; data summarization; determine density of strata in Frame I and estimate population size; determine fledgling success; identify active burrow distribution; identify predation events. Export data from Excel or other file structures; import these into database	Data Analyst	by Feb 15
Data Analysis Note: The tasks in this section occur every 5 years.	Determine density and estimate population size of Frame II. Export park-specific trends of density and distribution from Excel or other file structures; import these into database	Data Manager	by Feb 15
Reporting & Product Development	Export automated summary queries and reports from database	Park Lead	by Feb 28
	Produce report-quality map for reports and archives	GIS Specialist	by Feb 28
	Acquire the NRTR report template from the NPS website ²	Park Lead	by Feb 28
	Screen any data products for sensitive information (SOP #16)	Park Lead	by Feb 28
	Prepare draft NRTR and distribute to Park staff for preliminary review	Park Lead	by March 15
Product Delivery	Submit draft technical report to I&M Program Manager and PACN Program Manager for review	Park Lead	by April 15
	Review report for formatting and completeness, notify Park Lead of approval or need for changes	Park resource chiefs	by May 15
	Upload completed report to PACN Digital Library ¹ submissions folder, notify Data Manager (SOP #20)	Data Manager	upon approval
	Coordinate peer review of the technical report	Park resource chiefs	By June 15
	Deliver other products according to the delivery schedule and instructions (SOP #20)	Park Lead	upon completion
Posting & Distribution	Submit metadata to Data Store ³	Data Manager	by March 15
	Create Data Store ³ reference record and upload report	Data Manager	upon receipt
	Update NPSpecies ⁴ records according to data observations	Data Manager	by March 15
	Submit certified data and GIS data sets to Data Store ³	Data Manager	April (after 2-year hold)
Archival & Records	Store finished products in PACN Digital Library ¹	Data Manager	upon receipt

Project Stage	Task Description	Responsibility	Timing
Management	Review, clean up and store and/or dispose of project files according to NPS Director's Order #19 ⁵	Park Lead	March – April
Season Close-out	Inventory equipment and supplies	Park Lead or field staff	March
	Discuss and document needed changes to analysis and reporting procedures	Park Lead, Park resource chiefs, and Data Manager	April

¹ The PACN Digital Library is a hierarchical digital filing system stored on the PACN file server. Network users have read-only access to these files, except where information sensitivity may preclude general access.

² The Natural Resource Publications Management website (<http://www.nature.nps.gov/publications/NRPM/index.cfm>)

³ Data Store is a clearinghouse for natural resource data, metadata, and reports (<https://irma.nps.gov/App/Reference/Welcome>). Only non-sensitive information is posted to Data Store. Refer to the protocol section on sensitive information for details.

⁴ NPSpecies is the NPS database and application for maintaining park-specific species lists and observation data (<https://irma.nps.gov/NPSpecies/>).

⁵ NPS Director's Order 19 provides a schedule indicating the amount of time that the various kinds of records should be retained. Available at: <http://data2.itc.nps.gov/npspolicy/DOrders.cfm>

Appendix D. Hawaiian Petrel Species Summary

The Hawaiian petrel (*Pterodroma sandwichensis*), or 'ua'u, is a medium-sized nocturnal petrel endemic to Hawaii with light-colored under parts, dark upperparts and rump, and white forehead, throat and cheeks (Figures D.1a and 1b). A distinctive black hood that forms a partial collar on the sides of the neck distinguishes this bird from other species. The legs and feet are pink with mostly black webs. This species was federally and state listed as endangered in 1967 and 1973, respectively (USFWS 1983).



Figure D.1. (a) Hawaiian petrel at burrow, and (b) preparing for flight.

This colonial species formerly nested in large numbers on all the main Hawaiian Islands, except Ni'ihau. Hunting, predation and habitat destruction eliminated the 'ua'u in lower elevations. Remaining colonies are now found in remote high-elevation areas on the islands of Maui, Kaua'i, Hawai'i, Lana'i and possibly Moloka'i. On Maui, this bird nests in burrows that are commonly located at bases of rock outcrops where erosional debris provides adequate substrate for burrowing (Simons and Hodges 1998). Nest sites are highly variable, ranging from crevices less than 1 m deep to cracks and lava tubes that penetrate greater than 10 m into the cliff face. Nest composition varies from bare rock or soil to sizable dished nests made of grass or twigs. Colonies are generally found in high-elevation xeric or wet forest habitats (Mitchell et al. 2005).

Adult 'ua'u are believed to be monogamous and form long-term pair bonds, with pairs returning to the same nesting burrow year after year (Mitchell et al. 2005). On Maui, where the species has been well-studied, birds typically arrive within a seven-day period in late February or early March to select and construct burrows. Most birds visit their burrows regularly at night for several weeks following their return, removing debris, bringing in new nest material, or enlarging the burrow entrance. A pre-laying absence at the burrow lasts from late March until late April. Egg-laying occurs from the last week of April through mid-May. Incubation of the single white egg ranges from 54-58 days. Both sexes share in the incubation duties. Hatching occurs in the last week of June through the first week of July. Adult feeding activity at nests peak between 30 and 60 days, the period of maximum chick growth. The nestling period ranges from

100-119 days with nestlings fledging between 8 – 30 October. Breeding chronology may differ on other islands; little information is currently available.

Literature Cited

- Mitchell, C., C. Ogura, D. W. Meadows, A. Kane, L. Strommer, S. Fretz, D. Leonard, and A. McClung. 2005. Hawaii's comprehensive wildlife conservation strategy. Department of Land and Natural Resources. Honolulu, Hawaii. Available at <http://www.state.hi.us/dlnr/dofaw/cwcs/> (accessed 8 August 2008).
- Simons, T. R., and C. N. Hodges. 1998. Dark-rumped petrel (*Pterodroma phaeopygia*). No. 345 in A. Poole and F. Gills, editors. The Birds of North America. The Birds of North America, Inc., Philadelphia, Pennsylvania.
- U.S. Fish and Wildlife Service. 1983. Hawaiian dark-rumped petrel and Newell's Manx shearwater recovery plan. U.S. Fish and Wildlife Service, Portland, Oregon.

Appendix E. Hawaiian Petrel Database Documentation

The database for this project will consist of four types of tables: core tables describing the “who, where and when” of data collection, project-specific tables, lookup tables that contain domain constraints for other tables, and cross reference tables that link lookup tables with data tables. Although core tables are based on PACN standards, they may contain fields, domains or descriptions that have been added or altered to meet project objectives.

The database will include the following standard tables:

tbl_Sites	Survey sites – individual parks
tbl_Locations	Survey locations – area where monitoring is being conducted
tbl_Events	Data collection event for a given location
tbl_Images	Images associated with sample collections and nest checks
tbl_Db_Meta	Database description and links to I&M metadata tools
tbl_Db_Revisions	Database revision history data

The following are project-specific data tables:

tbl_Grid_Cells	Grid cell location information – within survey locations
tbl_Nest_Check	Nest check monitoring information
tbl_Nests	Nest information
tbl_Collections	Sample collection information
tbl_Collection_Locations	Location information of sample collections

The following are a few of the more prominent, standard lookup tables:

tlu_Contacts	Contacts data for project-related personnel
tlu_Enumerations	Enumerated lookup table

The following are a few of the more prominent, standard cross-reference tables:

xref_Event_Contacts	Cross-reference table between events and contacts
---------------------	---

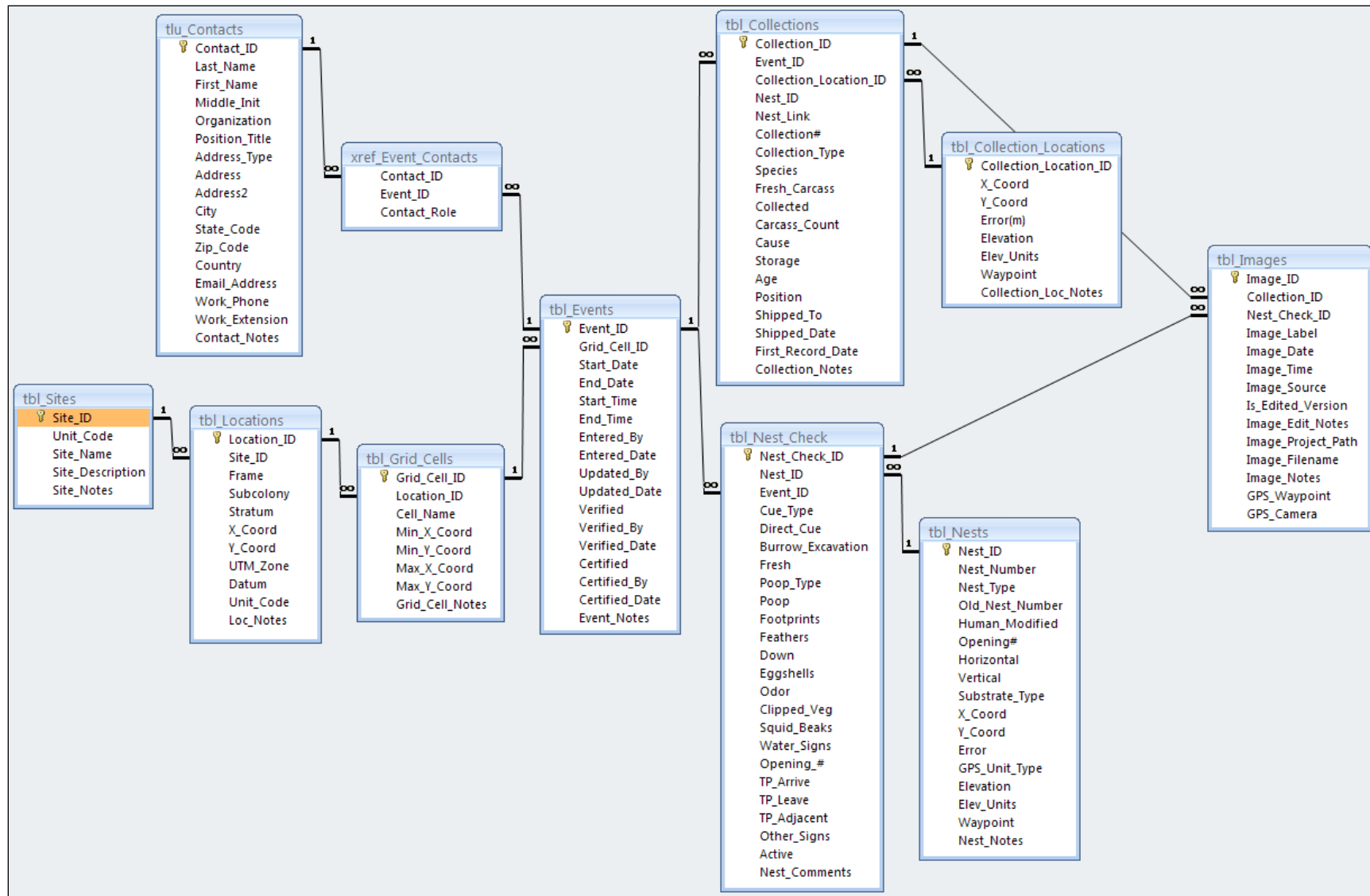


Figure E.1. Data model for the PACN Hawaiian Petrel Monitoring database.

Database Tables

tbl_Sites: Survey sites – individual parks

Field	Primary?	Data Type	Size	Description
Site_ID	Yes	Text	50	Unique identifier for park records
Site_Name	No	Text	50	Unique name or code for a park
Site_Description	No	Text	255	Park Description
Site_Notes	No	Text	255	General notes on the park
Unit_Code	No	Text	50	Four letter Park, Monument or Network code

tbl_Locations: Survey locations – area where monitoring is being conducted

Field	Primary?	Data Type	Size	Description
Location_ID	Yes	Text	50	Unique identifier for location records
Site_ID	No	Text	50	Link to tbl_Sites
Frame	No	Text	50	Frame
Subcolony	No	Text	50	Subcolony
Stratum	No	Text	50	Stratum Name
X_Coord	No	Number	Double	X coordinate
Y_Coord	No	Number	Double	Y coordinate
Datum	No	Text	150	Datum
UTM_Zone	No	Text	10	UTM Zone
Unit_Code	No	Text	4	Four letter Park, Monument or Network code
Loc_Notes	No	Memo	-	Location notes

tbl_Events: Data collection event for a given location

Field	Primary?	Data Type	Size	Description
Event_ID	Yes	Text	50	Unique identifier for event records
Grid_Cell_ID	No	Text	50	Link to tbl_Grid_Cells
Start_Date	No	Date/Time	-	Starting date for the event
End_Date	No	Date/Time	-	Ending date for the event
Start_Time	No	Date/Time	-	Starting time for the event
End_Time	No	Date/Time	-	Ending time for the event
Entered_By	No	Text	50	Person who entered the data for this event

Entered_Date	No	Date/Time	-	Date on which data entry occurred
Updated_By	No	Text	50	Person who made the most recent updates
Updated_Date	No	Date/Time	-	Date of the most recent edits
Verified	No	Boolean	-	Whether the data has been verified
Verified_By	No	Text	50	Person who verified accurate data transcription
Verified_Date	No	Date/Time	-	Date on which data were verified
Certified	No	Boolean	-	Whether the data has been certified
Certified_By	No	Text	50	Person who certified data for accuracy and completeness
Certified_Date	No	Date/Time	-	Date on which data were certified
Event_Notes	No	Memo	0	General notes on the event

tbl_Images: Images associated with sample collections and nest checks

Field	Primary?	Data Type	Size	Description
Image_ID	Yes	Text	50	Unique identifier for image records
Collection_ID	No	Text	50	Link to tbl_Collections
Nest_Check_ID	No	Text	50	Link to tbl_Nest_Check
Image_Label	No	Text	100	Image caption or label
Image_Date	No	Date/Time	-	Date on which the image was created
Image_Time	No	Date/Time	-	Time in which the image was created
Image_Filename	No	Text	100	Name of the image including extension (.jpg) but without the image path
Image_Source	No	Text	50	Name of the person or organization that created the image
Image_Project_Path	No	Text	100	Location of the image from the main project folder or image library
Is_Edited_Version	No	Boolean	-	Indicates whether this version of the image is the edited [originals = False]
Image_Edit_Notes	No	Memo	-	Comments about the editing or processing performed on the image
GPS_Camera	No	Boolean	-	Was a GPS Camera used?
GPS_Waypoint	No	Text	10	GPS waypoint
Image_Notes	No	Memo	-	Notes or comments about the image

tbl_Grid_Cells: Grid cell location information – within survey locations

Field	Primary?	Data Type	Size	Description
Grid_Cell_ID	Yes	Text	50	Unique identifier for grid cell records
Location_ID	No	Text	50	Link to tbl_Locations
Cell_Name	No	Text	50	Name of grid cell
Max_X_Coord	No	Number	Double	Maximum X Coordinate
Max_Y_Coord	No	Number	Double	Maximum Y Coordinate
Min_X_Coord	No	Number	Double	Minimum X Coordinate
Min_Y_Coord	No	Number	Double	Minimum Y Coordinate
Grid_Cell_Notes	No	Memo	-	General notes on the grid cells

tbl_Nest_Check: Nest check monitoring information

Field	Primary?	Data Type	Size	Description
Nest_Check_ID	Yes	Text	50	Unique identifier for nest check records
Nest_ID	No	Text	50	Link to tbl_Nests
Event_ID	No	Text	50	Link to tbl_Events
Cue_Type	No	Text	50	Cue type - direct or indirect
Direct_Cue	No	Text	50	Direct cue - burrowscope, flashlight, other
Burrow_Excavation	No	Boolean	-	Fresh signs of digging around the burrow?
Fresh	No	Boolean	-	Fresh droppings?
Poop_Type	No	Text	50	Poop type - species
Poop	No	Text	25	Poop [1=tacky, 2=dark, 3=thick, 4=white-wash]
Footprints	No	Boolean	-	Footprints
Feathers	No	Text	50	Feathers [adult, chick, chukar]
Down	No	Text	50	Down [adult or chick]
Eggshells	No	Boolean	-	Eggshell fragments?
Odor	No	Boolean	-	Musty odor?
Clipped_Veg	No	Boolean	-	Clipped vegetation near burrow entrance?
Squid_Beaks	No	Boolean	-	Squid beaks?
Water_Signs	No	Boolean	-	Signs of water near burrow entrance
Opening_#	No	Text	50	Opening number
Active	No	Text	25	Is the nest active in your judgment [Yes, No, Unknown]

Other_Signs	No	Text	200	Other signs of occupancy
TP_Arrive	No	Text	25	Toothpick number upon arrival at each entrance [separate numbers at each entrance by a comma]
TP_Leave	No	Text	25	Toothpick number up upon leaving at each entrance
TP_Adjacent	No	Boolean	-	Were toothpicks knocked down adjacent?
Nest_Comments	No	Memo	-	Nest check comments or descriptions

tbl_Nests: Nest information

Field	Primary?	Data Type	Size	Description
Nest_ID	Yes	Text	50	Unique identifier for nest records
Old_Nest_Number	No	Text	100	Previous nest identification number
Nest_Number	No	Text	100	Nest identification number
Nest_Type	No	Text	50	Nest type [lava tube, tumulus, other]
X_Coord	No	Number	Double	X coordinate
Y_Coord	No	Number	Double	Y coordinate
Error	No	Text	25	Error in meters
Elevation	No	Number	Lgn Int	Elevation of the location
Elev_Units	No	Text	20	Units for elevation data
GPS_Unit_Type	No	Text	25	Type of GPS unit used for data collection
Waypoint	No	Text	10	GPS waypoint
Human_Modified	No	Boolean	-	Does the nest appear human modified?
Opening#	No	Text	25	Number of openings to the nest
Horizontal	No	Text	25	Horizontal entrance dimension (cm)
Vertical	No	Text	25	Vertical entrance dimension (cm)
Substrate_Type	No	Text	50	Substrate type [weathered pāhoehoe, smooth pāhoehoe, a'a']
Nest_Notes	No	Memo	-	Nest check comments or description

tbl_Collections: Sample collection information

Field	Primary?	Data Type	Size	Description
Collection_ID	Yes	Text	50	Unique identifier for collection records
Event_ID	No	Text	50	Link to tbl_Events
Collection_Location_ID	No	Text	50	Link to tbl_Collection_Locations

Nest_ID	No	Text	50	Link to tbl_Nests
Nest_Link	No	Text	5	Is the collection linked to a nest?
Collection#	No	Text	100	Collection number
Collection_Type	No	Text	50	Description of item collected
Species	No	Text	100	Species
Fresh_Carcass	No	Boolean	-	Is the carcass fresh?
Collected	No	Boolean	-	Was a sample collected?
Carcass_Count	No	Number	Double	How many other carcasses were found with this one?
Cause	No	Text	25	Cause of death
Storage	No	Text	100	Where is the sample stored?
Age	No	Text	25	Age [adult, juvenile or unknown]
Position	No	Text	100	Was carcass on surface or protected from sun and water?
Shipped_To	No	Text	100	Who was the sample shipped to?
Shipped_Date	No	Date/Time	-	Date sample was shipped
First_Record_Date	No	Date/Time	-	Date sample was first recorded [does not mean it was necessarily collected]
Collection_Notes	No	Memo	-	Collection notes

tbl_Collection_Locations: Location information of sample collections

Field	Primary?	Data Type	Size	Description
Collection_Location_ID	Yes	Text	50	Unique identifier for data location records
X_Coord	No	Number	Double	X coordinates
Y_Coord	No	Number	Double	Y coordinates
Error(m)	No	Text	25	Error in meters
Elevation	No	Number	Double	Elevation of the location
Elev_Units	No	Text	20	Units for elevation data
Waypoint	No	Text	10	GPS waypoint
Collection_Loc_Notes	No	Memo	-	Collection location notes

tbl_Db_Meta: Database description and links to I&M metadata tools

Field	Primary?	Data Type	Size	Description
Db_Meta_ID	Yes	Text	50	Local primary key
Db_Desc	No	Memo	-	Description of the database purpose

DSC_GUID	No	Text	50	Link to I&M Dataset Catalog desktop metadata tool
Meta_File_Name	No	Text	50	Name of the metadata file that describes this NRDT data file (must be in the same directory as this data file)
Meta_MID	No	Text	255	Link to Data Store

tbl_Revisions: Database revision history data

Field	Primary?	Data Type	Size	Description
Revision_ID	Yes	Text	50	Database revision (version) number or code
Db_Meta_ID	No	Text	50	Link to tbl_DB_Meta
Revision_Contact_ID	No	Text	50	Link to tlu_Contacts
Revision_Date	No	Date/Time	-	Database revision date
Revision_Desc	No	Memo	-	Revision description
Revision_Reason	No	Memo	-	Reason for the database revision

xref_Event_Contacts: Cross reference table between events and contacts

Field	Primary?	Data Type	Size	Description
Contact_ID	No	Text	50	Link to tlu_Contacts
Event_ID	No	Text	50	Link to tbl_Events
Contact_Role		No Text	50	The contact's role in the protocol

tlu_Contacts: Contact data for project-related personnel

Field	Primary?	Data Type	Size	Description
Contact_ID	Yes	Text	50	Unique contact record identifier
Last_Name	No	Text	50	Last name
First_Name	No	Text	50	First name
Middle_Init	No	Text	4	Middle initial
Organization	No	Text	50	Organization or employer
Position_Title	No	Text	50	Title or position description
Address_Type	No	Text	50	Address (mailing, physical, both) type
Address	No	Text	50	Street address
Address2	No	Text	50	Address line 2, suite, apartment number
City	No	Text	50	City or town

State_Code	No	Text	8	State or province
Zip_Code	No	Text	50	Zip code
Country	No	Text	50	Country
Email_Address	No	Text	50	E-mail address
Work_Phone	No	Text	50	Phone number
Work_Extension	No	Text	50	Phone extension
Contact_Notes	No	Memo	-	Contact notes

tlu_Enumerations: Enumerated lookup table

Field	Primary?	Data Type	Size	Description
Enum_Code	No	Text	50	Code for lookup values
Enum_Description	No	Memo	-	Lookup value description
Enum_Group	Yes	Text	50	Category for lookup value
Sort_Order	No	Number	Integer	Order in which to sort lookup values

Hawaiian Petrel Monitoring Protocol Pacific Island Network

Standard Operating Procedure (SOP) #1: Before the Field Season

Version 1.00

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, and identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

Abstract

This Standard Operating Procedure (SOP) provides an outline of preparation needs that should be done before any Hawaiian petrel field monitoring occurs, and provides a list of equipment that will be needed for monitoring at Hawai'i Volcanoes National Park (HAVO) and Haleakalā National Park (HALE).

Procedures

This SOP provides basic instructions to prepare for field monitoring of Hawaiian petrels in PACN national parks. Prior to the field season each year, observers should review the Hawaiian Petrel Monitoring Protocol including the SOPs. For a complete SOP list, see Appendix A: List of Standard Operating Procedures in the Protocol Narrative.

Review of Hawaiian petrel identification by sight and sound, and knowledge of daily and seasonal behaviors is especially important (see Appendix D: Hawaiian Petrel Species Summary and SOP #2 "Training Observers"). All observers should follow the outlined field schedule.

A master equipment list for this protocol can be found in Appendix S1.a of this document. The master equipment list should be updated simultaneously if any SOP associated with or containing gear lists is revised. All of the equipment and supplies listed in this SOP should be organized and made ready for the field season, and copies of the field data form in SOP #7 “Collecting, Evaluating and Summarizing Hawaiian Petrel Burrow Data” should be made on all weather copier paper.

General Preparation and Review

Data Forms and Field Notebooks

Field data forms should be prepared, reviewed and approved by the Park Lead in advance of field work. Writing should be legible in both data books and forms. If used, field notebooks for the current monitoring year should be prepared with columns indicating sampling schedules, observer names, field hours and unique activities or occurrences that may influence how the data are interpreted and reported. Field season reports are based on information recorded in field notebooks or data forms, so it is imperative that they are clearly organized and readable for ease of field note entry.

Species Lists

Observers may encounter seabird species other than Hawaiian petrels near colony sites. Reviewing field identification guides will aid in visual identification of these species, if they are seen during the day. A list of possible seabirds that may be encountered at each park can be found in Appendix S1.b of this document.

Maps

Copies of all maps are to be made on regular copy paper or weatherproof (e.g., Rite-in-the-Rain) paper prior to field work. Small field maps may be laminated to protect them from handling and environmental damage.

Global Positioning System (GPS) Units

GPS units should be made ready for the field before field work is conducted. Either rechargeable batteries should be charged, or packs of batteries should be purchased for each unit, with additional batteries for each before entering the field. Any previous data on the units should be wiped clean once it has been downloaded. Any pertinent data dictionaries should be loaded into a GPS unit by the Park Lead, a designated field person, or the I&M GIS Specialist. Field observers should read the operation manual for the unit, and even practice marking waypoints, prior to field surveys. For more details on loading location data into GPS units, see SOP #4 “Using Garmin Global Positioning (GPS) Units” and SOP #5 “Using Trimble Global Positioning (GPS) Units.”

Waypoints (set of coordinates, X and Y, that identify a point in physical space) for each known 50 x 50 m grid unit (at least two corners of each grid) to be surveyed and individual burrow locations must be loaded onto the GPS unit prior to the start of the field season.

Burrowscope

Prior to the HAVO petrel field season, contact the I&M Program to borrow their burrowscope. This property is stored at the I&M office at Qtr. 22, HAVO. A Sensitive Property Pass Form must be filled out and signed by the I&M Program Manager as part of the check out procedure. This form can be obtained from the administrative staff person at I&M. This equipment, including a camera mounted on a hose, battery and head-mounted video monitor are housed in a durable Pelican case.

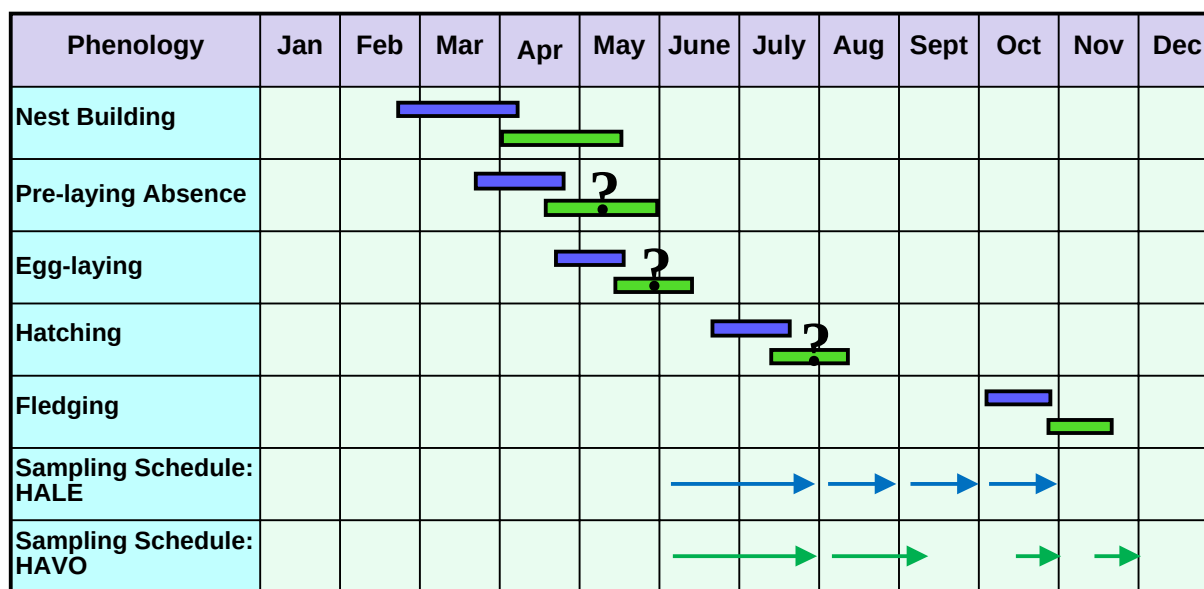
Review Previous Materials

Review available notebooks, maps, photographs, and inventory and other reports from previous surveys to identify any unique events that were and may be encountered in the current field season. Review location information about all known Hawaiian petrel subcolonies and individual burrows. This information includes UTM coordinates, marked topographic quad maps, labeled photographs, sketches, and written directions.

Scheduling Field Work***Sampling Dates***

Sampling dates should be scheduled and logistics organized well before the field season begins. Hawaiian petrel monitoring will generally begin in June at HALE and HAVO and extend no later than the last full week of November (Table S1.1), a period that includes much of Hawaiian petrel breeding activity. Burrow checks may occur prior to this time table, however, at the discretion of the Park Lead. Although it is preferable to sample at approximately the same time each year, inclement weather, personnel workloads, or slight variations in timing of breeding due to seasonal weather patterns (i.e., rainy season or hurricane season) may preclude the scheduling of sampling events to specific annual dates. Green bars with question marks in Table S1.1 indicate that the timeframe for these breeding events are inferred, based on what is known about breeding events for Hawaiian petrels in HAVO.

Figure S1.1. Hawaiian petrel breeding phenology at Haleakalā National Park (blue bars; adapted from Simons and Hodges 1998) and Hawai'i Volcanoes National Park (green bars; Darcy Hu, pers. comm.), and suggested sampling schedule.



Field Crews

Monitoring efforts within each park will require a field crew of at least two persons for collecting data and for safety reasons. The parks may possess site-specific safety requirements. SOP #3 “Safety Procedures” should be reviewed by all personnel prior to entering the field.

Organizing Supplies and Equipment

Review Equipment Lists

Equipment will be gathered, organized, and made ready prior to the field season the parks. Time to make needed repairs and order equipment should be allocated before field work starts, at least two months in advance. Appendix S1.a in this document provides equipment checklists for the activities associated with seabird monitoring. Any equipment taken into the field must first be signed out on an equipment list sheet by the person using the equipment, who will be primarily responsible for ensuring that equipment is used properly and does not receive undue damage in the field.

Field Data Forms

Review and be familiar with all fields on the Hawaiian petrel data forms. Copies of field data forms are to be made on acid-free, all-weather copier paper (e.g., Rite in the rain paper). See the three field data forms in SOP #7 “Collecting, Evaluating, and Summarizing Hawaiian Petrel Burrow Data” for procedures on how to properly fill out the forms.

Reference Materials

Review appropriate references (see Table S1.2) on Hawaiian petrels, their biology and behavior, and monitoring techniques that have been utilized for this species.

Table S1.1. Suggested reference materials by park and region.

Park or Region	Reference
HAVO	Hu, D., C. Glidden, J. S. Lippert, L. Schnell, J. S. MacIvor, and J. Meisler. 2001. Habitat use and limiting factors in a population of Hawaiian dark-rumped petrels on Mauna Loa, Hawaii. <i>Studies in Avian Biology</i> 22: 234-242.
HALE	Brandt, C. A. J. K. Parrish, and C. N. Hodges. 1995. Predictive approaches to habitat quantification: Dark-rumped petrels on Haleakalā, Maui. <i>Auk</i> 112(3): 571-579.
	Cooper, B. A. and R. H. Day. 2003. Movement of the Hawaiian petrel to inland breeding sites on Maui Island, Hawaii. <i>Waterbirds</i> 26(1): 62-71.
	Hodges, C. S. N., and R. J. Nagata, Sr. 2001. Effects of predator control on the survival and breeding success of the endangered Hawaiian dark-rumped petrel. <i>Studies in Avian Biology</i> 22: 308-318.
	Simons, T. R. 1985. Biology and behavior of the endangered Hawaiian dark-rumped petrel. <i>Condor</i> 87: 229-245.
All Hawai'i Parks	Harrison, C. S. 1990. Seabirds of Hawai'i. Cornell University Press, Ithaca, New York.
	Hawaii Audubon Society. 2005. Hawaii's Birds, sixth edition. Hawaii Audubon Society, Honolulu, Hawaii.
	Simons, T. R., and C. N. Hodges. 1998. Dark-rumped petrel (<i>Pterodroma phaeopygia</i>). No. 345 <i>In</i> A. Poole and F. Gill, editors. The Birds of North America. The Birds of North America, Inc., Philadelphia, Pennsylvania.
	U.S. Fish and Wildlife Service. 1983. Hawaiian dark-rumped petrel and Newell's Manx shearwater recovery plan. U.S. Fish and Wildlife Service, Portland, Oregon.
Pacific Islands	Pratt, H. D., P. L. Bruner and D. G. Berrett. 1987. A field guide to the birds of Hawai'i and the tropical Pacific. Princeton University Press, Princeton, New Jersey.
	Harrison, P. 1996. Seabirds of the world: A photographic guide. Princeton University Press, Princeton, New Jersey.
	U.S. Fish and Wildlife Service. 2005. Regional seabird conservation plan, Pacific region. U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region, Portland, Oregon.

Digital Camera

Digital cameras should be made ready before the field season. Batteries should be charged and memory or picture cards should be wiped clean before the next use. Field observers should review the operation manual before going into the field. Cameras are useful and often necessary for capturing pictures of survey sites, petrel burrows, flying or grounded birds, and landscapes. See SOP #12 "Managing Photographic Images" for information on how to process images taken in the field.

Portable Radios

Portable radios should be fully charged before being taken into the field. Field observers should review the operation manual and radio call numbers and radio channels before entering the field. Each observer is required to take a radio with them, especially during back-country trips. The radios are especially important as a means of communication in the event of injuries in the field.

It is also an important tool for communicating seabird observations between observers who may be some distance away from each other. See SOP #3 “Safety Procedures” for information relating to the use of radios in a field situation.

Vehicles

Vehicles should be in proper working order and the gas tank filled before going into the field. To ensure the safety of observers who may need to drive slowly along a road, a “slow vehicle” sign is suggested to be posted in the back window of the vehicle to warn oncoming vehicles. See SOP #3 “Safety Procedures” for details on the use of vehicles in the field.

Helicopter

Reservations of an Aviation Management Directorate (AMD)-approved helicopter and pilot must be made in advance. A helicopter flight plan, an AMD-approved helicopter operations manager and an AMD-approved helicopter crew must be secured prior to any helicopter trip.

Appendix S1.a. Master Equipment List for Hawaiian Petrel Monitoring

HAVO Two-person Team	
# Required	Item
2	GPS unit (Garmin or Trimble), carrying cases, extra AA batteries
2	Binoculars, one per person
2	Radios and extra batteries
1	Burrowscope
1	Kestrel weather tracker, extra AAA batteries
1	Digital camera with 256 or higher MB memory card, extra battery and memory card, or GPS camera, if available
2	Compass
Several	Mechanical pencils
Several rolls	Flagging, assorted colors
Several	Flagging on wire stakes
Several	Aluminum tags
2 boxes	Toothpicks
As needed	1-gallon bags for collecting feathers, carcasses
1 box	Latex gloves to protect hands during collection
Several	Disposable dust masks in case needed when using burrowscope
Several	Field data forms, copied on all-weather paper
One set per observer	Maps identifying roads, trails, grid units and known burrows
1 each	Copy of NPS and USFWS permits
As needed	Reference materials
2	Backpack
2	Tent, one-man
2	Sleeping bag
Several	Water bottles, 1 quart size or larger, filled with water

HALE Two-person Team	
# Required	Item
2	GPS unit, carrying case, extra AA batteries
2	Binoculars
2	Radios and extra batteries
1	Burrowscope
1	Kestrel weather tracker, extra AAA batteries
1	Digital camera with 256 or higher MB memory card, extra battery and memory card, or GPS camera, if available
2	Compass
Several	Mechanical pencils
Several rolls	Flagging, assorted colors
Several	Aluminum tags
2 boxes	Toothpicks
As needed	1-2 gallon bags for collecting feathers, carcasses
1 box	Latex gloves to protect hands during collection
Several	Disposable dust masks in case needed when using burrowscope
Several	Field notebooks, all-weather
One set per observer	Maps identifying roads, trails, grid units and known burrows
1 each	Copy of NPS and USFWS permits
As needed	Reference materials
Several	Water bottles, 1 quart size or larger, filled with water
For backcountry monitoring, in addition to above	
2	Backpack
2	Tent, one-man
2	Sleeping bag

Appendix S1.b. Seabirds That May be Encountered at Survey Sites by Park

Hawai'i Volcanoes National Park – HAVO			
Scientific Name	Common Name	Code	Local Name
<i>Pterodroma sandwichensis</i>	Hawaiian petrel	HAPE	'ua'u
<i>Puffinus auricularis newelli</i>	Newell's shearwater	NESH	'a'o
<i>Oceanodroma castro</i>	Band-rumped storm petrel	BRSP	'ake 'ake
<i>Sterna fuscata</i>	Sooty tern	SOTE	'ewa'ewa
<i>Phaethon lepturus dorotheae</i>	White-tailed tropicbird	WTTR	koa'e kea

Haleakalā National Park – HALE			
Scientific Name	Common Name	Code	Local Name
<i>Pterodroma sandwichensis</i>	Hawaiian petrel	HAPE	'ua'u
<i>Puffinus auricularis newelli</i>	Newell's shearwater	NESH	'a'o
<i>Oceanodroma castro</i>	Band-rumped storm petrel	BRSP	'ake 'ake
<i>Anous minutus</i>	Black noddy	BLNO	noio
<i>Phaethon rubricauda melanorhynchos</i>	Red-tailed tropicbird	RTTR	koa'e ula
<i>Phaethon lepturus dorotheae</i>	White-tailed tropicbird	WTTR	koa'e kea

Hawaiian Petrel Monitoring Protocol Pacific Island Network

Standard Operating Procedure (SOP) #2: Training Observers

Version 1.00

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, and identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

Abstract

This Standard Operating Procedure (SOP) outlines the requirements and training procedures that all field observers should follow to successfully complete Hawaiian petrel (*Pterodroma sandwichensis*), or 'ua'u, monitoring at Hawai'i Volcanoes National Park (HAVO) and Haleakalā National Park (HALE). Before conducting field work, observers should review the Protocol Narrative and all SOPs.

A master equipment list for the entire Hawaiian Petrel Monitoring Protocol can be found in Appendix S1.a, SOP #1 "Before the Field Season." The master equipment list should be updated if any SOP requiring an equipment list is revised.

Observer Requirements

Observers should be physically fit and fairly well versed in seabird identification. Observers should be able to drive a vehicle, use binoculars and GPS units, use maps to navigate, enter data into a field form, enter data into a computer database, operate a camera and take representative photo documentation of birds, burrows and habitat, and report on survey results.

Training

Adequate training is necessary to minimize potential bias between observers. To ensure that observers meet the minimum proficiency requirement for conducting various aspects of field monitoring, all observers are encouraged to be evaluated and only those meeting the minimum criteria should be cleared to perform field work. Training is best done by working closely with someone who has already performed and is proficient with Hawaiian petrel surveys. Currently, there are three biologists at HALE and two at HAVO who are proficient (10+ years of experience) with Hawaiian petrel surveys. Training observers for some portions of field work can be done prior to the field season. These efforts can be done to avoid interfering with the formal schedule of visits, as well as during windows of opportunity throughout the field season. Training prior to the field season should include sampling design review, and equipment familiarity. If burrows already exist, observers can be trained to identify burrows by examining existing burrows prior to the field season. This will help observers become familiar with the survey methodology and the key characteristics of 'ua'u habitat. Field training should strongly emphasize grid set up and search and methods used to identify burrows. Identification of petrel signs (e.g., droppings, footprints, feathers) is best done while petrels are present in the colony. Training time required will vary with the experience of the observer. Methods used to train observers must be consistent from one monitoring year to the next to keep observer variability as low as possible.

Training includes:

- Preparing observers to correctly identify 'ua'u activity signs around or in burrows
- Providing a basic understanding of the life history, including reproductive chronology, of Hawaiian petrels
- Identifying the habitat required and utilized by this species
- Disturbance and/or predation concerns to burrows
- Efficiently and effectively collecting field data
- Providing information on archeological sites and features in or near subcolonies, how to identify sites and features, and how to avoid or minimize disturbance
- Two or more field training sessions at a petrel subcolony:
 - During the first session (or more as needed) the instructor will show field personnel how to set up and search a grid for petrel burrows.
 - The instructor will demonstrate how to identify a burrow through various identification methods, how to determine whether a burrow is active using direct and indirect detection methods, how to set up toothpicks at the burrow entrance, how to examine nest chambers using a burrowscope, and how to record field data.
 - The instructor will also discuss cultural resources that have been or may be found near petrel burrows and how to recognize them.

Training may require a two-day to two-week period to accomplish, depending on the skills and experience of the trainee. It is recommended that a primary observer who has experience in conducting Hawaiian petrel surveys train secondary observers.

Burrow and Sign Identification

The ability to find and recognize signs of 'ua'u activity at or near potential burrows and determine nest activity is crucial to the success of this monitoring program. Therefore, observers

must become familiar with the types of signs that 'ua'u may leave near burrows (e.g., droppings, tracks, and feathers). In addition, observers must be able to distinguish the differences between 'ua'u signs from signs left by other animals. This is accomplished by partnering with experienced observers in the field, prior to and during the field season, who will assist in direct identification, and by reviewing photos taken of these indicators of activity. Inexperienced observers must be able to, with adequate training, locate and identify burrows using these signs as guides.

It is also important and necessary to review reports and other documentation of this species to understand how it behaves in its natural habitat. For example, this species sometimes leaves signs at shallow spaces under rocks that may look like 'ua'u burrows. 'Ua'u burrows are typically deep (greater than one meter). Detailed information on signs and how to collect information is further detailed in SOP#7 “Collecting, Evaluating, and Summarizing Hawaiian Petrel Burrow Data.”

Hawaiian Petrel Identification

It is rare when a petrel will be observed in the field, as most birds forage at sea during the day, returning to burrows at dusk or later. However, observers can be trained to identify the species using auditory (i.e., 'ua'u recordings) and visual methods (i.e., photos, field guides, internet searches). Other reference materials are also available (i.e., published and unpublished reports), some of which can be found in SOP #1 “Before the Field Season.” Hawaiian petrel and other seabird calls that might be heard near the petrel subcolonies have been recorded onto a CD, which is available from the HAVO and HALE Park Leads.

Leave No Trace Training

The national parks utilize Leave No Trace programs which follow ethical principles designed to help people, whether visitors or park employees, make decisions on how to prevent or minimize impacts to natural and cultural resources. The seven principles of Leave No Trace are: (1) plan ahead and prepare, (2) travel and camp on durable surfaces, (3) dispose of waste properly (pack it in, pack it out), (4) leave what you find (do not touch or remove natural objects and cultural artifacts), (5) minimize campfire impacts, (6) respect wildlife, and (7) be considerate of other visitors. As part of the HALE petrel training program, all persons traveling to Wilderness Areas at HALE must watch a Leave No Trace DVD (file name LNT3.avi), which can be viewed at the HALE Visitor’s Center and on the network server (ShData on HALE, Applications Server 1, Dell PE 2600 (Inphaleapp01):\Leave No Trace\). HAVO also has a Leave No Trace training video, available through the Resource Management office, as well as a training program provided through the HAVO Protection Division. The Park Lead at each park will provide the video to field crews during the training process, and/or other Leave No Trace training as available.

Working near Cultural Resources

Several archeological sites and features have been found near 'ua'u subcolonies (Tuggle and Tomonari-Tuggle 2008). Some high elevation areas of the park have not yet been extensively surveyed (Tuggle and Tomonari-Tuggle 2008), so it is possible that petrel field crews could encounter cultural remains before state or park archeologists. It is of utmost importance, and a requirement, that all field personnel be provided a pre-field season briefing on: (1) the location of known sites and features in relation to their survey areas, (2) how to recognize sites and features,

(3) how to proceed in the event a site or feature is found, (4) how to avoid or minimize disturbance to these resources, and (5) who to report to when a new feature is found. Some sites and features may not be easy to identify due to natural deterioration. A few features that observers may come across are briefly described below (from Moniz 2006). Photographs may be available as part of the training program to assist the field crew in identifying these and other cultural features.

- Rock Piles – loosely constructed piles of cobbles and/or boulders, which are irregular in shape
- Mounds – free-standing structures constructed of piled rocks, with convex surfaces and vertical or nearly vertical sides. Mounds are typically circular, oval or elongated in shape
- Walls – low, linear structures constructed of loosely stacked basalt rock
- Enclosures – circular, oval, rectangular or square shaped, defined by an enclosing wall
- Lava Tube Caves – large cavities formed when pāhoehoe lava flows crusted over and formed continuous roofs. Many of these caves have been modified for human habitation.
- Trails – linear features found on both 'a'ā and pāhoehoe surfaces
- Modified Pits – surface and subsurface rock has been removed to form an unnatural hole. A pit may have been widened from an existing hole or crack in the lava, or from breaking into the surface of the flow to create the pit. It may be difficult to differentiate a pit from natural areas where rocks have become loosened and dislodge from earthquakes, human or animal movements, or gravity.

Field crews should know where sites and features are in relation to burrow locations, so these sensitive cultural resources are better avoided (where possible). The park cultural resources manager will provide information to the Park Leads regarding the location of archeological sites and features that have been found near the petrel subcolonies. Locations may be provided in the form of GPS coordinates or field maps. The cultural resources manager or staff and/or Park lead will train field crews in identifying these features and their locations so the field crew is aware of their existence when they travel to burrow sites.

It is crucial field personnel know how to proceed to avoid disturbing any part of a site or feature. When working around any cultural resource:

- Respect that the area is culturally sacred to the Hawaiian people
- Avoid moving any rocks
- Place gear away from features, preferably on a solid portion of the flow or in a sandy pocket
- Avoid walking through features if you can walk around them
- When walking in or near archeological features, do so slowly, pick up your feet carefully, and avoid stepping on rocks that may be loose and dislodge
- If working in features (e.g., to investigate a potential burrow), use knee pads or a foam pad to kneel down on, and if necessary, leather gloves. Do not brush loose rocks away to clear a smooth spot to work or kneel in

If field personnel encounter a site or feature and are not sure whether it has been documented by park archeologists, some basic information about the resource should be recorded, including: (1)

a brief description of the shape and approximate size, (2) the general location of the feature in relation to local geographic features, (3) a GPS waypoint to confirm the location, and (4) photographs should be taken, but only if you can do so without disturbing any part of the feature. This information must be delivered to the park cultural resources manager upon the field crew's return to the park office.

Summary of Data to Be Collected During Monitoring

Suitable 'ua'u nesting habitat at HAVO and HALE will be surveyed annually to collect reproductive data (i.e., fledging success) and to detect changes in colony density. At these colonies, visual clues must be interpreted correctly when investigating burrows to determine the fate of birds. Density data will be collected across the park landscape in more remote areas less often (i.e., about every 5 years). See SOP #7 for details.

Additional Training

Navigating to Monitoring Sites

Monitoring sites may be located in remote areas and accessing these areas may require leaving main roads, going through gates, and walking on long trails or along steep cliffs. Each park has its own set of logistics that are required to reach petrel colonies. Maps that identify where colonies are located, and how to access them, are available through Resources Management at both parks. The Park Lead will release this information as needed to field crews.

Regardless of the park, the preferred choice is for experienced observers to show inexperienced observers how to navigate the roads, trails, and lava flows leading to sampling sites. Reviewing maps of field site locations and the pathways leading to them will provide valuable information to both first-time and repeat observers. Drivers should have a good driving record and observe all laws of the road. A safety briefing should be conducted before each trip (see SOP #3 "Safety Procedures") to help observers use precautionary measures in the field.

Global Positioning System (GPS) Use

GPS is an important tool for all petrel field work described in this protocol. To be effective in the field, observers should be able to: (1) create and store waypoints, (2) navigate to a pre-designated position using the navigation feature, and (3) create, store, download, and archive GPS data on a computer. Prior to field work, observers should review SOP #4 "Using Garmin Global Positioning System (GPS) Units" or SOP #5 "Using Trimble Global Positioning System (GPS) Units" (depending on the unit being used) to set up the GPS in preparation for data collection. Practice scenarios will help solidify techniques.

Setting Up Grids

Two-dimensional 50 x 50 m² grids will be set up at each park where Hawaiian petrel burrow searches will be conducted. As part of the training program, inexperienced observers should be involved in setting up these grids and searching for burrows. For more details on setting up grids, see SOP #6 "Setting up Sampling Units at Colonies." Once a burrow is located using visual and

other signs of activity, a waypoint is created that marks the location of the burrow, which will help guide observers when they return to the grid and burrow in later visits.

There will be instances when poor weather does not allow observers to finish searching a grid. If this occurs, it is necessary to repeat the entire grid survey to ensure no active burrows were missed. Repeating the grid survey could give NPS insights into searcher efficiency at finding nest entrances, so if a burrow has been found once, observers can see how long it takes to identify it again. Experienced observers should test inexperienced observers in relocating burrows within a grid, especially if some time has elapsed between visits. Observers will repeat certain grid surveys throughout the breeding season (e.g., legacy burrows) to determine the reproductive success of active nests.

Taking Photographs

An extremely important aspect of this monitoring program is to document what is observed at and near Hawaiian petrel colony sites, both through written and photographic records. Digital photos of burrow entrances, visual signs, and nearby landscape features are an important supplement to written records. Photographs should be taken of every nest site as it is discovered, which will become a permanent record for that site. There is a lot of variability of burrow entrances from one nest site to another (one site may have only one entrance, another may have three). If there are hundreds of these sites being monitored in one season, and between one season and the next, photo documentation becomes an even more important and necessary way to identify all the nesting sites. GPS waypoint data helps observers find the general location of already discovered nest sites, but there may be a location accuracy error of several feet on the GPS unit. Therefore, visual records of vegetation (especially at HAVO where it is sparse), other nearby landscape features, and burrow features will be very useful in subsequent visits to the nesting sites. Photos of each site can then be taken into the field, along with written records.

Field observers should have a basic understanding of how to operate a digital camera and download the images to the appropriate database and/or file on a computer. Prior to surveying, observers should read the user manual and practice taking photos. Tips can be gleaned from experienced observers to optimize photo images. SOP #12 “Managing Photographic Images” describes the procedures used to manage, download and store digital images taken in the field.

Data Management

Computerized data entry and management will require standard computer and data entry skills for MS Access and/or Excel. Observers that will be entering data should have an understanding of database design, data entry steps, archiving methods, and metadata procedures. Training may involve entering data jointly with an experienced data manager. Observers should review SOP #13 “Data Entry and Verification,” SOP #14 “Post-season Data Quality Review and Certification,” and SOP #15 “Metadata Development” for details.

Analysis and Reporting

Standard computer skills are necessary when analyzing data or reporting results, especially in the programs MS Word, MS Access, and Excel. Data analysis and reporting should be done under the direction of experienced field observers and/or the Park Leads. Previous reports may be reviewed and writing may be done jointly with experienced individuals. For all NPS-prepared

reports, report preparers should review I&M's report format and distribution requirements. See SOP #17 "Data Analysis" and SOP #18 "Reporting" for details.

Literature Cited

Moniz, J. 2006. Hawai'i Volcanoes National Park feature definitions. National Park Service Unpublished Report, Hawai'i Volcanoes National Park, Hawaii.

Tuggle, H. D., and M. J. Tomonari-Tuggle. 2008. Archeological overview and assessment and research design, Hawai'i Volcanoes National Park. International Archeological Research Institute, Honolulu, Hawaii.

**Hawaiian Petrel Monitoring Protocol
Pacific Island Network**

**Standard Operating Procedure (SOP) #3:
Safety Procedures**

Version 1.00

Revision History Log:

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Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, and author of revision, and identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

Abstract

This Standard Operating Procedure (SOP) explains safety procedures that all Hawaiian petrel observers should follow when working in the field to ensure optimum safety. A portion of this SOP covers material found in the Pacific Cooperative Studies Unit (PCSU) Hawaii's SOP (2008) for field operations. This SOP also discusses the importance of Job Hazard Analyses (Appendix S3.a), covers material provided to PACN I&M staff during a Wilderness Hiking and Backpacking Training workshop in January 2007 (Appendix S3.b), and provides a written examination (Appendix S3.c). The answer sheet for this examination is available at the I&M office, Hawai'i Volcanoes National Park (HAVO).

Safety Procedures

This protocol recommends that Hawaiian petrel field personnel examine the following procedures, before working in the field, to ensure all safety procedures are understood and followed. These field safety rules and regulations are meant to ensure the safety and well-being of all field workers.

All participants should also be familiar with the NPS Reference Manual #50B, Occupational Safety and Health Program: <http://www.nps.gov/policy/RM50Bdoclist.htm>.

Field Personnel Rules and Regulations

1. Always be safety-oriented, not mission oriented. Safety must be the overriding factor on determining whether or not to proceed with the mission.
2. Prior to conducting field work, supervisors and field personnel should conduct a Job Hazard Analysis (JHA) for their situation (see Appendix S3.a for details and example forms).
3. Only staff and approved field crew are allowed to assist with field work. Friends, pets and children are prohibited from accompanying field teams. Employees of state and federal agencies on official business connected with the project may accompany people working in the field. Always consult with the Park Lead if you are uncertain regarding someone's eligibility to accompany you in the field.
4. Field personnel must avoid working in the field alone. Notify a park contact person or supervisor if you need to travel by vehicle alone during working hours, but personnel should not traverse trails or difficult terrain by themselves. Whatever the case, ensure that someone knows where you are and when you are expected to return. Take a radio and cellular phone if you will be working off the road or in a remote area.
5. When working in the sun, always wear a hat and a pair of sunglasses to protect yourself from harmful ultraviolet rays. You should also use a sunscreen lotion on exposed skin.
6. Be aware of weather forecasts and unexpected changes in the weather, and be prepared to alter field work and field clothing accordingly.
7. Learn how to lift heavy objects properly. Ask for help when lifting heavy objects.
8. The on-site supervisor will make decisions concerning safety of field personnel. An individual may refuse to engage in what they believe is an unsafe operation.
9. It is the employee's responsibility to notify the supervisor regarding any health problems that might put the employee at additional risk of injury in the field. Such problems include fever, aches, fatigue, colds or other ill health, as well as allergies and other long-term and chronic health concerns.
10. Any injury incurred on the job will be reported to the supervisor IMMEDIATELY. Failure to report injury may result in the denial of workers compensation claims and/or disciplinary action.
11. Vehicles must be operated safely and in a manner consistent with Standard Operating Procedures for Vehicles for the agency whose vehicle you are driving. You should ask your supervisor for a briefing on the procedures before you operate the vehicle for the first time.
12. Field work will be planned ahead of departure and discussed with the Park Lead. On a daily basis, a contact person (and Park Lead if not part of the field crew) at the Resource Management office will be notified of the itinerary and destination (i.e., specific area/strata in the park) of the field crew and the estimated return. The contact person is responsible for notifying Dispatch and a Safety Officer if a field person is missing or injured.
13. A backcountry permit must be filled out at the Visitor Center prior to any backcountry or overnight work. Provide the camp waypoint, if known, cell phone numbers, radio call number and emergency contact in the RM office.
14. Give park Dispatch, the Park Lead and RM contact person a brief written itinerary of field activities. Each day when in the field, the field crew must call Dispatch when setting out from camp or the trailhead to the backcountry, and must call again when back at camp.

15. Notify Dispatch and the Visitor Center when the field crew has hiked out of the backcountry.
16. Notify the RM contact person and the Park Lead when the field crew is back in the office.
17. You must know the Emergency Action Plan.

Emergency Action Plan

1. The contact person at RM is responsible for making sure that an emergency alert and/or process is initiated if field personnel do not return when scheduled or no radio or cell phone contact is received from the field at the expected call-in time.
2. Personal cell phones and work cell phones should be called if the crew does not call in as planned, as field crews may be reachable even in very remote locations.
3. If the contact person cannot reach the field crew, she or he should call dispatch to determine when the field crew called last.
4. Thirty (30) minutes after the call-in time, an alert is issued. The Chief of Resources Management and the petrel Park Lead should be notified immediately that the field crew is overdue. The contact person or another person should stay near the phone in case field personnel call in.
5. One hour from the call-in time, search procedures should begin.
6. One person should remain near the phone, and one person familiar with the field area should begin tracking the scheduled route.
7. The tracking person should have a radio and/or cell phone and call back to the office every 20 minutes to see if field personnel have made contact.
8. Tracking continues until the field crew is found or word is received that the field personnel are safe.

Emergency Response Plan

1. If an emergency arises and a call must be placed to 911, be sure to give the following information: name, location of emergency, type of emergency and type of help required.
2. Notify any supervisory personnel and provide them with the same information.
3. If you are working in a national park, notify the local manager.
4. If 911 cannot be reached because access to a landline is not available, follow the park's emergency procedures for contacting emergency personnel via radio (e.g., Park Dispatch, Park Headquarters, your supervisor).

Safety Clothing and Equipment

1. Field personnel shall wear sturdy boots that provide ankle support and traction. Sturdy sneakers may be allowed if terrain is not very rugged. Bare feet, other shoes, and slippers are not allowed.
2. Rain gear and outerwear (i.e., sweater or jacket) shall be carried in the field at all times in wet forests or other locations. Rain gear includes rain pants and rain jacket. The combination of clothing must be adequate to keep the worker warm and reasonably dry until returning from the field or reaching field shelters, or for surviving an extended, unplanned stay overnight in the field.
3. Each field person shall carry water on their person in the field in canteens or other suitable containers. Sufficient water shall be carried for unplanned, extended emergency stays overnight in the field.

4. Each field person shall carry on their person a First Aid Kit while in the field. Additionally, each vehicle should carry a fully stocked first aid kit and a survival kit.
5. There shall be one individual per field crew with current Standard First Aid and CPR certificates.
6. Each person working in the field should have a box of matches (kept in a ziplock bag), a space blanket, a whistle and a flashlight or headlamp in their pack.

Travel on Foot

1. Wear proper clothing and footwear.
2. Always carry a first aid kit, radio and water.
3. Be sure that equipment and supplies are carried in a manner consistent with safe travel over rough terrain. Backpacks should be in good repair and fit properly. Do not overestimate your load capacity.
4. Always be aware of what's around you (on ground and overhead). Rocks underfoot can shift. Stay far enough back from the person in front to avoid branch whiplash.
5. Be conscious of surroundings – when disoriented, familiar objects can set you on track. Even if you have a GPS, carry a compass as backup and an area (field) map showing locations of pertinent transects, roads and trails, and other landmarks, especially in unfamiliar surroundings and/or when fog, rain, or darkness can set in.
6. Observers should traverse their expected path during the day, before traversing the terrain at night.
7. Always be sure someone at the park knows where you are and when you are expected to return.
8. Never overextend your capabilities.
9. Be sure permission is GRANTED before entering private property.
10. Report accidents immediately to your supervisor.
11. If you do get lost or become disoriented STAY WHERE YOU ARE. You may be overcome by panic. Sit down and quietly organize your thoughts on where you are. A few moments of recollection may clarify your situation. If not, find a comfortable place to rest. Use your whistle or other means to attract the attention of anyone around you. Do not try to leave the area if there are no signs of where to go. Do not follow a stream down hill, as it will almost certainly go over a waterfall at some time. Do not travel at night.
12. Reviewing hiking procedures, such as the RCUH-PCSU-U.S. Army Hiking and Backpacking Techniques in Appendix S3.b in this document.

Portable Radios

The most important thing that field observers should know about a portable radio is that it is a communication tool that helps to ensure the safety of personnel in the field. Portable radios allow other staff in the park to know the location and status of the field crew. Because observers often work off-trail in the park backcountry and hike over uneven ground, slopes, and near cliff edges, the radios are especially important as a means of communication in the event that injuries are incurred. The radios also provide an invaluable tool for communicating Hawaiian petrel observations (on a separate channel) if observers are some distance apart. Hawaiian petrel observers should have a working knowledge of the protocols for communicating with the radios, and a basic understanding of how to use them. Specific procedures for using radios effectively

and appropriately for each park can be found in the Hawaiian petrel protocol file cabinet in the I&M Office, Qtr 22, HAVO.

1. Read and review the user guide for the portable radio, if available. A manual provides a good introduction to the terminology and use of the radio model. Also review the radio call numbers and radio channels. Observers should photocopy the list of radio call numbers and take it in the field as a reference.
2. Whenever the portable radio is not in use, make sure that the unit is turned off (with the on/off volume control dial turned as far counterclockwise as possible) and charging in a battery charger. Chargers are available in the I&M or park resource management office, and should be assigned to observers at the beginning of the field season or sampling session.
3. At least one portable radio or cellular phone shall be carried by each field team. Additional radios or cellular phones will be carried if field persons will be out of sight and earshot of one another.
4. Before going into the field, take an extra battery from a charging unit, in the event that the battery in the radio loses its charge while in use. Make sure the extra battery fits the radio.
5. Before traveling into the field at **HAVO**: You must call park dispatch – the dispatch station through which all travel plans in the park should be documented – and let them know your plans in the field, and your estimated time of arrival (ETA) back at your departure point.
 - a. Perform a radio check before leaving the office.
 - b. Perform a radio check with the park headquarters when staying overnight in the backcountry to establish a location where contact is possible.
 - c. Establish radio contact procedure for contacting frontcountry field work
 - d. During your time in the field, keep the radio on with the volume loud enough that you can hear and respond to any communications directed at your radio call number.
 - e. When you are returning from the field, contact dispatch again to let them know you are safe.
6. Before traveling into the field at **HALE**: On the day of departure, you must contact the resource management office to provide details about the planned field work.
 - a. Perform a radio check before leaving the office.
 - b. Perform a radio check with the park headquarters when staying overnight in the backcountry to establish a location where contact is possible.
 - c. All staff members must be back in the office at least one hour before the end of the work day.
 - d. If staff will return late, they must contact the office via radio or cell phone.
 - e. During backcountry trips, staff must contact the RM office via radio at 3:00 pm, daily.
 - f. On the day of departure from the backcountry base site, staff must contact the RM office 1 hour prior to departure.
 - g. If emergencies occur after hours, staff must contact Haleakalā Dispatch via radio.
7. After signing off with dispatch, drain batteries before recharging to maintain battery life and “memory”
8. Return radios to charger units, and make sure the radios are turned off while charging. Return the extra batteries to the battery chargers.
9. Monitor radio traffic and think out your communication before you transmit. Be brief.
10. Be careful about carrying your radio in your back pack or wearing it while using the seatbelt in a vehicle. The radio key could be activated by the pressure of your seat belt or something

in your back pack that will not allow anyone else to use the radio. Also, everyone in the park with a radio on can hear what you might be talking about or other noises related to what you are doing. Having the radio key activated will keep the system out of use for other traffic, including emergencies.

11. Protect radios from moisture, dust and hard impacts.

Driving Vehicles (both 2WD and 4WD)

1. Vehicle operators must have a valid driver's license before driving any vehicle, whether on the road or off-road. Persons not experienced in 4-wheel driving may require training in off-road driving.
2. Always carry emergency equipment (i.e., first aid and basic survival kit and car jack).
3. Always be sure someone in the park knows where you are going and when you are expected to return.
4. On private land the owners and their workers have the right of way. Drive slowly so as not to kick up dust.
5. Any vehicle being used to reach sampling sites should be inspected prior to use. Check fluids, tire pressure, windshield wiper blades and water. Test 4WD before leaving base yard area.
6. Report any vehicle problem immediately to the supervisor and maintenance.
7. Report accidents to your supervisor immediately.
8. Obey the rules of the road even when driving off-road.

Helicopter Safety

1. All helicopter activity must be conducted in accordance with NPS Director's Order 60 (<http://www.nps.gov/policy/DOrders/DO60final.pdf>) and NPS Reference Manual 60 (http://www.nps.gov/fire/download/fir_avi_RM60.pdf).
2. A project flight plan must be filled out and approved.
3. Helicopter, pilot and crew-members must be AMD-certified.
4. Mishap and emergency procedures must be developed.
5. If you will be a passenger (a passenger is defined as any person aboard an aircraft who does not perform the function of a flight crew member) in a helicopter for work-related activities (i.e., Hawaiian petrel monitoring at HAVO), you are required to take an 8-hour Basic Aviation Training (B-3 Safety Training) provided by the Aviation Management Division of the National Business Center.
6. All DOI employees are required to take their initial B-3 training in the classroom. Web-based training modules can be used if refresher training is needed (see the Interagency Aviation Training website for online modules at <https://www.iat.gov>).
7. RCUH/PCSU personnel involved in work that requires use of helicopters must have completed the IHOG (Interagency Helicopter Operations Guide) basic Helicopter Safety Course or a similar approved course within the last three years. All field workers involved in sling-load helicopter operations must have also completed the appropriate course within the last three years.
8. All personnel involved with helicopter operations must use the appropriate Nomex flight suits, gloves, hard hats with chin straps or helmets, leather boots, and other prescribed protective and safety clothing.
9. See your supervisor for details about participating in this training program.

Pathogenic Contact

All persons working in field conditions should be aware of potential pathogenic hazards that could be encountered. Indirect contact with birds and mammals (through their dropping and urine) may occur, leading to a risk of pathogenic exposure.

The best protection from pathogens we may encounter in the field (e.g., bacterial disease that causes leptospirosis, parasites that cause toxoplasmosis and viruses that cause Hantavirus) is to protect hands by using sterile latex gloves before handling live or dead birds, eggs or related materials (e.g., feathers, shell fragments, or guano), and wash hands thoroughly with soap and water, antibacterial gel, or disinfectant wipes as soon as gloves are removed and also before eating. Hand gel and disinfectant wipes should be available in all field first aid kits.

There is a known risk of leptospirosis in Hawai'i. This is a bacterial disease (*Leptospira* spp.) transmitted in the urine of an infected animal. Several mammalian species including rats, mice, dogs, cows, sheep, pigs, cats, and humans can be carriers. The bacteria can survive long periods of time in fresh water and mud and can enter the body through the eyes, nose, mouth and broken skin. Animals that lick the urine of infected animals off the grass or soil, drink from an infected pool of water, or eat contaminated food, can become carriers. It is inadvisable for humans to drink or swim in potentially contaminated water (i.e., streams and ponds).

Leptospirosis often begins with flu-like symptoms, causing fevers, chills, muscle cramps severe headaches, rash, abdominal pain, diarrhea, and vomiting. In humans, symptoms appear after a 4-14 day (may be longer) incubation period.

Hantavirus is a rare, but frequently fatal, viral illness that continues to be diagnosed in many parts of the country. It is carried by the deer mouse in the western United States. According to the Centers for Disease Control (CDC), "early symptoms include headache, chills, dizziness, non-productive cough, nausea, vomiting, and other gastrointestinal symptoms in addition to fever." Staff should immediately seek care if they develop these symptoms within 45 days of contacting rodents, rodent nests or rodent burrows. Human infection may occur when infective saliva or excreta are inhaled as aerosols produced directly from the animal, or after being bitten by an infected animal.

Toxoplasmosis is a parasitic disease caused by the protozoan *Toxoplasma gondii*. This protozoan can cause subclinical infections and mortality in warm-blooded animals, including birds. In the Pacific Islands, feral cats are the only known definitive hosts (Work et al. 2002). Both native and introduced birds, such as the nene goose, Hawaiian crow, red-footed booby and Erckel's francolin act as intermediary hosts when they come in contact with or ingest the oocytes in cat feces (Work et al. 2002). Humans that come into contact with traps used in predatory control, or conduct fieldwork in areas where feral cats have been seen, should be particularly careful to avoid hand-to-mouth contact to prevent accidental ingestion of fecal oocytes. Symptoms include fever, sore throat, swollen glands in the neck, armpits or groin, sore muscles and tiredness, and some people experience temporary blurred vision or loss of vision.

Cuts and Scratches

An open cut may become infected easily under field conditions, therefore all scratches and cuts should be given appropriate attention, such as disinfecting and bandaging, and any injury should be monitored. Antibacterial cream, such as Neosporin, may be applied to reduce swelling and ease pain. Persons with serious injuries should seek professional medical attention as soon as possible.

Avoid entering freshwater if you have breaks in the skin, due to the potential risk of leptospirosis infections.

Exposure during Field Work

An open cut may become infected easily under field conditions. Therefore all scratches and cuts should be given appropriate attention, such as disinfecting and bandaging, and any injury should be monitored. Antibacterial cream, such as Neosporin, may be applied to reduce swelling and ease pain. Persons with serious injuries should seek professional medical attention as soon as possible.

Avoid entering freshwater if you have breaks in the skin, due to the potential risk of leptospirosis infections.

If You Become Ill

If you come down with flu-like symptoms after working in or wading through water, or in muddy conditions, visit a doctor and explain that you have been working in the field monitoring Hawaiian petrels and may have been exposed to zoonotic diseases such as leptospirosis. If you come down with any severe fever or other symptom, ask your doctor to consider whether there are any unusual diagnoses that should be considered because of your fieldwork. If you are diagnosed with an illness related to your work environment, notify your supervisor(s) immediately. This will allow the supervisor(s) to take the proper course of action for preventing further exposure to the zoonotic disease.

Appendix S3.a. Job Hazard Analysis

1. Prior to conducting field work, supervisors and field personnel should conduct a Job Hazard Analysis (JHA) for their situation (see an example form below).

JOB HAZARD ANALYSIS		Date: October 29, 2007	☒ New JHA ☐ Revised JHA
Park Unit: Haleakala National Park	Division: Resources Management	Branch: Endangered Species Management Program	Location: Crater District
JOB TITLE: 'Ua'u monitoring		JHA Number: ESM-08-UAU	Page <u>1</u> of <u>4</u>
Job Performed By: ESM Staff	Analysis By: ESM Staff	Supervisor: Cathleen Bailey	Approved By: Cathleen Bailey
Required Standards and General Notes:	Risk assessment training. Orientation to 'u'au burrow checks. Basic first aid/CPR		
Required Personal Protective Equipment:	Hiking boots, protective clothing, rain gear, sunscreen, sunglasses.		
Tools and Equipment:	Headlamps, flashlight, radio, binoculars, flagging, metal tags, first aid kit		
Sequence of Job Steps	Potential Hazards	Safe Action or Procedure	
Prepare for the day in the field	• Having a mission oriented attitude	• Conduct risk assessment to determine "go or no go." • <u>Prepare for day in the field:</u> • Prior to going out in the field, create a plan for the day and make sure you have proper equipment. • Have a plan in case weather deteriorates or if incident occurs. • Monitor and assess weather conditions; do not go out in the field in adverse weather conditions (storms, strong winds, heavy rain, etc.), especially in off-trail areas. • Assess physical and mental condition; do not go out in the field if you are not physically or mentally capable or prepared. • Pack a radio and turn it on. • Pack sunscreen, sunglasses, and a first aid kit. • Pack maps as needed.	

2. A JHA is a training and evaluation tool that focuses on job tasks as a way to identify hazards before they occur. It focuses on the relationship between the employee, the task, the tools and the work environment.
3. A JHA helps all employees to analyze their jobs and recognize workplace hazards that, if left uncontrolled, could result in injury or illness.
4. List, rank and set priorities for hazardous jobs. A supervisor or other responsible staff person will provide input during this process. There are four basic steps to take when conducting a JHA:
 - a. Select the job to be analyzed,
 - b. Break the job down into a sequence of steps,
 - c. Identify potential hazards, and
 - d. Determine safe actions or procedures to overcome these hazards.
5. Good hazard scenarios describe where it is happening (environment), who or what is it happening to (exposure), what precipitates the hazard (trigger), the outcome that would occur should it happen (consequence), and any other contributing factors.
6. Separate from the JHA form is a JHA booklet (see example below), which is filled out by individual employees as tasks are performed in their work environment. This is a learning tool to assist employees in identifying potential job hazards in the tasks they are undertaking.



Job Hazard Analysis Form
Endangered Species Management Program
Haleakalā National Park

Date 12/5/07	Task office work, computer data, misc office errands
Potential Hazards - Eye, back, wrist strain - Dehydration - Clutter in work space - Cold weather	
Precautionary Actions - Take breaks, hydrate, eat snacks - Keep work area clear - Wear warm gear - Maintain good posture	
Reviewed with (signatures, at least 2 others) <u>David P. Hanna</u> <u>David P. Simmons</u> _____ _____	



Job Hazard Analysis Form
Endangered Species Management Program
Haleakalā National Park

Date 01/02/08	Task Backcountry - predator control, Nene monitoring, pest control
Potential Hazards - Uneven, wiggled terrain - tripping/falling - Weather - hypothermia, wind blows, rain - Dehydration, hunger - Sun burn	
Precautionary Actions - Take breaks, hydrate, eat - Sunscreen, sunglasses - Warm gear, raingear, gloves - Pack properly	
Reviewed with (signatures, at least 2 others) <u>[Signature]</u> <u>David P. Simmons</u> _____ _____	

Appendix S3.b. Hiking and Backpacking Techniques (RCUH – PCSU – U.S. Army)

Worker injuries, in addition to causing physical harm, directly impact projects by reducing personnel and funds available for project research. Over the past 4+ years, PCSU worker injuries have accounted for 42% of claims, and 35% of costs within the RCUH system. Of those PCSU losses, 35% of claims, and 31% of costs resulted from hiking injuries.

Although most workers may possess varying degrees of wilderness hiking knowledge and experience, and the act of wilderness hiking or backpacking may seem obvious and simple without many hazards, it should not be taken for granted. The majority of PCSU injuries result from slips, trips, and falls while hiking. Just like any other work activity, the hazard exposures must be identified, safe procedures and techniques must be developed, and workers must be trained to perform this task safely.

This training program is designed to insure that workers are aware of the hazards, and knowledgeable of the procedures and techniques, for safely hiking and backpacking in wilderness areas. A written examination for hiking and backpacking techniques is available in Appendix S3.b.

Section 1

What are our individual levels of physical conditioning, knowledge, and experience for wilderness hiking and backpacking?

Personal (Non-Work Related):

• Years of experience • Types of terrain and elevation changes • Climate and environmental conditions • Length and duration of hikes • Types of gear utilized • Amount of weight carried • Types of physical conditioning • Types of wilderness activities • Participation in and training or certifications from hiking/climbing organizations

Work Related:

• Years of work experience • Types of terrain and elevation changes • Climate and environmental conditions • Length and duration of hikes • Types of work gear utilized • Amount of weight carried • Types of work-related physical conditioning • Hiking certifications or training from employers • Involvement in wilderness work activities requiring hiking

Section 2

What are our specific work activities that involve hiking and backpacking?

• Rare Species Monitoring and Surveying • Bird, Plant, Mammal, Invertebrate Surveys • Invasive Plant Eradication • Ungulate and Predator Control • Fence Construction • Other Project-Specific Activities

Section 3

What are the hazards involved in our hiking and backpacking activities?

- Lack of physical conditioning

- Improper footwear
- Carrying backpacks
- Carrying hand tools and equipment
- Improper protective eyewear
- Slips, trips and falls due to uneven terrain
- Ascending, descending, or traversing hillsides
- Abrupt ledges and cliffs
- Grass or brush-concealed rocks, holes, roots, forest debris, drop-offs
- Brush and other low-growing vegetation
- Lava tubes and tree molds (Hawai'i)
- Broken, jagged lava flows (Hawai'i)
- Logs
- Slippery mud
- Loose rocks
- Footing conditions while hiking alongside or crossing streams
- Flash flood hazards while hiking alongside or crossing streams
- Falling limbs and trees in windy conditions
- Extreme weather: Lightening, heavy rain, windstorm, or misty or foggy conditions
- Fatigue and heat stress
- Dehydration
- Disorientation
- Hypothermia
- Over-confidence
- Lack of communication and a daily check-in procedure
- Poor time management resulting in a rushed schedule or return in darkness
- Being unprepared as far as needed gear, and mental readiness for the daily challenges and unplanned circumstances

Section 4

What are the procedures and techniques utilized to mitigate hiking and backpacking hazards?

- Physical conditioning is the key critical element in performing hiking tasks, especially when additional weight, such as backpacks, tools, or equipment is to be carried, and the terrain is steep. Lack of conditioning may lead to fatigue and poor judgment in executing safe hiking procedures.
 - “Buddy System” – Always work in the field with a Buddy.
- Always be prepared for the day’s tasks, mentally, physically, and with the proper equipment. At a minimum, all staff should have first aid kits, field maps, cell phone, pager, radio, raingear, lunch, and water.
- Always conduct a hiking hazard safety briefing with crews prior to starting the hike.
- High-visibility bright colored clothing is required for all field operations to more readily locate workers in the wilderness. Long and short-sleeved shirts are provided for all workers by their project unit.

- Good footwear is essential for hiking safely. Proper footwear will provide good traction, firm ankle and arch support, protection from sharp tools, and general comfort. For hiking in steep, muddy, wet, or loose terrain, lace-up boots that are a minimum 8" (20cm) high with lug soles are required. It is important that footwear fit properly, be worn with appropriate socks, and be "broken in" to prevent blisters. Footwear must be maintained in good condition, and periodically inspected, especially the soles, to maintain skid resistance.
- Backpack fit and comfort improve hiking safety. An ill-fitting pack can result in short and long term back pain and injury. For a good fit follow these tips:
 - Use a pack with wide, padded shoulder straps.
 - Make sure the straps are long enough.
 - Ensure that the pack properly fits your torso and stays contoured correctly along your back.
 - Never put more weight in a pack than you can comfortably carry. (Never exceed 1/3 of your body weight.)
 - Position your pack low on your back. Wearing your pack too high can increase shoulder and neck pain.
 - Adjust the hip-belt correctly. Your pack should rest right above your hip bones. For smaller packs, the hip-belt serves to reduce bouncing. It helps keep the pack comfortably in place. For larger packs, the hip-belt also helps distribute the weight load more evenly.
 - Use both straps to carry your pack.
 - Typically, if you are able to stand up straight and comfortably when using your pack, you have a good fit.
 - Use a sternum strap to position shoulder straps in the correct position.
- Knowing how to pack your backpack can also improve comfort and safety. Follow these packing tips:
 - Distribute the weight throughout your pack.
 - Most heavy items do best toward the middle of your pack, closest to your back, or toward the bottom for a lower center of gravity.
 - With too many heavy objects toward the top or outside of your pack, your posture will shift to accommodate the added burden.
 - Pad bulky items (i.e., tools and equipment) well so they don't stick out and irritate your back.
 - Secure the hip-belt to help distribute weight more evenly.
- Always carry tools and equipment on the downhill side of the body. Tools should be sheathed while walking, unless they are needed for clearing vegetation (i.e., pruning saw). Never carry loads that require use of both hands; instead have two persons carry them or use a backpack or pack frame. Long pieces of equipment, are best carried by two persons.
- Wear tempered sunglasses, safety glasses, or goggles whenever there is a chance of eye injury. The project provides safety glasses for eye protection which is required in areas with thick vegetation and in dusty environments.
- Maintain safe walking and working distance between people (10' min.) to avoid being struck by branches and tools. Stagger out across slopes such that people are not directly below other personnel higher on the slope. Be sure other workers in the vicinity know where you are. If something comes loose from a slope, warn others by yelling "ROCK!!!"

- The majority of injuries involve slips, trips and falls. When negotiating the hazards of uneven terrain and hidden ground surface hazards, either on or off designated trails, watching where you step is most critical as this can prevent 99% of slip, trip and fall incidents. If work tasks require observation of items or areas other than the path you are walking, make periodic stops to conduct your observations, and then resume your travel with a focus on the path in front of you. Never look at the forest canopy while walking.
- Always examine the ground ahead of where you are walking, and test and use secure footing. Plan ahead, select safe routes, and be alert to changes in ground surface, slick spots, or unusual hazards. Select each stepping spot carefully, and do not shift body weight until you are sure the spot is solid.
- In heavy undergrowth, lift your knees high to clear obstacles. Slow down and exaggerate steps in the area of exposed roots to keep from catching your toes.
- Watch for and avoid lava tubes, earth cracks, and tree molds when walking through forest, shrubland, and grassland. Walk slowly and test footing. Uluhe fern is very effective at concealing holes and cracks, so be especially careful when walking in areas covered by uluhe.
- Avoid walking on logs because they can be deceptively slippery. Step over small logs. If you must cross a large log, sit on it and swing your legs over one at a time. If stepping on a log is unavoidable, test the footing first before shifting your full weight to the log. Walk slowly.
- When contouring a steep slope, do not lean into the hill. This tends to loosen footing. Erect posture, or slightly leaning out, gives more secure footing.
- When moving uphill or in sandy soils, lean slightly forward, turn feet outward, shorten stride, and use as much of the inside of the foot as possible. Another technique is to toe into the slope by kicking your toe in and creating a step
- On slippery, loose ground, or going downhill, keep most of your weight on your heels. Shorten your stride, keep knees bent, and lean slightly backward. Make sure of secure footing and safe working positions. Walk – never run down slopes.
- Rocky slopes, especially loose rock and steep country, are treacherous. Have one hand free, preferably on the uphill side, for protection against falls or obstructions. Always carry tools on your downhill side.
- When slipping, lean into the slope and grasp for things to help arrest your descent. Do not lean out away from the slope, as this may result in a head over heels tumble.
- If you feel yourself slipping, pick a landing spot. Even before this, as you traverse a steep area, survey the area and look for good landing spots.
- Know how to fall to avoid hard impacts. Keep flexible with knees slightly bent. This helps your legs act as a shock absorber. Sit down if you begin to slide, or roll with the fall.
- Carry webbing for use when hiking or working in steep environments. Be conservative when deciding to use webbing. Remember, it is always easier to go up, than down.
- Do not stick your arms out to break a fall from a log or on level ground. Keep your arms slightly bent in front of your head. Protect your head and back.
- “Curse your fall.” This means shout out an exclamation as you fall. This ensures you exhale as you land, which in turn releases air from your lungs. This can help minimize damage to your internal organs.

- When crossing streams, scout the area to determine a safe spot to ford the stream. Avoid crossing where the water is knee high or higher. Do not cross on logs that span the stream. Do not attempt crossing during heavy rainfall or if upslope thunder has been noted. Walk slowly and deliberately to allow for proper evaluation of upcoming terrain in order to avoid any potentially dangerous obstacles. Place your feet carefully in firm footholds. Avoid loose rocks, high water flow, slippery rocks, and overly steep or muddy terrain. When climbing rocks or crossing rocky areas attempt to have three points of contact at all times and keep your center of gravity low. A wading pole is required to aid in balance and exploring for drop off's. Appropriate footwear with traction (tabies, or shoes with a felt or nylon sole, lace-on oversoles, or bonded carpeting sole) should be used for stream work. If wearing a non-quick release backpack, slip off the upstream shoulder strap so the pack can be discarded in an emergency situation.
- Reliable weather reports should be obtained for the areas that influence the streams or river beds in areas where work will be conducted, prior to leaving for the field. Avoid working in flooded areas or where water is moving swiftly. Cancel work activities during or following storm events that would compromise the safety of such activities. Be aware of quick weather changes, especially upslope of stream sites (excessive rain, although it may be sunny at the site). Be alert and listen for signs of a flash flood. Any sudden increase of debris, muddy water, or a low roar of thunder are indicators of a possible flash flood. Leave yourself with exit routes in the event of flash flooding.
- Always be on guard against injury from falling trees, snags, limbs, rolling logs or rocks. Never run blindly if a rolling rock, log, or tree is heard. Try to determine the direction of fall, and then move out of the path.
- Do not enter the forest during a lightning storm. If a lightning storm is heard approaching, leave the forest and get into the vehicle. If a lightning storm is occurring while you are still in the forest do the following:
 - Put down all tools.
 - Do not use the cell phone or radio.
 - Do not lean against a tree.
 - Get off of ridges and hilltops, and avoid open spaces, ledges, outcrops of rock, and other exposed locations.
 - If you feel your hair standing on end or your skin tingling, lightning may be about to strike you. Squat down immediately, keeping the soles of your feet flat on the ground and curl into the smallest ball possible.
- Avoid fatigue and heat-stress. Plan long-distance foot travel for the cooler hours of the day. Stop for frequent rest periods of at least 15 minutes to cool down and drink water, especially if carrying heavy loads. Keep hydrated and include in meals and snacks potassium-rich foods, such as bananas and citrus fruits. Avoid high-protein foods (meats) which increase metabolic heat production and water loss. Wear lightweight, light colored, loose, clothing. During periods of continued extreme temperatures, monitor each other and watch for signs of heat-stress disorders.
- Prevent dehydration. Carry 2-4 liters of water for the day – more if the day is going to be hot. Take drinks regularly so that normal urination patterns are maintained. Keep a reserve quart in the vehicle for use on the return to base. Don't drink stream or ponded water without first filtering and treating to eliminate harmful organisms (e.g., giardia and leptospirosis).

- Avoid disorientation. Always remain within verbal hailing distance of another crewmember. Always carry and know how to use a compass and a site map that shows true and magnetic north relative to the study area and the location of the parked vehicle. Orient yourself at the parking area and at intervals as you walk through and work in the forest. Trust your compass. Turn on, carry, and periodically test operability of field radios among crewmembers. Check in with Base at lunch, and at the end of the day. Carry charged replacement batteries. Stay put if lost, and protect yourself from hypothermia by keeping warm and dry. Wear high visibility clothing.
- Prevent hypothermia. Hypothermia results in a subnormal core body temperature and is a medical emergency. Carry in your pack a long-sleeve shirt or jacket. If you feel chilled, put it on. Always carry a full set of rain gear and put it on when rain starts falling. Each crewmember must carry the supplied emergency space blankets. Crewmembers must know the symptoms and treatment of hypothermia.
- Know Your Limits! When you start as a new worker in the field, you may not be sure of your limits, and should explore and expand them slowly, at your own pace. When working with an experienced staff member whose limits are beyond yours, do not feel obligated to push yourself to follow them onto a ledge or across a steep slope unless you feel comfortable doing so. Forcing yourself to go beyond your limits may increase the chance of an accident.

Section 5

Written Examination

- ▶ All workers must attain a passing score of 70% or above.

Appendix S3.c. Hiking and Backpacking Techniques Written Exam

Name: _____ Project: _____

Please answer all questions in one of the following ways: circle (T) True or (F) False; circle the appropriate multiple choice letter(s) (A, B, C, D); or write a brief answer, as indicated by the question. You must score 70% or higher (i.e., at least 17 questions must be right) to pass this examination. Give the exam to the Park Lead or Field Lead upon completion.

1. What is the one key element that can have a major impact on hiking and backpacking abilities?

- A. Backpack fit
- B. Proper footwear
- C. Physical conditioning
- D. Wilderness knowledge

2. Which of the following is approved hiking footwear?

- A. Lace-up boots min. 8" or 20cc high w/ lug soles or spikes
- B. Rubber Slippers
- C. Sturdy Tennis Shoes
- D. Spiked tabies

3. Always carry tools and equipment on the uphill side of your body to provide good balance.

T F

4. The "minimum" safe walking distance between hikers is:

- A. 15'
- B. 3'
- C. 10'
- D. 5'

5. The primary reason for maintaining a safe distance between hikers is to:

6. When contouring a steep slope, lean into the hill to provide more secure footing.

T F

7. On slippery, loose ground, when going downhill, keep most of your weight on:

- A. Your toes

B. Your Heels C. Your Whole foot D. None of these
8. Options for hiking uphill or in sandy soils include shortening stride and: A. Using inside of foot B. Remaining erect C. Toeing into the slope D. Leaning slightly forward
9. When slipping while ascending or descending a slope, remain erect to maintain balance. T F
10. If you fall from a log or on level ground, stick out your arms to break your fall and protect your body. T F
11. Why should you "curse your fall"? _____ _____
12. You know you have a good fit for your pack if, for comfort, you are: A. Leaning a bit forward B. Standing up straight C. Leaning a bit backward D. Leaning sideways
13. The most important thing you can do to prevent a slip, trip, or fall is to: _____ _____
14. The best time to conduct a hiking hazard safety briefing is at the first rest break into the hike, when you are aware of the actual trail conditions and hazards. T F
15. To avoid slips, trips, and falls when hiking In heavy undergrowth: A. Lift knees high to clear obstacles B. Slow down C. Exaggerate steps in area of exposed roots D. All of the above
16. If work tasks require observations of items or areas other than the path you're

walking, you should:

17. If an object comes loose from a steep slope, warn others by yelling:

- A. Heads Up!!!
- B. Look Out!!!
- C. Rock!!!
- D. Take Cover!!!

18. To know how to fall and avoid hard impacts you should:

- A. Keep arms slightly bent in front of your head
- B. Keep your body flexible
- C. Keep knees slightly bent
- D. Sit down to increase your friction if you begin to slide down a slope, or roll with the fall if on level ground.

19. If a rolling rock, log, or tree is heard:

- A. Yell “Heads Up!!!”
- B. Start Running
- C. Try to determine direction of the fall
- D. Move out of the path of the fall

20. Safety glasses are required for eye protection from hiking hazards. List three hazards that could cause eye injuries while hiking.

- 1. _____
- 2. _____
- 3. _____

21. If a lightning storm occurs while you are in the forest:

- A. Put down all tools
- B. Alert others via cell phone/radio
- C. Find a tree to lean against
- D. Avoid ridges, hilltops, and open spaces

22. To avoid fatigue and heat stress, stop for frequent rest periods to cool down, drink water to stay hydrated, eat potassium-rich foods and avoid high-protein foods, and wear clothing that is lightweight, light colored, and loose.

T F

23. How frequently should radio checks be made with Base each day?

A. Hourly B. At lunch and end of day C. For emergencies only D. Every 3 hours		
24. Explain what the term "Know Your Limits" means: _____ _____		
CORRECT _____	INCORRECT _____	SCORE _____%

Literature Cited

Pacific Cooperative Studies Unit, Hawai'i. 2008. Standard operating procedures for field operations: 2008-2009. Pacific Cooperative Studies Unit, Honolulu, Hawaii.

Work, T. M., J. G. Massey, D. S. Lindsay, and J. P. Dubey. 2002. Toxoplasmosis in three species of native and introduced Hawaiian birds. *Journal of Parasitology* 88(5): 1040-1042.

Hawaiian Petrel Monitoring Protocol Pacific Island Network

Standard Operating Procedure (SOP) #4: Using Garmin Global Positioning System (GPS) Units

Version 1.00

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reasons for Change	New Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, and identify paragraphs and pages where changes are made and the reason for making the changes along with the new version number.

Abstract

This Standard Operating Procedure (SOP) explains how to use a Garmin GPS receiver to navigate to and collect field data. This SOP is written specifically for Garmin GPSMap76CSx model, but it may be used for any other Garmin GPS models that can average a waypoint and collect track logs. The data transfer process uses DNR Garmin 5.4.1 and ArcGIS 9.3 software.

Pre-Field Preparation

Equipment

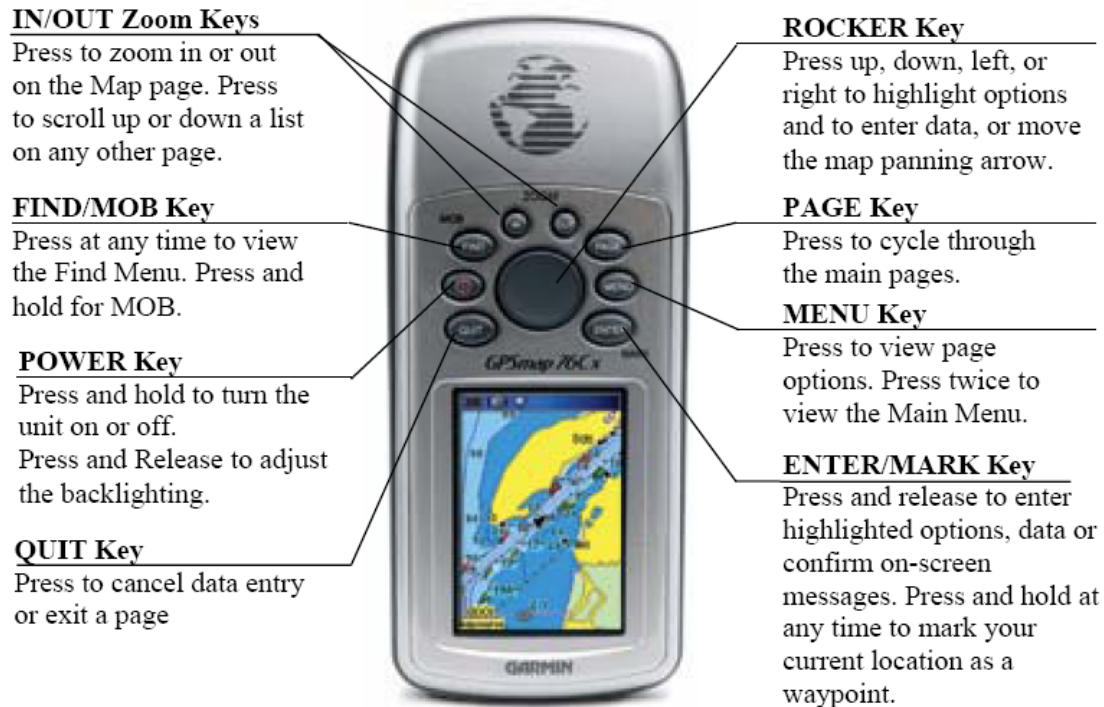
The following equipment should be taken into the field:

- GPS receiver
- Map
- Fresh AA batteries (at least 2)

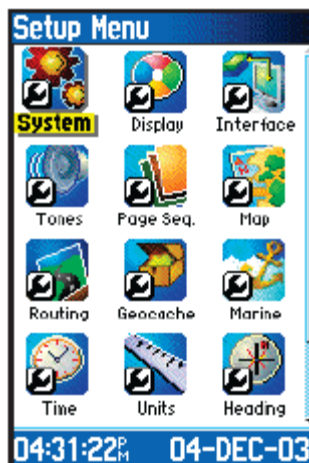
- Compass with declination adjustment (if desired)
- Waypoint(s) preloaded (if necessary)
- Waypoint metadata form (Appendix S4.a) and pencil/pen
- Notebook for recording description of waypoints

Garmin GPS Preparation

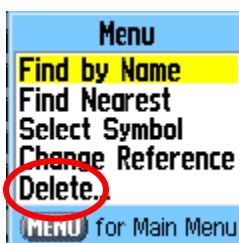
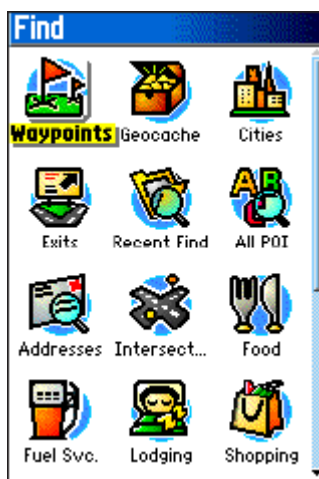
1. Read and become familiar with the Garmin GPS user manual, hardware, and software. The graphic below demonstrates the keys of a GPSMAP 76Cx unit, and their functions.



2. Load freshly charged batteries and have extra charged sets available. Put extra batteries in a water tight “dry bag” or a re-sealable plastic bag.
3. Download a fresh Almanac into your Garmin GPS if the unit has not been used for more than 1 week. Or if the GPS unit has been traveled a distance of 150 miles or more from the last location (i.e. travel between PACN islands). A fresh Almanac automatically sets the correct time/date and time zone for your GPS, as well as other local settings acquired from the satellites. To download an Almanac, turn on your Garmin GPS and stand in an open area (i.e. away from buildings, tree canopy, and obstructions) for about 20-30 minutes depends on cloud cover.
4. Get familiar with the Main Menu page and the Set Up page on your Garmin GPS.



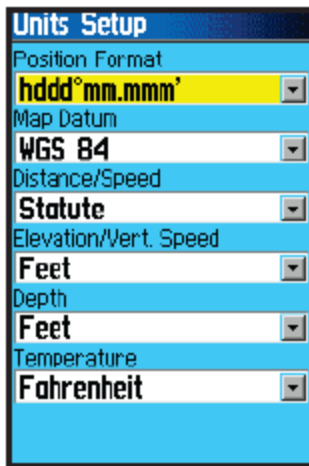
5. Make sure your Garmin GPS interface is set correctly. From Main Menu page → Setup → Interface. Select *Garmin* for “Serial Data Format” field.
6. Make sure that WAAS is enabled. From Main Menu page → Setup → System. Set “WAAS” field to *Enabled*.
7. If necessary, delete old waypoints or tracks from your GPS memory (make sure data has been downloaded and saved on your computer).
 - To delete all waypoints, press FIND → Waypoints. Press ENTER, then press MENU. Select *Delete...* and press ENTER. Select *All Symbols* and press ENTER.
 - To delete all tracks, from Main Menu page → Tracks. Press ENTER, then press MENU. Select *Delete All Saved* and press ENTER. Select *Yes* and press ENTER.



8. If necessary, upload GIS data (e.g. shapefiles) to the GPS unit using DNR Garmin software (see SOP #9 “Downloading and Uploading Data between Garmin GPS and ArcGIS” for instructions).
9. If you plan to GPS a line showing where you traverse (i.e. a track), then make sure to set up the Track Log. From Main Menu page → Tracks → Setup. Check the box *Wrap When Full* if

you want Track Log records over oldest data with new data, otherwise leave the box unchecked. Set “Record Method” field to *Time*. Set “Interval” (i.e. logging rate for data collection) field to *00:00:05* (5 seconds is recommended for data collection while walking).

10. Set the coordinate system. From Main Menu page → Setup → Units. For the field “Position Format”, select either *hddd.ddddd*, or *hdd mm.mmm*, or *hddd mm ss.s* if you want your waypoints collected in LAT/LONG. Otherwise select *UTM UPS*. Note: Standard unit for Distance, Elevation, and Depth is *Metric* or *Meters* for all PACN islands.



11. Set the Map Datum. From Main Menu page → Setup → Units. Set “Map Datum” field to either *NAD83* or *WGS84* depends on island location. Standard Map Datum settings for PACN islands are in Table S4.1 below.

Table S4.1. Coordinate systems and datum for PACN islands

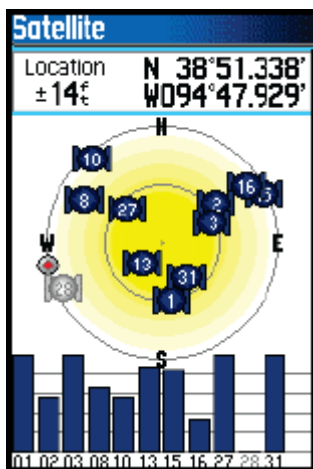
Island	Datum	Coordinate system
Hawaii Island	NAD83	UTM zone_5N
Maui Island	NAD83	UTM zone_4N
Molokai Island	NAD83	UTM zone_4N
Oahu Island	NAD83	UTM zone_4N
Guam	WGS84	UTM zone_55N
Saipan	WGS84	UTM zone_55N
American Samoa (all islands)	WGS84	UTM zone_2S

12. If necessary, check North Reference setting. From Main Menu page → Setup → Heading. Set “North Reference” field to *True*.
13. After using Garmin GPS in the field, make sure to put the unit in its carrying pack and store in a dry location.

GPS Field Procedures

Data Collection Preparation

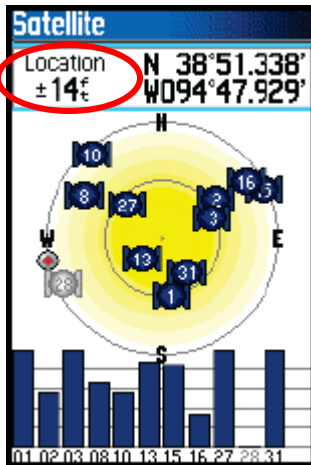
1. Turn on your Garmin GPS unit. Press PAGE button several times to access the Satellite page, then press MENU and select *Use With GPS On*, press ENTER.
2. Hold GPS unit in front of you. Keep it flat and leveled. Wait for the satellites to appear on the Satellites page. Note: A minimum of **4 satellites** is required to ensure data accuracy.



IMPORTANT NOTE: Garmin GPS will collect data regardless of how many satellites being detected or no matter what the GPS positioning quality is, therefore you must check the Satellites page frequently while collecting data. A good rule of thumb is **ONLY** collecting data when the 3D satellite fix mode signal is shown on the Status bar at the top of the screen of your GPS unit. Avoid collecting data when Garmin GPS is in 2D fix mode.



Also, check the Location accuracy error from time to time to ensure the GPS positioning quality when you collect data.



Navigating To Waypoints

1. Press FIND → Waypoints, press ENTER.
2. Use the Rocker key (move Up/Down or Left/Right) to enter the name of the waypoint or just select OK. Scroll down the list and select the waypoint that you want to navigate to, press ENTER. Select *Go To* at the bottom of the page and press ENTER.

The 'Waypoint' screen displays the following information:

- Waypoint Name:** LAKE TRAIL
- Note:** 07-DEC-03 10:58:01AM
- Location:** N 38°51.338' W 094°47.930'
- Elevation:** 1093'
- Depth:** -----'
- From Current Location:** ----- m
- Buttons:** Delete, Map, Go To

3. Map page should open automatically (if not, press PAGE button several times to access the Map page). Start walking and follow the compass direction on the Map page to navigate to the waypoint.

Collecting Waypoints

1. Stand still at the location where you want to GPS.
2. Press and hold ENTER/MARK button until the Mark Waypoint page appear.

3. At the top of the Mark Waypoint page, enter a waypoint name, using the Rocker key. Tip: To save time in the field, write down any notes/comments about this waypoint into a notebook. You may enter this information later back at the office, after downloading the waypoints into ArcGIS.
4. Select OK at bottom of the page and press ENTER.
5. Go to your next location and repeat the above steps.

Collecting Tracks

1. Turn Track Log to ON. From Main Menu page → Tracks. Select *On* and press OK. Also, from Main Menu page → Tracks → Setup Track Log, make sure the box *Wrap When Full* is checked if you want Track Log records over oldest data with new data (otherwise leave the box unchecked).

2. Begin walking and Track Log will start collecting track points (at an interval of every 5 seconds as you walk).

3. Turn Track Log to OFF to stop collecting. From Main Menu page → Tracks. Select *Off* and press OK.
4. Tip: You may stop Track Log when nearing the beginning point of an area (polygon) you've walked. Track Log will automatically close the polygon even if a track is left open ended.

Other Data Collection Tips

For more detail information on data collecting with Garmin GPS units, check out the user guides for various models at this link

<http://www8.garmin.com/support/userManual.jsp?market=3&subcategory=All&product=All>

Appendix S4a. Incident GPS Metadata Form (Field Log)

Metadata completed by: _____ Date: _____

Date of data collection (mm/dd/yyyy): _____

Time of data collection: Start: _____ Stop: _____

Data collector(s) name: _____

Collector's contact information: _____

Geographic location of GPS survey: _____

Park/Forest/Preserve/County: _____

State/Province: _____

Purpose of GPS survey: (*why*) _____

GPS equipment: Make _____ Model _____

Differential Correction (*circle*):

No CORS WAAS Post Processing Other: _____

(e.g., Satellite Differential, Mobile Base Station)

Method of travel used to collect data (*circle*):

Helicopter Fixed Wing ATV Foot Other: _____

(e.g., Mountain Bike, Boat)

Number of waypoints collected: _____

Number of tracks collected: _____

Track Logging Interval (*circle*): Time (Interval Value _____)

Distance (Interval Value & Units _____)

Record Dilution of Precision (DOP) or estimated error (EHE/EPE) range of values:

Min _____ Max _____

1) Electronic Data Output

File information contact person: _____

Machine or disk name: _____

Directory Path (e.g., c:/working/02252003/): _____

GPS Download Software: _____

ESRI Output File (shapefile, coverage) Parameters:

Units (*circle*): N/A Meters Feet

Coordinate system (projection) (*check*):

____ Lat/Long (Geographic) - Decimal Degrees (ddd.dddd°)

____ UTM UTM zone _____

____ Other: _____ (e.g., State Plane, Albers Equal Area)

Datum (*circle*): NAD27CONUS NAD27Alaska NAD83 WGS84

Other: _____

ESRI File Name(s) (e.g., *.shp, *.shx, *.dbf): _____

Describe GPS mission (provide any unique and useful information pertinent to the data collected during the GPS mission, or information about the mission itself): (*How*) Use other side of paper.

**Hawaiian Petrel Monitoring Protocol
Pacific Island Network**

**Standard Operating Procedure (SOP) #5:
Using Trimble Global Positioning System (GPS) Units**

Version 1.00

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, and author of revision, and identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

Abstract

Location data for new sampling locations is necessary to maintain current data in the Hawaiian petrel database, and allows the same sampling location to be revisited in the future. This Standard Operating Procedure (SOP) explains the process for preparing and collecting GPS data using the Trimble GeoXM/XT GPS units, Pathfinder Office software for processing and import/export, and TerraSync field software for GPS data collection.

Trimble GPS Capabilities

The Trimble GeoXM and GeoXT are examples of mapping-grade GPS units that record data with location accuracy ranging from sub-meter to less than five meters. In comparison, a Garmin GPS unit (a recreational-grade GPS unit) is not as accurate, with spatial accuracy less than 15 meters. Mapping-grade units have a greater ability to capture spatially referenced metadata (i.e., attributes) than recreational-grade GPS. These units can acquire spatial data related to points, lines and polygons along with associated tabular attributes. Careful forethought and advanced planning are required to take advantage of these capabilities long before data collection begins.

Prior to using a Trimble GeoXT (mapping-grade) GPS unit, the following documents should be reviewed:

- Appendix A and B of this SOP
- GeoExplorer CE Series: Getting Started Guide
- GPS Mapping for GIS with TerraSync and GeoExplorer CE Series or TerraSync Operation Guide v2.4x
- Basic GPS Data Capture Using TerraSync: A Quick Start Guide
- PACN Data Management Guidelines

Initializing the GPS

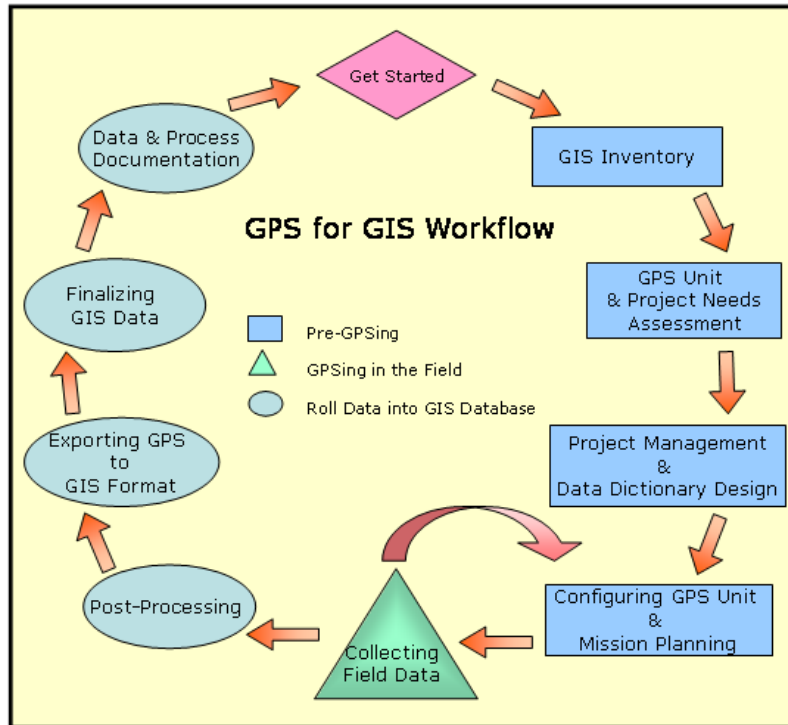
1. Read and become familiar with the Trimble GeoExplorer Series Getting Started Guide, hardware, and software. Before using the GPS unit for the first time, you must charge the battery. Leave to charge in the support module for up to eight hours. Place unit in standby (pop green button) to leave screen turned off when charging.



2. Load freshly charged batteries and have extra charged sets available in the field. Put extra rechargeable batteries in a water tight “dry bag” or a re-sealable plastic bag.
3. Turn the power on: press and hold down the green power button. Set the time zone, clock and date. In the *Today* screen, tap the clock icon. The *Clock & Alarms Settings* screen appears. Tap the up and down buttons on the *Time* tab to set the correct hour and minute. Tap the up and down buttons on the *Date* tab to set the correct month, day and year. Then select the correct time zone.

Work Flow

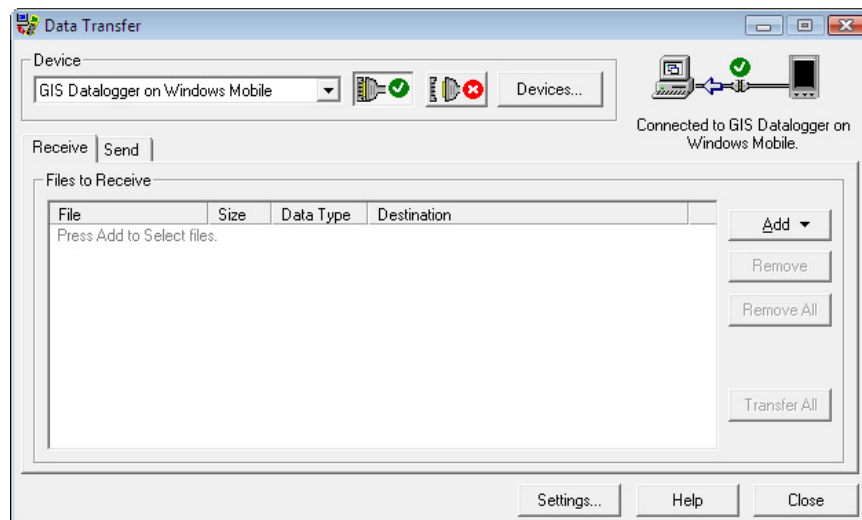
- Create a Data Dictionary (see Appendix C of this document, or talk with the PACN GIS technician if a data dictionary has not been created for the project)
- Transfer GIS shapefiles and imagery to GPS unit
- Collect/Update data in the field
- Open data dictionary. Choose feature for data collection
- Post Process
- Export to Shapefile
- Repair Shapefile (defines projection for shapefile)
- Merge into data set



Transferring Data to the GPS Unit

Before taking the GPS unit into the field for a new project, transfer the Data Dictionary from the computer to the GPS.

1. Place the GPS unit in the support module. Connect the module to the computer via the USB cable.
2. Select *Utilities / Data Transfer* to start the Data Transfer utility in Pathfinder Office. The Data Transfer screen will appear.



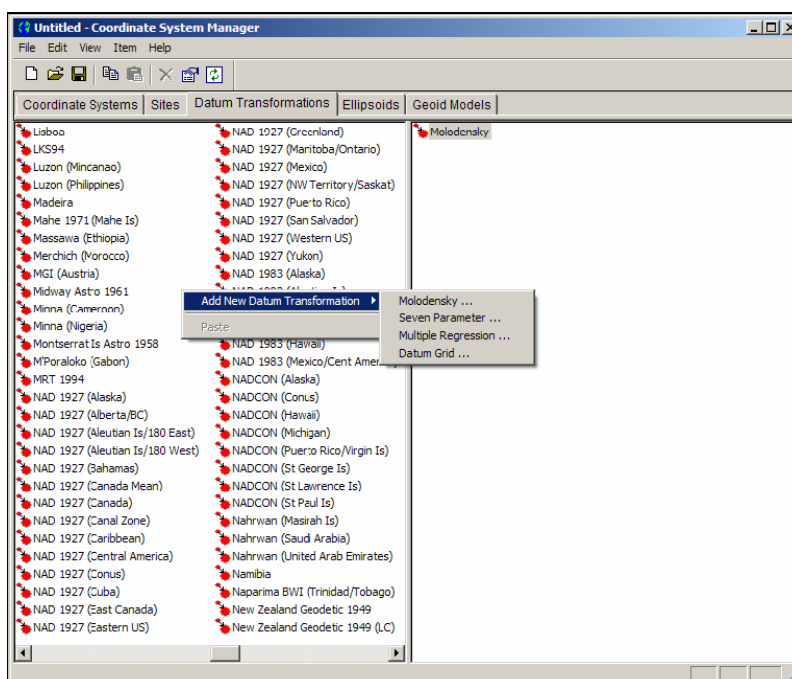
3. Select the *Send* tab, click *Add*, and select *Data Dictionary* from the list.
4. Browse the open screen until the data dictionary appears on the list of files. Highlight the file and click *Open*. The data dictionary will appear in the *Files to Send* box of the *Data Transfer* screen.
5. Click *Transfer All* to transfer the data dictionary to the GPS unit.
6. Click *Close* in the message box that shows summary information about the transfer.
7. Click *Close* in the Data Transfer screen.

If navigation to existing waypoints is applicable to a project, waypoints must be loaded onto the GPS unit before departing to the field. Printed topographic maps of the waypoint locations are also recommended to maximize field time and efficiently navigate between waypoints.

Many mapping-grade GPS units have the capability of storing and displaying background maps or layers, which can be very helpful when navigating in the field. The PACN GIS technician can help identify and load these layers onto a unit before field work begins.

Creating a User-defined Datum Transformation

1. Open the GPS Pathfinder Office software.
2. Select *Utilities / Coordinate System Manager*.
3. Select *Datum Transformations*. The window that appears displays the current list of datum transformation definitions within the coordinate system database (CSD).
4. Right-click in the left pane of the *Coordinate System Manager* window. A pop-up menu appears.
5. Select *Add New Datum Transformation / Seven Parameter*:



6. Name the new transformation, for example *NAD 1983 (CORS 96)*.
7. Select the *Geodetic Reference System 1980* ellipsoid and then select the *From WGS-84* option.
8. Enter the following parameters:

T_x = 0.91023 m
T_y = -2.10411 m
T_z = -0.56015 m
R_x = 0.027741 arcsec
R_y = 0.013468 arcsec
R_z = 0.002712 arcsec
S = 0.0

These are the transformation parameters between ITRF 2000 and NAD 83 (CORS 96), as defined by the National Geodetic Survey (<http://www.ngs.noaa.gov/CORS/coordinates>).

The *Datum Transformation Properties* dialog should match the following example:

Datum Transformation Properties

Seven Parameter

Name : NAD83 new (PACP00)

Export Name : NAD83 new (PACP00)

Ellipsoid : Geodetic Ref System 1980

Parameters

☐ To WGS-84 ☒ From WGS-84

Translation X (m) : 0.91023

Translation Y (m) : -2.01411

Translation Z (m) : -0.56015

Rotation X (secs) : 0.027741

Rotation Y (secs) : 0.013468

Rotation Z (secs) : 0.002712

Scale Factor (ppm) : 0

OK Cancel Apply Help

Conducting Equipment Check

1. Before going out into the field with the GPS, check that you have all the necessary hardware, batteries and cables.
2. Before leaving the office, set up the entire GIS/GPS data collection system and test it to make sure that everything is connected correctly.
3. Make sure that the GPS receiver and field computer batteries are charged and that these two pieces of equipment are communicating correctly.

4. Turn on the field computer and start the TerraSync software. The GPS receiver should start automatically when you start the software program. Tap  and then select *Programs / TerraSync*. While the software is loading, a Trimble identification screen appears. Use the satellite icon on the status bar to check whether the receiver is computing GPS positions.
5. The *Skyplot* screen in the Status section appears after the identification screen. Use the Status section to view the satellites currently tracked and those that are being used to calculate the current position.
6. Obtain a clear view of the sky:
 - Purchase a hurricane antenna for best performance – especially under canopy.
 - If you do not have an external antenna, you must hold the GPS receiver flat and away from your body, but as close as possible to the object you want to GPS. If a handheld or backpack antenna (Figure S5.1) is available, position it directly over the object you want to GPS.
 - Move clear of signal reception obstacles, such as heavy tree cover, buildings, people, vehicles, and anything that blocks light.



Figure S5.1. Handheld and backpack antennas for Trimble GPS unit.

Collecting Data

Data collection is accomplished by using the data dictionary customized for a project. Users should keep in mind the following key concepts:

- If using a GPS unit that gives an approximate five meter horizontal (XY) accuracy, the user cannot map anything as a polygon that is less than 4-6 meters in width. The object must be captured as a point feature.

- If a GPS user is collecting a line or polygon feature and then stops moving, the GPS unit will continue to collect data. Users need to be familiar with the *Pause/Resume* toggle key and use it liberally.
- Another way to avoid errors is to collect point features that represent the beginning and end points of a line transect. Having these reference point locations will mean easier editing of any zig-zagging line features.

Creating a New Data File

Before starting the data collection session, you need to create a new data file to store the new features and attributes you collect. Use the Data section to do this. To create a new file:

1. Tap the Section list button, and then select *Data*.
2. Tap the Subsection list button, and then select *New File*. The *New File* screen appears. The TerraSync software automatically enters a default name with a prefix and date-time stamp as follows: RMMDDHHX, where R = Unit prefix, MM = Month, DD = Day, HH = hour, X = a, b, c... (order of files created in an hour). You should preface the GPS file name with an alpha code (i.e., A, B, C) if there are multiple Trimble GPS receivers being used on the project. Keep in mind that rover file names exceeding 20 some characters will be truncated during export.
3. In the Dictionary Name field, make sure the Hawaiian petrel data dictionary is selected.
4. Tap **Create**. The *Confirm Antenna Height* form appears. If necessary, enter the correct antenna height and measurement point, and then tap **OK**.
5. The *Collect Features* screen appears. This screen shows a list of all the features in the data dictionary.
6. You have created a new data file and can now begin mapping Hawaiian petrel burrows (and other features) and recording field observation data.

Collecting a point feature

The first feature you want to record is a sampling station (e.g., a burrow). This is a point feature. To record a point feature, you remain stationary while the TerraSync software logs GPS positions. These positions are averaged to compute the final GPS position of the point feature. When the software is logging GPS positions, the logging icon appears in the status bar. The number beside the icon indicates how many positions have been logged for the selected feature. To record a point feature:

1. Make sure that the *Collect Features* screen is open. If it is not, tap the Section list button, select *Data*, and then tap the Subsection list button and select *Collect Features*.
2. In the *Choose Feature* list, highlight *Birds*, and then tap create. The attribute entry form for the *Species name* appears.
3. Type in the species name for the observed bird.
4. As the software logs GPS positions, the counter beside the logging icon increments. When you have finished entering the attributes, tap **OK** to close the bird *Species* feature. The attribute entry form closes and you are returned to the *Collect Features* screen.
5. For information on recording line or area features, refer to the TerraSync Software Getting Started Guide.

Ending the Data Collection Session

When the data collection session is complete, close the data file and exit the TerraSync software. To close the open data file and exit the software:

1. Tap **Close** in the *Collect Features* screen. A message appears, asking you to confirm that you want to close the open file.
2. Tap **Yes** to close the current data file and return to the New File.
3. Tap the Close button  in the upper right corner of the screen. A message appears, asking you to confirm that you want to exit the TerraSync software.
4. Tap **Yes** to exit the software.

Processing the Data in Pathfinder Office

See Appendix A of this document for instructions on setting up your computer with Pathfinder Office and creating file folders for data storage.

Set the Coordinate System

1. Select *Options / Coordinate System* from the menu
2. Use the **Coordinate System** dialog box to set the coordinate system for GPS data being uploaded to your computer. The *UTM Zones* for the Pacific Islands are listed below:

Table S5.1. Table coordinate systems for Hawaii and American Samoa.

Island	Datum	Projection
Hawaii Island	NAD83 (PACP00)	UTM zone_5N
Maui Island	NAD83 (PACP00)	UTM zone_4N
Molokai Island	NAD83 (PACP00)	UTM zone_4N
Oahu Island	NAD83 (PACP00)	UTM zone_4N
Guam	WGS84	UTM zone_55N
Saipan	WGS84	UTM zone_55N
American Samoa (all islands)	WGS84	UTM zone_2S

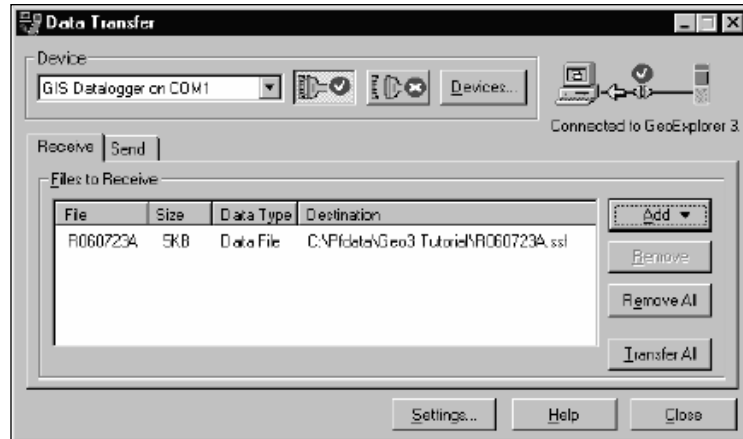
3. Click **OK** to accept the changes.

Transferring GPS Data to the Computer

For Trimble GPS units, Pathfinder Office is used to download, process the data collected and then export the data to GIS format. Note that Trimble offers a free downloadable utility for transferring data from the GPS unit into an ssf file needed for differential correction if Pathfinder Office is not available on the field computer (available online: <http://www.trimble.com/datatransfer.shtml>).

The following steps describe how to download data from a Trimble GPS unit to the desktop computer using Pathfinder Office. Note that these steps require ActiveSync, which can be freely downloaded from: <http://www.microsoft.com/downloads>.

1. Place the GPS unit in the Support Module that is connected to the computer.
2. Switch on both the field computer and the office computer and connect the two computers.
3. In the GPS Pathfinder Office software, select *Utilities / Data Transfer*. The *Data Transfer* dialog appears.



4. Select the device name from the *Device* list that represents your GPS unit. The Trimble Data Transfer utility automatically connects to the field computer.
5. Select the *Receive* tab.
6. Click *Add* and select Data File from the list. The *Open* dialog appears. The files that appear are the files in the TerraSync data folder on the field computer.
7. The software will default to a file on the C: drive. Browse in the Destination field to the specific project folder on the server.
8. Select one or more files to be transferred. Highlight the filename(s) and click *Open*. The *Open* dialog disappears, and the selected data file appears in the *Files to Receive* list.
9. Click *Transfer All*. The data file is transferred to the desktop computer.
10. Click *Close* to close the message providing transfer information.
11. Click *Close* to close the Data Transfer screen. For more information refer to the *GPS Pathfinder Office Help*.

Differentially Correcting Data

The data collected by GPS receivers is subject to errors, including small satellite clock errors, orbit errors, atmospheric noise, and multipath errors. The majority of these errors can be removed from the data by differential correction, which improves the accuracy of GPS positions to the specified accuracy of the receiver. Once the data are differentially corrected, they can be verified and edited. Unintentional features can be deleted and attributes can be reviewed. For more information on differentially corrected data, refer to the TerraSync Software Getting Started Guide.

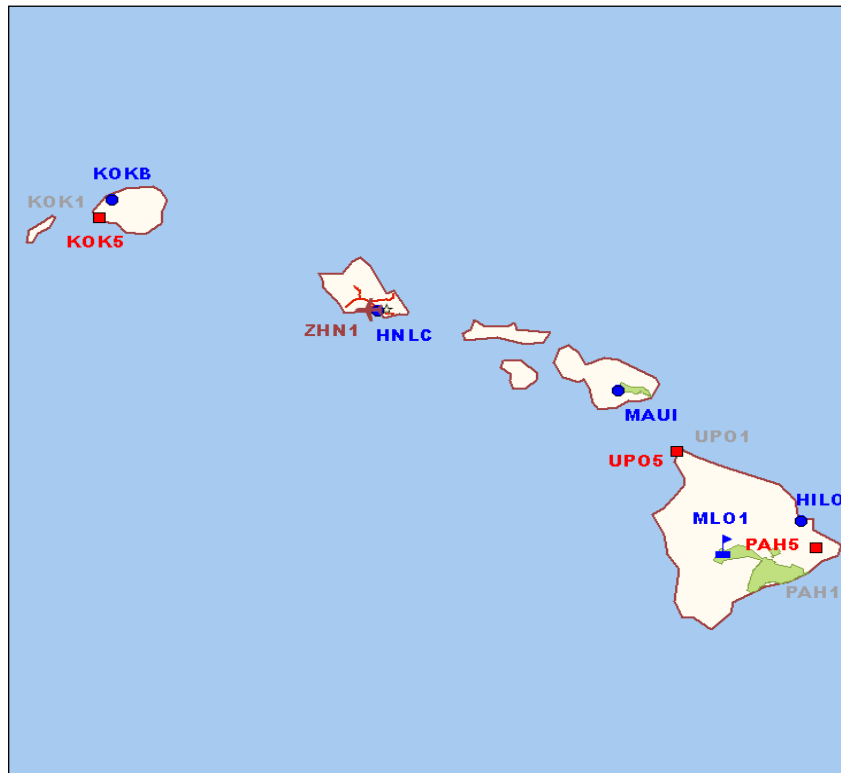
Post-processing (differential correction) should be performed as soon as possible after data collection. The CORS base station data is usually available within a two-hour lag time, though occasionally there are periods of time when data are not available, either due to equipment malfunction, inadequate satellite coverage, or high ionospheric disturbance. These factors are not within the control of the field personnel collecting the data, but post-processing will uncover these problems. Any affected locations should be revisited to obtain high accuracy information.

CORS stations maintain complete records for only 30 days, after which the data collection interval is reduced from 1-, 5-, or 30-second (depending on the station) to 30-minute intervals. This is done in order to save hard drive space. Differential correction files that are downloaded

should be archived with the data, so that high temporal resolution base station files are available, in the event that post-processing needs to be redone on a dataset at a later time.

Examples of CORS sites downloaded from <http://www.ngs.noaa.gov/CORS/> are listed below. For best performance choose a site that collects GPS information every 1 or 5 seconds (rate).

ST	Site Name	ID	online	offline	Rate*	HorD#	Agency
GT	GUATEMALA CITY	GUAT	2000/216	-----	30	D	Instituto Geografico Nacional
GT	HUEHUETENANGO	HUEH	2002/158	2002/312	30	H	Instituto Geografico Nacional
GT	SANTA ELENA	ELEN	2001/342	-----	30	D	Instituto Geografico Nacional
GU	U OF GUAM	GUUG	2003/239	-----	05	H	University of Guam
GU	USGS GUAM OBSERV	GUAM	1996/272	-----	30	D	JPL
HI	HALEAKALA MAUI	MAUI	2002/054	-----	30	D	SOEST
HI	HILO AIRPORT	HILO	2002/054	-----	30	D	SOEST
HI	HONOLULU TIDE GAU	HNLC	2002/054	-----	30	D	SOEST
HI	HONOLULU WAAS 1	ZHN1	2003/301	-----	01	H	FAA
HI	KOKEE PARK	KOKB	2000/108	-----	30	D	JPL
HI	KOKOLE POINT 1	KOK1	1996/037	2007/310	05	H	U.S. Coast Guard
HI	KOKOLE POINT 2	KOK2	1996/142	2007/314	05	H	U.S. Coast Guard
HI	KOKOLE POINT 5	KOK5	2007/310	-----	05	H	U.S. Coast Guard
HI	KOKOLE POINT 6	KOK6	2007/314	-----	05	H	U.S. Coast Guard
HI	MAUNA LOA OBSERVA	MLO1	2004/343	-----	30	H	NOAA Global Systems Division
HI	PAHOA 1	PAH1	2003/120	2008/023	05	H	U.S. Coast Guard
HI	PAHOA 2	PAH2	2003/126	2008/014	05	H	U.S. Coast Guard
HI	PAHOA 5	PAH5	2008/023	-----	05	H	U.S. Coast Guard
HI	PAHOA 6	PAH6	2008/023	-----	05	H	U.S. Coast Guard
HI	UPOLU POINT 1	UPO1	1996/032	2008/023	05	H	U.S. Coast Guard
HI	UPOLU POINT 2	UPO2	1996/141	2008/015	05	H	U.S. Coast Guard
HI	UPOLU POINT 5	UPO5	2008/023	-----	05	H	U.S. Coast Guard
HI	UPOLU POINT 6	UPO6	2008/023	-----	05	H	U.S. Coast Guard
HO	SAN LORENZO	STOR	2000/298	-----	30	H	Instituto Geografico Nacional



1. Open the *Differential Correction Wizard* dialog box (Figure S5.2): Select *Utilities / Differential Correction*.
2. Click the add button  and select the raw ssf file (rover file) downloaded from the GPS in the section “Transferring GPS Files to your Computer”. Click *Next*.

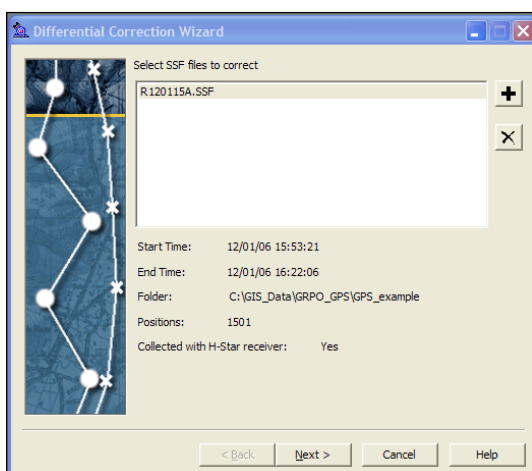


Figure S5.2. Differential correction wizard using Pathfinder Office.

3. Select *Automatic Carrier and Code Processing* and click *Next* and then click *Next* again.
4. Select the radial button next to *Base Provider Search* and select the base station closest to your field data collection site (e.g. CORS, Paho, HI; Figure S5.3). Click *Next*.

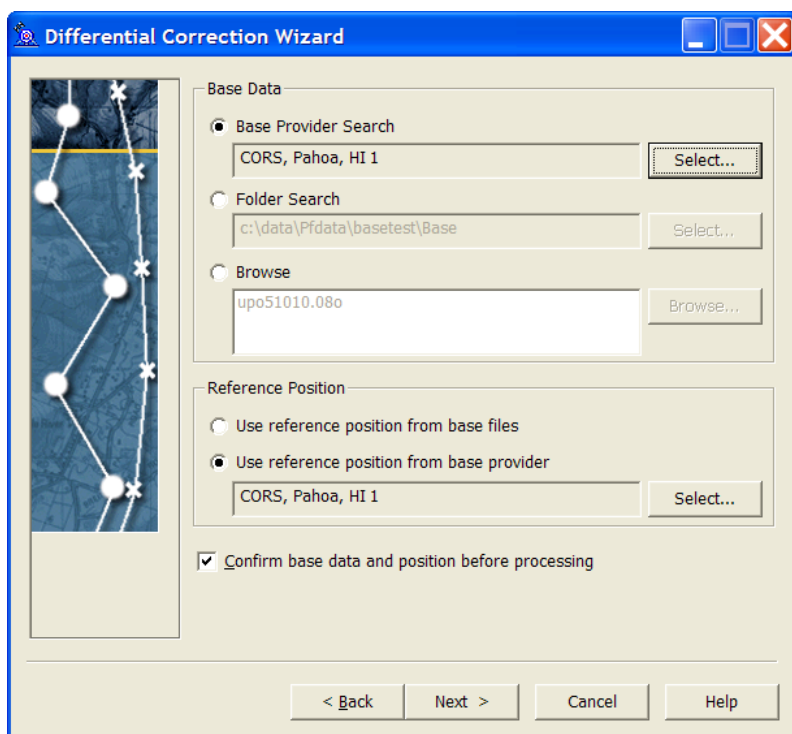


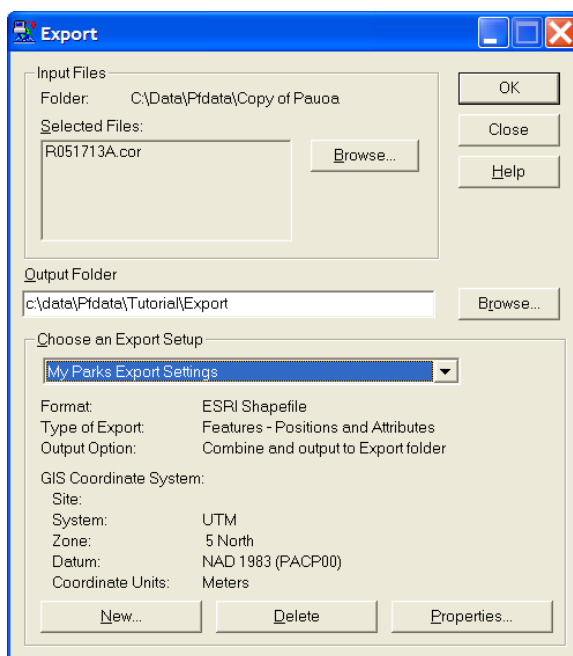
Figure S5.3. Select Use reference position from base providers.

5. Select the *Use reference position from base provider* and click *Next*.
6. Click *Next* again and ensure that *Use the project folder* and *Create a unique filename based on the input file name* are selected and then finally click *Start*.
7. Pathfinder Office will provide a report on the number of features processed.

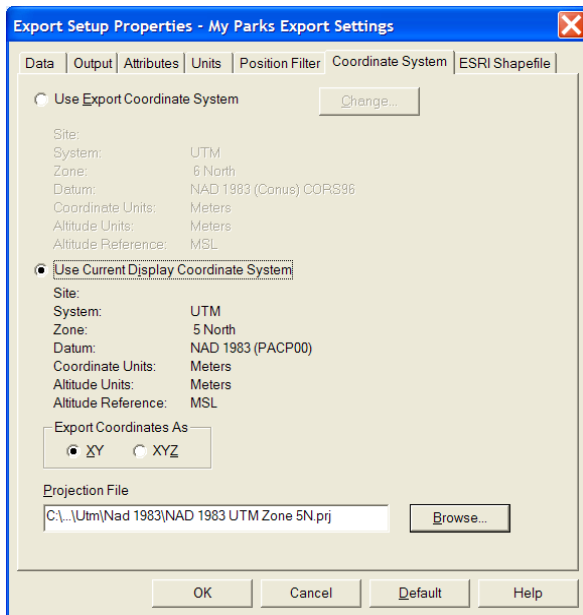
Exporting Data to a GIS

The last step is exporting the data set to GIS (ArcGIS). The Trimble Export utility in the GPS Pathfinder Office software converts your differentially corrected (*.COR) files into a format that can be read by a GIS, CAD, or database system. It lets you export point, line and area features, attributes, and positions to a variety of formats.

1. Select *Utilities / Export*.



2. Select the *Properties* tab and then the *Coordinate System* tab. Export the COR file to shapefile format using the NAD83 (PACP00) datum (see Table S5.1 for zone number).



3. Browse to the PRJ file that correctly defines the coordinate system of the exported data. Click OK. Note that coordinates systems are provided by ArcGIS in C:\.....\ArcGIS\Coordinate Systems.
4. Click the *Attributes* tab. To be on the safe side check all attributes next to *All Features*, *Point Features*, *Line Features*, and *Area Features* (Figure S5.4). Attributes that are checked will be included in the exported shapefile.

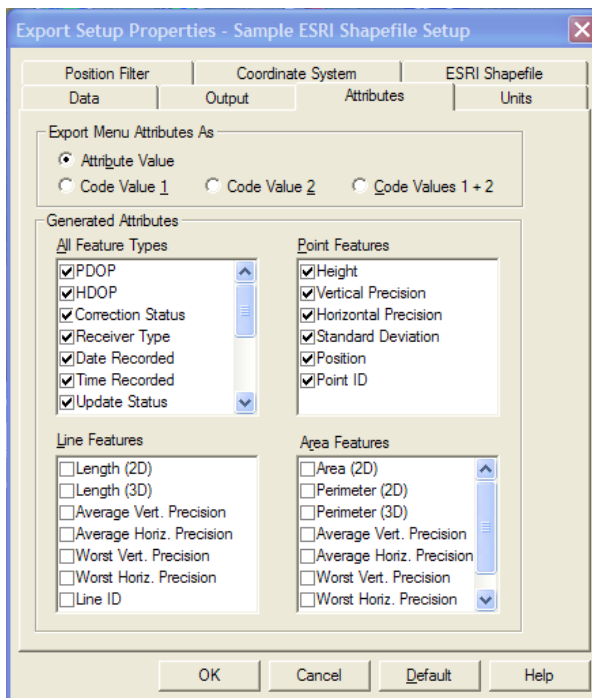


Figure S5.4. To be on the safe side, ensure that all boxes above are checked when exporting corrected GPS files.

5. Click the *Output* tab and select the radial button next to “For each input file create output Subfolder(s) of the same name.”
6. Click OK to save your settings. Click OK again to export the GPS data to Shapefile format.
7. Finally, archive the output files from Pathfinder Office. Copy the pathfinder project directory to the GPS/Trimble directory on the I: drive.
8. Be sure to include the steps used to process your GPS data in the metadata.
9. For additional information refer to the TerraSync Software Getting Started Guide.

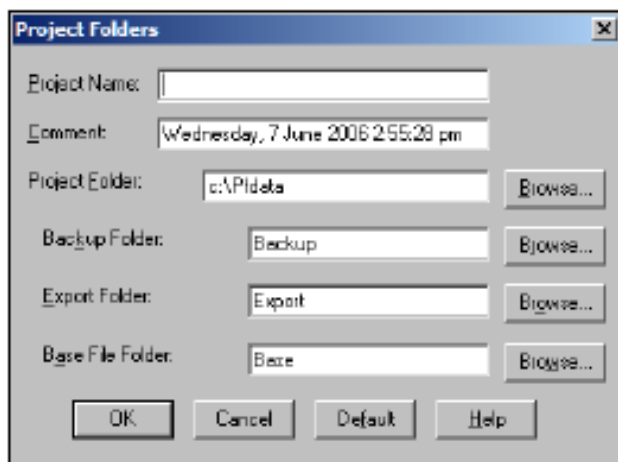
End of Project

At the end of a project, all data and background files should be removed from the GPS unit. Data files should not be left on a unit if they have been properly downloaded and verified. Complete required metadata fields for exported GPS data.

Appendix S5.a. Preparing for GPS Processing

Computer Setup

1. To use the Trimble GPS unit, install GPS Pathfinder Office software (desktop GPS processing software) on the office computer. Pathfinder Office software is used to transfer, correct, display, edit, plot and export your data. Once the software is installed, field data from the GPS unit may be transferred to Pathfinder Office.
2. When a field sampling trip to a new sampling location is planned, a GPS directory should be created for the collection of location data.
3. Before proceeding, create a directory for each park you will be collecting GPS data for. Name the directories by park code (e.g., HAVO, HALE)
4. From Programs on your Start Menu, open the Pathfinder Office program. A Trimble identification screen appears while the program is loading. This is followed by the GPS Pathfinder Office application window.
5. By default, the *Select Project* dialog appears. To create a new project directory click the *New* button at the bottom left of the dialog box. The *Project Folders* dialog appears:



6. In the *Project Name* field, enter the project name (e.g., **Hawaiian petrels**), and then click **OK**.
7. Click **OK** again to close this dialog and create the new project.
8. In the Project Folder Browse to the park folder you created earlier (e.g. HAVO). Click **OK** to create the new project.

Installing TerraSync Software

See the TerraSync Software Getting Started Guide for detailed installation instructions.

The Trimble TerraSync Professional software is a data collection and data maintenance tool designed to work seamlessly with Trimble's GeoExplorer XM/XT GPS receivers and Pathfinder Office desktop software. The Trimble GPS unit uses TerraSync software to record and update geographical data (GIS and spatial data) in the field. The field computer is either:

- a Windows CE device (a handheld running a supported Microsoft Windows CE operating system, or the Windows Mobile software), or
- a PC (a laptop or desktop computer running a supported Microsoft Windows desktop operating system).

You can connect a GPS receiver (e.g., a GeoXM handheld) to a field computer that has TerraSync software installed and use the software to track GPS status, log data and update existing data, and navigate in the field. This software acts as the controlling software. It communicates with Trimble GPS receivers connected to the field computer, allowing you to set GPS parameters in the receiver, record GPS positions on the field computer, and update existing GIS data.

1. Install TerraSync GPS software (version 2.52 or later) on the handheld. This software is used to collect and maintain GIS and GPS data.
2. To install the TerraSync software, insert the software CD in the CD-ROM drive of a computer and use the menus provided, or run the downloaded setup file. Detailed installation instructions are provided in the documentation for the software.
3. The first time you use your GPS field software on the handheld unit, you may need to specify which GPS COM port to connect to.
4. The integrated GPS receiver has three COM ports for communicating with software on the handheld and with external devices. To use GPS, open the appropriate GPS COM port.
5. TerraSync software automatically activates the integrated GPS receiver on COM3. This port outputs and receives TSIP (Trimble Standard Interface Protocol) messages, which is used by Trimble GPS applications and is also supported by some other GPS applications.

Appendix S5.b. Procedures Prior to Field Work

Prior to collecting GPS data, planning should be done with a current almanac, and windows of low satellite availability should be noted. Travel between sites should be scheduled for these windows. Trimble planning software (SetupPlanning) is a free download utility, available from the Trimble website at: http://www.trimble.com/planningsoftware_ts.asp. Planning software provides a graphical interface (Figure S5.5) for pre-determining time periods of poor satellite geometry (too few satellites and high PDOPs) and planning work schedules during periods of best satellite coverage. This step is recommended, but not required, because a full constellation is available for most time periods.

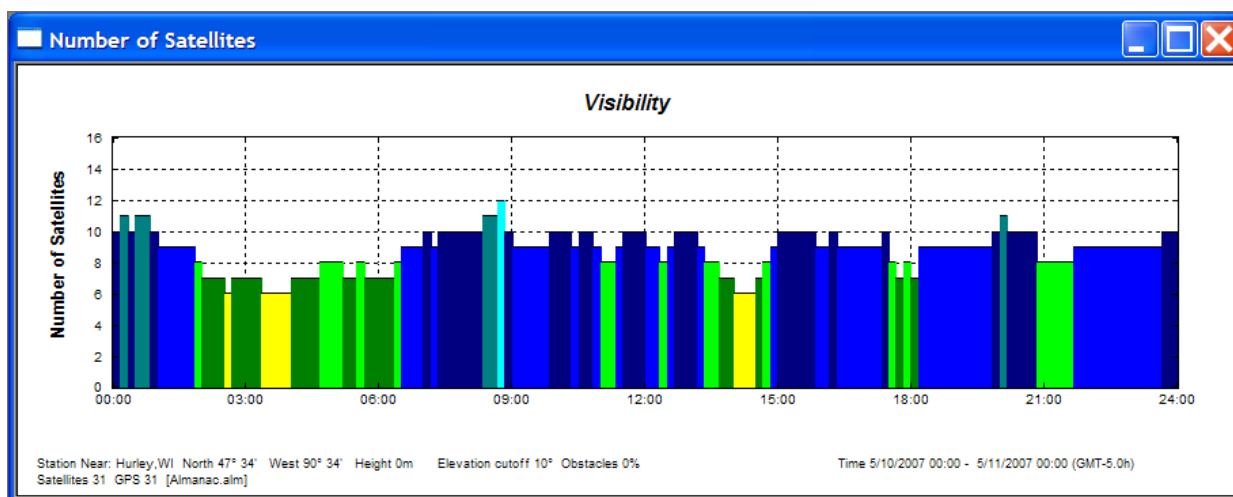


Figure S5.5. Setup planning graph for satellite availability.

Accuracy Test

Ideally, a calibration/accuracy test should be performed in the vicinity of the GPS data collection. This is done by locating a survey marker with an established high precision location, and collecting a GPS coordinate with the XH directly over the location. Typically, these are high order NGS points used for horizontal control. The purpose for this is to establish an estimate of the accuracy that can be expected using the best CORS stations available. Performing this test also provides a check on the differential correction using different groups of CORS stations, to identify which is truly providing the best data. This should be performed during optimal satellite reception so as to maximize accuracy. Locations of existing benchmarks or survey markers can be found on-line at: <http://www.ngs.noaa.gov/cgi-bin/datasheet.pr1>.

There are several options at the National Geodetic Survey (NGS) site for locating survey markers, including by county or a bounding box, and downloading a shapefile. Each site has a PID (Permanent Identifier), which can then be accessed through the NGS site to obtain the high accuracy coordinates, or "truth," which can then be compared to the GPS coordinates to get an estimate of the true accuracy of the unit under existing conditions. Do not rely on the estimated vertical and horizontal accuracy provided in the attributes of the GPS output, as these can be in error by an order of magnitude or greater.

GPS Settings

Positional accuracy can be affected by several factors which mapping-grade GPS units can track, and to some extent, compensate for. Table S5.2 lists these functions, their definitions, and the standard settings. All spatial data collected shall be analyzed for spatial accuracy and shall meet or exceed the National Map Accuracy Standards (see <http://rockyweb.cr.usgs.gov/nmpstds/nmas.html>). Table S5.1 indicates the coordinate system settings for data collection in Hawai'i and American Samoa.

Table S5.2. Minimum GPS receiver settings standards.

Name	Definition	Standard
Almanac	GPS unit collects data containing estimated position of satellites, time corrections, and atmospheric delay parameters	Acquired within 10 days prior to data collection or navigating
Altitude reference	Ellipsoid model	Height above Ellipsoid (HAE) [preferred] or Mean Sea Level (MSL); if MSL used, indicate Geoid Model
Antenna heights	GPS unit height above the ground	1.0-1.5 meters
Datum	Geodetic model designed to fit a point on the earth's surface to the ellipsoid	NAD83 (PACP00) or WGS84
Elevation mask	The minimum angle at which a GPS receiver will track satellite vehicles	15 degrees
Feature types	The physical location and geometry of spatial data	Point, line, area (polygon)
Logging intervals	Time interval between positions gathered	Point: 1 second Line and polygon: 5 seconds
Minimum number of positions for a point feature	Number of positions received then averaged to create a point feature	10-20
Mode	2-Dimensional or 3-Dimensional	3-Dimensional (4 satellites)
PDOP Mask	Positional Dilution of Precision is a measurement of the geometry of the satellites	6.0 or less
Satellite Vehicles	Number of satellites, currently a constellation of 29 DOD satellites	4
SNR Mask	Signal-to-Noise Ratio is a measure of the strength of the satellite signal relative to background noise	4.0 minimum, 6.0 or greater preferred
Unit of Measure	Units of measure	Meters

Appendix S5.c. Creating a Data Dictionary

A data dictionary contains a description of the features and attributes relevant to a particular project. In the field, the data dictionary structures and speeds data collection and makes it easy for observers to enter data in the correct format. This helps to ensure data uniformity and integrity. In creating a data dictionary a bird is a feature, whereas the information that you record for each bird are attributes (e.g., species name and sighting distance). The PACN GIS technician should be directly involved in the creation of data dictionaries. Basic steps include:

- Identify the features to be mapped. These features are real world objects mapped as points, lines or polygons (e.g., bird sightings can be mapped as points, trails mapped as lines, and plots mapped as areas/polygons).
- Identify the data to be collected about each feature and create a data dictionary using the steps described below.
- Test and implement the data dictionary. A complete trial run for newly created data dictionaries should be done before beginning field work. Corrections and refinements are inevitable after such a trial.

1. To create a data dictionary, perform the following steps:

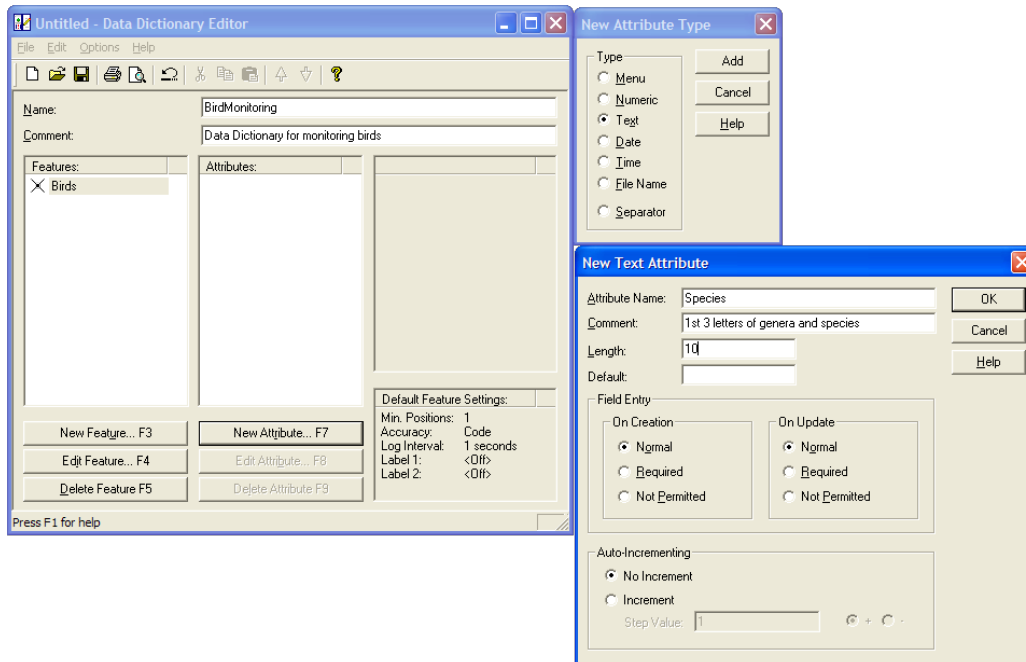
- Select *Utilities / Data Dictionary Editor* using Pathfinder Office software. The Data Dictionary Editor screen will appear.
 - Enter the project title in Name field.
 - Type your name in the Comment Field.
 - Save the data dictionary in the folder created on your server.

2. Click on *New Feature* and enter a feature name (e.g., birds, trails, plots). Next designate the feature as a point, line or polygon. To change the name or designation of a feature, click on *Edit Feature*.

3. To define attributes you wish to record in the field, click on *New Attribute* and pick *New Attribute Type*:

- Menu – letters, numbers, or other characters. Can select only one value (use for the comment field and possibly the name field if you know all the possible names)
- Numeric – numbers only, with decimal point (use for the ID #)
- Text – letters, numbers, or other characters. Can enter any value – use for the name field if you don't use a menu
- Date – collects a date value
- Time – collects a time value
- File Name – collects a file name

4. Click the Add button.



5. In the New Attribute dialog box type in the *Attribute Name* (e.g., *Species*) and the length required for the data/values (e.g., 10 characters are needed to store the first three letters of the Genera and Species names, with optional characters reserved for varieties). Designate whether data entry of an attribute is optional (normal), required, or not permitted. Continue until all attributes have been entered. For example, you may want to create an *Attribute Name* called *Field_Observer* and make it a required attribute.

Appendix S5.d. GPS Usernotes for ASUS A63X PDA, Trimble ProXH GPS Receiver Using Bluetooth Wireless Connection, and Zephyr External Antenna

The following instructions require a Trimble ProXH GPS Receiver, wireless connection to a Personal Digital Assistant (PDA) running Windows Mobile OS, and a Zephyr dual frequency antenna.

Collecting H-Star data requires some canopy openings as the unit must maintain a lock on the same four satellites (or five when roaming) for at least two minutes. Such reception is unlikely under dense forest canopy, and accuracies with the Trimble XH unit under canopy are expected to be marginally better than those achieved with lower resolution XT units. The Network has a range pole extendible to 4.6 m, which can dramatically improve reception by getting the unit above the sub-canopy.

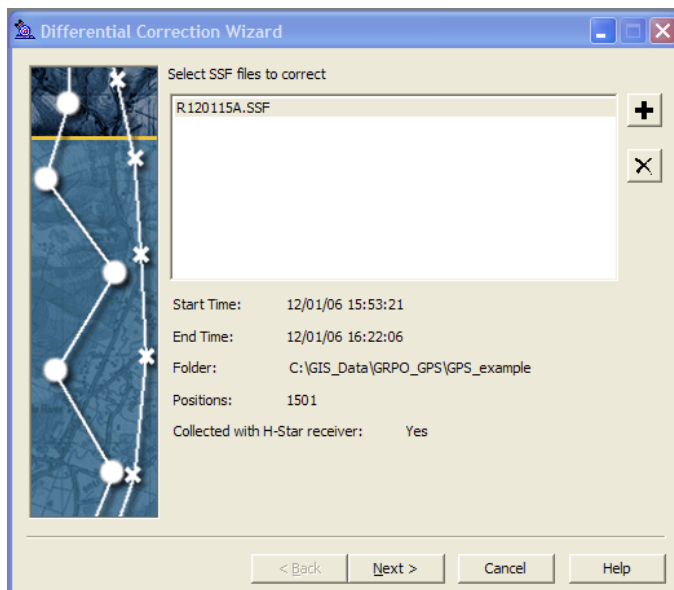
The Zephyr external antenna is necessary in order to achieve the 20-50 cm accuracy, as it is able to collect dual frequency satellite signals, (L1 and L2). The L1 frequency is common to all GPS receivers, whereas the L2 frequency accounts for ionospheric delays, which can be a significant source of error in single-frequency receivers.

1. Connect Zephyr antenna cable to XH and turn the GPS receiver on first, then start the PDA.
2. On the PDA, go to Start-Programs, and select the *TerraSync* icon (or select *TerraSync shortcut* from Start Menu).
3. The PDA Bluetooth connection should auto-establish with GPS (look for “connector plug” icon in upper screen of TerraSync). If not, check the TerraSync Status-Receiver submenu or Status-Plan for “GPS is Disconnected” message.
 - To manually connect Bluetooth, go to TerraSync Setup-Options and select Connect to GPS.
 - If TerraSync gives error message “Failed to connect to GPS receiver because the COM port is in use by another application,” close TerraSync and go to PDA Start-Settings, select *Connections* tab, select *Bluetooth* icon, and select *Turn On*. Save, close and return to TerraSync.
4. Attach the GPS receiver to the range pole and/or tripod using the threaded connection. Set the tripod such that the antenna is directly over the center of the target, and measure the height (to nearest cm). Use the bubble level on the range pole to ensure that the antenna is vertically centered directly over the target. Ideally, the antenna should also be above the operator’s height to avoid any possibility of operator interference with satellite reception.
5. Start data collection – with a 1-second collection interval set, allow unit to capture at least 200 points, under H-Star collection active (see step #5, above).

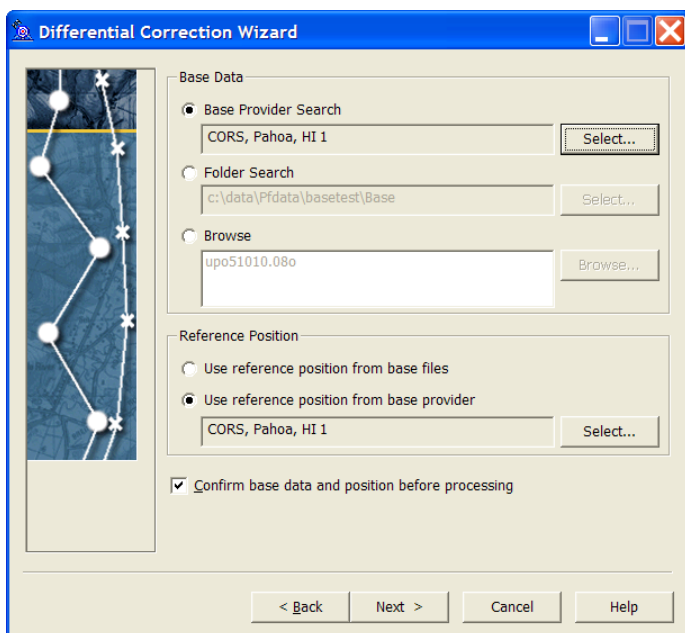
Post-processing the data

The Network is currently using Pathfinder Office (v.4) for completing differential correction on the field data files. Alternatively, ArcGIS GPS Analyst may be used, and is an extension to ArcGIS, available from Trimble. Both software packages effectively accomplish the same task using a nearly identical interface.

Data files should be downloaded from the PDA shortly after returning from the field. This is done using the 'Data Transfer' option under *Utilities* within Pathfinder Office. The files are downloaded as a bundled ssf file. The PDA must be connected to the computer, and ActiveSync is used to establish the communication. In Pathfinder Office, select the file, and go through the differential correction utility. Note that the last line verifies that H-Star quality data was collected in the field.



1. Select *H-Star Carrier and Code Processing* radio button in the next dialog box. Then proceed through verifying processing parameters when clicking **Next** again.
2. Selections in the next dialog box should be as indicated in the screen capture below:



3. Using reference position from base providers ensures that all data will be in WGS84 reference frame (or datum). Trimble maintains a database in which all station locations are based on WGS84 (or ITRF). Selecting as above accesses that database rather than using the data directly from base files. Also click on **Confirm Base Data and Position Before Processing** button. This will check for any discrepancies between the base provider file in the Trimble software with the actual base station location information.
4. There are three relevant files in gathering information on each CORS station, and are accessible from the NGS website (<http://www.ngs.noaa.gov/CORS/>). These are the data sheet, log file and RINEX2 file. It is advisable to manually verify the location of the base station by downloading the data sheet from NGS.

Literature Cited

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http://www.trimble.com/terrasync_ts.asp?Nav=Collection-30232

Hawaiian Petrel Monitoring Protocol Pacific Island Network

Standard Operating Procedure (SOP) #6: Setting up and Searching Sampling Units at Colonies

Version 1.00

Sampling Units

Two-dimensional 50 x 50 m grids will be set up at each park. If topography allows, the grids will be set along the current Universal Transverse Mercator (UTM) coordinate system for each park. However, in areas of steep topography, the grids will be set as perpendicular to the slope as possible. Once set, these grids will be permanent units to be used year after year.

Number of Sampling Units to Monitor

HAVO will monitor 60 sampling units or grids, and HALE will monitor 75 sampling units or grids (each 50 x 50 m in size) during each monitoring year. However, the number of units is based upon the availability of personnel and funding, as well as weather, so there may be slight variations from year to year.

Some sampling units will be monitored every year. These legacy units contain Hawaiian petrel nests that have already been monitored for several years. “Legacy burrows” provide important long-term reproductive or other life history information. Eighteen legacy units, containing legacy burrows, will be monitored at HALE and 13 will be monitored at HAVO. Other units (“random units”) will be randomly selected and monitored for one year only, with new units selected in each subsequent year.

Creating the Grid Overlay and Selecting Random Sampling Points

The grid overlay and associated corner and transect points (steps 1-2) should be created only once, as described here, prior to the first round of monitoring. The resulting files should be stored appropriately and used for all subsequent rounds of monitoring.

1. A GIS program can be used to create a polygon grid layer of 50 x 50 m cells (sample units) across the sampling frame area. The grid layer then will be overlaid on top of other GIS layers (e.g., sampling frame area, park boundary, nest locations) for the map of each park. To create a polygon grid layer using Hawth's Tools:
 - In ArcMap, open Hawth's Tools, select *Sampling Tools*, select *Create Vector Grid (line/polygon)*.
 - For Input Extent, select *Same as this layer*. Use scroll down arrow to select the sampling frame area layer.
 - For Parameters/Spacing between lines, enter *50* for *X* and check *Lock 1:1 ratio* box.

- Check the next 2 default parameters.
- For Output, select *Output polygon features*.
- Under *New shapefile to create*, select a location on computer to store the polygon grid layer and give it a name.
- Under *Projection definition*, check to make sure the appropriate coordinate system is selected (by default it should be the same as the coordinate system of sampling frame area).
- Click OK. A polygon grid layer with 50x50m cells will be generated.
- Next, the polygon grid layer needs to be clipped with the sampling frame area layer using the Clip Tool in ArcMap.
- Open ArcToolbox. Click *Analysis Tools*, click *Extract*, and double click *Clip* to open its dialog window.
- For Input Features, select the polygon grid layer.
- For Clip Features, select the sampling frame area layer.
- For Output Feature Class, select a location on computer to store the clipped polygon grid layer and give it a name.
- Click OK. The grid layer will be clipped to match the boundary of the sampling frame (i.e., only shows 50 x 50 m cells **within** the sampling frame area).
- With the guidance of a GIS specialist, permanently assign a unique, consecutive number to each grid within in the frame that falls within suitable habitat.
- This is the final polygon grid layer and should be used for all subsequent monitoring. The HAVO file is located on the share drive: S:/~RM~/GISfiles/2013/LABELED 50 METER GRID 2013. Backup copies are stored with the PACN I&M program.
- Print several master maps showing all grids with their permanent numbers (Figure S.6.1).

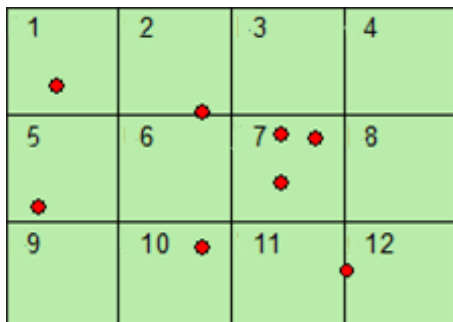


Figure S.6.1. Representative grid cells labeled with their permanent, consecutive grid numbers. Red dots represent Hawaiian petrel burrows.

2. Create database of UTM coordinates of both grid corners and starting points of 4 meter transects along which to conduct nest searches:
 - To avoid having duplicate names for corner points (since each grid corner “belongs” to four different grids), designate each grid by its NE corner and associated UTM. E.g., 6NE is the name of the corner point for the top right corner of grid I-6 in the example in Figure S.6.1, and it also is the top left corner of neighbor grid I-7 (which lies directly right of grid I-6).

- For starting points of nest search transects, assign and label 12 points along the North boundary of each grid, starting 4 meters from the east end and moving west, ending 2 meters from the NW corner of the grid. Label north transect points, from East to West, as: GRID#N1-12 (i.e. 6N1 through 6N12).
3. This protocol uses two approaches to select grids to sample: Deliberate, non-random selection to identify “legacy grids,” and random, unbiased selection of “random grids.” Legacy grids are chosen in year one and then re-sampled in all subsequent monitoring years. In contrast, random grids are selected and sampled each year, and a new random sample then is drawn and sampled the following year.
 - At HALE, 75 total units will be monitored each year, 18 of which are legacy units chosen on the basis of large numbers of known active burrows. The remaining 57 grids are randomly chosen the first year, with a new set chosen in each of the following monitoring years.
 - At HAVO, 60 total units will be monitored each year: 13 are legacy units chosen because they contained known, recently active burrows at the time monitoring started, and 47 are random units selected annually.
 4. Refer to all selected grids, both legacy and random, by their permanently-assigned grid numbers.
 5. Legacy units were selected at HAVO prior to the first round of monitoring in 2012. See Appendix to this SOP for HAVO Legacy and Random Grids used in 2012 and 2013.
 6. Random units: A new set of random units is chosen for each year of monitoring as follows:
 - Select random grids using the Excel RANDBETWEEN function, which returns a random number between the range of numbers you specify.
 - Specify the bottom number = 1 and the top number = highest permanent grid number within your sampling frame.
 - Copy RANDBETWEEN formula until you have selected enough random grids-- 57 for HALE and 47 for HAVO.
 - Select at least 10 additional, “back up” grids in case any random units prove too unsafe or unsuitable to survey.
 7. Illustrate legacy and random grids (including all back up grids) on the field map using their permanent numbers. Save a copy of the map for each season for documentation.
 - For the 2012 and 2013 HAVO monitoring season, all selected grids were assigned numbers beginning with “L” for legacy or “R” for random (L1-L13 and R1-R47).
 - For these seasons, ensure that each L and R# assigned is linked to the permanent grid number for that cell (on datasheets and in database), as these grids may be re-sampled and only the permanent number will be utilized during future seasons.
 8. Prior to annual monitoring, determine the UTM coordinates of all four corners transect start points for each legacy and random sample unit that will be monitored.
 - Create a table to store this information and enter it into GPS units. Print and bring the table into the field as a back-up in the event of GPS failure. File a copy of this table with the end of season summary.
 - Start by adding the NE corner point for each selected grid. To obtain the other 3 corners, look up the NE corner points for the grid to the left and the grids below

the selected grid and its neighbor to the left. See Figure below: grid 13 has been selected, use its NE corner as well as the NE corners of grids 12, 18 and 19.

- Add the North transect points for the selected grid (*e.g.* 13N1-13N12) as well as the North transect points for its southerly neighbor (*e.g.* 19N1-19N12).
- Transects will guide survey teams, allowing them to systematically and thoroughly search each grid for active petrel burrows. For each grid, field staff will walk 12, equally spaced (4m apart) north-south transects that cover the entire grid area. In the given example (Figure S.6.2) field staff would navigate from 13N1 to 19N1 then back up from 19N2 to 13N2 and so on.

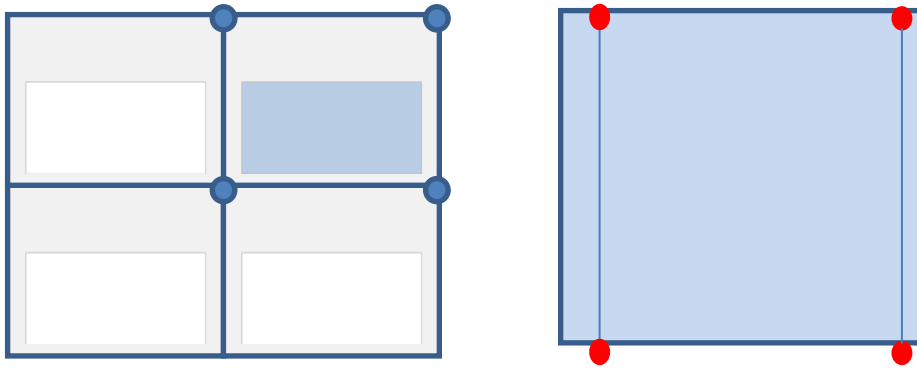


Figure S.6.2. Finding the corner points and N transect start points for each selected grid using NE corners and North transects of southerly neighbor.

9. Once all grids are selected and mapped out, plan field routing(s) so that travel to selected grids is most efficient.
10. Provide Park Lead with copies of random grid table, field map(s) and field routing plan prior to monitoring trips.

Setting Up and Marking a Square Sampling Unit

Materials

Use the following materials to set up sample units:

1. GPS unit
2. Compass
3. Map of flow with all selected and alternate grids marked and suggested route indicated
4. Spreadsheet containing four corner points for all selected grids.
5. Binoculars, one for each person (optional)
6. Radios, one for each person
7. Permanent grid corner markers (e.g., heavy stainless steel washers)
8. Flagging tape (pink for grid marking, blue for nests)
9. Paint pen
10. Aluminum tags (1 x 3 inch size)
11. Pens or pencils

Field Methods for Grid setup:

1. Using your pre-planned grid survey route map, navigate to a known corner of the first grid. Quickly assess the general area the grid will cover to determine if terrain will allow safe set-

up and subsequent searching, referring to JHA as necessary. If not, discard unsafe grid and select previously-determined alternate grid. Proceed to next nearest grid to begin set-up.

2. Mark all actual grid corners with stainless steel ($\frac{1}{2} \times 2$ inch) washers tied with a piece of flagging tape. Write location name (e.g., 24NE) on the washer (with a paint pen or permanent marker) and place labeled side down at NE corner (to limit weather exposure). For the 2012 season at HAVO, corners were labeled with temporary grid numbers (e.g., R24NW or L4SE) only. These corner markers will be replaced opportunistically with permanent NE grid number markers.
3. Also label all corners with an aluminum tag: Write location name on tag with a pen or pencil (again, always in the format of Grid#NE) and attach tag to bush nearest to the actual corner mark. (Note: same temporary marking system was used for these tags in 2012 at HAVO; these also will be replaced opportunistically).
4. Attach a small piece of PINK flagging to the same bush as the aluminum tag. While it needs to be visible, flagging should be as unobtrusive as possible to avoid attracting feral cats. Moreover, long tails of flagging at high elevations quickly deteriorate due to wind and UV radiation. Flags and other permanent markers should not be visible from trails
5. In subsequent monitoring years, replace legacy grid corner markers and flagging as necessary. Check random grid corners opportunistically and replace as needed.

Field Methods for Setting up Units in Sloped Areas

1. Using the method described above in areas of steep topography will produce distances between the four corners greater than 50 m due to the slope (Figure S6.2). This is much more likely to occur at HALE.

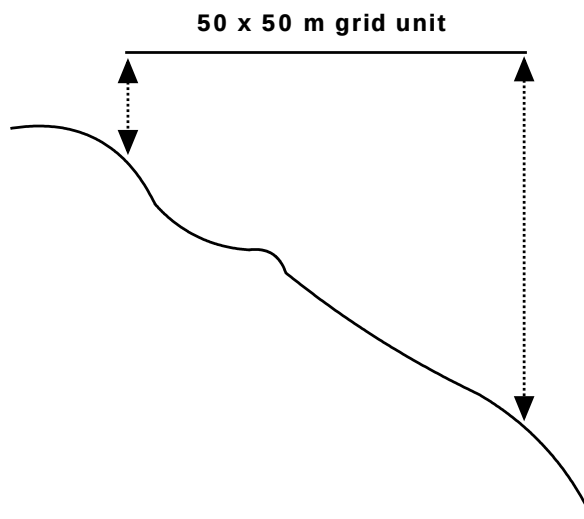


Figure S.6.2. Distortion of 50 x 50 m grid unit on a steep slope.

Below are examples of how “distorted” the 50-m distance would become based on slope, as calculated using the formula $50 \text{ m} / \cos(\text{slope angle})$:

- 10 degrees slope = 50.8 m
 - 15 degrees slope = 51.7 m
 - 30 degrees slope = 57.7 m
 - 45 degrees slope = 70.0 m
2. It is recommended that once the grid units have been selected from the grid shapefile in GIS, the XY coordinates of the **lower left corner of each unit** be uploaded to the GPS.
 3. In the field, find that point with the GPS unit.
 4. Use a compass to measure 50 meters north and 50 meters west from the point (at 90 degree angles to each other) to find the other three corners of the unit. A measuring tape, 50-m length of heavy string, or a range finder can be used to find the exact corners.
 5. This method will assure that the units on sloped topography are always 50 x 50 m on the ground. It may be also be less time consuming than finding all four corners with the GPS unit, and likely more accurate.

Searching for Active Burrows within a Sampling Unit

1. Observers usually conduct grid (or unit) searches immediately after either marking corner points of the grid or re-locating them (if the grid was marked previously).
2. Observers conducting searches must be able to differentiate between activity signs of Hawaiian petrels versus those of other animals (e.g., chukars, rats, mongooses, cats).
3. Two people should conduct a burrow search in north to south sweeping pattern across each sample unit. In field trials in 2012, searches using two adjacent observers were most efficient. Field workers also thought that having two observers walking abreast minimized chances of missing active petrel burrows.
4. The overall idea is for both observers to methodically walk parallel swaths back and forth across the grid until the entire grid surface is searched (i.e., a boustrophedon search pattern; see Figure S. 6. 3). To do this, observers navigate from the starting points of two adjacent transects on the north boundary of the unit to the corresponding ending points on the south boundary:
 - Use the GPS to navigate to the first two adjacent transect starting points (points 1 and 2) on the North or South boundary of the grid.
 - From there, walk slowly abreast, using the GPS compass to maintain course on a straight line to the corresponding point on the opposite grid boundary, e.g., from 24N1 to 24S1.

5. As each observer walks, she/he visually searches a 4 meter wide swath, 2m on either side of the transect, for evidence of burrows and visual signs of Hawaiian petrels or other animal activity. See SOP #7 “Collecting, Evaluating, and Summarizing Hawaiian Petrel Burrow Data” for details about visual signs. When observers reach the end of each transect, they move over to the adjacent two 4m points (i.e., to points 3 and 4) and continue until they have searched all 12 transects within the grid.
6. If the terrain does not allow for walking in a consistent swath (e.g., cliff faces, large boulders, and unstable surfaces are in your path), the observers should navigate around the obstruction and continue searching along the swath. This is most likely to occur at HALE.

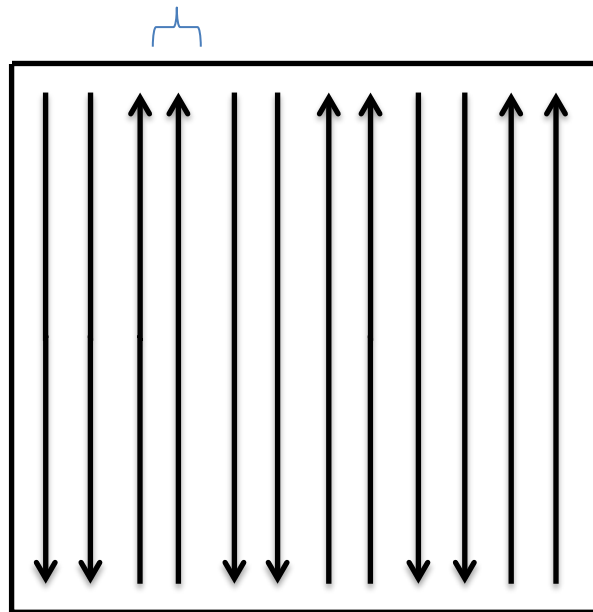


Figure S.6.3. Schematic of two observer search pattern used to canvass a sampling unit (grid) for active petrel nests.

7. Do not attempt to see farther than about 2 m to each side of the swath. Walk slowly enough on the line to be able to search thoroughly. Observers should communicate and visually inspect for each other when necessary (i.e., when terrain hides sections of the swath from view of one, but not the other, observer).
8. Investigate all potential burrows or a visual signs identified. If leaving the transect to investigate, leave a small piece of flagging or equipment to mark the line.
9. If a potential burrow is located, thoroughly examine it to determine if it is indeed a Hawaiian petrel burrow. At HALE, chukars often make homes in shallow burrows. Hawaiian petrel burrows are extensive (longer than one meter) and have definite signs of petrel activity (e.g., footprints, feces, and/or feathers, see SOP 7).

10. Record burrow data as specified in SOP #7. Use a GPS unit to mark the location of new burrows found (known burrows that are in the grid should be marked and already have GPS locations documented; check with the Park Lead).
11. Resume walking the line, searching back and forth, until the opposite end of the sample unit is reached.
12. The observers continue searching up one line and down the next until the entire unit is searched.

Is the Burrow Inside or Outside the Sample Unit?

1. In most cases, burrow tunnels are long and convoluted, and it is next to impossible to locate or see the nest chamber. In situations like this, the only way to determine if a bird is visiting a burrow is through the identification of visual clues that are seen in and around the burrow entrance (see SOP #7 for more details). Therefore, the location of the burrow entrance determines if the burrow is within a selected grid unit.
2. There may be cases where a burrow entrance is found straddling the edge of a sample unit. If an identified entrance to a burrow falls on the line of a sample unit (e.g., Figure S6.4, example burrows circled in blue), use the following rule: burrow entrances straddling the northern and eastern grid boundaries will be included within the subject grid. Those entrances straddling western and southern grid boundaries will be excluded.

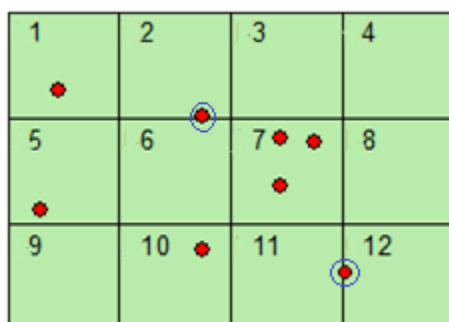


Figure S6.4. Representative burrows straddling two sample units. According to the rule, the burrow between grids 2 and 6 falls into grid 6, and the burrow between grids 11 and 12 falls into grid 11.

3. If a burrow has two or multiple entrances, determine which entrance is being used by looking for visual signs. One or more entrances may be found in the sample unit being monitored, but others may fall outside that unit. Determine which is the main entrance or entrances. If the main entrance lies in the unit, the burrow is then included in that unit, even though other entrances may lie outside the unit. However, if the main entrance falls across the edge of the sampling unit, use the rule above to determine whether the burrow should be included in the unit or not.

4. All questionable burrows encountered in the field should be treated as though they are in the grid. Obtain the most accurate GPS point possible, map the point upon return, and make a determination based on the above standards.

Assigning Numbers to Burrows at HALE

Temporary numbers

New burrows found are initially assigned *temporary numbers* with a different type of aluminum tag made of a thinner material than the permanent aluminum tag (see section on Permanent Numbers for determining when to change tags from temporary to permanent numbers). This tag is affixed to a nearby bush or rock. A burrow may show signs of activity, but the activity may be from prospecting birds that only examine the burrow once or twice but never return. A temporary burrow may remain for several years before it is determined that the burrow is actually utilized by a Hawaiian petrel. Sometimes less experienced observers mistake chukar burrows for petrel burrows.

The temporary tag includes the colony, founder's initials, date (MMDDYY), and number of the burrow found on that day. For example, if three burrows are found by one person in two different colonies on the same day, the numbers would look like:

LC CB080607-01

LC CB080607-02

WH CB080607-03

An attempt by breeding adults to produce a chick must be verified before a permanent number is given to the burrow.

Permanent numbers

Each burrow is assigned to a colony based on location within the park. Colonies have two-letter abbreviations. Burrows that have been verified as being occupied by breeding Hawaiian petrel adults (either because they were found in the past or are new burrows) and show signs of reproduction (e.g., egg shell fragments, chick down, fledging chicks) receive *permanent numbers*. The newest burrows are assigned the next number within the series.

A spot on a rock near each burrow may be painted so that the burrow can be located from a distance. Permanent tags, which are numbered and made of aluminum, are placed directly above burrow entrances. Each aluminum tag has the 2-letter colony abbreviation and the burrow number. Placement of these tags is extremely important, since burrow entrances can be difficult to identify. Some burrows may have openings that appear to be burrow entrances, but actually terminate before reaching the nest chamber.

When assigning a number to a burrow, record the date and colony abbreviation in a field notebook. Create a table (similar to the one shown in Table S6.1) to also record the assigned number for each burrow, whether the burrow was entered (= E) or not entered (= NE) by a Hawaiian petrel, and the visual signs seen at the burrow entrance (i.e., droppings, feathers, tracks, shell), or if no sign was observed (= ns). See SOP #7 for details on recording field signs.

For burrows with multiple entrances, arrows are written onto tags which point downwards to indicate each entrance. Each of these entrances is assigned a letter (i.e., L = left, M = middle, R = right). If there are more than three entrances, then numbers are assigned in addition to the letters (e.g., see Table S6.1 for an example: L1 = 1st left entrance, L2 = 2nd left entrance). In the field notebook, the letters for multiple entrances are recorded directly after the burrow number and then circled. During burrow checks, toothpicks that are placed or replaced in front of burrows and visual signs are recorded. Each entrance is recorded separately.

Table S6.1. Example of data collected at five previously surveyed consecutive burrows.

06 August 2007 LC (date and colony ID)				
Burrow #	Entrance	Entered/ Not Entered	Sign	Descriptions
431		NE	ns	NE = not entered, ns = no sign
432	L1	E	tr dr	1st left entrance, E = entered, tr = tracks, dr = droppings
432	L2	E	tr	
432	M	E	dr	M = middle entrance
432	R	E	dr	R = right entrance
433		NE	ns	
434		E	eggout	eggout = egg found outside burrow, depredated
435		E	dr sh dn	dr = droppings, sh = shell, dn = down

Assigning Numbers to Burrows at HAVO

If a burrow has several entrances, they are referred to either by number (i.e., 1, 2, 3, usually in the order they were found) or in order from the proximity to the summit of Mauna Loa (e.g., mauka entrance, middle, makai entrance or mauka right side entrance, and mauka left side entrance). Most nests have a nest card, a 3 x 5" index card containing a drawing of the burrow, adjacent landmarks (e.g., shrubs, the nest tag, etc), and all burrow entrances, each labeled with its name or number. Observers try to determine which entrance is the most actively used (e.g., toothpicks consistently down at one entrance) and note it on the card. Entrance numbers referred to on nest check forms should correspond to the entrance numbers noted on the nest card, since a different observer may conduct the next nest check.

Aluminum forestry tags only are used at HAVO. Each burrow is labeled with an aluminum tag that includes the nest number, date found, and the observer's initials. For example:

N-200
12/5/07 JSL

The tag itself is secured with a metal wire to a sturdy branch in a nearby shrub. It is placed well inside the shrub, where it will not blow and its glint is less visible to feral cats and other predators. A short piece of blue flagging is placed higher up in the shrub on the same branch as the tag. The flagging should be long enough to see but not blow in the wind, which could attract predators to the burrow. After reading the tag, the observer tucks it back inside the shrub. Old flagging, which disintegrates over time, should be removed and replaced with fresh flagging as needed.

Aluminum tags are also used to mark a Hawaiian petrel carcass. The date, observer initials and carcass number are written on the tag. The tag is placed where the carcass was located, especially if the carcass was collected. This tag is placed face-down to protect the writing from the elements. The carcass number is usually the nest number, so a carcass at nest N-200 would be labeled C-200. If there is more than one carcass at the burrow, the first carcass is labeled C-200, the second C-200A, and the third C-200B. A second tag with the history of carcasses is also placed with the nest tag. If a carcass is located some distance from any burrow, and identifying what burrow the bird might have come from is not possible, an aluminum tag in the C-700 series (indicating it is not associated with any nests) is used to mark the location of the carcass. A GPS waypoint is taken to mark the location, and a number from the above series is assigned. The Carcass Form (Appendix S7a in SOP #7) is used to record this location, identification number, and description of where the carcass was found and what features it was associated with, as well as its proximity to any nest or subcolony site.

Cultural Features at Colony Sites

Many locations within our national parks were at one time settled or visited by Hawaiians. Archeological features may remain in areas in and surrounding petrel nest sites. Features that have been found in subalpine petrel habitat on Mauna Loa at HAVO include human-modified pits, where pieces of lava rock were excavated to make or enlarge openings in the lava (Hu et al. 2001). These enlarged pits are utilized by petrels for nesting, and it is suspected that the pits were used by Hawaiians to capture young petrels for human consumption (Hu et al. 2001). Over 200 cultural sites along the rim of the summit and within the crater at HALE have also been identified (NPS 2004). Features vary and include platforms, shelters, trails, and quarries. Unlike HAVO, however, petrels at HALE are not necessarily associated with archeological features. In addition to archeological features, the entire summit and crater areas of Haleakalā is sacred (similar to the sacredness of a shrine) to the Hawaiian people of today.

As part of the training program for this protocol, it is required that all field personnel be provided a pre-season briefing to ensure each person knows the Hawaiian significance of the area, what the cultural features look like and are able to readily identify the features, receive instruction on prohibitions of caves, and how to carefully work in the area. See SOP #2 “Training Observers” for further details.

In brief, when working around cultural features and sites:

1. Respect that the area is culturally sacred to the Hawaiian people.
2. Avoid moving any rocks.

3. Place gear away from features, preferably on a solid portion of the flow or in a sandy pocket.
4. Avoid walking through features if you can walk around them.
5. When walking in or near archeological features, do so slowly, pick up your feet carefully, and avoid stepping on rocks that may be loose and dislodge.
6. If working in features (e.g., to investigate a potential burrow), use knee pads or a foam pad to kneel down on, and if necessary, leather gloves. Do not brush loose rocks away to clear a smooth spot to work or kneel in.

Literature Cited

Hu, D., C. Glidden, J. S. Lippert, L. Schnell, J. S. MacIvor, and J. Meisler. 2001. Habitat use and limiting factors in a population of Hawaiian dark-rumped petrels on Mauna Loa, Hawaii. *Studies in Avian Biology* 22: 234-242.

National Park Service. 2004. Resources management plan, Haleakalā National Park. Draft. U.S. Department of Interior, National Park Service, Makawao, Maui, Hawaii.

Hawaiian Petrel Monitoring Protocol Pacific Island Network

Standard Operating Procedure (SOP) #7: Collecting, Evaluating, and Summarizing Hawaiian Petrel Burrow Data

Version 1.00

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, and identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

Abstract

This Standard Operating Procedure (SOP) describes procedures for conducting Hawaiian petrel (*Pterodroma sandwichensis*, 'ua'u) nest searches at Hawai'i Volcanoes National Park (HAVO) and Haleakalā National Park (HALE). This SOP describes methods to collect data and assess burrow occupancy using direct and indirect methods. Processing field data forms or data books, performing data entry, and entering data points into GIS also are briefly discussed.

Burrow Checks

Burrow or nest checks have two purposes: (1) To assess burrow status for possible inclusion in density calculations (all burrows found within sampling units are assessed for activity when they are found, and only active burrows are included in density calculations), and (2) to estimate fledging success (active burrows also will be checked a minimum of three additional times to

determine the success of active nests). Grid searches and the associated burrow checks for density estimation ideally occur in the time frame of June-July (at HALE) and August-September (at HAVO). The additional three fledging success burrow checks occur in September, mid-October, and mid- to late-November for HAVO and in August, September and October for HALE.

Observers should be trained in nest search and data collection methodology before entering a petrel sub-colony (see SOP #2 “Training Observers,” SOP #6 “Setting Up Sampling Units at Colonies,” and SOP #7 “Collecting, Evaluating and Summarizing Hawaiian Petrel Burrow Data” for details). Nest checks are performed during daylight hours.

Each observer will have a field notebook (HALE) or datasheets (HAVO) to record information about burrows, as well as a map of burrows to be checked. The map can depict additional known active and non-active burrows and other features that may serve as landmarks. For checks of burrows that already have been monitored at least once during the season at HAVO, it is helpful to bring copies or summaries of the season’s previous nest checks and nest cards (although HALE has too many nests for this to be an effective method). Nest cards are index cards containing a sketch of the burrow’s entrances plus nearby landmarks such as vegetation, distinctive rocks, and the location of the nest’s permanent field tag, all labeled, to assist the nest checker in relocating all the burrow’s entrances.

There are four data forms used at HAVO for documenting information at or near burrows (Table S7.1) Two petrel nest data forms used at HAVO have different functions. The Hawaiian Petrel New Nest Form (Appendix S7.b) is used whenever a new Hawaiian petrel nest is located. This form provides fields for recording the nest ID number, type of nest, number of openings, substrate type, and location information. The Hawaiian Petrel Nest Check Form (Appendix S7.a) is used to document direct or indirect signs (i.e., activity) at potential or known petrel burrows encountered within either legacy or random grid units, record the number of toothpicks placed or displaced at burrow entrances, and record any petrel remains discovered. A separate Carcass Form (Appendix S7.c) is filled out for each newly-discovered carcass or set of partial remains. The Hawaiian Petrel Density Grid Survey Form (Appendix S7.d) is used to determine the number of active burrows per grid and strata or frame.

Table S7.1. Hawaiian petrel data forms used at Hawai’i Volcanoes National Park.

Data form	Function
Hawaiian Petrel Nest Check Form	For documenting direct and indirect signs, recording toothpicks, and recording carcass remains
Hawaiian Petrel New Nest Form	For documenting new nests and associated features
Carcass Form	For recording carcasses or partial remains
Density Form	For determining number of active burrows/grid/strata or frame

There are two types of burrow checks. Indirect checks are performed on burrows that have nest chambers that cannot be viewed by an observer (either by eye or using a burrowscope).

Thus, during these checks, the observer documents cues near the burrow entrance (e.g., footprints, fallen down toothpicks that have been placed across burrow entrances, odor) that collectively indicate petrel activity. HAVO checks will almost always be indirect. Direct checks rely on the observer's ability to see contents of the nest chamber.

Burrows Checks: Indirect Methods

The long, angular channels of burrows make it impossible to view most 'ua'u nest chambers. Thus, these “inaccessible” burrows are assessed indirectly via a variety of cues in and around the burrow entrance(s).

Indirect Signs (or Cues)

When indirect signs are present, observers enter a description and a code into a field data book or onto a data form (see Appendix S7.a, Hawaiian Petrel Nest Check Form). The following lists these descriptions and codes:

- **Burrow excavation = EX.** Fresh signs of digging may be seen as Hawaiian petrels expand burrows prior to nesting (primarily at HALE).
- **Poop = PO.** As petrels move into or around burrow entrances, they may leave fecal droppings, which are referred to as “poop” in written records (e.g., field notebooks or data sheets). The fresher the droppings, the more recent the burrow activity (Figure S7.1a). At HAVO, it is classified by approximate age and all ages of droppings present are recorded: 1= fresh and still tacky; 2 = recent, still colored but dry; 3 = thick and off-white, chalky; 4 = whitewash, old (HALE just indicates fresh droppings).
- **Footprints/Tracks = FP.** These are noticeable where soil is present (Figure S7.1b), but not on solid rock or where leaves or moss cover the ground at the burrow entrance.
- **Feathers = FE.** Feathers that are clean are probably fairly fresh, and those that are very dirty or matted may have been there for some time. Natal down is dark to medium grey and may be found as tiny strands or as larger balls of fluff. Down from adults occurs in tiny tufts and is white.
- **Eggshell fragments = SH.** If shell fragments are seen in or near the burrow, further examination of nest contents may warrant the use of a burrowscope to see if the egg hatched or was predated and to check the status of the chick. Note in comments field on Hawaiian Petrel Nest Check Form if eggshell fragments are relatively large and/or clean. This may help determine nest fate.
- **Odor = OD.** Hawaiian petrels have a distinctive, musty smell, so if the odor is strong, this is an indication of recent activity.
- **Clipped vegetation = VEG.** Sometimes petrels cut vegetation (usually grasses and forbs) near the nest entrance, presumably for use in the nest chamber. One can see both clipped ends of plants strewn around the burrow opening, as well as the base of still-rooted plants that have been shorn off. However, clipped vegetation can persist for quite some time, and regrowth may be slow, so note the freshness of the evidence.
- **Toothpicks:** Observers place a line of toothpicks, approximately 2.5 cm apart, loosely in the soil across burrow entrances so birds are not injured if the toothpicks are walked over. Birds that enter or exit a burrow will knock at least several adjacent toothpicks down, which these

will be seen in later nest checks. Use the Hawaiian Petrel Nest Check Form to record the number of toothpicks up and fallen down.

- **No sign of entry or activity = NS.**



Figure S7.1. Indirect signs of Hawaiian petrel activity: (a) fresh fecal dropping (i.e., poop), and (b) footprints in soil near a burrow.

Four or more letters may be used if the type of sign is not as common, but is not unusual. For example:

- **Adult down = ADDO.**
- **Chick down = CHDO.** Prior to fledging, Hawaiian petrel chicks snag downy feathers on the ground, on rocks, and in vegetation in and near the burrow entrance.
- **Rat droppings = RATPO.**
- **Chukar feathers = CHUKARFE.**
- **Oma'o droppings = OMAOPO.**
- **Squid beaks = SQBE.** Generally very small (<5mm), dark brown or black. Presumably, these indigestible remains are regurgitated by chicks being provisioned at the nest.
- **Signs of water = H₂O.** Water running near burrow entrance may create water erosion or may knock down toothpicks.

Record other incidental signs, including the presence of flies going into and out of the nest chamber, which may indicate a dead bird or rotting egg. A bird in a burrow may be detected visually (sometimes birds move to burrow entrances, or nest chambers can be seen by burrowscope or by looking), or by listening (although rarely, 'ua'u sometimes call or move while on their nest).

Burrows Checked One Time for Density Calculations

These burrows are checked once when they are found during grid searches. All signs of petrel presence are recorded, including 'ua'u droppings (e.g., relative freshness), footprints, feathers (including adult and natal down), characteristic petrel odor, eggshell fragments, squid beaks, and the presence of clipped vegetation. Fishing line and plastics may also be found and should be recorded and completely removed. Vegetation that is growing inside or around the burrow is also

recorded. After evaluating all cues present, the observer scores the burrow as Active, Inactive, or Unknown. Only active burrows are used to calculate density.

Burrows Checked Multiple Times for Fledging Success Calculations

Inaccessible burrows checked for reproductive success are monitored by the same indirect cues described above for density burrows. However, in addition, the observer places a line of toothpicks loosely in the soil across burrow entrances, about 2.5 cm apart. Birds subsequently entering or exiting the burrow will knock at least several adjacent toothpicks down, and these will be seen in later nest checks. Because other animals can also disturb toothpicks, note any evidence (e.g., droppings, tracks) of rodents, birds (e.g., chukars or oma'o), mongooses and/or cats. Burrows are considered entered by rats if single or alternate toothpicks are displaced, and either rat tracks or rat droppings are found near burrow entrances. The use of toothpicks to determine burrow activity has been proven effective at HALE (Natividad Hodges 1994; Natividad Hodges and Nagata 2001), where toothpicks were also placed across entrances of "accessible" burrows, those with visible nests, to confirm the validity of the method. During each burrow check, toothpick placement (i.e., number standing, and whether fallen toothpicks were adjacent to each other) and the number of toothpicks reset are recorded. The observer then evaluates all the indirect cues present and makes an assessment of whether the burrow is active or not.

Each nest is classified as "entered" or "not entered." Nests are considered "entered" by 'ua'u if at least three adjacent toothpicks are displaced and other 'ua'u signs are present at a check. "Not entered" are those burrows with all toothpicks intact, or displacement of a single or alternate (i.e., down, up, down, up) toothpicks and no additional signs of 'ua'u presence. "Unk" nests are those at which the observer cannot make a determination. There should be few nests that fall in this category, primarily nests with entrances unsuitable for placement of toothpicks because of rock substrate.

To facilitate the next nest check, indirect cues may be cleared from burrow entrances and tunnels. Cinder or soil is smoothed at the entrance of burrows with the edge of a field notebook to remove evidence of footprints or old droppings, which assists observers in identifying new tracks or other evidence. Clipped vegetation, however, is generally left in the burrow, or is moved a short distance from the burrow opening, in case it is still being utilized by petrels during the nesting season. At HAVO, any fecal matter on rock should not be scrubbed or rubbed to avoid disturbing or defacing archeological features. Instead, record the presence, freshness of the droppings (classified by approximate age [e.g., 1 = fresh and tacky]: See page 3 of this SOP for all age classifications of "poop"), approximate location, and number of droppings. Use the Hawaiian Petrel Nest Check Form, Appendix S7a of this document, to record this information. At HAVO, natal or chick down does not usually persist over winter, so it does not need to be removed after the season's final check. However, chick down does persist over winter at HALE and should therefore be removed.

Burrow Checks: Direct Methods

Direct methods involve direct observation of the nesting chamber within a burrow to assess Hawaiian petrel breeding activities and to search for evidence of predation. Some nests can be

directly observed by looking from the burrow entrance into the nest chamber, with or without flashlights. When looking inside the burrow without a flashlight, observers should take a moment for their eyes to adjust to the darkness of the nest chamber and work as quickly and quietly as possible to minimize disturbance to birds in the chamber. This method only works if the burrow tunnel is short and fairly straight. Otherwise, burrows should be observed with a flashlight to see if there are signs left by petrels or if a bird can be seen in the nest chamber.

A second method involves snaking a burrow camera or “burrowscope” in from the burrow entrance toward the nest. This is a custom-built device which allows accurate visual examination of nests at the end of narrow tunnels (Boland and Phillips 2005). A burrowscope consists of a small remote video camera with a B/W wide-angle lens and high sensitivity to low light levels. Several infrared light-emitting diodes (LEDs) are attached to the outside of the camera, which is enclosed in a cylindrical housing. The camera and LEDs are mounted onto one end of a length of flexible hose. The hose houses a live feed that extends to a handheld or head-mounted video monitor which displays images. This protocol will utilize the Peeper 2000™ Video Inspection System (Sandpiper Technologies, Inc., Manteca, CA; Figure S7.2a) to monitor burrow activity. The camera and hose are carefully pushed into a burrow and maneuvered around corners until the nest is visible on the video monitor (Figure S7.2b). Because most burrows have multiple side passages, it may not always be possible to find the nest chamber, even with a burrowscope.



Figure S7.2 (a) Peeper 2000™ burrowscope system, and (b) observer examining a nest chamber with a similar burrowscope system.

Burrowscope operators should be aware that a burrowscope is not a rapid or unobtrusive method for examining nest chambers. If a burrow tunnel is long and convoluted, it may take 30 or more minutes to arrive at the nest chamber. Additionally, the camera on the end of the hose twists as it moves through the tunnel, so the observer may be viewing a rotating or upside-down image in the video monitor. The camera may also bump into a bird in the chamber or tunnel before the operator actually knows the bird is there. Therefore, operators should practice using this equipment in inactive burrows or holes before attempting to check active or potentially active burrows.

Assessing Activity and Fledging Success

For the purposes of this protocol, fledging success is defined at the scale of the individual burrow as whether or not an active burrow fledged a chick. At the scale of the subcolony or colony, fledging success refers to the percentage of active nests that produce a fledgling.

Upon locating the burrow, the first step is to determine if the burrow is Inactive or Active:

- Inactive: Old carcass(s), bones, feathers; no fresh sign. (In the field, document inactive nests with Carcass Form, Appendix S7.c., as appropriate. Nests of uncertain Activity status may be documented on a nest check form pending determination at the end of the breeding season.)
- Active: Shows evidence of extended Hawaiian petrel presence at least one time during the breeding season: Bird entered and stayed long enough to leave droppings; or bird, egg or chick seen in nest. (In the field, document active nests with Hawaiian Petrel Nest Check Form, Appendix S7.a.)

Burrows that are "entered" and have petrel droppings in or near them during the checks are considered "active," since 'ua'u always defecate near the entrances of active burrows. Fledging success is determined for active burrows only and is based on cumulative evidence from individual nest checks. Nest check data is assessed in the standardized manner outlined in Table S7.1.

Table S7.1. Fledging success categories for the Hawaiian petrel monitoring protocol. At the conclusion of the breeding season, each active nest should be assigned to one Success Category based on accumulated indirect and/or direct cues gathered during multiple nest checks.

Fledging Success Category	Indirect Cues	Direct Cues
Non-breeder		Adults in attendance (nest is active), but no egg ever laid
Failed Nest or Non-breeder	Old egg shell fragments, recent droppings, or other signs of adult activity from the current season that cease before September (HALE)/Oct (HAVO) and no other definite signs of failure (e.g., as in Failed Nest below).	
Failed Nest	- Fresh-looking shell fragments or signs of chick presence (e.g., squid beaks or marine debris suggesting regurgitation from current season) but no chick down in Oct or Nov (under good conditions where down would be visible if present); or - Adult carcass or large quantities of feathers that suggest a carcass out of sight within the burrow. (Note: a dead adult with no other clues about egg-laying or chick presence could either be a breeding adult or a non-breeder, so in this case, we cannot distinguish between a failed nesting attempt or a failed [=dead] non-breeder).	- Chick carcass - Abandoned or predated/sca-venged egg
Fledged Nest	- Droppings or footprints seen at or after early-Oct (HALE) or mid-Oct (HAVO) and chick down at burrow entrance after early-Oct/mid-Oct; or - Droppings or footprints seen after early-Oct (HALE)/mid-Oct (HAVO), and activity after early-Oct/mid-Oct, although down not detected due to large entrance, recent rain, or a late check, and no other sign of failure.	Chick with developed flight feathers seen in burrow in Sept or Oct (HALE) or Oct or Nov (HAVO), and no sign of chick death afterwards
Unknown Outcome	Unable to determine if nest fledged or failed.	

Each nest is assessed based on data collected during nest checks and assigned to a fledging success outcome category. Place each active nest into the best-fitting category based on criteria in Table S7.1: Non-breeder, Failed Nest or Non-breeder, (known) Failed Nest, or Fledged nest. Avoid use of the “Unknown” category if possible. The reproductive status (Active or Inactive) and fledging outcome of each nest then is summarized in the Repro Success summary table in the Hawaiian Petrel Database.

Processing Field Data Forms or Data Books

Data forms should be reviewed for quality assurance before data is entered into the Hawaiian Petrel Database for either park. Check field data sheets or data books to correct obvious errors to ensure complete and accurate information was recorded for each burrow. Sheets and books should be examined at the end of each field day to look for errors or misinformation.

At the top right of each data form in this SOP, a text box has been added that allows petrel monitoring staff to initial and date when: (1) datasheets have been checked in the field, (2) data on these datasheets have been entered into an Access or related database program, and (3) entered data is checked for quality assurance. It is important to have a record showing when data sheets were processed, and who did the processing. It is equally important to track any changes to the data from those originally written in the field. A red pen should be used when changes are directly made to any data sheet or field notebook, to distinguish these changes from the original records made in pencil or dark ink.

Field checked by _____	Date ____/____/____
Entered by _____	Date ____/____/____
Post-entry checked by _____	Date ____/____/____

See SOP #11 “Field Form Handling Procedures” for further details.

Data Entry

Data entered into the Hawaiian Petrel Database includes burrow data, reproductive data, and density data. Once data forms or field books that contain this information have been reviewed, field data can be entered into the database and verified. See SOP #13 “Data Entry and Verification” for details.

Downloading Data Points into ArcGIS

Locations of previous season burrows and new burrows are recorded with a Garmin or Trimble GPS unit (see SOPs #4 and #5 for details on using Garmin and Trimble GPS units). All UTM coordinates collected by the GPS unit for each burrow location should be uploaded into an ArcGIS map. See SOP #9 “Downloading and Uploading Data between Garmin GPS and ArcGIS” for details.

Calculating Fledging Success

1. Use the Repro Success table in the Hawaiian Petrel Database to tally the total number of active nests and all nest outcome categories.
2. In this protocol, fledging success is the proportion of active nests that fledge a chick:

$$\text{FS} = \frac{\text{\# fledged nests}}{\text{Total \# active nests}}$$

NOTE: If additional nest monitoring (beyond nests in grids) has occurred during the current season, ensure fledging success for this protocol is calculated using only nests monitored in current grids.

Literature Cited

- Boland, C. R. J., and R. M. Phillips. 2005. A small, lightweight and inexpensive “burrowscope” for viewing nest contents of tunnel-nesting birds. *Journal of Field Ornithology* 76(1): 21-26.
- Natividad Hodges, C. 1994. Effects of introduced predators on the survival and fledging success of the endangered Hawaiian dark-rumped petrel (*Pterodroma phaeopygia sandwichensis*). Thesis. University of Washington, Seattle, Washington.
- Natividad Hodges, C and R. Nagata. 2001. Effects of predator control on the survival and breeding success of the endangered Hawaiian dark-rumped petrel. *Studies in Avian Biology* 22: 308-318.

Field checked by _____ Date ____/____/____
 Entered by _____ Date ____/____/____
 Post-entry checked by _____ Date ____/____/____

Appendix S7.a. Hawaiian Petrel Nest Check Form

Area/flow: _____ Observer: _____

Date 2 - - -	N E S T #	O P E N I N G #	Poop 1-tacky 2-dark 3-thick 4- wwash	# Toothpicks UP			Foot- prints? Y/N/NA	Chick Down Y/N	Other Feather Smell Adult down	Was burrow entered by a petrel? Y/N/U	Comments or Description (e.g. carcass/grass clippings/wet conditions-not able to see chick down/flies/vespula)
				a r r i v e	l e a v e	a d j a c e n t ?					

Petrel Nest #: Use consecutive numbers. Ex: N62, N64

Toothpicks: record number up on arrival. Record number left up upon leaving. Record whether toothpicks knocked down were adjacent (Y/N)

Footprint: NA = nest is on substrate that will not record footprints (i.e., rock, wet, mossy)

Down: NA = wet conditions/not able to see down/vs. large opening; down will be grey with no central rib. White = adult down

Carcass #: If carcass or parts are present, assign number (corresponding to nest #) in comments section & fill out CARCASS form (on reverse on some sheets)

Entered ?: **Y**= Nest has been entered: toothpicks down, footprints present, recent poop, smell or chick down seen since last check. **N**= Nest not entered: toothpicks remain up, no signs of poop, footprints, smell, or down since last check. **U**= unknown if nest entered: evidence is missing (e.g., potentially washed away) or unclear.

Field checked by _____	Date ____/____/____
Entered by _____	Date ____/____/____
Post-entry checked by _____	Date ____/____/____

Appendix S7.b. Hawaiian Petrel New Nest Form

Area: _____ Observer(s) _____

Date					Entrance dimensions						
20 ____	Nest #	Nest Type	HM ? Y/N	Opening #s	horiz. (cm)	vertical (cm)	Substrate type	UTMs	Error (m)	Elevation (m or ft)	Comments or Description

Petrel Nest: Use consecutive numbers. Ex: N62, N64
Nest Type: **1** = lava tube **2** = tumulus; **3** = other (describe in comments)
HM?: does it appear HUMAN MODIFIED?
Substrate: Weathered pahoehoe, smooth pahoehoe, or a'a'
Tag nest with metal tag: Nest # (N-XXX), date found, your initials
ALSO make sketch on nest card or in your field notebook (to be transferred to a nest card) for our permanent records

Field checked by _____ Date ____/____/____
 Entered by _____ Date ____/____/____
 Post-entry checked by _____ Date ____/____/____

Appendix S7.c. Carcass Form

Tag all carcasses found & not collected with carcass #, date, and initials. Use next line for Comments if necessary **OBSERVER:**

Date 2_ _ _	Carc #	Description (i.e., headless, bridled, scattered, wings only) Does keel have teeth marks? Digital photos should be taken of each carcass	Fresh? Y/N	Adult or Juv ¹	# carcs w/ ²	Position (on surface, in tube, exposure to sun and weather)	UTM or nest # ³	Collected?
	C-							
	C-							
	C-							
	C-							
	C-							
	C-							
	C-							
	C-							

¹ Down present = juvenile; no down = adult

² How many other carcasses were found with this one (i.e., 0, 1, 2)?

³ Take a GPS reading only if not associated with a nest

Field checked by _____	Date ____/____/____
Entered by _____	Date ____/____/____
Post-entry checked by _____	Date ____/____/____

Appendix S7.d. Hawaiian Petrel Density Grid Survey Form

Park: _____ Area (or Frame/Stratum): _____ Observer: _____

Date 20____	Grid ID # (perma-nent)	Legacy or Random (L/R)	NEST ID # ¹	UTMs		NEST Status		Comments
				Northing	Easting	Active	Not Active	

NEST ID#: Any new nest detected will be given a permanent number using existing nest numbering protocols. If no nests are present in grid, note NONE

NEST Status: Check active or inactive for each nest located. Use Nest Check Form to record details on nest status.

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Standard Operating Procedure (SOP) #8: After the Field Season

Version 1.00

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, and author of the revision, and identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

Abstract

This Standard Operating Procedure (SOP) describes procedures that all field personnel involved in the Hawaiian Petrel Monitoring Protocol should be familiar with and follow after the field season is completed. This SOP describes procedures for the following: post-season maintenance and storage of field equipment, entering and proofing data, writing trip reports, preparing data sheets for data entry and archival, and the compilation of field notes. The post-season follows the last Hawaiian petrel survey of each monitoring year.

Returning Field Equipment

1. *Clean and repair all equipment before storage.* Equipment should be thoroughly examined for damage and repairs made, if possible, before returning it to storage cabinets.
2. *Sign in and return field equipment.* The Park Lead or Field Lead will sign-in all gear that was issued to each field observer in the beginning of the season, assuring that issued items are returned and/or accounted for accordingly. The Park Lead or Field Lead must organize any damaged or incomplete equipment, and include labels describing the damage.

3. *Store monitoring equipment and supplies.* The I&M office at HAVO has cabinets designated for I&M-owned equipment storage. Equipment owned by the park will be stored by the appropriate park division. At HALE, park-owned equipment will be stored according to park procedures. Tents, sleeping bags, backpacks, burrowscopes, binoculars, cameras and any other field equipment should be cleaned and dried before placement in storage. All reference manuals should be re-shelved on the appropriate bookshelf. Other reference materials and extra data forms need to be filed in the appropriate filing cabinet. Clean the inside and outside of all vehicles used in the field.
4. *Repair damaged equipment when possible.* Compile a list of needed purchases or repairs and give this list to the Park Lead. The repair or replacement costs can then be included in this or next year's budget.

Data Forms, Data Entry and Verification, Data Certification

1. *Process the field data sheets according to directions in SOP #11 "Field Form Handling Procedures."*
2. *Update project database.* Enter data from the data forms into the appropriate seabird MS Access database. Follow data management instructions in SOP #13 "Data Entry and Verification" to ensure accurate and complete data entry and verification.
3. *Certify data.* When all data have been entered and verified, the Park Lead will certify the data according to instructions in SOP #14 "Post-season Data Quality Review and Certification."
4. *Submit project data to Data Manager.* Once the data has been certified by the Park Lead, data products will be submitted to the Data Manager according to instructions in SOP #19 "Product Delivery Specifications."

Field Notes, Photographs, and Final Reports

1. *Photocopy the field notes from all crew members.* Store the copies of the field notes with the original data sheets. If possible, original data sheets should be scanned and saved digitally. Digital copies should also be archived with the original data sheets.
2. *Process all photographs (or sketches if no photos are available).* Download all photographs taken in the field and name each one, following instructions in SOP #15 "Managing Photographic Images."
3. *Write final reports.* At the end of the field season, the Park Lead field crew leader will write a final report based on information collected at survey sites and file these with the original data forms, field notes and digital photographs. An annual report including field season data should be submitted to the I&M Program Manager, park biologists, Data Manager, and GIS specialist within four months after the completion of surveys. No sensitive data, such as UTM coordinates, should be included in the field report to protect the location of Hawaiian petrel colonies. Final field reports should include the following:

- a. Dates of surveys
- b. Start and end times for each survey
- c. Colony site/burrow ID numbers
- d. Brief descriptions of sampling design, including sample frame and sample units
- e. Crew members and their responsibilities
- f. General descriptions of colony locations and habitats
- g. Number of active burrows
- h. Density estimates within frame and individual strata
- i. Reproductive data
- j. General observations of weather, other disturbance events, and other animals encountered
- k. Any discrepancies that might affect data integrity/consistency
- l. Potential hazards
- m. Unique or noteworthy events
- n. Advice for future survey crews

Final reports will be submitted following standard NPS scientific format (see SOP #18 “Reporting”).

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Standard Operating Procedure (SOP) #9: Downloading & Uploading Data between Garmin GPS and ArcGIS

Version 1.00

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, and author of the revision, and identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

Abstract

This Standard Operating Procedure (SOP) describes how to download/upload GPS data using DNRGarmin, free software that is the Pacific Islands NPS standard for incorporating Garmin GPS data into GIS. This SOP is written specifically for Garmin GPSMap76CSx model, but it may be used for any other Garmin GPS models that can average a waypoint and collect track logs. The data transfer process uses DNR Garmin 5.4.1 and ArcGIS 9.3 software.

If using a Trimble unit, see SOP #5 “Using Trimble Global Positioning System (GPS) Units” for details on how to download and upload GPS data between a Trimble and GIS program.

Installation of DNR Garmin Software

1. If you already have DNR Garmin 5.4.1 installed on your computer, go to next section “Connect Garmin GPS unit to Computer” below.

2. If a previous version of DNR Garmin exists on your computer, start from Step 3. If there is no previous DNR Garmin software on your computer, start from Step 5.
3. Uninstall any previous versions of DNR Garmin by using the Start → Control Panel → Add/Remove Programs function.
4. When un-installation is done, perform a search on local drives for all files named “dnrgarmin.” If found, delete them. Note: Failure to completely remove any earlier versions can cause problem running the current DNRGarmin version.
5. Install DNRGarmin: If you have access to I&M server, go to M:\Software\GPS_Garmin\DNRGarmin5.4.1, then go to Step 6 to install the software. If you don’t have access to the I&M server, you may download the free DNR Garmin 5.4.1 software from the Minnesota Department of Natural Resources at this link <http://www.dnr.state.mn.us/mis/gis/tools/arcview/extensions/DNRGarmin/DNRGarmin.html> and then go to Step 6 to install it.
6. Double click the dnrgarmin54setup.exe file.
7. Press Next at the Welcome Screen, then accept the License Agreement. Press Next to continue.
8. The program will be installed in a default location “c:/program files/dnrgarmin.” Press Next to continue.
9. The program will install a desktop shortcut and a DNR Garmin folder will be added to the Start → All Programs menu. Press Finish and view the Readme file if desired, otherwise close Readme file.

Connect Garmin GPS Unit to PC

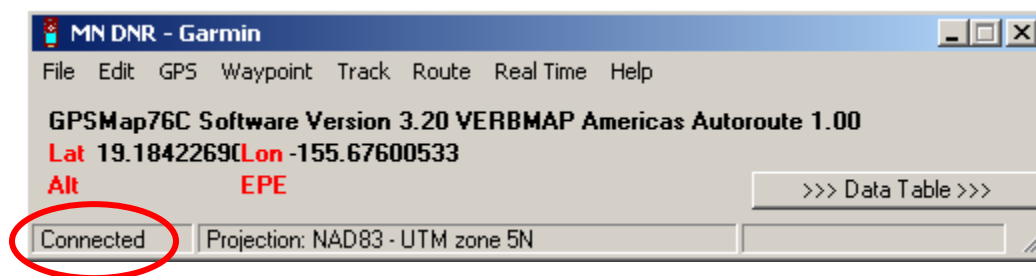
1. Attach the Garmin Cable to either a COM1 serial port or a USB port (depends on what type of cable that comes with your Garmin GPS unit) in the back of your computer.
2. Attach the other end of the Garmin Cable to the back of the Garmin GPS.
3. Turn on the GPS by pressing and holding the red lantern button.
4. Press the Menu button and select the “Use With GPS Off.”
5. Press Enter and the Garmin should be in Simulator Mode (GPS unit no longer is searching for satellites).
6. Press the Page button several times until you get to the Main Menu.
7. Make sure the “Serial Data Format” field is set to *Garmin*. From Main Menu page → Setup → Interface.

8. You're now ready to download or upload data between a Garmin GPS unit and your computer.

Download GPS Data into ArcGIS

GPS waypoints and tracks collected in the field can be downloaded directly into ArcGIS as shapefiles.

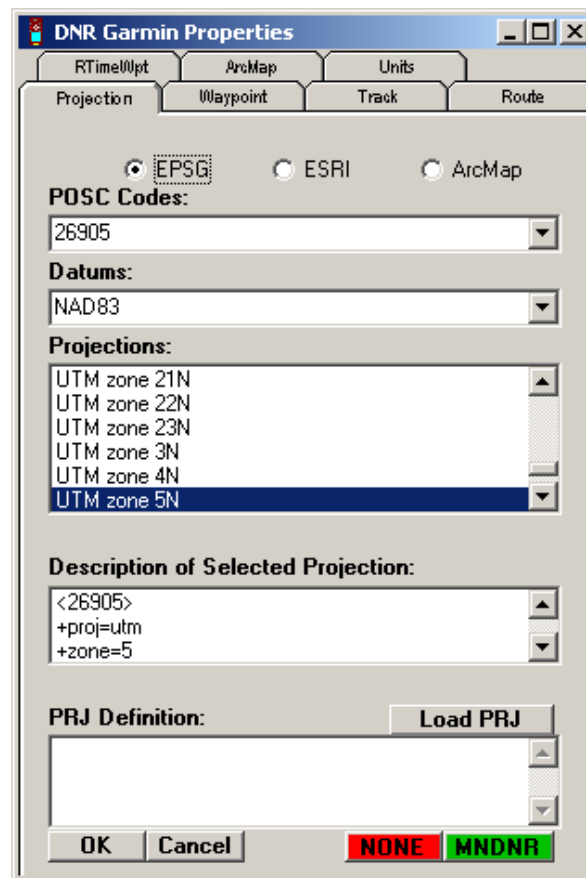
1. Open ArcMap.
2. Launch DNR Garmin from the desktop shortcut or loading from All Programs → DNR Garmin. You should see a screen announcing version 5.4.1 and MN-DNR Garmin window opens with the word "Connected" displayed at the bottom. **If you receive a connection error message or "Not Connected" displayed at the bottom of the DNRGarmin screen, go to section "Connection Troubleshooting Guide" at the end of this document for suggested steps to resolve connection problem.**



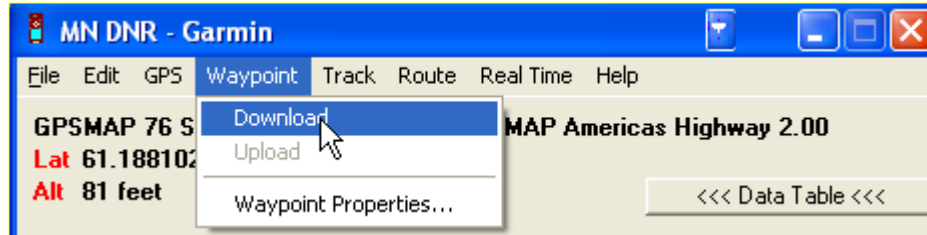
3. When DNR Garmin opens for the first time on a computer, you will be asked to accept or change the default projection of UTM -1983, Zone 15. **Select NO to change the default projection.**
4. The DNR Garmin Properties dialog box appears.
5. Set projection based on Table 1 below.

Table 1. Projection settings for islands in PACN

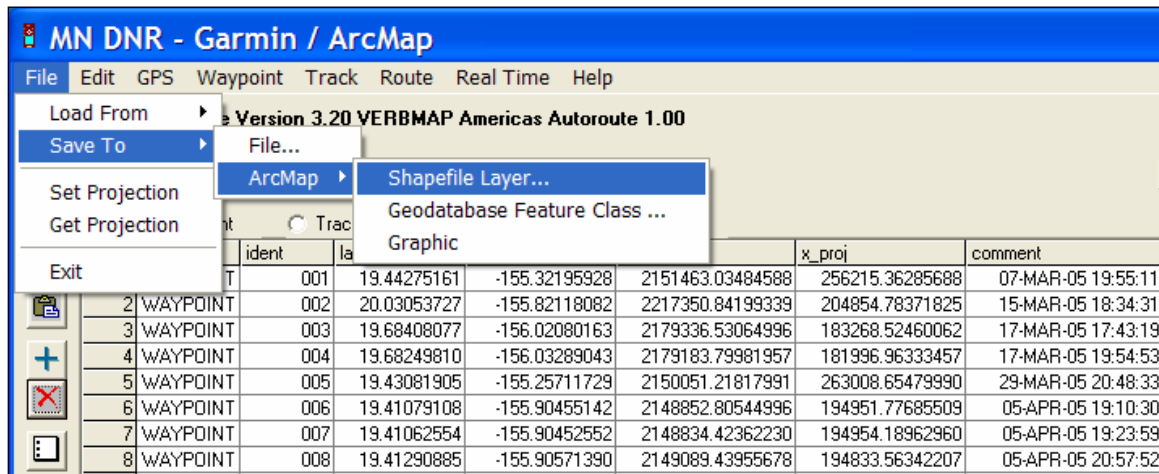
Island	ESRI (or EPSG) POSC code	Datum	Projection
Hawaii Island	26905	NAD83	UTM zone_5N
Maui Island	26904	NAD83	UTM zone_4N
Molokai Island	26904	NAD83	UTM zone_4N
Oahu Island	26904	NAD83	UTM zone_4N
Guam	32602	WGS84	UTM zone_55N
Saipan	32602	WGS84	UTM zone_55N
American Samoa (all islands)	32775	WGS84	UTM zone_2S



6. When Finished Press OK. **These projection settings MUST be checked EACH time you download GPS data** by selecting File → Set Projection.
7. In ArcMap, ensure that the Data Frame is set to the appropriate projection:
 - Right click on Data Frame name, select Properties.
 - In Data Frame Properties window, select Coordinate System tab. Read the information in Current Coordinate System box. It should have the same Datum and Projection as the GPS data you're about to download.
 - If it is NOT the same or "No projection" is displayed, then go down to Select a Coordinate System box, click on Predefined folder and select the appropriate coordinate system (refer to Table 1 above).
8. Download the waypoints (or tracks) into ArcGIS:
 First, download waypoints into DNRGarmin by selecting Waypoint (or Track) → Download. The waypoints (or tracks) will be tabulated and it might take a while.



Next, you MUST save the waypoints (or tracks) as a GIS layer by selecting
File → Save To → ArcMap → Shapefile Layer.

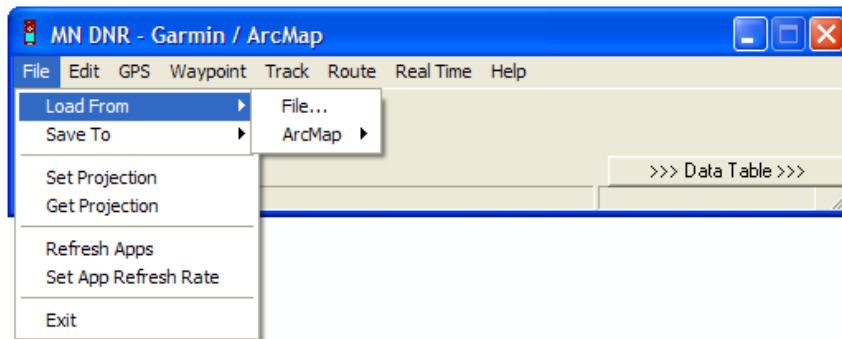


9. Select a location folder and type in a name for the shapefile.
10. Press the Save Button. The new shapefile will be automatically added into ArcMap.

Upload GIS Data into Garmin GPS

GIS data (point, line, and polygon shapefiles) can be uploaded into the Garmin GPS unit to be used as background map features or locations to navigate to.

1. Connect GPS to computer (see section “Connect Garmin GPS unit to Computer” above).
2. Launch DNRGarmin.
3. Go to File → Set Projection to change the coordinate system if needed. It should match the coordinate system of the GIS data you want to upload.
4. Chose either of the 2 methods below to start uploading data.



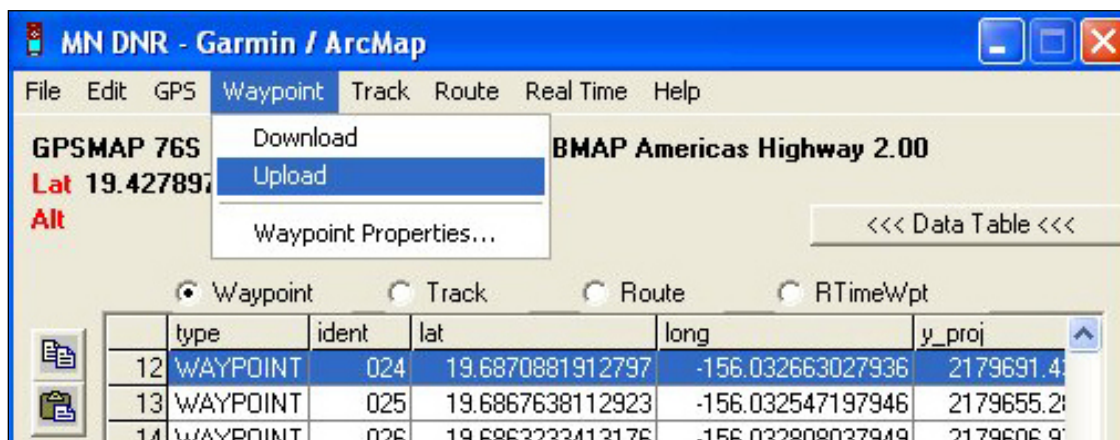
From ArcMap Method

This is an option if you already have an ArcMap project opened and you want to upload a layer from your map project into the Garmin GPS.

1. In ArcMap Table of Content, highlight the layer you want to upload.
2. In DNRGarmin, select File → Load From → ArcMap → Layer. Data will be transferred into DNRGarmin. **Note: The data are NOT uploaded into your GPS yet, must perform step 3.**
3. From the Waypoint (or Track, Route) menu, select Upload and data will be uploaded into the GPS.

From DNR Garmin Method

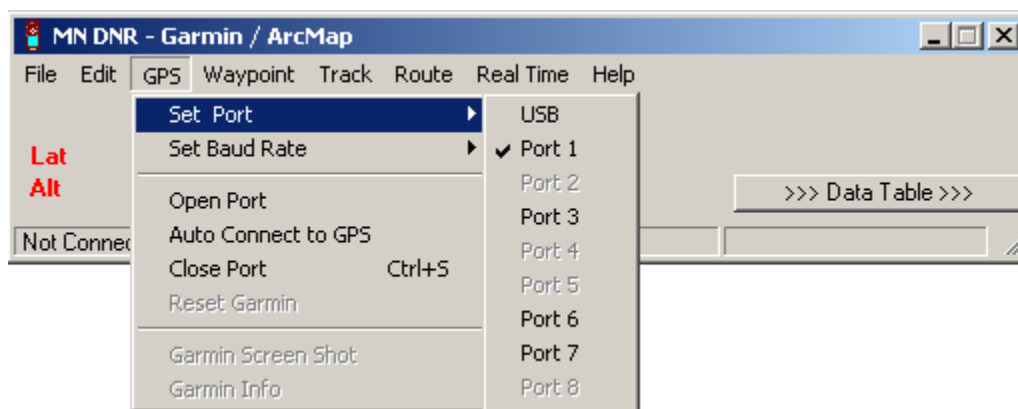
1. Go to File → Load From → File. Select *Shapefile* as Files of Type. Navigate to where the shapefile is located on your computer and select it. Press Open.
2. An Identify Fields dialog may open. Fill in the appropriate fields if necessary. Click OK. Data will be transferred into DNRGarmin. **Note: The data are NOT uploaded into your GPS yet, must perform step 3.**
3. From the (or Track, Route) menu, select Upload and data will be uploaded into the GPS.



Connection Troubleshooting Guide

Here are some steps to follow if you failed to make a connection between the GPS unit and your computer:

1. Ensure the GPS is in Garmin Interface Mode. On your Garmin GPS unit, from Main Menu page → Setup → Interface. Check to make sure the “Serial Data Format” field is set to *Garmin*.
2. Check all cable connections to ensure everything is secured tightly. In DNR Garmin, click GPS → Set Port. Make sure *Port 1* is checked if you attached the cable to COM1 serial port. Otherwise, *USB* should be checked if you attached to a USB port on your computer.
3. If your computer has two or more serial ports, make sure you are attached to COM1. If COM1 port is already taken up by another cable (printer, scanner, etc.), attach the Garmin cable to another available serial port, i.e. COM2, COM3. Then in DNR Garmin, go to GPS → Set Port and select Port 2 or Port 3 accordingly.



4. If you are using a serial port cable, make sure it has 4 prongs on one end (where it attached to the back of the Garmin GPS unit) and a parallel port on the other end (attached to a parallel port on your computer).
5. If you are using a USB cable, **you may need to install a USB driver to make this connection work**. The driver is available on I&M server. Follow the steps below to install the USB driver on your computer (you must have administrative privileges to install):
 - Close all running programs.
 - Go to M:\Software\GPS_Garmin\USB Driver. Double click on USBDrivers_221.exe
 - Click Run button to start the installation process.
 - Click Next.
 - Select “I accept the terms in License Agreement”, then click Next.
 - Select “No, Not at this time”, then click Next.
 - Select “Install the software...(Recommended)”, then click Next.
 - Click Finish.

- Restart your computer when installation is successfully done.
 - Connect USB cable from Garmin GPS to your computer. Turn on GPS unit, check to make sure “Use with GPS off” is set and GPS is in Garmin Interface Mode (refer to section “Connect Garmin GPS unit to Computer” above if needed).
 - Launch DNRGarmin, go to GPS → Set Port and select USB. Connection should be established.
6. If you’re using COM1 serial port and DNR Garmin is still not connecting to your GPS after performing step1-5 above, then follow these additional steps (written for Windows XP, may be slightly different for other Windows operating systems):
- Close DNR Garmin, ArcGIS and turn off GPS unit. You may leave GPS unit connected to the COM1 serial port.
 - Click on Start → Control Panel → Performance and Maintenance → Administrative Tools.
 - Double-Click Computer Management.
 - Double-Click Device Manager.
 - Open up Ports and select COM 1.
 - Right mouse over COM 1 and select Disable.
 - Say yes to really disable this.
 - Press OK or Apply all the way out to close all windows.
 - Restart your computer.
 - When the computer is rebooted, Windows will re-establish the COM1 port. Proceed to step 1 of section “Connect Garmin GPS unit to Computer” of this document.

Other Troubleshooting Tips

1. You must have administrative privileges to install DNRGarmin software in the C:/Program Files directory on your computer. Contact your system administrator if installation was stalled because of installation rights.
2. If you have an earlier version of the DNR Garmin program on your machine you **MUST** uninstall before installing the new version. Uninstall previous versions by using the Start → Control Panel → Add/Remove Programs tool.
3. ActiveSync software (for use with Trimble GPS) often conflicts with DNR Garmin or other software needing access to a serial port. You may need to exit or disable ActiveSync on your computer first before using DNR Garmin.

For other installation errors please refer to Minn. DNR Help page at:
<http://thoreau.dnr.state.mn.us/mis/gis/tools/arcview/Training/WebHelp/Training.htm>

Hawaiian Petrel Monitoring Protocol Pacific Island Network

Standard Operating Procedure (SOP) #10: Workspace Setup and Project Records Management

Version 1.0

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, and author of the revision, and identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

Abstract

This Standard Operating Procedure (SOP) describes how to set up a project workspace on one's computer, and describes the Pacific Island Network (PACN) Digital Library which is used for archival of finished Hawaiian petrel monitoring products.

Set Up Project Workspace

A section of the networked file server at each host park is reserved for this project. Access permissions are established so that project staff members have access to needed files within this workspace. Prior to each season, the Park Lead should make sure that network accounts are established for each new staff member, and that the Data Manager is notified to ensure access to the project workspace and databases. If network connections are too slow for efficient data entry and processing, individual staff members may set up a workspace on their own workstation with periodic data transfer to the PACN server. Daily back-ups of the workstation to an external hard drive will ensure that no data is lost.

The recommended file structure within this workspace is shown in Figure S10.1. Certain folders – especially those for GPS data and images – should be retained in separate folders for each calendar year as shown in Figure S.10.1. This will make it easier to identify and move these files to the project archives at the end of each season (see Chapter 5: Season Close-out).

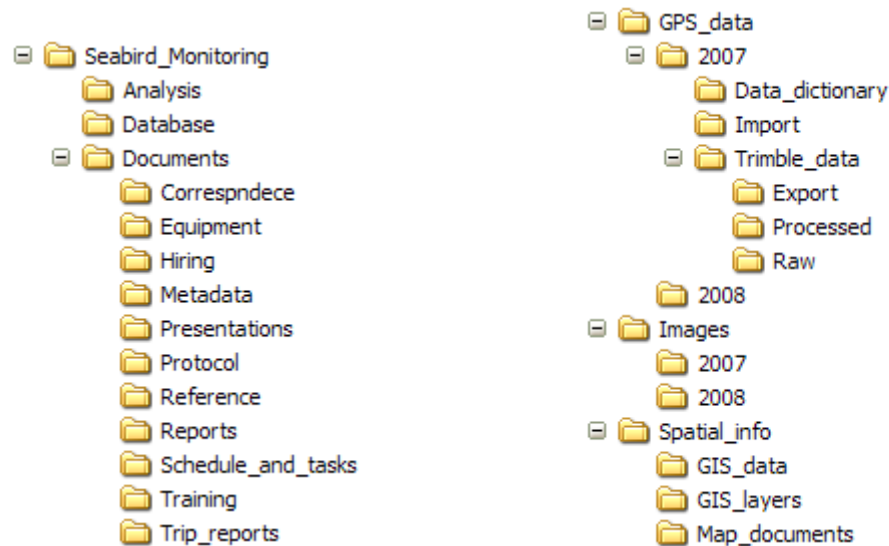


Figure S10.1. Recommended file structure for project workspace.

Each major subfolder is described as follows:

- Analysis – Contains working files associated with data analysis.
- Database – Contains the working database file for the season. The master database for the project is stored in the PACN Digital Library.
- Documents – Contains subfolders to categorize documents as needed for various stages of project implementation.
- GPS data – Contains GPS data dictionaries and raw and processed GPS data files, separated by type of unit used (i.e., Trimble or Garmin). Note that this folder contains subfolders to arrange files by year.
- Images – For storing images associated with the project (refer to SOP #12 “Managing Photographic Images”). Note that this folder contains subfolders to arrange files by year.
- Spatial info – Contains files related to visualizing and interacting with GIS data.
 - ArcMap Products – Map composition files (.mxd).
 - GIS data – New working shapefiles and geodatabases specific to the project.

- o GPS data – Contains GPS data dictionaries and raw and processed GPS data files.
Note that this folder contains subfolders to arrange files by year

Naming Conventions

Folder Naming Standards:

In all cases, folder names should follow these guidelines:

- No spaces or special characters in the folder name.
- Use the underbar (“_”) character to separate words in folder names.
- Try to limit folder names to 20 characters or fewer.
- Dates should be formatted as YYYYMMDD.
-

File Naming Standards:

In all cases, file names should follow these guidelines:

- No spaces or special characters in the file name.
- Use the underbar (“_”) character to separate file name components.
- Try to limit file names to 30 characters or fewer, up to a maximum of 50 characters.
- Dates should be formatted as YYYYMMDD.
- Correspondence files should be named as YYYYMMDD_AuthorName_subject.ext.

Archival and Records Management

All project files should be reviewed, cleaned up and organized by the Park Lead on a regular basis (e.g., annually in January). Decisions on what to retain and what to destroy should be made following guidelines stipulated in NPS Director’s Order 19¹, which provides a schedule indicating the amount of time that the various kinds of records should be retained. Although many of the files for this project may be scheduled for permanent retention, it is important to isolate and protect these important files and not lose them in the midst of a large, disordered array of miscellaneous project files. Because this is a long-term monitoring project, good records management practices are critical for ensuring the continuity of project information. Files will be more useful to others if they are well organized, well named, and stored in a common format. In addition, it is important that files containing sensitive information be stored in a manner that will enable quick identification. Refer to SOP #16 “Sensitive Information Procedures” for more information.

To help ensure safe and organized electronic file management, PACN has implemented a system called the PACN Digital Library, which is a hierarchical digital filing system stored on the PACN file servers. The typical arrangement is by project, followed by year to facilitate easy access. Network users have read-only access to these files, except where information sensitivity may preclude general access. Submission of certified products occurs in the PACN Digital Library by uploading the certified products in the “Submissions” folder and notifying the Data Manager.

¹ <http://www.nps.gov/policy/DOrders/DOrder19.html>

As digital products are delivered for long-term storage according to SOP #19 “Product Delivery Specifications” and the schedule in the same document, they will be catalogued in the PACN project tracking database and filed within the PACN Digital Library by the Data Manager. The master versions of all digital files relating to the Hawaiian petrel protocol are stored within the PACN Digital Library, with regular file back-ups accomplished automatically. Presently, the master protocol files include the protocol narrative, the SOPs, and the Hawaiian petrel database files. Analog (non-digital) materials are to be handled according to current practices of the individual park collections.

Archived Data Maintenance

Any editing of archived data is accomplished jointly by the Park Lead or designee and PACN Data Manager. Prior to any major changes of a dataset, a copy is stored with the appropriate version number to allow for tracking of changes over time. Likewise, any time a revision of the protocol requires a revision to the database, a complete copy of the database will be made and stored in an archive directory. In addition to this copy in its native database format, all tables will be archived in a comma-delimited ASCII format that is platform-independent by using the `Access_to_ascii.mdb` utility developed by Northern Colorado Plateau Network.

Versioning of archived datasets is handled by adding a three digit number to the file name, with the first version being numbered 001 (e.g., `Hawaiian_petrel_HAVO_be_2008_validated_v001`, for the first version of a back-end data file validated by the Park Lead and Data Manager at the end of the 2008 field season). The two text files generated by the `Access_to_ascii.mdb` utility, `FieldDef.txt` and `TableDef.txt`, will be stored in a similarly named folder (e.g., `Hawaiian_petrel_HAVO_be_2008_validated_v001_text`). Each additional version is assigned a sequentially higher number. Frequent users of the data are notified of the updates, and provided with a copy of the most recently archived version.

Every change must be documented in the edit log and accompanied by an explanation that includes pre- and post-edit data descriptions. All data collected for this protocol are subject to the following three caveats:

Only make changes that improve or update the data while maintaining data integrity.
Once archived, document any changes made to the dataset through an edit log. At end of each fiscal year, the Data Manager will update the central database and will post read-only versions.

Mistakes can be made during editing so updates must be compared with the original data form prior to validating the data.

**Hawaiian Petrel Monitoring Protocol
Pacific Island Network**

**Standard Operating Procedure (SOP) #11:
Field Form Handling Procedures**

Version 1.0

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, and author of the revision, and identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

Abstract

This Standard Operating Procedure (SOP) describes how to process field data forms.

Field Form Handling Procedures

As the field data forms are part of the permanent record for project data, they should be handled in a way that preserves their future interpretability and information content. As a rule, all data forms that are filled out in the field need to be reviewed for completeness before the crew leaves the field. However, due to the number of field days and field observers, some deficiencies in data recording may not be identified until all data forms have been organized and reviewed. If changes to data on the forms need to be made either during or after field data acquisition, the original values should not be erased or otherwise rendered illegible. Instead, changes should be made as follows:

- Draw a horizontal line through the original value, and write the new value adjacent to the original value with the date and initials of the person making the change.

- All corrections should be accompanied by a written explanation in the appropriate notes section on the field form. These notes should also be dated and initialed.
- Use the box in the upper right hand corner of the data form for initials and dates when field checks, data entry, and quality assurance checks are made to each data form. In this way it will be possible to track who conducted data form checks and when it occurred.
- If possible, edits and revisions should be made in a different color ink, preferably red, to make it easier for subsequent viewers to be able to retrace the edit history, and to distinguish these changes to the data from the original records made in pencil or dark ink.
- Edits should be made on the original field forms and on any photocopied forms.

These procedures should be followed throughout data entry and data revision. After each field tour, organize the original field data forms by calendar year and date of nest check (e.g., 8/1/2008 before 8/6/2008). These data forms will be placed into three-ring notebooks or file folders in a designated filing cabinet used by the Hawaiian Petrel Monitoring Protocol. Data forms are to be scanned as PDF documents and placed in the project workspace folder assigned to data forms (see SOP #10 “Workspace Setup and Project Records Management” for more details). These digital files will be archived with the certified data. The PDF files may then serve as a convenient digital reference of the original if needed.

**Hawaiian Petrel Monitoring Protocol
Pacific Island Network**

**Standard Operating Procedure (SOP) #12:
Managing Photographic Images**

Version 1.0

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Abstract

This Standard Operating Procedure (SOP) describes how to process photographic images collected by project staff or volunteers during the course of conducting project-related activities. Images that are acquired by other means (e.g., downloaded from a website or those taken by a cooperating researcher) are not project records and should be handled separately.

Procedures

Care should be taken to distinguish data photos from incidental or opportunistic photos taken by project staff. Data photos are those taken for at least one of the following reasons:

- to document a particular feature or perspective for the purpose of site relocation,
- to capture site habitat characteristics and possibly to indicate gross structural changes over time, and
- to document species detection that is also recorded in the data.

Data photos are linked to specific records within the database, and are stored in a manner that permits the preservation of those database links. Other photos (e.g., of field crew members at work, or photos showing the morphology or behavior of certain bird species) may also be retained but are not necessarily linked with database records.

Effectively managing hundreds of photographic images requires a consistent method for downloading, naming, editing and documenting. The general process for managing data photos proceeds as follows:

- A. File Structure Setup – Set up the file organization for images prior to acquisition
- B. Image Acquisition
- C. Download and Process
 - Download the files from the camera
 - Rename the image files according to convention
 - Copy and store the original, unedited versions
 - Review and edit or delete the photos from the camera card
 - Move photos into appropriate folders for storage
- D. Establish Database Links
- E. Deliver Image Files for Final Storage

File Structure Setup

Prior to data collection for any given year, project staff will need to set up a new folder under the Images folder in the project workspace as follows:

[Year]	The appropriate year (e.g., 2007, 2008)
_Processing	Processing workspace
[Park code]	Arrange files by park (e.g., HAVO, HALE)
Data	Data images
[Site_code]	Arranged by sampling locations, or
[Date]	by date, for images not taken at sampling locations
Miscellaneous	Non-data images taken by project staff
[Site_code]	Arranged by sampling locations, or
[Date]	by date, for images not taken at sampling locations
Originals	Renamed but otherwise unedited image file copies
[Site_code]	Arranged by sampling locations, or
[Date]	by date, for images not taken at sampling locations
Non-NPS	Images acquired from other sources

This folder structure permits data images to be stored and managed separately from non-record and miscellaneous images collected during the course of the project. It also provides separate space for image processing and storage of originals. Note: For additional information about the project workspace, refer to SOP #10 “Workspace Setup and Project Records Management.”

Folder Naming Standards

In all cases, folder names should follow these guidelines:

- No spaces or special characters in the folder name
- Use the underscore (“_”) character to separate words in folder names
- Try to limit folder names to 20 characters or fewer
- Dates within folder names should be formatted as YYYYMMDD (for better sorting)

Image Acquisition

Digital photographs should be captured at a resolution and quality setting appropriate for the highest detail intended use. As a general rule, images destined for printing or publication should be of a higher quality and resolution than images that will be used for email or internet use. If the camera will allow, the resolution should be set at 1760 x 1168 or higher. The quality should be set for “super fine” or “high”. Uncompressed TIFF files retain the greatest amount of image information, but the trade-off for the highest image quality is that these image files are large, and fewer images can be saved to any single memory card. Publication quality photos should be taken at a minimum of 5 megapixels. Because the destination of a photo is unknown at the time it is taken, all photos should be taken with this resolution, or for lower resolution cameras, the highest resolution possible. Any resizing or file compression should be done during post processing using image editing software.

Though most digital cameras can digitally imprint the date and time directly onto the photo image, this feature usually should not be used. Date and time data are automatically recorded in the EXIF metadata by most digital cameras. If the image is being cataloged and documented it has value – imprinting the image reduces the image quality and hence the image value. Different brands of digital cameras name photos differently. Some cameras will have several file naming options that may include:

- Sequential numbering which resets each time a memory card is formatted or a new card is put in.
- Sequential numbering which loops from 0001 to 9999.
- Numbering based on date-photo sequence.

As a general rule, the most useful setting is a date-photo sequence, then the 0001-9999 loop and the least useful the card based sequence. Projects must carefully review the naming options of the project cameras for the most useful convention. Projects must also ensure the same convention is used by all cameras collecting data photos. Photos will be renamed later following the naming conventions described below.

Download and Processing Procedures

1. Download the raw, unedited images from the camera into the appropriate “_Processing” folder.

2. Rename the images according to convention (refer to the image file naming standards section below). If image file names were noted on the field data forms, be sure to update these to reflect the new image file name prior to data entry. See SOP #11 “Field Form Handling Procedures” for additional details.
3. Copy the images to the “Originals” folder and set the contents as read-only by right clicking in Windows Explorer and checking the appropriate box. These originals are the image backup to be referred to in case of unintended file alterations (e.g., file deletion, loss of resolution, or loss of image metadata upon rotation).
4. Process the photos in the _Processing folder. At a minimum, the following processing steps should be performed on all image files:
 - Delete any poor quality photos, repeats, blurred or otherwise unnecessary photos. Low quality photos might be retained if the subject is highly unique, or the photo is an irreplaceable data photo.
 - Rotate the image to make the horizon level.
 - Photos of people should have ‘red eye’ glare removed.
 - Photos should be cropped to remove edge areas that grossly distract from the subject.
5. When finished, move the image files that are to be retained and possibly linked in the database to the appropriate folder – data images under the Data folder, other images under the Miscellaneous folder. Photos of interest to a greater audience should be copied to the PACN Digital Image Database, ThumbsPlus. Enter any associated image metadata into the ThumbsPlus program. To minimize the chance for accidental deletion or overwriting of needed files, no stray files should remain in the processing folder between downloads.
6. Large groups of photos acquired under sub-optimal exposure or lighting can be batch processed to enhance contrast or brightness. Batch processing can also be used to resize groups of photos for use on the web. Batch processing may be done in ThumbsPlus, Extensis Portfolio or a similar image software package.

Image File Naming Standards

In all cases, image names should follow these guidelines:

- No spaces or special characters in the file name
- Use the underscore (“_”) character to separate file name components
- Try to limit file names to 30 characters or fewer, up to a maximum of 50 characters
- Park code and year should either be included in the file name or be conclusive by the directory structure

The image file name should consist of the following parts:

- The date of data capture (formatted as YYYYMMDD)
- The sampling location (if recorded at a sampling location)

- Optional: a brief descriptive word or phrase
- Optional: a sequential number if multiple images were captured
- Optional: time (formatted as HHMM)

Examples:

- 20080621_Frame I_Stratum I_burrow_245.jpg: The habitat at Frame I Stratum I burrow 245 taken on June 21, 2008
- 20080518_training_004.jpg: 4th photo taken during training on May 18, 2008

In cases where there are small quantities of photos it is practical to individually rename these files. However, for larger numbers it may be useful to rename files in batches. This may be done in ThumbsPlus, Extensis Portfolio or a similar image software package. A somewhat less sophisticated alternative is to batch rename files in Windows Explorer, by first selecting the files to be renamed and then selecting File > Rename. The edits made to one file will be made to all others, although with the unpleasant side effect of often adding spaces and special characters (e.g., parentheses) which will then need to be removed manually.

Renaming photos may be most efficient as a two part event. One step is performed as a batch process which inserts the date and frame and stratum number at the beginning of the photo name. During the second step, a descriptive component is manually added to each file name.

Establish Database Links

During data entry and processing, the database application will provide the functionality required to establish a link between each database record and the appropriate image file(s). To establish the link, the database prompts the user to indicate the root project workspace directory path, the specific image folder within the project workspace, and the specific file name. This way, the entire workspace may be later moved to a different directory (i.e., the PACN Digital Library) and the links will still be valid after changing only the root path. Refer to SOP #13 “Data Entry and Verification” for additional details on establishing these links.

Note: It is important that the files keep the same name and relative organization once these database links have been established. Users should not rename or reorganize the directory structure for linked image files without first consulting with the Data Manager.

Deliver Image Files for Final Storage

Note: Please refer to SOP #19 “Product Delivery Specifications.”

At the end of the season and once the year’s data are certified, data images for the year may be delivered along with the working copy of the database to the Data Manager on a CD or DVD. To do this, simply copy the folder for the appropriate year(s) and all associated subfolders and images onto the disk. These files will be loaded into the project section of the PACN Digital Library, and the database links to data images will be updated accordingly.

Prior to delivery, make sure that all processing folders are empty. After delivery, the delivered folders should be made read-only to prevent unintended changes.

Hawaiian Petrel Monitoring Protocol Pacific Island Network

Standard Operating Procedure (SOP) #13: Data Entry and Verification

Version 1.0

Revision History Log:

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Abstract

This Standard Operating Procedure (SOP) describes the general procedures for entry and verification of field data in the working project databases. Refer to the sections in Chapter 4: Overview of Database Design and Data Entry and Processing for related guidance, as well as an explanation of the distinction between the working database and the master database.

Data Entry

The following are general guidelines to keep in mind:

1. Data entry will be conducted by the Park Lead, Field Lead, and field crew at their duty station.
2. Data entry should occur as soon after data collection as possible so that field crews keep current with data entry tasks and catch any errors or problems soon after data collection.

3. The working database application is found in the project workspace. The project workspace may be on the user's computer if the connection to the networked server is too slow (see SOP #10 "Workspace Setup and Project Records Management"), with periodic uploads to the network server. If the workspace resides on the networked server, it is recommended that users copy the front-end database onto their workstation hard drives and open it there for enhanced performance. This front-end copy may be considered "disposable" because it does not contain any data, but rather acts as a pointer to data residing in the back-end working database.
4. Each data entry form is patterned after the layout of the field form. This form has built-in quality assurance components such as pick lists and validation rules to test for missing data or illogical combinations. Although the database permits users to view the raw data tables and other database objects, users are strongly encouraged only to use the pre-built forms as a way of ensuring the maximum level of quality assurance.
5. As data are being entered, the person entering the data should visually review each data form to make sure that the data on the screen match the field forms. This should be done for each record prior to moving to the next form for data entry.
6. Once data entry for a data form has been completed, that person should initial and date the "Entered by..." line in the box on the top right corner of the data sheet.
7. After each data entry session, the Park Lead or Field Lead should upload the working copy of the database onto the networked server, if the database has been stored on his/her computer.

Data Verification

Data verification checks that the digitized data match the source data. The following guidelines regarding data verification should be followed:

1. The Park Lead is responsible for specifying in the project protocol one or more of the data verification methods available and ensuring proper execution. At the discretion of the Park Lead, additional verification methods may be applied.
2. Data verification is carried out by staff thoroughly familiar with data collection and entry.
3. All records (100%) should be verified against original source data using the method below.
 - 3.1. Visual review after data entry: Upon completion of data entry, all records are printed and compared with the original values from the hard copy. Errors are clearly marked and corrected in the database as soon after data entry as possible. Reliability increases if someone other than the person keying the data performs the review. Alternatively, two technicians (one reading from the original data and one checking the entered data) can perform this review.

4. A subset of randomly selected records (10%) should be reviewed after initial verification by the Park Lead. If errors are found, the entire data set should be verified again.
5. A record of the verification process for each data set, including number of iterations and results, will be prepared by the Park Lead as part of formal metadata generation.
6. Once data verification for a data form has been completed, that person should initial and date the “Post-entry checked by...” line in the box on the top right corner of the data sheet.
7. Spatial data collected as part of the project will be viewed in a GIS and visually inspected for accuracy (e.g., points located outside park boundaries, upland locations occurring in water).

Database Instructions

The first step is to make sure the data entry workspace is set up properly either on a networked drive or the user’s computer (if networked server connections are too slow for efficient data entry). If you are unclear about where the data entry workspace should be contact the Data Manager (see SOP #10 “Workspace Setup and Project Records Management” for more information).

- Store the back-end database file in the database folder in the project workspace. The back-end file has “_be_” as part of its name.
- The user’s copy of the front-end database should also be stored in the same folder.
- If it doesn’t already exist, also create a folder in the same folder named “backups” for storing daily backups of the back-end database file.
- Open the front-end database. The first thing it will do is to ask to update the links to the back-end database file. This will only need to be done once for each new issue of the front-end database.

Important Reminders for Daily Database Use

- A copy of the front-end will need to be copied to your workstation if the project workspace is set up on the networked server. Do not open up and use the front-end on the network as this ‘bloats’ the database file and makes it run more slowly.
- The front-end application will automatically prompt you to make a backup upon initially opening the application.
- To save drive space and network resources, backup files should be compacted by right-clicking on the backup file in Windows Explorer and selecting the option: “Add to Zip File.” Older files may be deleted at the discretion of the Field Lead.
- New issues of the front-end application may be released as needed through the course of the field season. If this happens, there should be no need to move or alter the back-end file. Instead, the front-end file may be deleted and replaced with the new version, which will be named in a manner reflecting the update (e.g., Hawaiian Petrel_HAVO_2008_v2.mdb).
- If the front-end database gets bigger and slower, compact it periodically by selecting Tools > Database Utilities > Compact and Repair Database.

Working Database Functions

The working front-end application has the following functional components, which are accessed from the main application switchboard form that opens automatically when the application starts:

Data Entry and Review

1. Data entry/edit: After verifying default settings (e.g., park, coordinate datum) the data gateway form will open. From here, data for a particular sampling date and location can be reviewed and edited if necessary. By choosing the option “Add a New Record” the data entry form will open and new data may be entered.
2. Quality assurance tools: This opens a form that shows the results of pre-built queries that check for data integrity, missing data, and illogical values. It allows the user to fix these problems and document the fixes. See SOP #14 “Post-season Data Quality Review and Certification” for details.

Other Functions

1. Manage lookups: Opens a tool for managing the lookup values for the project data set (e.g., species list, list of project personnel)
2. View database window: Allows the user to view the database objects (tables, queries and forms)
3. Back up data: Creates a date-stamped copy of the back-end database file
4. Connect back-end database: Verifies the connection to the back-end working database file, and provides the option to redirect or update that connection
5. Set system defaults: User name, declination, current park, coordinate datum
6. View release history: Opens a form describing known bugs and changes made to the front-end database since its first release

General Use Instructions

To view detailed instructions for entering and editing data, see the Hawaiian Petrel Database User Guide, which is stored in the PACN Digital Library and housed in the HAVO and HALE Resource Management offices, as well as in the I&M file dedicated to Hawaiian petrel monitoring documents. The Park Lead will provide this user guide as needed.

**Hawaiian Petrel Monitoring Protocol
Pacific Island Network**

**Standard Operating Procedure (SOP) #14:
Post-season Data Quality Review and Certification**

Version 1.0

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Abstract

This Standard Operating Procedure (SOP) describes the procedures for validation and certification of data in the working project database. Refer also to protocol sections in Chapter 4: Overview of Database Design, Quality Review, and Data Certification and Delivery for related guidance and a clarification of the distinction between the working database and the master database.

Data Validation

Data validation is the process of checking data for completeness, logical consistency, and structural integrity. At the end of each field season, the Park Leads and the PACN data management staff are collectively responsible for finalizing a validated dataset for that field season. The Park Leads will complete all data validation. Some validation methods (ensuring that the data make sense) have been incorporated into the Hawaiian Petrel Database. Other more specific validation routines will be worked out with the Park Lead and/or project staff and incorporated into the database as appropriate. These modifications will be described in the edit

log and the functionality of the validation routines will be explained in detail in the Hawaiian Petrel Database User Guide.

Completing Data Certification

Data certification is a benchmark in the project information management process that indicates: (1) the data are complete for the period of record, (2) the data have undergone and passed the quality assurance checks, and (3) that the data are appropriately documented and in a condition for archiving, posting and distribution as appropriate. Certification is not intended to imply that the data are completely free of errors or inconsistencies which may or may not have been detected during quality assurance reviews.

To ensure that only quality data are included in reports and other project deliverables, the data certification step is an annual requirement for all tabular and spatial data. Once the data have been through the validation process and metadata have been developed for them, they are to be certified by completing the PACN Project Data Certification Form, available from the Data Manager. The Park Lead is primarily responsible for completing this form. The completed form, certified data, and updated metadata may then be delivered to the Data Manager according to the timeline in Appendix F: Yearly Project Task List. Refer to SOP #19 “Product Delivery Specifications” for delivery instructions.

Hawaiian Petrel Monitoring Protocol Pacific Island Network

Standard Operating Procedure (SOP) #15: Metadata Development

Version 1.0

Revision History Log:

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Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, and identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

Abstract

This Standard Operating Procedure (SOP) describes the guidelines for documenting data and how it should be accomplished.

Metadata Documentation

Data documentation is a critical step toward ensuring that data sets are usable for their intended purposes well into the future. This involves the development of metadata, which can be defined as structured information about the content, quality, condition and other characteristics of a given data set. Additionally, metadata provide the means to catalog and search among data sets, thus making them available to a broad range of potential data users. Metadata for all PACN monitoring data will conform to Federal Geographic Data Committee (FGDC) guidelines and will contain all components of supporting information such that the data may be confidently manipulated, analyzed and synthesized.

Updated metadata is a required deliverable that should accompany each season's certified data. For long-term projects such as this one, metadata creation is most time consuming the first time it is developed – after which most information remains static from one year to the next. Metadata records in subsequent years then only need to be updated to reflect changes in contact information and taxonomic conventions, to include recent publications, to update data disposition and quality descriptions, and to describe any changes in collection methods, analysis approaches or quality assurance for the project.

Specific procedures for creating, parsing, and posting the metadata record are found in PACN Metadata Development Guidelines, available from the Data Manager or on the PACN server. The general flow is as follows:

1. After the annual data quality review has been performed and the data are ready for certification, the Aquatic Ecologist (or a designee) updates the PACN Metadata Interview Form, available from the Data Manager or on the PACN server.
 - a. The metadata interview form greatly facilitates metadata creation by structuring the required information into a logical arrangement of 15 main questions (many with additional sub-questions).
 - b. The first year, a new copy of the metadata interview form should be downloaded. Otherwise the form from the previous year can be used as a starting point, in which case the Track Changes tool in MS Word should be activated in order to make edits obvious to the person who will be updating the XML record.
 - c. Complete the metadata interview form and maintain it in the project workspace. Much of the interview form can be filled out by cutting and pasting material from other documents (e.g., reports, protocol narrative sections, and SOPs).
 - d. The Data Manager can help answer questions about the metadata interview form.
2. Deliver the completed interview form to the Data Manager according to SOP #19 "Product Delivery Specifications."
3. The Data Manager (or GIS Specialist for spatial data) will then extract the information from the interview form and use it to create and update an FGDC- and NPS-compliant metadata record in XML format. Specific guidance for creating the XML record is contained in PACN Metadata Development Guidelines.
4. The Data Manager will post the record and the certified data to the Data Store¹, and maintain a local copy of the XML file for subsequent updates.
5. The Park Lead should update the metadata interview content as changes to the protocol are made, and each year as additional data are accumulated.

¹ <https://irma.nps.gov/App/Reference/Welcome>

Identifying Sensitive Information

Part of metadata development includes determining whether the data include any sensitive information, which is partly defined as the specific locations of rare, threatened or endangered species. Prior to completing the metadata interview form, the Park Lead should identify any sensitive information in the data after first consulting SOP #16 “Sensitive Information Procedures.” The Park Lead’s findings may be documented and communicated to the Data Manager through the metadata interview form.

Hawaiian Petrel Monitoring Protocol Pacific Island Network

Standard Operating Procedure (SOP) #16: Sensitive Information Procedures

Version 1.0

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, and author of the revision, and identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

Abstract

This Standard Operating Procedure (SOP) describes the process for identifying and distributing sensitive information.

Purpose

Although it is the general NPS policy to share information widely, the NPS also realizes that providing information about the location of park resources may sometimes place those resources at risk of harm, theft, or destruction. This can occur, for example, with regard to caves, archeological sites, native cultural information, and rare plant and animal species. Therefore, information will be withheld when the NPS foresees that disclosure would be harmful to an interest protected by an exemption under the Freedom of Information Act (FOIA). The National Parks Omnibus Management Act, Section 207, 16 U.S.C. 5937, is interpreted to prohibit the release of information regarding the “nature or specific location” of certain cultural and natural resources in the national park system. Additional details and information about the legal basis for

this policy can be found in the NPS Management Policies¹ (National Park Service 2006), and in Director's Order #66².

These guidelines apply to all PACN staff, cooperators, contractors, and other partners who are likely to obtain or have access to information about protected NPS resources. The Park Lead has primary responsibility for ensuring adequate protection of sensitive information related to this project.

The following are highlights of our strategy for protecting this information:

- *Protected resources*, in the context of the PACN Inventory and Monitoring Program, include species that have State- or Federally-listed status, and other species deemed rare or sensitive by local park taxa experts.
- *Sensitive information* is defined as information about protected resources which may reveal the “nature or specific location” of protected resources. Such information must not be shared outside the National Park Service unless a signed confidentiality agreement is in place.
- In general, if information is withheld from one requesting party, it must be withheld from anyone else who requests it, and if information is provided to one requesting party without a confidentiality agreement, it must be provided to anyone else who requests it.
- To share information as broadly as legally possible, and to provide a consistent, tractable approach for handling sensitive information, the following will apply if a project is likely to collect and store sensitive information:
 - Random coordinate offsets of up to two km for data collection locations, and
 - Removal of data fields from the released copy that are likely to contain sensitive information

What Kinds of Information Can and Cannot Be Shared?

Do not share: Project staff and cooperators should not share any information outside NPS that reveals details about the “nature or specific location” of protected resources, unless a confidentiality agreement is in place. Specifically, the following information should be omitted from shared copies of all data, presentations, reports, or other published forms of information:

- *Exact coordinates* – Instead, public coordinates are to be generated that include a random offset azimuth and distance. These offset coordinates can be shared freely.
- *Other descriptive location data* – Examples may include travel descriptions, location descriptions, or other fields that contain information which may reveal the specific location of the protected resource(s).
- *Protected resource observations at disclosed locations* – If specific location information has already been made publicly available, the occurrence of protected resources at that location cannot be shared outside NPS without a confidentiality agreement. For example, if the exact coordinates for a monitoring station location are posted to a website or put

¹ <http://www.nps.gov/policy/mp/Index2006.htm>

² <http://home.nps.gov/applications/npspolicy/index.cfm>

into a publication, then at a later point in time an endangered fish species is observed at that monitoring station, that monitoring station location in reference to the endangered fish species cannot be mentioned or referred to in any report, presentation, data set, or publication that will be shared outside NPS.

Do share: All other information about the protected resource(s) may be freely shared, so long as the information does not reveal details about the “nature or specific location” of the protected resource(s) that aren’t already readily available to the general public in some form (e.g., other published material). Species tallies and other types of data presentations that do not disclose the precise locations of protected resources may be shared, unless by indicating the presence of the species the specific location is also revealed (i.e., in a small park).

Details for Specific Products

Whenever products such as databases and reports are being generated, handled and stored, they should be created explicitly for one of the following purposes:

1. *Public or general-use* – Intended for general distribution, sharing with cooperators, or posting to public websites. They may be derived from products that contain sensitive information so long as the sensitive information is either removed or otherwise rendered in a manner consistent with other guidance in this document.
2. *Internal NPS use* – These are products that contain sensitive information and should be stored and distributed only in a manner that ensures their continued protection. These products should clearly indicate that they are solely for internal NPS use by containing the phrase: “Internal NPS Use Only – Not for Release.” These products can only be shared within NPS or in cases where a confidentiality agreement is in place. They do not need to be revised in a way that conceals the location of protected resources.

Data Sets

To create a copy of a data set that will be posted or shared outside NPS:

1. Make sure the public offset coordinates have been populated for each sample or observation location in tbl_Locations.
2. Delete any database objects that may contain specific, identifying information about locations of protected resources.

The local, master copy of the database contains the exact coordinates and all data fields. The Data Manager and/or GIS Specialist can provide technical assistance as needed to apply coordinate offsets or otherwise edit data products for sensitive information.

Maps and Other GIS Output

General use maps and other geographic representations of observation data that will be released or shared outside NPS should be rendered using offset coordinates, and should only be rendered at a scale that does not reveal their exact position (e.g., 1:100,000 maximum scale).

If a large-scale, close-up map is to be created using exact coordinates (e.g., for field crew navigation, etc.), the map should be clearly marked with the following phrase: “Internal NPS Use Only – Not for Release.”

The Data Manager and/or GIS Specialist can provide technical assistance as needed to apply coordinate offsets or otherwise edit data products for sensitive information.

Presentations and Reports

Public or general-use reports and presentations should adhere to the following guidelines:

1. Do not list exact coordinates or specific location information in any text, figure, table, or graphic in the report or presentation. If a list of coordinates is necessary, use only offset coordinates and clearly indicate that coordinates have been purposely offset to protect the resource(s) as required by law and NPS policy.
2. Use only general use maps as specified in the section on maps and other GIS output.

If a report is intended for internal use only, these restrictions do not apply. However, each page of the report should be clearly marked with the following phrase: “Internal NPS Use Only – Not for Release.”

Voucher Specimens

Specimens of protected taxa should only be collected as allowed by law. Labels for specimens should be clearly labeled as containing sensitive information by containing the following phrase: “Internal NPS Use Only – Not for Release.” These specimens should be stored separately from other specimens to prevent unintended access by visitors. As with any sensitive information, a confidentiality agreement should be in place prior to sending these specimens to another non-NPS cooperator or collection.

Procedures for Coordinate Offsets

1. Process GPS data, upload into the database, and finalize coordinate data records
2. Set the minimum and maximum offset distances (project-specific, typically up to 2 km)
3. Apply a random offset and random azimuth to each unique set of coordinates
4. Coordinates may then be either rounded or truncated so the UTM values end in zeros to give a visual cue that the values are not actual coordinates

5. Do not apply independent offsets to clustered or otherwise linked sample locations (e.g., multiple sample points along a transect line). Instead, either apply a single offset to the cluster so they all remain clustered after the offset is applied, or apply an offset to only one of the points in the cluster (e.g., the transect origin) and store the result in the public coordinates for each point in that cluster.
6. These “public” coordinates are then the only ones to be shared outside NPS (including all published maps, reports, publications, presentations, and distribution copies of the data set) in the absence of a confidentiality agreement.

The following components can be used to create individual offsets rounded to the nearest 100 meters in MS Excel:

- Angle = rand() * 359
- Distance = ((Max_offset – Min_offset) * rand() + Min_offset)
- Public_UTME = Round(UTME_final + (Distance * cos(Radians(Angle – 90))), -2)
- Public_UTMN = Round(UTMN_final + (Distance * sin(Radians(Angle + 90))), -2)

Sharing Sensitive Information

Note: Refer to SOP #20 “Product Posting and Distribution” for a more complete description of how to post and distribute products, and to keep a log of data requests.

No sensitive information (e.g., information about the specific nature or location of protected resources) may be posted to the Data Store³ or another publicly-accessible website, or otherwise shared or distributed outside NPS without a confidentiality agreement. An agreement must be signed between NPS and the agency, organization, or person(s) with whom the sensitive information is to be shared. Only products that are intended for public/general-use may be posted to public websites and clearinghouses, as these may not contain sensitive information.

Responding to Data Requests

If requests for distribution of products containing sensitive information are initiated by the NPS, by another federal agency, or by another partner organization (e.g., a research scientist at a university), the unedited product (e.g., the full data set that includes sensitive information) may only be shared after a confidentiality agreement is established between NPS and the agency, organization, or person(s) with whom the sensitive information is to be shared. All data requests will be tracked according to procedures in SOP #20 “Product Posting and Distribution.”

Once a confidentiality agreement is in place, products containing sensitive information may be shared following these guidelines:

- Always clearly indicate in accompanying correspondence that the products contain sensitive information, and specify which products contain sensitive information.

³ <https://irma.nps.gov/App/Reference/Welcome>

- Indicate in all correspondence that products containing sensitive information should be stored and maintained separately from non-sensitive information, and protected from accidental release or re-distribution.
- Indicate that NPS retains all distribution rights; copies of the data should not be redistributed by anyone but NPS.
- Include the following standard disclaimer in a text file with all digital media upon distribution: “The following files contain protected information. This information was provided by the National Park Service under a confidentiality agreement. It is not to be published, handled, re-distributed or used in a manner inconsistent with that agreement.” The text file should also specify the file(s) containing sensitive information.
- If the products are being sent on physical media (e.g., CD or DVD), the media should be marked in such a way that clearly indicates that media contains sensitive information provided by the National Park Service.

Confidentiality Agreements

Confidentiality agreements may be created between NPS and another organization or individual to ensure that protected information is not inadvertently released. When contracts or other agreements with a non-federal partner do not include a specific provision to prevent the release of protected information, the written document must include the following standard Confidentiality Agreement:

Confidentiality Agreement - I agree to keep confidential any protected information that I may develop or otherwise acquire as part of my work with the National Park Service. I understand that with regard to protected information, I am an agent of the National Park Service and must not release that information. I also understand that by law I may not share protected information with anyone through any means except as specifically authorized by the National Park Service. I understand that protected information concerns the nature and specific location of endangered, threatened, rare, commercially valuable, mineral, paleontological, or cultural patrimony resources such as threatened or endangered species, rare features, archeological sites, museum collections, caves, fossil sites, gemstones, and sacred ceremonial sites. Lastly, I understand that protected information must not be inadvertently disclosed through any means including websites, maps, scientific articles, presentation, and speeches.

Freedom of Information (FOIA) Requests

All official FOIA requests will be handled according to NPS policy. The Park Leads will work with the Data Manager and the park FOIA representative(s) of the park(s) for which the request applies.

Literature Cited

National Park Service. 2006. Management Policies. Online.
<http://www.nps.gov/policy/mp/policies.htm>). Accessed July 24, 2015

Hawaiian Petrel Monitoring Protocol Pacific Island Network

Standard Operating Procedure (SOP) #17: Data Analysis

Version 1.00

Revision History Log:

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Abstract

This Standard Operating Procedure (SOP) addresses data analysis for the Hawaiian Petrel Monitoring Protocol. Data analyses for Hawaiian petrel (*Pterodroma sandwichensis*) density and reproductive success are outlined with examples to show data structure, graphical plots, and statistical analyses.

Data analysis processes, synthesizes and interprets observations of the environment, transforming them into meaningful information. In this protocol, data analysis will document the status and evaluate trends (changes in status through time) in density, reproductive (fledging) success, and distribution of Hawaiian petrels nesting in HALE and HAVO. Determining status and trends of a natural resource is critical for managers to make better informed decisions about protection and restoration of the resource. Status is described primarily with summary statistics including means and variances, while trends are evaluated using appropriate statistical tests, typically linear regression.

Overview and Strategies

The Hawaiian petrel data analysis SOP consists of three steps: (1) pre-analysis quality assurance and quality control (QA/QC), (2) summarization including range of variation, and (3) analytic procedures. These steps are encompassed in the larger context of data management and data stewardship.

For more information on QA/QC see Standard Operating Procedure (SOP) #14: Post-season Data Quality Review and Certification.

The goal is to identify and reduce error at all stages in the data life cycle, including project planning, data collection, data entry, verification and validation, processing, and archiving. This approach requires that the Network:

- Develop a plan for quality assurance that will include the identification of roles and responsibilities of Network, park, and cooperative staff for maintaining quality standards at all levels of the program – from field and laboratory data collection to overall data management procedures
- Ensure that the process of achieving quality is not only documented, but maintained through routine review by Network staff
- Develop protocols and SOPs to ensure data quality
- Based on NPS standards, evaluate the quality of all data and information before data are distributed
- Perform periodic data audits and quality control checks to monitor and improve the Network's data quality program. Much QA/QC work involves defining and enforcing standards for electronic formats, locally defined codes, measurement units, and metadata.

Step 1: Pre-analysis Quality Assurance and Quality Control

The QA/QC step includes: (a) ensuring the monitoring data are collected correctly and consistently across all sites and throughout all years, (b) review of all data (e.g., raw data, spatial data, excel files, database, and metadata records), (c) review of data management and storage procedures, and (d) identification and documentation of outliers.

- a. Data collection and recording. Hawaiian petrel burrows will be searched at HAVO in a boustrophedon fashion within 50 x 50 m grid squares (see SOP #6 "Setting Up Sampling Units at Colonies," Figure S6.3, for an illustration of this search pattern). From past experience, scanning 0.75 m on either side of parallel traverses across the grid square will result in an adequate detection rate. As with any seabird, guano production by Hawaiian petrels is high near active breeding sites, which thus become marked by guano against volcanic rock. Where boustrophedon search on foot is not possible because of steep terrain (as at HALE), the site is discarded, the discard is recorded, and a second probabilistic site is occupied. If a square can be observed from the upper edge, but cannot be occupied for safety reasons, the square is discarded and another square is evaluated. At each potential breeding site additional signs of petrel activity, are recorded (e.g., feathers, footprints, and castings). This information is recorded on data forms (HAVO) or in field notebooks (HALE). Signs of predation (e.g., petrel carcass, egg out of burrow) or other animals (e.g., droppings, footprints) are also recorded. Consistency in data collection techniques and data recording

will be part of the training process for each field observer, which is necessary to allow comparisons between years and between parks regardless of who collected the data. Paper data forms or field notebooks will be inspected by the Park Lead or Field Lead at the end of each field day, as a key step in the quality assurance and quality control process.

- b. Data review. For Hawaiian petrel density and fledging success, a simple and effective method will be to review the location and history of each nest site at the end of each season. This includes checks on date, location, and whether an event (e.g., fledging) is consistent with earlier events at the site (e.g., chick loss).
- c. Review of data management and storage procedures. As field data forms and field notebooks are part of the permanent record for the Hawaiian petrel project data, they are handled to preserve their future interpretability and information content. To minimize the possibility of data loss, hardcopy data forms and field notebooks will be stored in a well organized fashion in a secure location, with photocopies and scanned data forms archived in a separate location (i.e., PACN data server) for five years or longer as determined by the Park Leads and I&M Program Manager. Hardcopy and digital maps and photographs are stored in a similar fashion. After field data have been entered and processed in the project database, they are reviewed for quality, completeness, and logical consistency by the Park Leads. The working database application facilitates this process by showing the results of pre-built queries that check for data integrity, data outliers and missing values, and illogical values. Review of these storage and data management procedures by the Data Manager, Park Leads and I&M Program Manager will occur when current practices require updating.
- d. Detection of outliers. An outlier is an observation that deviates substantially from the expected range of the data. It can be the result of an error in measurement or in recording data, but it can also be an extreme value generated by biological factors. For Hawaiian petrel density and nesting success, the ranges in nesting density and reproductive success are well known. Outliers are expected to be primarily the result of errors in recording. Outliers can be identified by logical criteria, by examination of frequency distributions, and by statistical criteria. Outliers that exceed ranges set by physical or logical criteria (e.g., a burrow count in a 50 x 50 m sampling unit that exceeds the known population size of the subcolony, or an obviously erroneous GPS location) will be identified. When a correction is made, it should be annotated with the reason for change and the date. Outlier detection by statistical criteria is described in Step 2.

Step 2: Summarization

The summarization step includes computing: (a) means, (b) variances, (c) frequency distributions, and (d) constructing appropriate plots or tables of density and fledging success by individual site (sampling stratum) and (for fledging success) by grid type--legacy or random. Note: Nest census data from legacy grids cannot be used to estimate density of the stratum since legacy grids were selected precisely because of their higher density of known nests. Means and variances are estimated for each stratum as shown in Table S17.1. The overall mean is a weighted mean, calculated as the sum of the burrows across strata, divided by the sum of units. The variance within strata is calculated as SS/df , where SS is calculated as shown in Table

S17.1, and where $df = \text{units} - 1$. The overall variance for the frame is a weighted variance, calculated as the sum of the SS across strata, divided by the sums of the df across strata.

Table S17.1. Number of burrows per unit in two strata at Haleakalā National Park. Number of burrows was taken from reconstructed data in Chapter 2, Table 2.1. N_{burrow}^2 is the squared deviation from the mean.

Burrows per unit	Stratum I (inside)			Stratum II (outside)			Frame
	Freq	Nburrow	Nburrow ²	Freq	Nburrow	Nburrow ²	
0	212	0	606.1	95	0	104.7	
1	55	55	26.3	28	28	0.1	
2	25	50	2.4	17	34	15.4	
3	22	66	37.7	7	21	26.6	
4	16	64	85.3	3	12	26.1	
5	15	75	164.3	6	30	93.6	
6	6	36	111.4	1	6	24.5	
7	11	77	310.1	2	14	70.8	
8	6	48	238.8	0	0	0.0	
9	8	72	427.4	1	9	63.2	
10	3	30	207.1	0	0	0.0	
11	2	22	173.3	0	0	0.0	
12	0	0	0.0	0	0	0.0	
13	1	13	127.9	0	0	0.0	
14	2	28	303.0	0	0	0.0	
15	1	15	177.1	1	15	194.6	
Units surveyed	385			161			546
Burrows		651			169		820
Burrows/unit		1.69			1.05		1.50
SSwithin (Nests/unit)			2998.22			619.60	3617.82
Varwithin (Nests/unit)			7.81			3.87	6.65

Summarization includes frequency distributions, which are used in establishing expected boundaries for response variables (density and fledging success). Table S17.1 shows the reconstructed frequency distribution for petrel densities, by stratum, at HALE. Reconstruction (see Chapter 2) is based on estimated percent coverage of area. Table S17.2 shows the reconstructed frequency distribution at HAVO.

Table S17.2. Number of nests per unit in six strata at Hawai'i Volcanoes National Park. Number of nests was taken from reconstructed data in Chapter 2, Table 2.3.

N/unit surveyed	Stratum I Kapapala		Stratum II Central		Stratum III Keauhou		Total
	Main Old	Lower Blue	Camp	East	Main	Southwest	
0	53	32	41	55	423	200	804
1	16	3	38	21	41	4	123
2	0	2	6	3	4	0	15
3	0	0	2	0	1	0	3
4	0	0	0	0	0	0	0
Total nests	16	7	56	27	52	4	162
Nests/unit surveyed	0.2319	0.1892	0.6437	0.3418	0.1109	0.0196	0.1714
Varwithin (nests/unit)	0.1807	0.2688	0.5111	0.3048	0.1287	0.0193	
Var/Mean	0.78	1.42	0.79	0.89	1.16	0.99	

Outliers are often screened with a statistical criterion, such as a value greater than the 95th percentile. For a normally distributed variable, the 95th and 99th percentiles occur at observations with z-scores of 2 and 2.5 respectively.

$$Z = \frac{|\text{mean} - \text{value}|}{SD}$$

Equation 17.1

Using this statistical criterion, a value with a z-score greater than 2 (and certainly greater than 2.5) would be checked for possible measurement or transcription error.

The use of z-scores is not recommended for data which are expected to deviate strongly from a normal distribution in being bounded at zero with a few extreme counts. For example, in Table S17.1 the standard deviation for Stratum I is $\sqrt{7.81} = 2.8$. Twice the SD = 5.6 and hence any density beyond $5.6 + 1.7 = 7.3$ would be considered an 'outlier.' For count data with these characteristics, graphical diagnosis relative to the frequency distribution is recommended rather than the use of z-scores. When an unusual value is detected, it is checked for accuracy in recording and transcription. If the unusual value cannot be clearly discarded as an error, the recommended procedure is to evaluate trends with and without the data point to evaluate the sensitivity of the interpretation to a single unusual value.

The frequency distributions in Tables S17.1 and S17.2 are estimated from the percent of area already surveyed. When monitoring begins, the probabilistic samples will produce the first direct estimate of the frequency distribution densities. Thus an appropriate summary table would show the frequency distribution from probabilistic samples in each year, compared to the estimates in Tables S17.1 and S17.2. A goodness of fit test could be used to decide whether differences between the observed and expected (Tables S17.1 and S17.2) frequency distribution are more than just chance.

Step 3: Analytical Approach and Procedures – General Considerations

Four levels of analytical methods have been identified for our monitoring data: (1) stratum level, (2) frame level, (3) among frames within park, and (4) synthesis (Table S17.3). The stratum level addresses quality assurance/quality control (QA/QC) and generates relevant summary statistics for response variables (i.e., density and reproductive success) within a sampling stratum. Frame level analyses examine whether change is occurring within a frame. The among-frame level addresses whether change is occurring at larger spatial scales of frames surveyed once every 5 years, e.g., in relation to management practice (fenced or not at HALE). The synthesis level compares and contrasts changes relative to broad-scale factors. This SOP addresses three levels – stratum, frame and among-frame. Synthesis examines patterns within and across ecological parameters to gain broad insight on ecological processes (notably Hawaiian petrel populations change in relation to predator pressure and and climate change). It is expected that synthesis will be addressed relative to other Vital Signs at the network level. The analyses outlined below should be completed within three months of the Hawaiian petrel monitoring season. Although density trend information at the scale of frame or stratum is important, trends at the scale of the entire park unit will be of particular interest to managers and other scientists, as this information will contribute to the greater monitoring effort being executed within and outside the park units by different agencies (i.e., Department of Land and Natural Resources and U.S. Fish and Wildlife Service).

Table S17.3. Three approaches for analyzing Hawaiian petrel monitoring data.

Description	Responsible Party
Quality assurance and control routines and calculation of individual, site-specific statistics from monitoring data	Park Lead and/or Field Lead with oversight by Park Natural Resource Chief
Step 1 (QA/QC): Data review, management and storage procedures	
Step 2 (Reproductive success estimation): Evaluation and documentation of reproductive success (RS) at individual nests using defined criteria. Documentation of any anomalies.	
Step 3 (Summarization and outlier ID): Density: measures of central tendency, variance, frequency histogram and box plots (to ID outliers), and other basic statistics for both stratum and frame. RS: table of outcomes by stratum and frame.	
Step 4 (Density and population estimation): Stratum- and frame-level calculations.	Park Lead with oversight by Park Natural Resource Chief
Comparison of density and RS between strata and frames.	
Step 1: (Density comparisons): ANOVA for between strata and frames.	
Step 2: (RS comparisons): Chi-squared tests for between-strata comparisons (e.g., areas with and without predator control).	Park Lead with oversight by Park Natural Resource Chief
Evaluation of Hawaiian petrel populations over time	
Step 1: (Density): regression for ≥ 5 years of data; otherwise, ANOVA.	
Step 2: (RS): Logistic regression with covariates, and ANODEV.	

Analysis procedures are to be documented for each park unit on an annual basis in a compiled document (such as an MS Word[®] file), referred to hereafter as an analysis log file. This file

would essentially be a ‘log’ of all the quantitative and qualitative steps taken, such as various descriptive statistics, and screen shots of data visualizations. A check list for the steps is provided in Appendix S17.a. Each monitoring year, two such files (one for each park that is planned for implementation of the Hawaiian petrel monitoring protocol) will be generated. These analysis log files are internal working documents that serve as the documentation and foundation for analyses for reports which are peer-reviewed. These files are not subject to explicit peer-review for most reporting other than protocol and programmatic reviews.

Many of the procedures described in the next sections can be carried out in a spreadsheet. Unfortunately, statistical computations in spreadsheets are limited and supplied routines are not always reliable. The computations in this SOP can be carried out by combination of a spreadsheet augmented by a widely available statistical package. The calculations in this SOP were carried out in either R/SPlus or SAS, two packages that statisticians currently rely upon:

1. S-Plus is an advanced commercial statistics package with a graphical user interface built around the R programming language. Data can be imported from virtually any source, and manipulated and managed using this software. Publication quality graphs can be created, and modern statistical analyses performed. A user manual for S-Plus is available online at <http://www.splusbook.com/splusintro.pdf>.
2. R is the freeware version of the S-Plus language. More information about this statistical package can be found online at <http://www.r-project.org>. Detailed download information is at <http://www.fort.usgs.gov/brdscience/LearnR11-01.htm>.
3. SAS/STAT[®] has long been the industry standard for statistical computing. Relevant features include ANOVA, general and generalized liner models, mixed models, regression analysis, statistical graphics, multivariate analysis, survey data analysis, and power and sample size computations. For further information about this software, see the SAS Institute website at <http://www.sas.com>.

Statistica and Minitab are additional reliable packages. Calculations with any other package should be checked against the calculations here. If the results differ, it is important to understand why, which likely will require advice from a statistician.

The following analytical procedures should only be conducted by an individual with field and statistical training, or by one who has access to reliable statistical consultation. In addition, many of the procedures described below may change over time due to advancements and updates in statistical tests, perspectives, techniques and software.

The purpose of Hawaiian petrel trend monitoring is to detect changes in density and fledging success in a proportion of the burrow-nesting population, which then can be extrapolated from the monitored sample units to the entire sampling frame. Data collected from all 50 x 50 m² legacy and randomly-selected sample units will be used to assess long term-trends in Hawaiian petrel populations and to compare current data with previously collected data sets.

Step 3: Analytical Approach and Procedures – Petrel Density

1. Density and population size.

At the stratum level, the analytic procedure is shown in Tables S17.1 and S17.2. These tables show the frequency distributions and computational flow used to obtain Tables 2.1 and 2.3 in Chapter 2: Sampling Design. At the frame level, weighted estimates of density and variance are calculated as described for Table S17.1. From these, an estimate of overall population size can be calculated because the samples are representative of the entire frame. Table S17.4 shows the computational flow for density, variance in density, and estimated population size.

Table S17.4. Estimate of population density and population size in two strata at Haleakala National Park. Numbers of units surveyed are allocated at 50 for Stratum I and seven for Stratum II (from Chapter 2, Table 2.6).

Burrows per unit	Stratum I (inside)			Stratum II (outside)			Frame
	Freq	Nburrow	Nburrow^2	Freq	Nburrow	Nburrow^2	
0	29	0	56.8	5	0	0.9	
1	7	7	1.1	1	1	0.3	
2	3	6	1.1	1	2	2.5	
3	3	9	7.7	0	0	0.0	
4	2	8	13.5	0	0	0.0	
5	2	10	25.9	0	0	0.0	
6	1	6	21.2	0	0	0.0	
7	1	7	31.4	0	0	0.0	
8	1	8	43.6	0	0	0.0	
9	1	9	57.8	0	0	0.0	
10	0	0	0.0	0	0	0.0	
11	0	0	0.0	0	0	0.0	
12	0	0	0.0	0	0	0.0	
13	0	0	0.0	0	0	0.0	
14	0	0	0.0	0	0	0.0	
15	0	0	0.0	0	0	0.0	
Units surveyed	50			7			57
Burrows		70			3		73
Burrows/unit		1.40			0.43		1.28
SSwithin (Nests/unit)			260.00			3.71	263.71
Varwithin (Nests/unit)			5.31			0.62	4.79
Units in Frame	856			528			1384
Population Size	1198			226			1425

The estimate of population size (1425) results from the product of the density estimate and the number of units in each stratum, summed over the frame. The density estimates from probabilistic surveys will produce an unbiased estimate of population number. A similar computational flow applies to data from HAVO, where the number of units in the frame is reported in Chapter 2 (Table 2.3), as well as the initial allocation among units (Table 2.7).

The computational flow for comparing strata uses the number of units per strata as the response variable. This is then weighted in the analysis by the frequency distribution. The data set up for comparing the three strata at HAVO, using R/S-Plus statistical software, is as follows:

The image shows two windows from the R/S-Plus software. The left window, titled 'HAVODensityComparison', displays a data table with 13 rows and 4 columns. The columns are labeled '1', '2', '3', and 'Location'. The rows contain numerical values for 'Freq' and 'NperUnit' for each 'Location' category.

	1	2	3	
	Freq	NperUnit		Location
1	41.00	0.00		Camp
2	38.00	1.00		Camp
3	6.00	2.00		Camp
4	2.00	3.00		Camp
5	55.00	0.00		East
6	21.00	1.00		East
7	3.00	2.00		East
8	0.00	3.00		East
9	32.00	0.00		LowerBlue
10	3.00	1.00		LowerBlue
11	2.00	2.00		LowerBlue
12	0.00	3.00		LowerBlue
13				

The right window, titled 'ANOVA', shows the 'Model' tab selected. The 'Data' section has 'Data Set' set to 'HAVODensityC' and 'Weights' set to 'Freq'. The 'Variables' section has 'Dependent' set to 'NperUnit' and 'Independent' set to 'Location'. The 'Formula' field contains 'NperUnit~Location'. The 'Create Formula' button is visible.

The dialogue box generates the following R code:

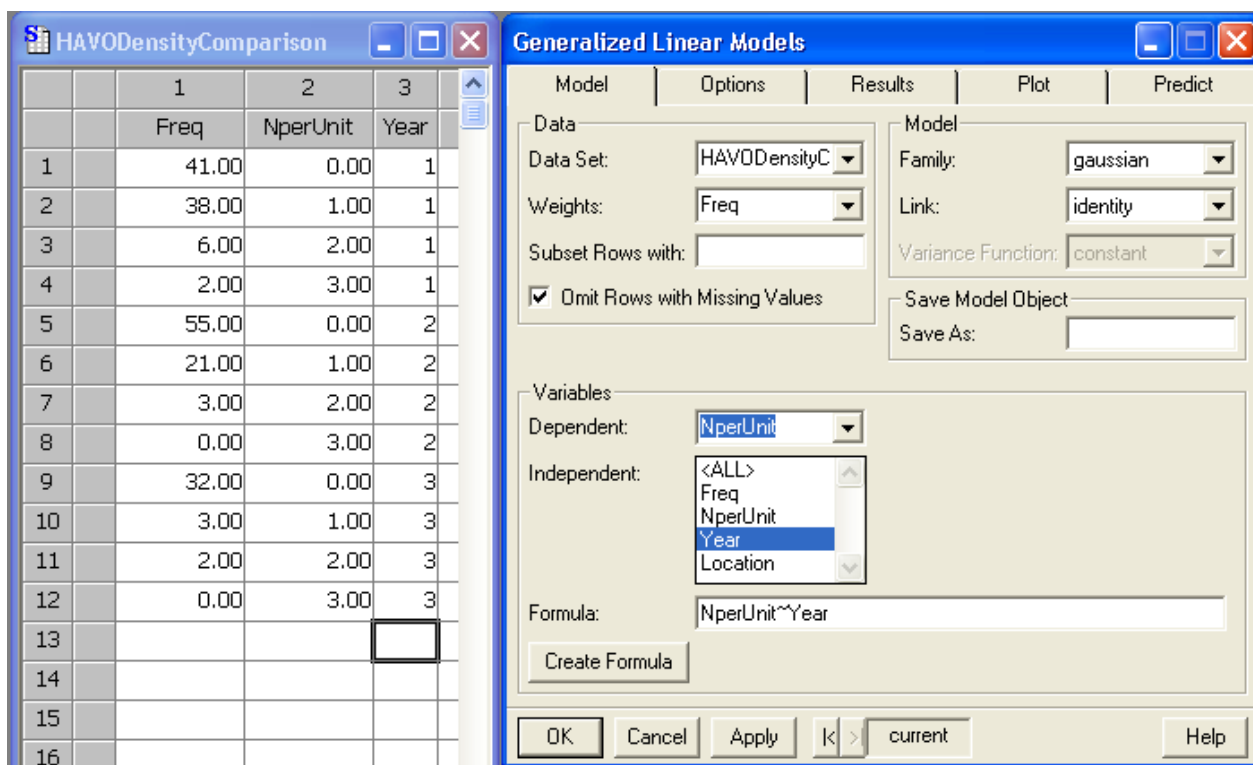
```
Call:
aov(formula = NperUnit ~ Location, data = HAVODensityComparison, weights = Freq,
na.action = na.exclude)
```

In this analysis, location is a factor with three categories, and hence 2df in the ANOVA table. The residuals from the analysis were acceptably homogeneous and normal, and hence the p-value in the ANOVA table from the analysis can be used to declare a decision. The ANOVA table has 9 degrees of freedom because two rows in the data (above) have zero frequencies, and so were counted as missing.

	Df	Sum of Sq	Mean Sq	F Value	Pr(F)
Location	2	6.69667	3.34834	0.3028138	0.7479463
Residuals	7	77.40185	11.05741		

2. Trends in density and population size.

Trends can be analyzed on a year by year basis (treating year as a factor) or as the average rate over multiple years (treating year as a regression variable). In general, at least five points in time are needed for regression. Hence trend analysis at the outset must be conducted by comparing the current year (as a category) with previous years (again as a category). For analysis by category, the computational flow is the same as in the previous section. To demonstrate trend analysis with regression, the data above were re-coded as years 1, 2, 3.



The dialogue box generates the following R-code:

```
Call: glm(formula = NperUnit ~ Year, family = gaussian,
data = HAVODensityComparison, weights = Freq, na.action = na.exclude,
control = list(epsilon = 0.0001, maxit = 50, trace = F))
```

The residuals were acceptable homogeneous and normal.

The regression coefficient was -0.24 birds/year, which was not significant for this analysis of data recoded to year for the purpose of illustration.

	Value	Std. Error	t value	df	p
(Intercept)	0.8647	0.5613	1.5404		
Year	-0.2403	0.2948	-0.8150	9	0.218

3. Sample allocation.

A further analytic step is reallocation of effort to strata, using updated estimates of density and variance in density. The computational flow to obtain the allocation is shown in Chapter 2 (Tables 2.6 and 2.7). This can be done after each sampling round, recognizing that the estimates after each round are unbiased and based on a small sample size. In contrast, the initial allocations (Table 2.6 and 2.7) were based on estimates of variance from a large but possibly biased sample. Radically different allocation after the first year is thus possible, although not expected. If it occurs, change in allocation should be undertaken gradually, preferably based on several rounds of sampling.

Retrospective power analysis is not recommended (Hoenig and Heisey 1972). Prospective power analysis is recommended, as it allows the data from any one year to be used to re-allocate the sample. Data are also used in on-going evaluation of sample sizes to detect trends. The power and sample size calculations in Chapter 2 were relatively simple. These were carried out in SPlus/R. There are a number of freeware, PC-based power analysis program available. The most common is TRENDS (Gerrodette 1987), which can be downloaded from the Southwest Fisheries Science Center at:

<http://swfsc.noaa.gov/textblock.aspx?Division=PRD&ParentMenuID=228&id=4740>.

This program will, upon request, also be made available by the I&M Program Manager.

Step 3: Analytical Approach and Procedures – Reproductive Success

1. Reproductive success using binomial error.

The long-term Hawaiian petrel data set consists of several types of data from legacy burrows and legacy units. These consist of raw burrow count data, calculated rates based on the raw count data, and estimates of reproductive success based on visual signs that indicate if young petrels fledged from a burrow. The counts, rates, and estimates of fledgling success are measurements of the stability and variance of Hawaiian petrel reproduction in the study areas of HAVO and HALE. Estimates from these data are potentially biased relative to the true values for the entire frame or the entire park. However, the use of a completely probabilistic design to eliminate this bias would predictably result in little information on reproductive success. Thus, legacy units were identified for long-term monitoring of reproductive success. However, to validate trends in reproductive success obtained from these legacy units, success estimates should be compared with those from random units.

The recommended comparison approach for these binomial data, which include a categorical variable, is a generalized linear model with regression. Here, we use regression to compare slopes using the following model:

Odds = timetrend + type + timetrend*type

Where Odds = $p/(1-p)$; p is percent success

Timetrend = year

Type is categorical: Legacy or random grid.

Analysis can be conducted using R code, similar to the trend example below. The resulting test statistic (the G test, Sokal and Rohlf 2012) is the modern replacement for the similar chi-square statistic commonly used in ecological analyses. The binomial error structure is more appropriate for these data than the Poisson error structure associated with the chi-square test statistic (McCullagh and Nelder 1989). If success does not significantly differ between grid types, data from all nests for the year may be combined for further analyses.

If success does differ, then only data obtained from burrows within the same grid type can be compared further. Because of the long record of information from legacy burrows and the

presumably greater field efficiency gained by using these burrows, the recommendation is to discontinue monitoring these only if they prove increasingly non-representative over a series of seasons.

Data have been collected from both parks for several years, and new data collected will be compared to past data. Table S17.5 shows data that have been collected over eight years at HAVO. These data may not be representative of the entire frame or park, but they are extensive and provide background against which to compare future change, recognizing their limitations. They are presented here to demonstrate analytic procedure for such data, using modern statistical methods.

Table S17.5. Summary of Hawaiian petrel data collected from Hawai'i Volcanoes National Park, 1995-1997 and 2000-2006.

Year	Number of Nests	# of Active Nests	# Fledged	# Failed		Unknown or N/A
				Reason unknown or N/A	Predation	
1995	47	31	21	5		3
1996	34	24	9	10		5
1997	51	27	3	4		20
2000	56	21	7	7	4	3
2001	85	39	11		6	21
2002	106	45	23	0	3	2
2003	116	45	8	3	5	32
2004	123	54	28	0	0	1
2005	121	57	27	3	4	23
2006	128	57	32	0	0	0

The traditional approach to count data in ecology, contingency tests, is of limited utility in analyzing rates such as number of chicks fledged per year. Reproductive measures typically consist of binomial proportions, which are incorrectly evaluated under the Poisson assumptions of contingency tests (McCullagh and Nelder 1972). The use of a normal approximation for comparison of binomial proportions (e.g., Zar 1984) is no longer necessary, as direct estimates under the assumption of binomial error can be made in nearly all modern statistical packages.

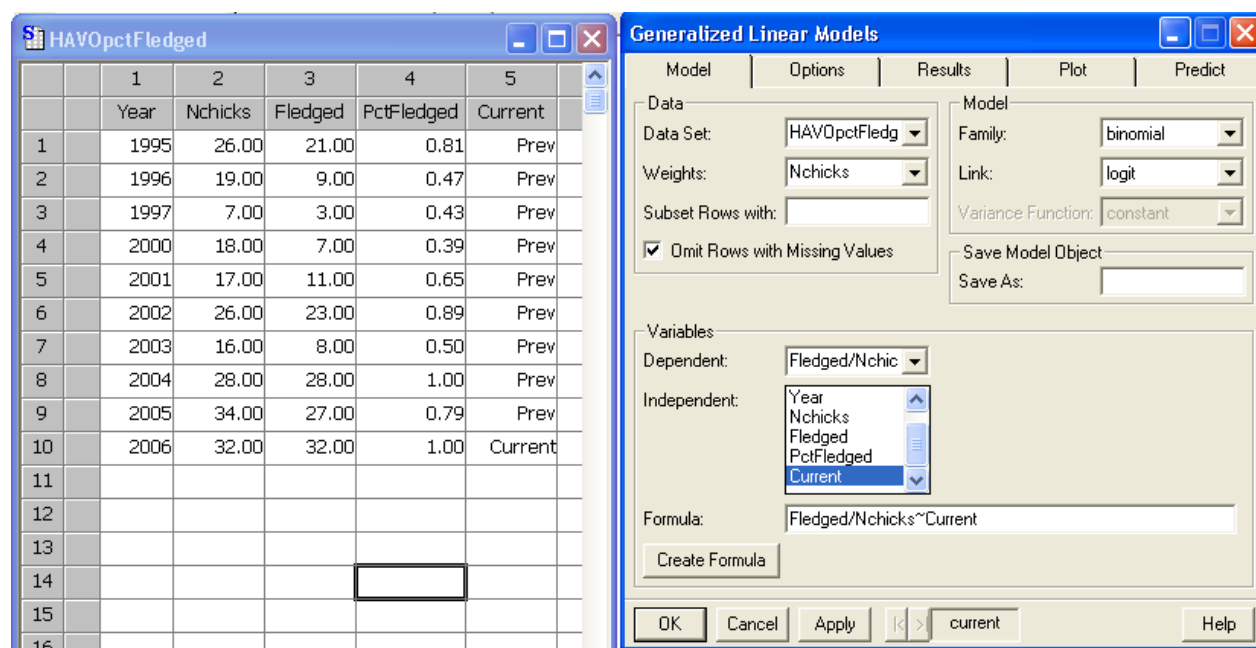
Following the procedures of Hodges and Nagata (2001), comparisons using chi squared tests will be made of Hawaiian petrel nesting activity and reproductive success between areas that are managed for predators and those that are not.

For trend analysis, we will use logistic regression with selected covariates (e.g., existence or degree of predator control; site or stratum; nest type, whether human modified or natural; nest disturbance [e.g., by construction equipment or other human-related factors]; effects of El Niño and La Niña events). The data are then analyzed within a logistic regression routine, which can be found in any modern software package, including Minitab, SAS, and SPlus/R. The response variable is success relative to trial, where number of trials is specified, as is the number of successes or proportion of successes (Table S17.6). Although called logistic regression, these routines allow analysis relative to factors (as in ANOVA), as well as relative to regression variables, and relative to both.

Table S17.6. Number of active burrows that produced or failed to produce fledglings. Data were taken from Table S17.5.

Year	# active burrows	Fledged		
		Trials (# burrows with fledglings)	Success	Failed
1995	31	26	21	5
1996	24	19	9	10
1997	27	7	3	4
2000	21	18	7	11
2001	39	17	11	6
2002	45	26	23	3
2003	45	16	8	8
2004	54	28	28	0
2005	57	34	27	7
2006	57	32	32	0

Here is an example for the data in Table 17.6, where year is treated as a categorical variable (previous vs current).



This image shows the graphics interface that generated the R-code, shown below.

```
Call: glm(formula = Fledged/Nchicks ~ Current, family = binomial(link = logit),
data = HAVOpctFledged, weights = Nchicks, na.action = na.exclude,
control = list(epsilon = 0.0001, maxit = 50, trace = F))
```

This routine reports the improvement in fit due to year as a factor with 4 categories, hence 3 df.

	Df	Deviance	Resid. Df	Resid. Dev
NULL			9	64.08711
Current	1	19.38671	8	44.70039

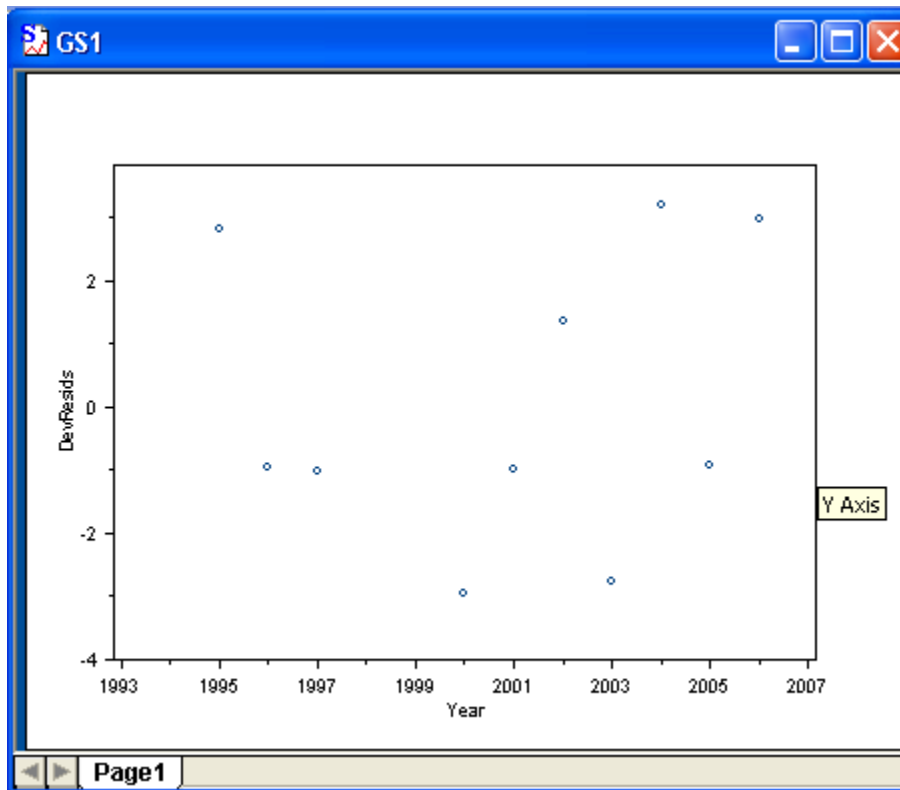
The result is an improvement in fit of $G = 19.39$ ($64.09 - 44.70$) on 1 df, which is significant ($p < 0.001$). The conclusion is that fledging success in 2006 was higher than in the previous years combined. Similar analyses can be made with respect to any categorical variable.

2. Trend analysis.

The same data can be analyzed for a trend, where proportion is a linear function of year.

```
Call: glm(formula = Fledged/Nchicks ~ Year, family = binomial(link = logit),
data = HAVOpctFledged, weights = Nchicks, na.action = na.exclude,
control = list(epsilon = 0.0001, maxit = 50, trace = F))
```

In this example the explanatory (independent) variable is now year, as shown with the highlight in yellow, above. Before interpreting the results we examine the residual versus fit plot, which is obtainable from any logistic regression routine.



The plot suggests that a straight line is not an acceptable model, due largely to a high value in 1995. The residuals appear to be homogeneous around a trend downward to 2000, and then upward from 2000 onward.

The result is again an analysis of deviance table, this time reporting the improvement in fit from the regression variable, year.

	Df	Deviance	Resid. Df	Resid. Dev
NULL			9	64.09492
Year	1	14.90794	8	49.18698

The improvement in fit was $G = 14.91$ on 1 df, which is significant at $p < 0.001$.

There is an overall increase in fledging rate from 1995 to 2006, but the trend is not linear and would thus need explanation in a discussion (and perhaps further examination of variables).

If these data are analyzed with an incorrect error structure (normal error) and incorrect weighting (each percent gets the same weight), the conclusion would be no significant change in overall fledging rate from 1995 to 2006.

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>p</i>
Regression	1	0.148054	0.14805354	3.380197	0.103278
Residual	8	0.350402	0.04380027		
Total	9	0.498456			

This analytic approach allows more detailed analyses, such as non-linear change over time, or comparisons of change in fledgling success among several locations.

Monitoring Trends in Density and Distribution in Frame II

Frame II will be sampled approximately every five years to document nesting colony distribution across the landscape. The primary aim of this monitoring is to determine if the species is expanding into areas outside known, core subcolonies. Thus, the most basic analysis is determining presence or absence in these Frame II locations. Secondly, we will assess status and trends in density in these locations. Because of the long time interval between sampling, we will not be able to statistically assess density trends in Frame II until after two rounds of sampling (i.e., after a decade). The approach used will necessarily compare current year with past years, using year as a factor, as described above for Frame I, to compare Frame I with Frame II to examine impact of differences in management regimes.

Literature Cited

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- McCullagh, P., and J. A. Nelder. 1989. Generalized linear models, second edition (monographs on statistics and applied probability). Chapman and Hall, London, UK.
- Nur, N., S. L. Jones, and G. R. Guepel. 1999. Statistical guide to data analysis of avian monitoring programs. U.S. Fish and Wildlife Service, BTP-R6001-1999, Washington, D.C.
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Appendix S17.a. Analysis Log File Checklist

Section	Analysis	Date Completed
Density	<i>Unit</i>	
	Examine outliers and treat data accordingly	
	Plot normal probability plot	
	Generate table of mean and standard deviation of density estimates at the level of the sample unit (mean $\pm$ SD of density/grid unit)	
	<i>Landscape</i>	
	Generate table of current year mean and standard deviation of density estimates at the level of the park, frame, and strata	
	Create ArcMap of known (active and non-active) Hawaiian petrel burrows in the park	
	<i>Trend</i>	
	Generate table of adjusted mean and standard deviation of density at the level of the park for previous year	
	Plot mean and standard deviation of density over all sampling periods	
	Conduct ANOVA tests	
	Create ArcMap plot of trends in density at park	
Distribution	<i>Unit</i>	
	Examine outliers and treat data accordingly	
	Plot normal probability plot	
	Plot frequency histogram of burrow distribution	
	<i>Landscape</i>	
	Create ArcMap of burrow distribution	
	<i>Trend</i>	
	Create ArcMap plot of trends in burrow distribution	
Reproductive (Fledging) Success	<i>Unit</i>	
	Examine outliers and treat data accordingly	
	Plot normal probability plot	
	Generate table of mean and standard deviation of fledgling success at the level of the sample unit	
	<i>Landscape</i>	
	Create ArcMap of colonies identifying burrows with at least one fledgling	
	<i>Trend</i>	
	Generate table of adjusted mean and standard deviation of fledgling success at the level of the park for previous year	
	Plot mean and standard deviation of fledgling success over all sampling years	

Hawaiian Petrel Monitoring Protocol Pacific Island Network

Standard Operating Procedure (SOP) #18: Reporting

Version 1.00

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, and author of the revision, and identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

Abstract

This Standard Operating Procedure (SOP) describes procedures for writing the annual summary reports following each field season of Hawaiian petrel monitoring in the Pacific Island Network (PACN). Summaries of this report may also be produced for non-technical audiences.

Procedures

1. Reports should be written following standard NPS scientific format.
2. Report the following standard survey parameters for the current year. At a minimum, report:
 - Monitoring dates and times
 - List project personnel and their roles
 - List and describe sample locations monitored during the current year
 - Details of survey effort: number of grids/strata/frame sampled per park, and the time spent on each survey
 - Summaries of data collected (after data analyses)

- Evaluate data quality and any related concerns and/or deviations from protocols that affect data quality and interpretability
- Evaluate and identify suggested or required changes to the protocol
- For annual Hawaiian petrel monitoring at HAVO and HALE (separate reports):
 - Description of sampling frames and strata monitored
 - Description of grid and sample size
 - Number of legacy vs. random grids sampled
 - Number of burrows monitored per grid and/or colony area (i.e., frame or stratum)
 - Number of known occupied burrows per grid (e.g., 20 grids with 2 burrows) and per colony area
 - Number of fledglings per grid and colony area
 - Occupancy rate: Proportion of known occupied burrows where adults or young were detected
 - Fledging success rate: Proportion of known occupied burrows that produced at least one fledgling
 - Frame and stratum burrow density and distribution
 - List of other seabird species and numbers detected during sample unit visits
 - Predation occurrences detected during observations
 - Carcass data: Report any specimens found and/or collected (per USFWS permit procedures) to Resource Management personnel right away, as this department possesses the above permit which allows these activities.
 - Additional comments: Any additional comments that help interpret the data.
- For 5-year Hawaiian petrel density monitoring at HAVO and HALE:
 - Density of known occupied burrows per frame or stratum
 - Burrow searches that are expanded to include rare or never-searched areas of the park, to incorporate wider density estimates
 - Number of occupied sample units (grids)

The current-year values should be added to a table that lists similar measures for all monitored years. Definitions for these parameters are explained in SOP #7 “Collecting, Evaluating, and Summarizing Hawaiian Petrel Burrow Data.”

3. Field and annual reports should be accompanied by copies of maps and digital images. Also, a CD or DVD should be included that contains all of the monitoring data in electronic form. This should include the database, photographs, and excel files containing UTM locations of grids, burrows, or sample sites.
4. The USFWS endangered species report should be completed by the Park Lead at each park by Jan 31 (per permit instructions) following each field season, and submitted to the park resource management office and permitting agency. Capture, banding, measurement, release or carcass data should be included in this report.
5. An annual report (which includes data and analyses from both parks), published as a Natural Resource Technical Report (NRTR), should be completed and submitted to the I&M Program Manager for review within four to five months of the field season. This technical report will also be peer reviewed at the network level.

6. Once peer review is complete and all changes are made to the technical report, the I&M Program Manager should provide copies of the reviewed report and associated data to the PACN Data Manager for archiving. See SOP #19 “Product Delivery Specifications” for disposition of project data.

Trend Assessments

Trend assessments of population densities should be conducted after 5 years of monitoring and potentially every year thereafter. Trends analyses for Hawaiian petrels may be conducted at the park unit level in HAVO and HALE (see SOP #17 “Data Analysis”). The Park Lead should either conduct or supervise the park-based analysis of trend assessments and report the results in the annual report.

Re-Evaluation of Sample Effort

To ensure that sample-size needs are sufficient to satisfy the sampling objectives, a re-evaluation of sampling effort relative to the variability of parameter measures should be performed every 3-5 years using standard power analysis methods. Given specified sampling objectives, power analysis should be used to determine if sampling effort should be adjusted to better achieve the objectives. Methods for power analysis and sample unit allocation are summarized, and equations are provided, in SOP #17 “Data Analysis.”

Five Year Analysis

A more in-depth analysis and report should be produced every five years. In addition to the above, the five-year report should also provide all annual occupancy estimates and variance around those estimates from the previous five years, and perhaps identify any possible distributional changes within the parks. The report should also evaluate operational aspects of the monitoring program, such as appropriateness of sampling periods and regions. Trend analysis information should be reported after 10 years of monitoring has been completed.

Products

We anticipate that all reports generated in association with this protocol will encompass Hawaiian petrel density estimates by integrating park and analysis strategies. Table S18.1 identifies product types, purposes, targeted audiences, responsible parties, production frequency, and review processes. We have identified five product categories: (1) monitoring protocol and project reports, (2) status and trends reports, (3) scientific writing and presentations, (4) interpretation and outreach, and (5) permit reports.

Table S18.1. Summary of anticipated products, grouped by report type and frequency.

Type of Report	Purpose of Report	Targeted Audience	Initiated By	Frequency of Reporting	Review Process
Monitoring Protocol and Project Reports					
➤ Vital Signs Monitoring Protocol Reports (NRTR series)	Document and archive annual monitoring activities and data, describe current resource condition and core analysis results, document related data management activities, document changes in monitoring protocol, communicate monitoring efforts to resource managers. During protocol development stages, will emphasize progress made and challenges encountered.	Park resource staff, PACN staff, external scientists, partners	Park Lead	Annual	Peer review at network level
➤ Summary of Vital Sign Monitoring Protocol Reports	Same as annual “Vital Sign Monitoring Protocol Reports” above, but highlights key points for non-technical audiences	Superintendents, NPS interpreters, public, partners	Park Lead and/or I&M Program Manager	Annual	Peer review at network level
Status and Trends Reports					
➤ Trend Analysis and Synthesis Reports	Describe and interpret patterns/trends of monitored resources, identify new characteristics of resources and correlations among monitored resources, identify relationships between drivers/stressors and responses at various scales, recommend changes to management of resources (adaptive management feedback). Analysis and reporting will occur at multiple scales, including park and network/regional.	Park resource managers, PACN staff, external scientists, partners	Park Lead	3-5 year intervals	Peer review at network and regional level
➤ Summary of Trend Analysis and Synthesis Report	Executive summary of “Trend Analysis and Synthesis Report” above with key points on one page for non-technical audiences. Usually this is a bulleted list.	Superintendents, NPS interpreters, public, partners	Park Lead and/or I&M Program Manager	Commensurate with reporting of “Trend Analysis and Synthesis Report”	Peer review at network level

➤ Report	Type of	Purpose of Report	Targeted Audience	Initiated By	Frequency of Reporting	Review Process
Scientific Writing and Presentations						
➤	PACN Vital Signs monitoring sessions at I&M/George Wright Society meetings	Review and summarize information on this Vital Sign, help identify emerging issues and generate new ideas	Park resource staff, network staff, external scientists, partners		Annual or biennial	Peer review at national level
➤	Scientific journal articles and book chapters	Document and communicate advances in knowledge of the resource, provides a broader perspective on quality assurance and peer review	External scientists, park resource managers, and professional staff	Park Lead	Variable	Peer review according to journal or book standards
Interpretation and Outreach						
➤	Park interpretive / outreach sessions	Review and summarize information on PACN Vital Signs; engage and involve greater participation in monitoring efforts	Park staff, public, partners	Park Lead and/or I&M Program Manager	Variable	
Permits and Permit Reports						
➤	Project Review and Environmental Screening Form	Submitted by park staff to address park compliance issues concerning monitoring project	Resource Council and park staff	Park Lead	Prior to field season	Resource Council
	Federal Fish and Wildlife Permit Report (USFWS)	A USFWS permit is granted to park's Resource Management Office due to endangered status of Hawaiian petrels. The report includes data collected and analyzed, the overall health of the population, and signs of illness and/or disease	Field Supervisor, Pacific Islands Fish and Wildlife Office (PIFWO)	Park Lead	Annual	Reviewed by PIFWO

Specific Instructions for Reports and Publications

Annual reports and trend analysis reports will use the NPS Natural Resource Publications template, a pre-formatted Microsoft Word template document based on current NPS formatting standards. Annual reports will use the Natural Resource Technical Report template. Instructions for acquiring a series number and other information about NPS publication standards can be found at the [NPS Natural Resources Publications](http://www.nature.nps.gov/publications/NRPM/index.cfm) website¹. In general, the procedures for reports and publications are as follows:

1. The document should be formatted using the NPS Natural Resource Publications template. Formatting according to NPS standards is easiest when using the template from the very beginning, as opposed to reformatting an existing document.
2. The document should be peer reviewed at the appropriate level. For example, I&M Annual Reports should be reviewed by other members of the appropriate project work group. The I&M Program Manager will also review all annual reports for completeness and compliance with I&M standards and expectations.
3. This report will be additionally peer reviewed at the network level by a network Key Official.
4. Upon completing the peer review, acquire a publication series number from the NPS Technical Information Center or the appropriate local or regional key official (currently the Regional I&M Coordinator).
5. Upload the file in PDF and MS Word formats to the PACN Digital Library submissions folder.
6. Send a printout to each Park Curator.
7. The Data Manager or a designee will create a bibliographic record and upload the PDF document to Data Store according to document sensitivity.

File naming conventions

In all cases, digital file names should follow these guidelines:

- No spaces or special characters in the file name
- Use the underscore (“_”) character to separate file name components
- Try to limit file names to 30 characters or fewer, up to a maximum of 50 characters
- As appropriate, include the project name (e.g., “Hawaiian_Petrel”), network code (“PACN”), park code, and year in the file name.

Examples:

- PACN_HAVO_Hawaiian_Petrel_2008_Annual_Report.pdf
- PACN_HAVO_Hawaiian_Petrel_2008_Field_Season_Report.doc

¹ <http://www.nature.nps.gov/publications/NRPM/index.cfm>

**Hawaiian Petrel Monitoring Protocol
Pacific Island Network**

**Standard Operating Procedure (SOP) #19:
Product Delivery Specifications**

Version 1.0

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, and identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

Abstract

This Standard Operating Procedure (SOP) provides details on the process of submitting completed data sets, reports and other project deliverables. Prior to submitting digital products, files should be named according to the naming conventions appropriate to each product type (see below for general naming conventions).

Procedures

All digital file submissions that are sent by email should be accompanied by a Product Submission Form, available from the Data Manager, which briefly captures the following information about the products:

- Submission date
- Name of the person submitting the product(s)
- Name and file format of each product

- Indication of whether or not each product contains sensitive information (see SOP #16 “Sensitive Information Procedures” for more detail).

The Product Submission Form can be obtained from the Data Manager or from the PACN website. Upon notification and/or receipt of the completed products, the Data Manager or GIS Specialist will check them into the PACN project tracking application.

Product Delivery Schedule and Specifications

Deliverable Product	Primary Responsibility	Target Date	Instructions	Destination(s)
Endangered Species Report for USFWS permit	Park Lead	by Jan 31 of the following year		Park Resource Management Files
Raw GPS data files	Park Lead	by Dec 15 of the same year	Post to Resource Management petrel folder on park server	and Park RM Petrel Folder
Processed GPS data files	Park Lead and GIS Specialist	by Jan 15 of the following year	Zip and send all digital files to the GIS Specialist who will post files to the PACN Digital Library ¹ . Park Lead will post to Resource Management petrel folder on park server	PACN Digital Library ¹ and Park RM Petrel Folder
Digital photographs	Park Lead	by Jan 31 of the following year	Organize, name and maintain photographic images in the project workspace according to SOP #12 “Managing Photographic Images”	PACN Digital Library ¹ and Park RM Petrel Folder
Certified working database	Data Manager and Park Lead	delivered by Feb 15 of the following year, not posted to public sites until April	Refer to the following section on delivering certified data and related materials. Data will be uploaded to the Data Store ² , and stored in the PACN Digital Library ¹ . Park Leads will post to Resource Management petrel folder on park servers	Master project database and GIS data sets, copy to PACN Digital Library ¹ , Park RM Petrel Folder and Data Store ²
Certified geospatial data	Park Lead and GIS Specialist			
Data certification report	Park Lead	by Jan 31 of the following year		PACN Digital Library ¹ and Park RM Petrel Folder
Metadata interview form				
Full metadata (parsed XML)	Data Manager and GIS Specialist	by Feb 15 of the following year	Upload the parsed XML record to the Data Store ² , and store in the PACN Digital Library ¹ and Park RM Petrel Folder	Data Store ² , PACN Digital Library ¹ and Park RM Petrel Folder

Deliverable Product	Primary Responsibility	Target Date	Instructions	Destination(s)
Annual I&M report (NRTR series)	Park Leads	by March 15 of the following year	Refer to SOP #18 "Reporting" on reports and publications. Final reports will be entered in Data Store ² , and stored in the PACN Digital Library ¹ and Park RM Petrel Folder	Data Store ² , PACN Digital Library ¹ , Park RM Petrel Folder, and printout to local park collections
5-year analysis report	Park Leads and Data Manager	Every 5 years by April 30		Data Store ² , PACN Digital Library ¹ , Park RM Petrel Folder, and printout to local park collections
Other publications	Park Leads, I&M Program Manager and Data Manager	as completed		Data Store ² , PACN Digital Library ¹ , printout to local park collections
Field data forms	Park Leads	Every year by Jan 30	Scan original, marked-up field forms as PDF files and upload these to the PACN Digital Library ¹ submissions folder and Park RM Petrel Folder. Originals go to the Park Curator for archival	Scanned PDF files in PACN Digital Library ¹ and Park RM Petrel Folder, physical copies moved to park collections
Other records	Park Leads	review for retention every January	Organize and send analog files to Park Curator for archival. Digital files that are slated for permanent retention should be uploaded to the PACN Digital Library and Park RM Petrel Folder. Retain or dispose of records following NPS Director's Order #19 ³	Retain according to NPS Director's Order #19 ³

¹ The PACN Digital Library is a hierarchical digital filing system stored on the PACN file servers. Network users have read-only access to these files, except where information sensitivity may preclude general access.

² Data Store is a clearinghouse for natural resource data, metadata, and reports (<https://irma.nps.gov/App/Reference/Welcome>). Only non-sensitive information is posted to Data Store. Refer to the protocol section on sensitive information for details.

³ NPS Director's Order 19 provides a schedule indicating the amount of time that the various kinds of records should be retained. Available at: <http://data2.itc.nps.gov/npspolicy/DOrders.cfm>

Specific Instructions for Delivering Certified Data and Related Materials

Data certification is a benchmark in the project information management process that indicates the data: (1) is complete for the period of record, (2) has undergone and passed the quality assurance checks, and (3) are appropriately documented and in a condition for archiving, posting and distribution as appropriate. To ensure that only quality data are included in reports and other project deliverables, the data certification step is an annual requirement for all tabular and spatial

data. For more information refer to SOP #14 “Post-season Data Quality Review and Certification.”

The following deliverables should be delivered as a package:

- *Certified working database* – Database in MS Access format containing data for the current season that has been through the quality assurance checks documented in SOP #14 “Post-season Data Quality Review and Certification.”
- *Certified geospatial data* – GIS themes in ESRI coverage or shapefile format.
- *Data certification form* – A brief questionnaire in MS Word that describes the certified data product(s) being submitted. A template form is available from the Data Manager.
- *Metadata interview form* – The metadata interview form is an MS Word questionnaire that greatly facilitates metadata creation. This form is available from the Data Manager. For more details, refer to SOP #15 “Metadata Development.”

After the quality review is completed, the Park Lead should package the certification materials for delivery as follows:

1. Open the certified back-end database file and compact it (in Microsoft Access, Tools > Database Utilities > Compact and Repair Database). This will make the file size much smaller. Back-end files are typically indicated with the letters “_be” in the name (e.g., Hawaiian_Petrel_HAVO_be_2008.mdb).
2. Rename the certified back-end file with the project name (“Hawaiian petrels”), the year or span of years for the data being certified, and the word “certified.” For example: Hawaiian_Petrel_HAVO_2008_certified.mdb.
3. Create a compressed file (using WinZip® or similar software) and add the back-end database file to that file. Note: The front-end application does not contain project data and as such should not be included in the delivery file.
4. Add the completed metadata interview and data certification forms to the compressed file. Both files should be named in a manner consistent with the naming conventions described elsewhere in this document.
5. Add any geospatial data files that aren’t already in the possession of the GIS Specialist. Geospatial data files should be developed and named according to PACN GIS Naming Conventions.
6. Upload the compressed file containing all certification materials to the submissions folder of the PACN Digital Library. If the Park Lead does not have access to the PACN Digital Library, then certification materials should be delivered as follows:
 - a. If the compressed file is under 5 mb in size, it may be delivered directly to the Data Manager by email.
 - b. If the compressed file is larger than 5 mb, it should be copied to a CD or DVD and delivered in this manner. Under no circumstances should products containing sensitive information be posted to an FTP site or other unsecured web portal (refer to SOP #16 “Sensitive Information Procedures” for more information).
7. Notify the Data Manager by email that the certification materials have been uploaded or otherwise sent.

8. These certification materials should also be uploaded to the park-specific Resource Management petrel folder for archiving.

Upon receiving the certification materials, the Data Manager will:

1. Review them for completeness and work with the Park Lead if there are any questions.
2. Notify the GIS Specialist if any geospatial data are submitted. The GIS Specialist will then review the data, and update any project GIS data sets and metadata accordingly.
3. Store the certified products together in the PACN Digital Library.
4. Upload the certified data to the master project database.
5. Notify the Park Lead that the year's data have been uploaded and processed successfully. The Park Lead may then proceed with data summarization, analysis and reporting.
6. Develop, parse and post the XML metadata record to the Data Store.
7. After a holding period of two years, the Data Manager will upload the certified data to the Data Store. This holding period is to protect professional authorship priority and to provide sufficient time to catch any undetected quality assurance problems. See SOP #20 "Product Posting and Distribution."

Hawaiian Petrel Monitoring Protocol Pacific Island Network

Standard Operating Procedure (SOP) #20: Product Posting and Distribution

Version 1.0

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, and author of the revision, and identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

Abstract

This Standard Operating Procedure (SOP) describes how certified data is posted and distributed once it is delivered to the Pacific Island Network (PACN) Data Manager.

Product Posting and Distribution

Once digital products have been delivered and processed, the following steps will be taken by the Data Manager to make them generally available:

1. Full metadata records will be posted to the Data Store¹, which is the NPS clearinghouse for natural resource data, metadata, and reports that is available to the public.
2. A record for reports and other publications will be created in Data Store. The digital report file in PDF format will then be uploaded and linked to the Data Store record.

¹ <https://irma.nps.gov/App/Reference/Welcome>

3. Species observations will be extracted from the database and entered into NPSpecies², which is the NPS database and application for maintaining park-specific species lists and observation data.

Holding Period for Project Data

To protect professional authorship priority and to provide sufficient time to complete quality assurance measures, there is a two year holding period before posting or otherwise distributing finalized data. This means that certified data sets are first posted to publicly-accessible websites (i.e., the Data Store) approximately 24 months after they are collected (e.g., data collected in June 2006 becomes generally available through the Data Store in June 2008). In certain circumstances, and at the discretion of the Park Leads, data may be shared before a full two years have elapsed.

Note: This hold only applies to raw data. All metadata, reports or other products are to be posted to NPS clearinghouses in a timely manner as they are received and processed.

Responding to Data Requests

Occasionally, a park or project staff member may be contacted directly regarding a specific data request from another agency, organization, scientist, or from a member of the general public. The following points should be considered when responding to data requests:

- NPS is the originator and steward of the data, and the NPS Inventory and Monitoring Program should be acknowledged in any professional publication using the data.
- NPS retains distribution rights. Copies of the data should not be redistributed by anyone but NPS.
- The data that project staff members and cooperators collect using public funds are public records and as such cannot be considered personal or professional intellectual property.
- No sensitive information (e.g., information about the specific nature or location of protected resources) may be posted to the Data Store or another publicly-accessible website, or otherwise shared or distributed outside NPS without a confidentiality agreement between NPS and the agency, organization, or person(s) with whom the sensitive information is to be shared. Refer to the section in this document about sensitive information and also to SOP #16 “Sensitive Information Procedures.”
- For quality assurance, only the certified, finalized versions of data sets should be shared with others.

The Park Leads and I&M Program Manager will handle all data requests as follows:

1. Discuss the request with other park biologists as necessary to make those with a need to know aware of the request and, if necessary, to work together on a response.
2. Notify the Data Manager of the request if s/he is needed to facilitate fulfilling the request in some manner.
3. Respond to the request in an official email or memo.

² <https://irma.nps.gov/NPSpecies/>

4. In the response, refer the requestor to the Data Store³, so they may download the necessary data and/or metadata. If the request cannot be fulfilled in that manner – either because the data products have not been posted yet, or because the requested data include sensitive information – work with the Data Manager to discuss options for fulfilling the request directly (e.g., burning data to CD or DVD). Ordinarily, only certified data sets should be shared outside NPS.
5. If the request is for a document, it is recommended that documents be converted to PDF format prior to distributing it.
6. If the request is for data that may reveal the location of protected resources, refer to the section in this document about sensitive information and also to SOP #16 “Sensitive Information Procedures.”
7. After responding, provide the following information to the Data Manager, who will maintain a log of all requests in the PACN Project Tracking database:
 - a. Name and affiliation of requestor
 - b. Request date
 - c. Nature of request
 - d. Responder
 - e. Response date
 - f. Nature of response
 - g. List of specific data sets and products sent (if any)

All official FOIA requests will be handled according to NPS policy. The Park Lead and I&M Program Manager will work with the Data Manager and the park FOIA representative(s) of the park(s) for which the request applies.

Special Procedures for Sensitive Information

Products that have been identified upon delivery by the I&M Program Manager as containing sensitive information will either be revised into a form that does not disclose the locations of sensitive resources, or withheld from posting and distribution. When requests for distribution of the unedited version of products are initiated by the NPS, by another federal agency, or by another partner organization (e.g., a research scientist at a university), the unedited product (e.g., the full data set that includes protected information) may only be shared after a confidentiality agreement is established between NPS and the other organization. Refer to SOP #16 “Sensitive Information Procedures” for more information.

³ <https://irma.nps.gov/App/Reference/Welcome>

Hawaiian Petrel Monitoring Protocol Pacific Island Network

Standard Operating Procedure (SOP) #21: Revising the Protocol

Version 1.00

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, and author of the revision, and identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

Abstract

This Standard Operating Procedure (SOP) explains how to make and track changes to the Hawaiian Petrel Monitoring Protocol Narrative and associated SOPs. Over time, the narrative and SOPs will likely need revision, as new information is obtained and methods are refined. Personnel making revisions should be familiar with this SOP to ensure that proper reviews are conducted and that documentation standards are followed to ensure the most current methodologies are used.

Overview

The Protocol Narrative and associated SOPs represent an effort to document and employ scientifically rigorous methodologies for collecting, managing, analyzing, and reporting monitoring data and information. However, all protocols regardless of initial rigor require editing as new and different information becomes available. Required edits should be made in a timely manner and appropriate reviews undertaken. Careful documentation of changes to the protocol, and a library of previous protocol versions, is essential for maintaining consistency in data collection and for appropriate treatment of the data during data summary and analysis. The MS

Access database for each monitoring component contains a field that identifies which version of the protocol was being used when the data were collected.

In this context of revising the protocol, the rationale for dividing this into a Protocol Narrative with supporting SOPs is based on the following:

- The Protocol Narrative is a general overview of the protocol that gives the history and justification for monitoring and an overview of the sampling methods, but does not provide all of the methodological details. The Protocol Narrative will only be revised if major changes are made to the protocol.
- The SOPs, in contrast, are very specific step-by-step instructions for performing a given task. They are expected to be revised more frequently than the Protocol Narrative.
- When a SOP is revised, in most cases it is not necessary to revise the Protocol Narrative to reflect the specific changes made to the SOP.
- All versions of the Protocol Narrative and SOPs will be archived in a Protocol Library.

Procedures

All edits require review for clarity and technical soundness. Small changes or additions to existing methods will be reviewed in-house by PACN staff (e.g., version changes by hundredths). However, if there is a complete or major change in methods, then an outside review may be required (e.g., version changes by whole numbers). When a major change in methodology is undertaken, either to the entire protocol or individual SOP or narrative components, The Pacific West Region Inventory and Monitoring Program coordinator should be consulted to determine the appropriate level of peer review required. Typically, Regional and National staff of the NPS, and outside experts in government, private sector, and academia with familiarity in seabird monitoring in the Pacific Islands, will be utilized as reviewers.

Revision Log

Edits and revisions to the Protocol Narrative and associated SOPs will be documented by version in the Revision History Log that is found on the first page of each SOP and Appendix B of the Protocol Narrative. Log changes only in the Protocol Narrative or SOP being edited. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02...) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0...). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

Metadata

Any changes to associated database design and organization are documented in the Metadata of the project database(s).

Notification

The Data Manager should be informed about changes to the Protocol Narrative or SOP so the new version number can be incorporated in the Metadata of the project database. The database

may have to be edited by the Data Manager to accompany changes in the Protocol Narrative and SOPs.

The appropriate PACN staff should be notified of the changes and appropriate level review process initiated as determined by the Park Lead.

Once review comments are received and incorporated, post revised versions on the internet and forward copies to all individuals so they can replace the previous version of the effected Protocol Narrative or SOP. Staff must also provide a copy to the PACN Data Manager so it can be included in the network's protocol library.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 963/129029, July 2015

National Park Service
U.S. Department of the Interior



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